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CHINA ENVIRONMENT SERIES

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金木水火土

Special Energy and Climate Issue

State of U.S.-China Relations on Climate Change

China As Global Laboratory For Advancing Carbon Capture and Sequestration

Lessons for Industrial Energy Cooperation with China

China's Green Bounty Hunters

Plus: Commentaries and Spotlight on NGOs

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COVER PHOTO

This front cover depicts the two "faces" of China's energy supply—the blackened faces of the coalminers remind us of China's still overwhelming (70+ percent) dependence on coal to fuel its booming economy. This coal burdens the country with heavy air pollution, degraded water, and the world's highest rate of mining-related deaths. The wind farm is a "face" of the country's green energy revolution, for over the past few years the Chinese government's investments and subsidies into clean energy, as well as increasingly stringent requirements for energy efficiency, renewables and cleaner coal have created an explosion of solar PV and wind power manufacturing.

Photo Credit: Coal Miners - Keren Su/Getty Images; Wind mill farm - istock images

ABOVE PHOTO

Choke Point U.S.: Understanding the Tightening Conflict Between Energy and Water in the Era of Climate Change

BENZIE COUNTY, MICHIGAN, JULY 2010: One of the last wells drilled into Michigan's Antrim Shale at sunrise. A new and deeper natural gas play appears to be unfolding as developers pay record amounts for oil and gas leases over Michigan's Collingwood Shale. Drilling deep shales utilizes a practice called fracking that pumps millions of gallons of water and thousands of pounds of chemicals into wells under intense pressure to fracture the rock and release the gas. The rock-punishing practice has produced evidence of serious water contamination in several states, according to ProPublica, a nonprofit investigative news organization. The public concern is emblematic of the choke point that the United States is experiencing as rising energy demand comes into conflict with global climate change and declining reserves of clean fresh water. For more information see the Feature Box on Choke Point: U.S. (page 40), an initiative by Circle of Blue investigating the growing conflicts between energy development and water shortages in the United States. Photo © Heather Rousseau / Circle of Blue

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CHINA ENVIRONMENT SERIES

THE CHINA ENVIRONMENT FORUM

For thirteen years, the Woodrow Wilson Center's China Environment Forum (CEF) has implemented projects, workshops, and exchanges that bring together U.S., Chinese, and other Asian environmental policy experts to explore the most imperative environmental and sustainable development issues in China and to examine opportunities for business, governmental, and nongovernmental communities to collaboratively address these issues.

The networks built and knowledge gathered through meetings, publications, and research activities have established CEF as one of the most reliable sources for China-environment information and given CEF the capacity to undertake long-term and specialized projects on topics such as U.S.-China energy and climate network building, environmental justice, creating a Japan-U.S.-China water network, municipal financing for environmental infrastructure, river basin governance, environmental health, water conflict resolution mechanisms, food safety, and environmental activism and green journalism.

The China Environment Forum meetings, publications, and research exchanges over the past year have been supported by generous grants from the Rockefeller Brothers Fund, Blue Moon Fund, U.S. Agency for International Development, Vermont Law School, Western Kentucky University, World Resources Institute, and the ENVIRON Foundation. Jennifer L. Turner has directed the China Environment Forum since 1999 and her assistant Peter V. Marsters just celebrated his first year with CEF.

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FOREWORD

Jennifer L. Turner (a.k.a. 吳嵐), Editor

The two faces of China's energy supply look back at us on this year's *China Environment Series* (CES) cover. The blackened faces of the coalminers remind us of China's still overwhelming (70+ percent) dependence on coal to fuel its booming economy. This coal burdens the country with heavy air pollution, degraded water, and the world's highest rate of mining-related deaths. The wind farm is a "face" of the country's green energy revolution, for over the past few years the Chinese government's investments and subsidies into clean energy, as well as increasingly stringent requirements for energy efficiency, renewables and cleaner coal have created an explosion of solar PV and wind power manufacturing. China is also now the world's leading builder of cleaner and more efficient coal-fired power plants. The Chinese government and business leaders see clean energy technologies as both a solution to the country's coal conundrum and energy security concerns as well as a huge opportunity for China's manufacturers to break into clean technology markets globally. China has notably attracted a steady stream of international investments—many from U.S. companies—into not just solar and wind, but also into relatively experimental technologies such as carbon capture and sequestration.

While the United States still produces some of the most cutting edge renewable energy technology in the world, the country invested half as much into clean energy as China in 2009. While some U.S. states—particularly California—have created a policy environment to encourage clean technology, overall, wind farms and solar power plants in the United States are hindered by the lack of energy and climate legislation that could create incentives for clean energy producers and consumers. While China's energy needs are driven by a booming economy and massive urbanization, the United States also faces pressure to create new energy sources and update outmoded infrastructure, for by 2020 nearly one-third of all coal-fired power plants will have to be retired. While some non-conventional energy sources are being promoted in the United States as a strategy to lessen the country's dependence on oil and coal, some of these energy investments are taking a heavy toll on water resources. For example, biofuel production can use up to 6,000 times more water than conventional gas production (See Circle of Blue's photo and anecdote on the inside front cover).

THIS ISSUE'S CONTENT

China's success in promoting clean energy technology has been a hot story over the past year as we pulled together this special Energy and Climate issue of CES, which ambitiously aspired to take a snapshot of major energy trends in China and understand some of the complexities in the U.S.-China energy and climate relations. This eleventh issue is our biggest yet, due not just to my inability to say no to paper proposals, but also because of the dynamism in clean energy developments in China and the many exciting advances in U.S.-China energy cooperation in the government, NGO, and business spheres.

Joanna Lewis opens up this issue with an article to help us grasp the magnitude and complexities of the energy and climate relationship between the United States and China—the world's two largest energy users and CO_2 emitters. Her nine-page table detailing the evolution of the energy agreements and cooperation for the past 30+ years is an invaluable reference. I am so pleased that two busy scientists at Lawrence Berkeley National Laboratory—**Lynn Price** and **Stephanie Oshita**—took the time to write us a feature article that details China's progress in promoting energy efficiency in the Chinese industrial sector, which uses 70 percent of the country's energy and thus is the major driver of China's CO_2 emissions. It is becoming clearer that carbon capture and sequestration is going to figure prominently in China's strategy to develop a low carbon economy, and **Craig Hart** and **Liu Hongwei's** feature article offers us insights on some of the drivers, challenges, and current pilot projects in this complex emerging technology. In the fourth feature, **Zhang Xuehua** uncovers a little known "green bounty hunters" initiative that while not yet widespread in China, has the potential to greatly increase citizens' role in environmental enforcement. While her article describes a single case study, it is nestled inside a wonderful review of the state of environmental governance at the local level—making this feature an update of sorts to Ken Lieberthal's article in CES 1, which I believe still remains one of our most oft-cited articles!

Our commentaries section sparked a rich collection of research and reflections from NGO activists, researchers, government representatives and students in China, Europe, and the United States. The energy-related commentaries touch on progressive policies and projects targeting some of the heaviest CO_2 emitting industries in China—cement (**Angel Hsu**, **Neelam Singh,** and **Song Ranping**); buildings (**Xu Wei** and **Don Anderson**); and the aluminum industry (**Louis B. Schwartz** and **Ryan Hodum**). The reporting and discussion surrounding China's wind and solar power development over the past year have vacillated from praise for the Chinese government for catapulting the country into a clean technology leader to condemnation of unfair trade practices in subsidizing renewable energy. No single article can resolve this debate, but **Derek Vollmer's** lead commentary on the potential for U.S.-China renewable collaboration, which draws on a newly released National Academies of Science/Chinese Academy of Social Science report, offers some balanced discussion on some of the challenges and opportunities in China's renewable development.

Pollution commentaries cover the intractable toxic algae pollution of Lake Tai (**Marcy Nicks Moody**); the growth of production of toxic flame retardants in China (Arlene Blum); and the growing public opposition to incinerators in China's cities (**Zhao Ang** and **Mao Da**). **Wang Jian** and **Jonathan Aloisi** delve into the seriousness of Beijing's huge water challenge and argue how major reform is needed to rationalize water management in the city. **Hu Kanping** provides a great and sometimes humorous example of Beijing's need for water reform in his examination of the capital's booming bath industry.

I always welcome commentaries that highlight how grassroots groups and citizens are playing a larger role in strengthening environmental governance in China and under this theme we have commentaries on green supply chain work by the World Environment Center (**Gwen Davidow**); stories of three Sichuan-based NGOs working to protect soil and water resources as a way to help farmers and the environment (**Jiong Yan**, **Hongyan Lu, Lei He**, **Jun Tian**, and **Yu Luo**); and examples of how citizens have been starting to utilize China's open environmental information measures (**Hu Yuanqiong**). A couple commentaries touch on how communities are being impacted by climate change—such as

One in five people in the world depend to some degree on water originating in Hindu-Kush Himalaya, often referred to as the Third Pole. Glacier melt from climate change threatens to undermine the stability of the millions in Asia who depend on water flowing from this region. The Valley of the Marshyangdi River in Annapurna, Nepal (pictured) is but one region facing growing droughts and floods. Learn more about the growing threat of humanitarian disasters at the Third Pole in a new publication coauthored by *chinadialogue: The Waters of the Third Pole: Sources of Threat; Sources of Survival.* Photo Credit: John Jackson – www.tabd.co.uk

Zhou Lei who discusses how communities living in the shadow of the Mingyong Glacier in Yunnan Province understand the melting of this glacier on one of Tibetan Buddhism's sacred mountains and **Pan Wenjing** from Greenpeace China who highlights some encouraging examples of farmers pursing eco-farming that helps them adapt to coming climate changes.

Guangdong is China's economic powerhouse and it is encouraging to once again have a commentary by **Christine Loh** and her team at Civic Exchange (**Megan Pillsbury**, **Andrew Lawson**, and **Mike Kilburn**) providing some new information on the National Development and Reform Commission's Green Plan for the Pearl River Delta. Two commentaries also thoughtfully reflect on China's greening during the economic downturn (**Leo Horn-Phathanothai** and **Elizabeth Balkan** with **Michelle Lau**).

The 17 Feature Boxes that are nestled between feature articles and commentaries should not be overlooked, for they include succinct and anecdote-rich discussions of energy, climate, and conservation trends, projects, and governance challenges in China. Most of the Feature Box contributors are people working on the ground in China from numerous international NGOs—such as **Clean Air Task Force, Regulatory Assistance Project**, **Center for Climate Strategies**, **iCET**, **Institute for Sustainable Communities**, **chinadialogue, Circle of Blue**, **International Crane Foundation** and **China Carbon Forum.** Three of the Feature Boxes provide valuable snapshots of bilateral activities by the **British**, **Danish**, and **Italian governments**. In the spirit of this issue's energy and climate theme, some boxes offer insightful information into private sector energy cooperation, such as the box by **Claire Casey** and **John Juech** who discuss the mutual benefits of U.S.-China power sector cooperation and the box by Jonathan Lewis that highlights some of the clean coal technology cooperation promoted by the Clean Air Task Force. Other boxes by CEF staff discuss two of our current projects—Cooperative Competitors and Building New Clean Water Networks in China—as well as one box on environmental mass incidents in Zhejiang Province.

Our lucky eight Spotlight on NGO Activism in China Boxes offer insights into the impressive work of some Chinese grassroots environmental groups—**GreenRiver**, **Green Stone, Green Anhui**, **Green Eyes**, **Green Earth Volunteers** and **Green Camel Bell**. Three powerhouse international NGOs are also included in these boxes—**International Crane Foundation**, one of the first environmental groups to start conservation work in China in the mid-1980s; **International Fund for Animal Welfare**, which has worked for 15 years to improve government conservation and animal management policies in China; **Natural Resources Defense Council**, which has 15 years experience working to promote energy efficiency and address climate challenges in China.

CEF'S SUPPORTERS

The China Environment Forum (CEF) is a small but busy office. Our current grants have enabled us to dig deeply into three main themes—energy, water, and environmental governance in China.

Energizing CEF's Energy Work

On the energy front we launched a new initiative—Cooperative Competitors: Building New U.S.-China Climate and Energy Networks in November 2009—the same month Presidents Obama and Hu signed 9 new energy agreements. This initiative—made possible through seed funding from **Blue Moon Fund** and **Rockefeller Brothers Fund**, and support from **USAID** and **Vermont Law School**—builds on CEF's thirteen years of convening dialogues of diverse policy, business, NGO and research experts to examine China's energy and environmental challenges. Under the first year of Cooperative Competitors work we have held 15 meetings, all examining energy and climate challenges in China and opportunities for U.S. collaboration. Building on these meetings, the CEF team also has begun posting a number of briefs online that attempt to dig even deeper into U.S.-China energy cooperation. We are grateful to the four funders listed above along with the **ENVIRON Foundation** for supporting the printing and staff time for this special energy and climate issue of CES.

Diving into Water

Water has long been a major focus at CEF and a few funders have enabled us to continue work on China's water issues. We are grateful to the **Center for Global Partnerships/ Japan Foundation** that has supported workshops and meetings on how the U.S. and Japanese governments, NGOs and researchers can contribute to improving water pollution governance in Lake Tai—one of China's most polluted lakes. This past year we received support from the **World Resources Institute** to assist them with developing a water risk assessment tool that will be launched soon online. CEF also concluded our work on environmental health with our friends at **Western Kentucky University** by creating the online multimedia website Hidden Waters: Dragons in the Deep with Circle of Blue that examines the challenging karst water challenges in southwest China. This environmental health project was made possible by support from **USAID** and the **ENVIRON Foundation**.

Investigating China's Environmental Governance

We were excited and honored this year to become a partner with **Vermont Law School** (VLS) on their **USAID**-supported U.S.-China Partnership for Environmental Law, in which CEF is helping VLS in outreach, meetings, and research on a broad range of environmental governance issues facing China. VLS and CEF also received a grant from the **U.S. Department of State** to set up an Environmental Justice Fellowship, creating a six-week exchange for 18 young environmental NGO, research and legal young professionals (9 from China and 9 from the United States) who wished to deepen their work on environmental justice issues. Over this part year CEF also worked with **Tetratech** on a **USAID**-supported project to carry out a China Environmental Management Assessment.

OUTREACH ACTIVITIES

Along with its grant specific programming, CEF has continued each year to serve hundreds of environmental professionals in our network who are seeking information, ideas, and partners to carry out their energy and environmental work in China. I do not have space here to list out the many examples of our exciting information clearinghouse work, but I want to highlight one. This summer CEF produced a short video highlighting energy and environmental challenges in China for the **Walt Disney Company**, which will be later posted on our website. Disney generously gave us an honorarium for this video and other work we did for them and we thank them for their support.

MY TEAM

This publication is a group effort, first and foremost dependent on the enthusiastic professionals in our network who, despite being incredibly busy people, still propose and then write about their work and insights related to energy and environmental issues in China. I also am grateful to the generous reviewers who gave us very valuable comments on the feature articles. Equally crucial in the success of this publication is the hard work of my team. **Pete Marsters** the CEF program assistant juggles way too many balls in his work balancing our budgets, assisting in fundraising, booking flights and doing other logistics for our meetings. Nevertheless he was still able to find the time and energy to be an efficient managing editor for CES and help me usher this huge issue with all its photos and charts through the editing and layout process. Luckily this year we were able to bring in two sharp-eyed colleagues **Allison Garland** and **Lauren Herzer** from the Wilson Center's Comparative Urban Studies Program to help us out as editorial assistants, lightening our load considerably. The CEF interns are always an integral part of the publication, not only helping in copy-editing, but also in doing some translation of articles that were submitted in Chinese or assisting authors with some supplementary research. Some of them also wrote feature boxes to help cover some topics that complemented submitted articles. This year I want to salute a great crew of interns—**Alan Campana**, **Kexin Liu**, **Natalie Matthews**, **Nick Sternhangen**, **Lindsey Eckelmann,** and **Ada (Yue) Wu**. Ada was with us for most of the year we worked on this publication and she was superb in helping some authors with supplementary research. I dubbed Kexin Mr. 911, for he did some excellent final editing and quick writing in the last weeks before we sent the publication for layout. I was bowled over by the creative new layout in CES 11 and would like to heap praise on our graphic designer **Kathy Butterfield** for her inventive design skills.

I am grateful to the **Rockefeller Brothers Fund** for providing the core funding of this publication and for the additional support from the **Blue Moon Fund**, **USAID, Vermont Law School**, **Western Kentucky University**, and the **ENVIRON Foundation**.

The State of U.S.-China Relations on Climate Change: Examining the Bilateral and Multilateral Relationship

By Joanna Lewis

The state of the U.S.-China relationship on climate change has been changing rapidly in the wake of the Beijing presidential summit and the Copenhagen negotiations that took place in the final months of 2009. The bilateral talks on climate and energy issues between the two countries are critically important, not just for addressing climate change, but for the future of the U.S.-China relationship. Bilateral talks may also facilitate a multilateral agreement on climate change that involves both countries. Fundamental differences exist, however, between the United States and China in how they each view the bilateral relationship, and how they see their roles in the multilateral system; and these must be carefully navigated. There clearly can be no solution to global climate change without the United States and China, and such a solution will depend on the ability of these two countries to see eye to eye. It will take many years for them build the trust needed to overcome their differences on this issue, to develop and adopt low-carbon technologies, and to transform their economies. As the entire world looks to the United States and China to make a move, the fate of the global climate system remains in their hands.

China and the United States are the two largest national emitters of the greenhouse gases that contribute to global climate change, and together comprise almost half of global emissions. Any global solution to climate change must therefore include participation by these two countries.

Around the world, there has been much discussion in recent months about how to bring the United States and China into a multilateral climate change agreement, and increased attention has been placed on the evolving bilateral relationship between the two counties with respect to climate and energy cooperation. The year 2009 seems, on paper at least, to have been a very successful year for U.S.-China cooperation on clean energy and climate change. It began with the inauguration of President Barack Obama who prioritized addressing climate change in partnership with China, and the release of several calls for action for increased energy and climate cooperation between the United States and China by researchers and NGOs (Asia Society & Pew Center, 2009; Lieberthal & Sandalow, 2009; NRDC, 2009; U.S.-China Clean Energy Forum, 2009). Presidents Obama and Hu Jintao seemed to have answered the call by signing an impressively long list of bilateral agreements during their summit in Beijing in November (U.S. DOE, 2009a–i).

Bilateral talks on climate and energy issues between the United States and China are critically important, not just for addressing climate change but for the future of the U.S.-China relationship. They may also be crucial to facilitating a multilateral climate agreement that involves both countries. Fundamental differences exist, however, between the United States and China in how they each view the

U.S.-China bilateral relationship, and how they see their roles in the multilateral system; and these must be carefully navigated. This became plainly evident in the final months of 2009, when despite a successful summit between Presidents Obama and Hu in Beijing in November, U.S.-China climate change relations ended on a somewhat sour note in December at the close of the Copenhagen climate change negotiations.

This article examines the current state of the U.S.-China relationship on climate change in the wake of the Beijing summit and the Copenhagen negotiations. It begins by recapping each country's role in contributing to and addressing the climate challenge. To provide insights into the ever-evolving climate relationship the article then reviews achievements reached through bilateral agreements between the United States and China over the past two decades, and assesses future prospects for the program of cooperation. Examination of the chain of events in Copenhagen and their likely repercussions help illuminate how the United States and China found themselves at the epicenter of a complex political negotiation involving around 190-plus countries. Finally, the article offers some ideas about how the United States and China could best use bilateral and multilateral forums to more effectively promote future bilateral climate change cooperation in a way that could be agreeable to both countries, while ensuring the rest of the world benefits from such cooperation.

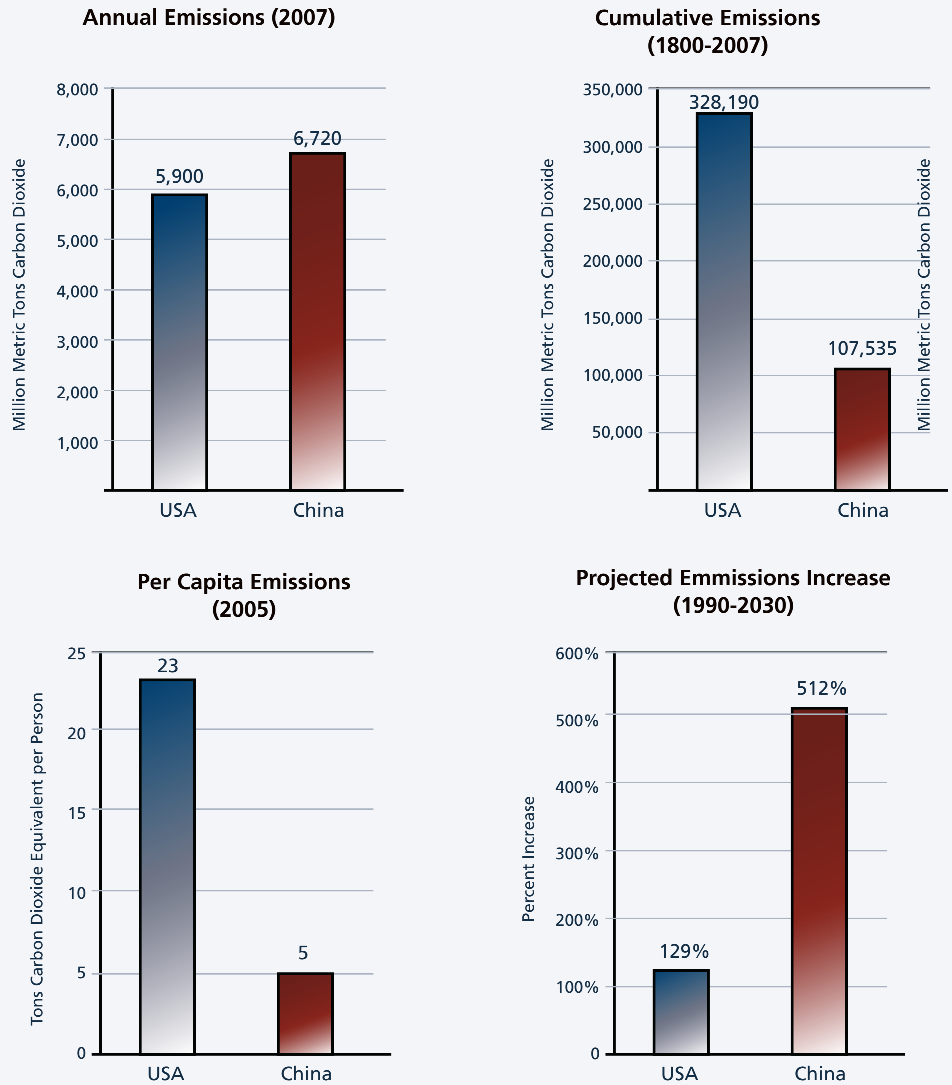
If China's emissions continue to grow at the rate of 10 percent per year, by the year 2040, it could be emitting as much CO_2 as the entire world is today.

THE ROLE OF THE UNITED STATES AND CHINA IN CLIMATE CHANGE

Greenhouse Gas Emissions

In historic terms, the United States is by far the largest contributor to the greenhouse gases now burdening the atmosphere, responsible for 29 percent of energy-related CO_2 emissions since 1850. China accounts for only about eight percent of these historic emissions. As China's economy has boomed, its emissions have soared, and it is now the world's largest emitter of greenhouse gases annually. Looking ahead, most projections put China's emissions in 2030 in the range of 500 percent above 1990 levels (EIA, 2009). Globally, this translates to about 40 percent of all new energy-related CO_2 emissions between now and 2030. If China's emissions continue to grow at the rate of 10 percent per year, by the year 2040, it could be emitting as much CO_2 as the entire world is today. In contrast, U.S. emissions are expected to grow in the rage of 130 percent between 1990 and 2030 (EIA, 2009).

Figure 1. Carbon Dioxide Emmissions Metrics in the United States and China



Reliance on Coal

Both China and the United States are heavily reliant on coal to fuel their energy systems, and are the world's largest and second largest producers and consumers of coal in the world, respectively. In the United States, which has the world's largest coal reserves, coal fuels 22 percent of primary energy and 49 percent of electricity generation. In China, coal fuels about 69 percent of primary energy, and 80 percent of electricity generation.

Given the substantial domestic coal reserves in each country and their heavy investment in coal-fired power plants over the past few decades, coal will likely remain an inescapable foundation of their economies for years to come. To render coal a climate-friendly energy source, however, will require significant advances and sustained investment in new technologies to burn it more efficiently as well as to capture and sequester the resulting greenhouse gas emissions.

In China, the average efficiency of coal power plants is rapidly catching up to that of developed countries as new, larger units come online and smaller, less efficient units are shut down. It is estimated that the average efficiency of China's coal-fired fleet was 32 percent in 2005, but is expected to approach 40 percent by 2030 as more large supercritical units come online and older subcritical units are phased out. In the United States, the majority of existing coal plants was built before 1989 using subcritical pulverized coal technology.

Accomplishments to Date

China's Low-Carbon Development Programs

Both the United States and China have begun to implement national policies and programs to address their increasing greenhouse gas emissions and reliance on fossil fuels. In China, the government has adopted a National Climate Change Program outlining an array of programs and policies to address climate change in the areas of energy efficiency, renewable energy, nuclear power, land use and forestry, and technology development. Domestic policies that could achieve significant greenhouse gas reductions include a national target to reduce energy intensity by 20 percent from 2005 levels by 2010, and a target for 15 percent of primary energy from non-fossil sources by 2020. In order to promote aggressive implementation of this challenging target and improve local accountability, China's National Development and Reform Commission (NDRC) has allocated the target among provinces and industrial sectors, and energy efficiency improvement is now among the criteria used to evaluate the job performance of local officials. There have also been increases in staffing and funding in key government agencies that monitor energy statistics and implement energy efficiency programs. In 2008 alone, China reportedly allocated 14.8 billion Yuan ($2.2 billion) of treasury bonds and central budget, as well as $27 billion Yuan ($3.9 billion) of governmental fiscal support to energy saving projects and emission cuts ("China's energy consumption," 2008).

To better facilitate local-level implementation, additional programs have been established to encourage specific actors to help meet this national intensity goal, including a program established in 2006 to improve energy efficiency in China's 1,000 largest enterprises (Price & Wang, 2007), which together consume one-third of China's primary energy. Another government effort targets the elimination, by 2010, of a number of small, inefficient power plants that represent around 8 percent of China's total generating capacity, by the end of 2010. Similar plant closings are planned across the industrial sector for inefficient cement, aluminum, ferro-alloy, coking, calcium carbide and steel plants.

Impact on China's Energy Intensity

As a result of the implementation of the measures described above to help the country mobilize towards achieving the 20 percent energy intensity reduction goal, China's worrisome trend of increasing energy intensity between 2003 and 2005—after decades of decreasing intensity—was successfully reversed starting in 2006. In order to meet the goal by 2010, China needed to achieve an average decline of 4 percent per year. In 2006, energy intensity was down 1.79 percent from the previous year; in 2007 it was down 4.04 percent; and in 2008 by 5.2 percent.[1] At the close of 2009, the government reported that energy intensity was down 14.38 percent from 2005 levels (Chen, 2010). Still short of the reductions needed to reach the 20 percent goal, several additional measures were put in place in a final effort to meet the target by the end of this year (Seligsohn, 2010). Due to reinvigorated economic growth in the first part of 2010, however, achieving the target is beginning to look less and less likely (Hornby, 2010).

The Carbon Challenge Remains

While estimates have been made of the

potential carbon emissions savings that could accompany the 20 percent energy intensity reduction target (Lin et al., 2007), China never put forth any targets that explicitly quantified its carbon emissions until late 2009. In November of that year the Chinese leadership announced its intention to implement a domestic carbon intensity target of a 40 to 45 percent reduction below 2005 levels by 2020 (PRC, 2009b). This target came within hours of President Obama's announcement that the United States would reduce its carbon emissions "in the range of 17%" from 2005 levels by 2020, and that the President himself would attend the UN international climate change negotiations in Copenhagen (White House, 2009b).

Between 1990 and 2005, China reduced its carbon intensity by 44 percent.

There is no question that China's announcement of its first carbon target represents a monumental change in China's approach to global climate change. It is also important to recognize, however, that even with this target in place, growth in absolute emissions could continue to increase rapidly. A meaningful reduction of emissions by a carbon intensity target that is a ratio of carbon emissions and GDP hinges upon future economic growth rates and the evolving structure of the Chinese economy, as well as on the types of energy resources utilized and the deployment rates of various technologies, among other factors. Carbon intensity, like energy intensity, has declined substantially over the past two decades. Between 1990 and 2005, China reduced its carbon intensity by 44 percent. China is also projected to reduce its carbon intensity 46 percent from 2005 levels by 2020, while still growing its emissions by 73 percent during this same period (EIA, 2009). This has sparked much debate over whether this domestic policy target is sufficient based on China's role in the global climate challenge.

Stalled U.S. Action on Greenhouse Gas Emissions
The United States has yet to enact a mandatory federal program to regulate greenhouse emissions on an economy-wide basis, though the House of Representatives has passed a bill proposing such a program, and a Senate bill is currently under discussion. As a result, the targets that President Obama put forth in Copenhagen may end up varying "in line with congressional legislation;" or if congress fails to act, and the Environmental Protection Agency is not able to pass carbon regulations of its own, the targets may never actually be enacted. In the meantime, however, in the absence of a federal mandate, 23 states are now participating in regional initiatives to reduce emissions through cap-and-trade systems. The State of California has set a mandatory goal of reducing emissions to 1990 levels by 2020, and 80 percent below 1990 levels by 2050. In addition, 36 U.S. states currently have renewable portfolio standards or specific goals to increase the use of renewable energy.

THE U.S.-CHINA BILATERAL RELATIONSHIP

The Opportunity

The United States and China not only share the top position of greenhouse gas emitters for developed and developing countries respectively, they also share many challenges in reducing their emissions. As large global economies, maintaining strong economic growth is a fundamental goal for political leaders hoping to maintain popularity. Both countries have abundant domestic coal resources that provide energy security benefits. While both China and the United States have excellent renewable resources, including wind and solar, the best resources and locations for renewable power plant development tend to be located far from population centers and electricity demand, and thus will require expanded and modernized transmissions infrastructures. Both countries have realized the potential energy efficiency gains that they can achieve, but they lag Europe, Japan and others in developing a more efficient energy system (Asia Society & Pew Center, 2009).

Due to the similarities in energy systems shared by the two countries, there are many areas where both the United States and China could benefit from cooperation on climate change and clean energy development. The United States and China in fact have a long history of bilateral energy and environmental cooperation both through official governmental channels, as well as between universities and nongovernmental organizations. Some examples of this historical and ongoing cooperation are described below, with a more comprehensive list of official bilateral cooperation on energy and climate change provided in Table 1.

Official Bilateral Energy Cooperation

Foundational Agreements

In 1979, the MOU for Bilateral Energy Agreements was signed between the U.S. Department of Energy (DOE) and the China State Development Planning Commission (SDPC), which over time led to 19 cooperative agreements on energy, including on renewable energy. Almost two decades later, in 1995, a series of bilateral agreements between the United States and China were signed by Secretary of Energy Hazel O'Leary including an agreement between the DOE and the Chinese Ministry of Agriculture on renewable energy, and between DOE and the State Science and Technology Commission (SSTC) on renewable energy technology development.

In 1995, the *Protocol for Cooperation in the Fields of Energy Efficiency and Renewable Energy Technology Development and Utilization* was signed between the DOE and various Chinese ministries. In 1997, President Jiang Zemin visited the United States, and the joint Energy and Environment Cooperation Initiative was signed between the DOE and the China State Planning Commission (SPC). The initiative targeted urban air quality, rural electrification and energy sources, and clean energy sources and energy efficiency. This ambitious initiative notably involved multiple agencies, as well as participants from business sectors, and linked energy development and environmental protection.

High-Level Forums for Dialogue

Also in 1997, Vice President Al Gore and then-Premier Li Peng co-chaired the first session of the U.S.-China Forum on Environment and Development in Beijing. The purpose of the forum was to expand cooperation and intensify dialogue between the United States and China on issues related to sustainable development, particularly protection of the global environment. During President Jiang's 1997 visit, Secretary of Energy Federico Peña and State Planning Commission Vice Chairman Zeng Peiyan signed the Energy and Environment Cooperation Initiative, an outgrowth of the forum designed to focus cooperative efforts on the intersection of energy and environmental science, technology, and trade. The second meeting of the forum was held in April 1999 in Washington, and was co-chaired by Vice President Gore and Premier Zhu Rongji (White House, 1999).

In 2006 the U.S.-China Strategic Economic Dialogue (SED) was founded by Vice Premier Wu Yi and U.S. Treasury Secretary Henry Paulson. The dialogue includes several agencies, including the DOE, U.S. Environmental Protection Agency (EPA), the NDRC, and China's Ministry of Science and Technology (MOST). It is a bi-annual, cabinet-level dialogue that includes an energy and environment track. In April 2009 the dialogue was re-branded as the U.S.-China Strategic and Economic Dialogue (S&ED), with the U.S. State Department and Treasury Department now co-chairing the dialogue for the United States. The strategic component was transferred to the State Department, and includes discussions on energy and climate change cooperation between the two countries. During the first meeting in July 2009, Treasury Secretary Timothy F. Geithner and Secretary of State Hillary Rodham Clinton were joined for the dialogue by their respective Chinese co-chairs, State Councilor Dai Bingguo (for the strategic track) and Vice Premier Wang Qishan (for the economic track) (Treasury, 2009). The second meeting was held in Beijing in May 2010 and included both high-level dialogues and public-private forums (discussed below). The Strategic Track produced 26 specific outcomes on energy security and climate change, including a Joint Statement on Energy Security Cooperation (State, 2010).

In 2008 the U.S.-China Ten-Year Framework for Cooperation on Energy and Environment (TYF) was signed as part of the fourth SED. On the U.S. side, the TYF includes DOE, Treasury, State, Commerce, and EPA; on the Chinese side it includes NDRC, the State Forestry Administration, the National Energy Administration (NEA), the Ministry of Finance, the Ministry of Environmental Protection (MEP), the Ministry of Science and Technology (MOST), and the Ministry of Foreign Affairs (MFA). It initially established five joint task forces on the five functional areas of the framework: (1) clean, efficient and secure electricity production and transmission; (2) clean water; (3) clean air; (4) clean and efficient transportation; and (5) conservation of forest and wetland ecosystems (Treasury, 2008). These five areas were further elaborated in seven specific action plans for implementation (State, 2008), and later expanded upon in the July 2009 *Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and Environment,* initialed by U.S. Secretary of State Hillary Rodham Clinton, U.S. Secretary of Energy Steven Chu, and Chinese State Counselor Dai Bingguo (State, 2009). The most recent Joint Working Group Meeting for the TYF was held in Washington, D.C. in May 2010.

New Push for Bilateral Energy Cooperation

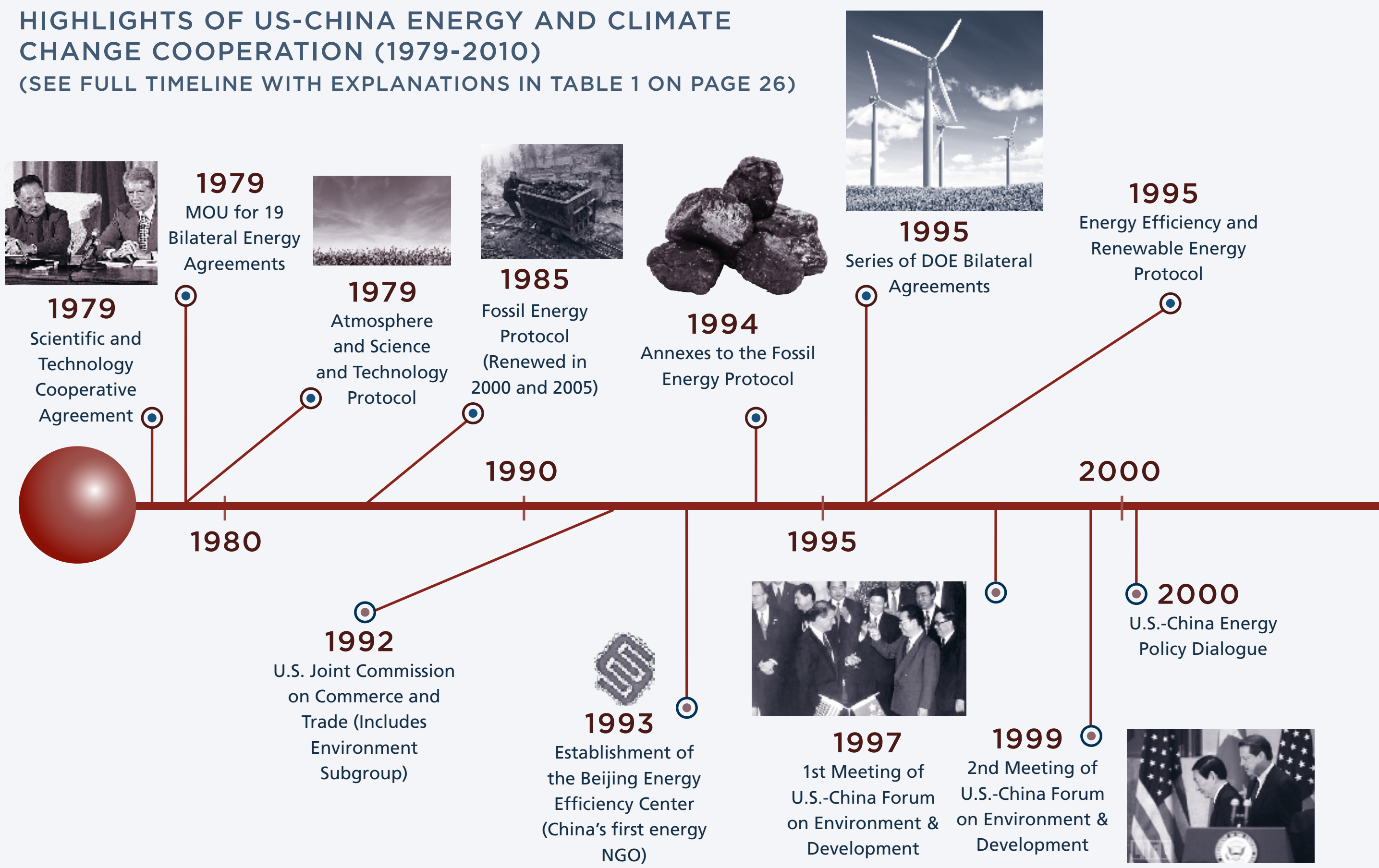
In July 2009 came the Obama administration's first announcement on U.S.-China energy cooperation in conjunction with Secretary Steven Chu's first trip to China (DOE, 2009a). Chinese Minister of Science and Technology Wan Gang and Chinese National Energy Administrator Zhang Guobao, along with Chu, signed a protocol announcing plans to develop a U.S.-China Clean Energy Research Center (CERC) that would facilitate joint research and development on clean energy by teams of scientists and engineers from the United States and China, as well as serve as a clearinghouse to help researchers in each country. The center would have one headquarters in each country, at locations to be determined, with priority topics to include building energy efficiency; clean coal (including carbon capture and storage); and clean vehicles. At the July meeting, the United States and China together pledged $15 million to support initial activities, with each government pledging equal amounts.

The U.S.-China Presidential Summit in Beijing in November 2009 resulted in a significant set of new agreements on joint energy and climate cooperation between the two countries (DOE, 2009b). First, the details surrounding the aforementioned U.S.-China Clean Energy Research Center (CERC) were formally announced, including the fact that the center will be supported by public and private funding of at least $150 million over five years, split evenly between the two countries (DOE, 2009c). As elaborated in the Protocol between the U.S. Department of Energy and the Ministry of Science and Technology and the National Energy Administration (NEA) of China for Cooperation on a Clean Energy Research Center, each side is to fund only the research activities of scientists from their own country. Any intellectual property rights created through CERC cooperative activities are to be jointly owned by both parties involved, with respective contributions pre-agreed by both sides under Technology Management Plans for each project. In addition the U.S. DOE and MOST/NEA are to jointly establish the U.S. China Steering Committee on Clean Energy Science and Technology Cooperation to provide high-level guidance for research activities and Secretariats based in each country to coordinate the joint activities (DOE, 2009j). In March 2010, U.S. Energy Secretary Steven Chu announced the availability of $37.5 million in U.S. funding over the next five years to support the CERC, which will require matching funding from the grantees for a total of $75 million; the center will include an additional $75 million in Chinese funding (DOE, 2010).

Second, in November 2009 the Presidents announced the launch of the U.S.-China Electric Vehicles Initiative (DOE, 2009d). The electric vehicles initiative will include joint standards development, demonstration projects in more than a dozen cities, technical roadmapping and public education projects, and builds upon the U.S.-China Electric Vehicle Forum held in Beijing in September 2009 (DOE, 2009d, and 2009e). Third, the Presidents announced a new U.S.-China Energy Efficiency Action Plan targeting buildings, industrial and residential sectors through the development of energy efficient building codes and rating systems, the energy efficiency benchmarking of industrial facilities, the training of building inspectors and energy efficiency auditors for industrial facilities, the harmonizing of test procedures and performance metrics for energy efficient consumer products, the exchange of best practices in energy efficient labeling systems, and the convening of a new U.S.-China Energy Efficiency Forum to be held annually, rotating between the two countries (DOE, 2009f). The Presidential summit also produced the

HIGHLIGHTS OF US-CHINA ENERGY AND CLIMATE CHANGE COOPERATION (1979-2010)

(SEE FULL TIMELINE WITH EXPLANATIONS IN TABLE 1 ON PAGE 26)



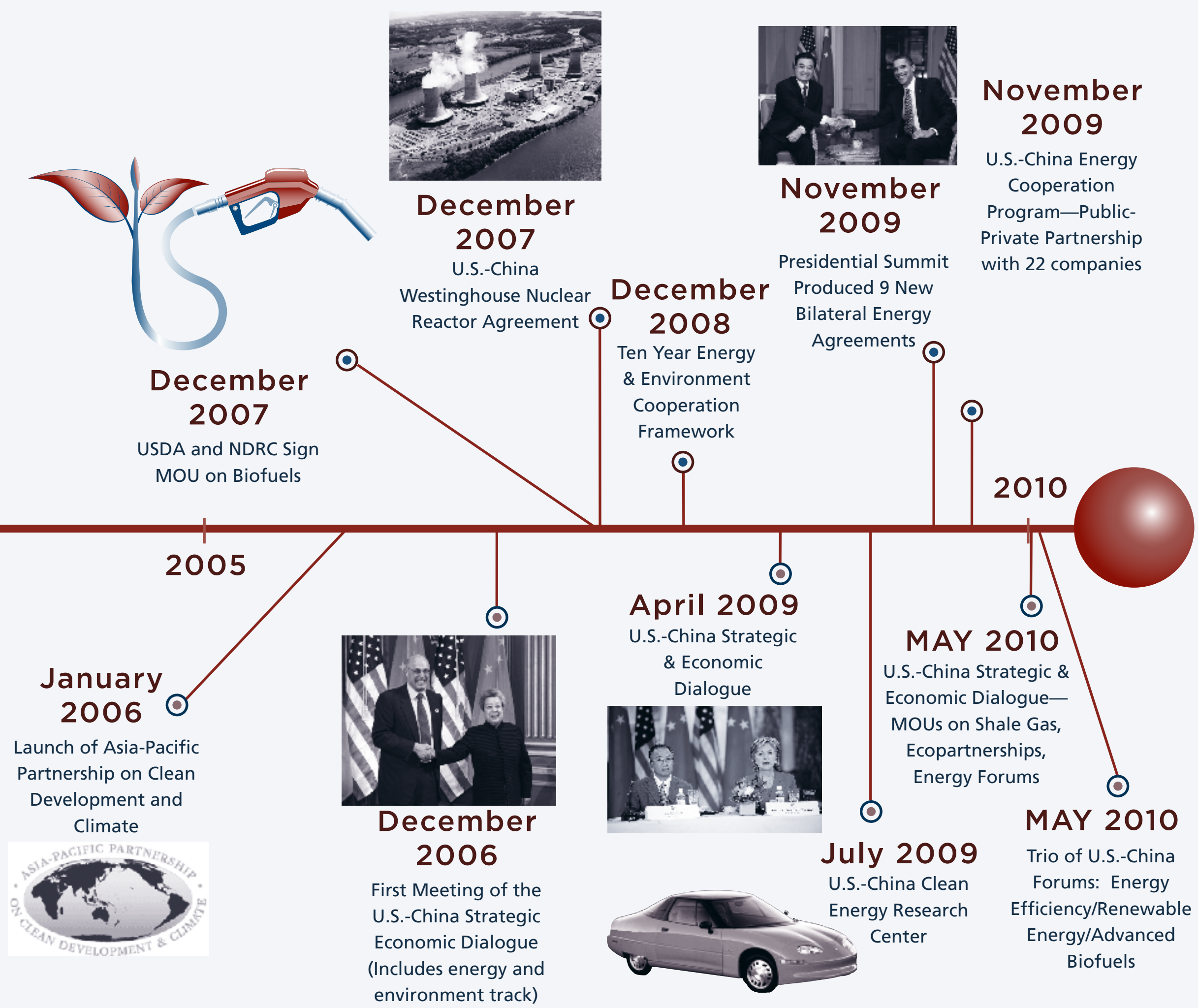
Sources: Asia Society & Pew Center, 2009; Price, 2008; Baldinger & Turner, 2002; DOE, 2006, 2008, 2009a, 2009b, 2009c, 2009d, 2009e, 2009f, 2009g, 2009h, 2009i, 2009j, 2010; State 2008, 2009, State, 2010; USTR, 2009; Treasury, 2008, 2009; White House Press Office, 1999, 2009a, 2009b.

announcement of a new U.S.-China Renewable Energy Partnership (USCREP). According to the U.S. Department of Energy, "both Presidents embraced a vision of wide-scale deployment of renewable energy including wind, solar and advanced bio-fuels, with a modern electric grid, and agreed to work together to make that vision possible (DOE, 2009g)." The National Renewable Energy Laboratory (NREL) is leading U.S. efforts on the USCREP.

Other agreements announced at the November 2009 Presidential Summit included the "21st Century Coal" pledge to promote cooperation on cleaner uses of coal, including large-scale carbon capture and storage (CCS) demonstration projects (DOE, 2009h); the Shale Gas Resource Initiative (DOE, 2009i); and the U.S.-China Energy Cooperation Program (ECP) to leverage private sector resources for project development work in China across a broad array of clean energy projects. The ECP program includes more than 22 companies as founding members, encompassing collaborative projects on renewable energy, smart grid, clean transportation, green building, clean coal, combined heat and power, and energy efficiency.

During the May 2010 meeting of the S&ED in Beijing, three clean energy forums established by the above agreements were held, including the U.S.-China Renewable Energy Industry Forum, the U.S.-China Advanced Biofuel Forum, and the U.S.-China Energy Efficiency Forum. All forums included representatives from both government and industry, and were accompanied by the announcements of many new public and private sector partnerships.

At the Biofuels Forum, 8 MOUs were signed covering topics such as aviation biofuel and cellulosic ethanol (Wang, 2010). Many private sector partnerships were also announced, including a partnership between Boeing and



PetroChina to work together to evaluate developing a sustainable aviation biofuels industry in China; an expanded research collaboration between Boeing Research & Technology and the Chinese Academy of Science's Qingdao Institute of Bioenergy and Bioprocess Technology on algae-based aviation biofuel development; and an inaugural flight using sustainable biofuel derived from biomass grown and processed in China conducted by Air China, PetroChina, Boeing and Honeywell ("Boeing and Chinese Energy Officials," 2010). At the Renewable Energy Forum, Applied Materials and China Energy Conservation and Environmental Protection Group (CECEP) signed a MOU to explore projects to accelerate the development and deployment of solar energy including through a 5 MW thin film PV project in Inner Mongolia ("Applied Materials," 2010).

Nongovernmental Cooperation

In addition to official government cooperation, there are many forms of U.S.-China energy cooperation between academic institutions, nongovernmental organizations, foundations, and the private sector, which have often been more sustained than the formal bilateral collaboration. Examples of these nongovernmental cooperation programs are briefly described below.

Similar to the government-established ECP, there are several nongovernmental partnerships focused specifically on engaging the private sector in both countries to establish partnerships, such as the American Council on Renewable Energy's U.S.-China Program, The Clean Air Task Force's Asia Clean Energy project, the Joint U.S.-China Collaboration on Clean Energy (JUCCCE), and the U.S.-China Green Tech Summit. Other organizations have convened groups of stakeholders to provide high-level recommendations to the U.S. and Chinese governments on U.S.-China energy and climate cooperation, such as the Asia Society's Initiative for U.S.-China Cooperation on Energy and Climate, and the U.S.-China Clean Energy Forum. Track II U.S.-China dialogues comprised of leading thinkers outside the government or former government officials, such as those convened by the Brookings Institution and the Carnegie Endowment for International Peace, provide opportunities for high-level exchanges on climate and energy in a non-official environment. In addition, many U.S.-based nongovernmental environmental organizations now have sizable offices in China and engage in cooperative activities with Chinese partners, including Natural Resources Defense Council and Environmental Defense Fund, and World Resources Institute. Many U.S. and Chinese universities have official research collaborations on energy and climate issues, for example the Tsinghua-MIT Low Carbon Energy Research Center.

One of the largest nongovernmental organizations engaged in U.S.-China co-operation is the China Sustainable Energy Program (CESP), established by the San Francisco-based Energy Foundation in Beijing in 1999. Staffed by Chinese nationals and supported by international experts, CESP supports China's energy efficiency and renewable energy policy efforts. Armed with an astute political sense and excellent relationships with government leaders, as well as a multi-million dollar budget, the CSEP serves as a grant-maker for Chinese agencies, experts, and entrepreneurs so they can solve energy challenges for themselves, and links them with "best practices" expertise from around the world (CESP, 2009).

BARRIERS TO COOPERATION

Looking at the list of past and ongoing clean energy cooperation efforts between the governmental, nongovernmental and private sector in China, it is clear that there has been quite a bit of activity. While the official governmental track is certainly not the only means of bilateral cooperation, nor is it always the most effective, it is clearly important for cooperation to occur through official as well as unofficial channels. Despite the long list of official bilateral agreements signed between the United States and China in the area of clean energy and climate change, there have been many challenges to following through on the successful implementation of agreed upon activities. Official bilateral cooperation has suffered in the past from a lack of consistent funding as well as from insufficient high-level political support and commitment. Cooperation is also hampered by the increasingly competitive relationship between the United State and China in the global economic marketplace.

Funding and Follow Through

While the list of agreements signed has been well documented by both governments, less attention has been paid to the results of these programs. The level of funding support provided to each initiative is generally also quite difficult to track, in many cases because the MOUs or initiatives signed were not backed by secure funding commitments. As a result, there has been some skepticism surrounding government agreements for bilateral cooperation that are not accompanied by both high-level political support *and* dedicated funding commitments. This skepticism has played a role in U.S.-China bilateral relations, and has contributed to some mistrust, or at the very least to reluctance to pursue future cooperation initiatives.

The cancellation or downscaling by the United States of several key clean energy projects has led to an understandable skepticism in China on the prospects for stronger long-term cooperation. Recent examples include the two-plus year expiration and eventual renewal of the U.S.-China Protocol on Energy Efficiency and Renewable Energy, and the postponement and significant restructuring of the FutureGen project to build, in partnership with China, a commercial-scale advanced generation coal plant with carbon capture and storage.[2]

It is particularly notable that more U.S.-China bilateral clean energy and climate change agreements were signed in the year 2009 than in any prior year. The fact that the majority of these agreements were signed by the President of each country illustrates political support at the highest level on both sides. Many of the details regarding the implementation of these agreements are yet to be worked out, but real challenges remain, particularly regarding stable funding resources. The agreements outlining the new China-U.S. Clean Energy Center and the Renewable Energy Partnership, for example, both point to existing funding sources for implementing domestic actions in both countries, with minimal additional funding sources for collaborative projects. While it is clearly important that both sides bring some form of resources to the table, if nothing new is allocated for these agreements, it is unclear how they will result in any deviation from current practices. In addition, if both sides are paying their own way and there is no financial incentive for cooperation, activities must be in the clear interest of both sides or there is little reason for either to come to the table.

Cooperative Competitors?

Cooperation is increasingly common between the United States and China in areas ranging from basic research to joint business ventures. At the same time, China and the United States are competitors for resources, talent, and economic markets. While competition can be an engine for innovation, and clean energy development in particular is an area where innovation will be vital, it is hard for any country to put long-term global interests ahead of near-term domestic interests—particularly in the fast-moving clean technology sector.

Fears that U.S. climate regulations would help Chinese companies out-compete American companies have led to the inclusion of trade measures aimed at large developing countries—primarily China—in several draft proposals for climate change legislation in the United States Congress ("Trade Sanctions Emerge," 2007). The inclusion of trade measures became prevalent in several legislative proposals of the 110th Congress (2007-2008) including S.1766, the "Low Carbon Economy Act" introduced by Senators Jeff Bingaman and Arlen Specter, and S. 2191, "America's Climate Security Act," introduced by Senators Joseph Lieberman and John Warner; in the current Congress (111th), similar provisions are contained in the American Power Act introduced by senators Kerry and Lieberman. With a stated purpose of protecting against foreign countries' undermining a U.S. objective of reducing greenhouse gas emissions, U.S. importers must buy international reserve allowances to offset lower energy costs of manufacturing certain goods coming from certain countries.[3] While some least developed countries are excluded from these requirements, most developing countries are subject to the requirement unless they have taken policy action at home deemed to be of comparable stringency to U.S. action. While the impact of such measures on leveling the carbon playing field between the United States and China has been questioned (Houser et al., 2008), it is widely believed that U.S. legislation will contain some form of carbon leakage provision (also called a "China provision") aimed at appeasing labor interests, which have widely supported and helped shape the provision.

Trade measures are not the only means of addressing the competitiveness issue between the United States and China. Fashioned carefully, closer collaboration on clean energy could enhance the economic prospects of both nations while conferring on neither an unfair competitive advantage. However, recent events have illustrated ongoing tensions in both countries surrounding access to clean energy markets. For example, announcements in October 2009 that Chinese wind turbine manufacturer Shenyang Power Group was supplying 2.5-MW turbines made in China for a wind farm in west Texas raised many concerns, particularly from members of the U.S. Congress, that China was trying to compete with the United States in its own domestic market in an industry that the government had specifically been trying to promote with tax credits and other green jobs initiatives (Smith, 2009; Pasternack, 2009). The discussion over the Texas wind farm occurred close to the time that U.S. Department of Commerce Secretary Gary Locke traveled to China to ask for the removal of a 7-plus year policy requirement that wind turbines installed in China must be locally manufactured, essentially restricting any imported turbines. In a somewhat surprising turn of events, China agreed, opening up the Chinese market to U.S.-manufactured wind turbines. Then in mid-November 2009, Shenyang's parent company, A-Power Energy Generation Systems Ltd., announced that it had partnered with the U.S. Renewable Energy Group to build a wind turbine production factory in the United States (Burnham, 2009), and Chinese wind company Goldwind has announced its intentions to do the same. In fact, many Chinese wind companies have benefited greatly from cooperation with U.S. wind technology companies, including top firms Sinovel and Dongfang.

While the United States and China may argue over where to build the wind turbines, both countries stand to benefit from the best, lowest cost, wind turbine technology available, and healthy competition should encourage both countries to try to produce it. Clearly there is a long way to go to build the trust that will be crucial to scaling up clean energy cooperation between the United States and China that the world needs.

THE MULTILATERAL CHALLENGE

The climate change challenge is of course much bigger than just the United States and China, but these two countries are instrumental players in the ongoing international negotiations to reach a global climate change agreement. The relationship between the United States and

China, however, does not get any simpler when they are moved into a room containing 190 other countries with a vast range of alliances and interests. The U.S.-China relationship was only a minor sideshow in the international climate negotiations of the past 8 years, primarily due to minimal engagement by the United States in these talks. This has changed now that President Obama has launched a new era of U.S. climate engagement, bringing an increased focus on the country that had been singled out time and again by the U.S. Congress in the aftermath of the Kyoto Protocol—China.

The Kyoto Legacy

One of the lessons that came out of the negotiations over the Kyoto Protocol was that the executive branch, which represents the United States in the international negotiations, cannot get out too far ahead of the legislative branch of government. President Obama must balance his reluctance to put forth a target that has not been backed by U.S. legislation with pressure from the international community for U.S. leadership on climate change. The other crucial lesson of Kyoto was that Congress wants to see action by developing countries. As stated in the "Byrd-Hagel" resolution, "the exemption for Developing Country Parties is inconsistent with the need for global action on climate change and is environmentally flawed" (S.Res. 98, 1997). While the U.S. Congress has come a long way in its understanding of both the global climate change problem and its solutions since the days of the Byrd-Hagel resolution, there is still a strong concern about the United States taking on commitments to reduce greenhouse gases in the absence of similar commitments from the large developing countries. Most of the other "Annex I" countries share this concern (UNFCCC, 2009a).[4]

A key obstacle to developing country engagement in the international climate change negotiations is the "firewall" that has been placed between developed and developing countries. Institutionalized in the Kyoto Protocol, this firewall emerged in the context of the negotiations initiated by the 1995 Berlin Mandate. The Berlin Mandate allowed the international climate regime to advance by focusing only on developed country emissions, leaving developing country emissions not only off the table, but also by many interpretations, fully excluded from future discussion (UNFCCC, 1995; Bodansky, 2009).[5] But while the discussions leading up to the Kyoto Protocol were primarily focused on reaching agreement between the European Union (EU) and the United States, since the adoption of the Marrakesh Accords in 2001, the central axis in the negotiations has shifted from EU-U.S. to developed-developing (Bodansky, 2009). At the center of this developed-developing axis are the United States and China.

Today, while the U.S. Congress deliberates potentially monumental energy and climate change legislation, the international community waits and watches. The developed countries that not only signed up for a Kyoto Target back in 1997, but also are making good on their promise to fulfill it, are loathe to be left alone again in the next round of negotiations without the largest developed country emitter, the United States, at their side. The EU has already put a mandatory emissions trading program in place, and has announced a unilateral commitment to further reduce its emissions to 20 percent below 1990 levels by 2020. While such actions may signal the EU's intent to act in the absence of action by the United States, this is most certainly not the desired outcome. Japan is also deeply cognizant of its post-Kyoto legacy in the form of a challenging emissions reduction target, and is less likely than Europe to act unilaterally. While most developed countries are unwilling to act without the United States, the United States in turn is unable to act without China, and as a result U.S.-China relations moved to the center of the international climate change negotiations as countries began to negotiate a post-Kyoto framework.

The Bali Reframing

In many ways, the 13th Conference of the Parties to the United Nations Framework Convention on Climate Change that took place in Bali in December 2007 marked a significant event in the history of the climate negotiations. The Bali Action Plan that was unanimously agreed to the day after the meetings were scheduled to conclude included a new call for action from the developing countries that had largely remained off the hook in previous negotiations. In addition, the Plan left a door open for the United States to re-enter the next round of a treaty with a new commitment.

While no concrete steps were agreed to in Bali, the Conference of the Parties (COP) launched a post-2012 negotiation process which for the first time allowed for the consideration of "nationally appropriate mitigation actions" (NAMAs) by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity building, in a measurable, reportable and verifiable manner" (UNFCCC, 2007). These words marked the first opening for discussing enhanced developing country action, and possibly commitments.

Another notable occurrence that became evident in Bali was the beginning of a break in unity among the G-77 nations. Historically, the developing world has stood united as a negotiating block. Such a block gives small countries power in numbers, while allowing large countries like China to avoid being singled out to take on mitigation actions perhaps more in line with its contribution to the problem. As some developing countries show increased willingness to take on additional mitigation actions, the pressure for others to follow suit rises. In Bali, several of the nations that are home to the world's tropical rainforests, and as a result a large portion of global forestry related greenhouse gas emissions, began coming forward with proposals to take on voluntary targets to slow deforestation rates. Several of the OECD "developing" countries including Mexico, South Korea and South Africa, also began to show openness to taking on additional actions, and since Bali their positions have evolved even further. As a result, at this stage in the negotiations it was common to see fingers pointed at China and India as the two largest developing country emitters of fossil fuel related greenhouse gas emissions that had yet to come forward with meaningful international pledges or commitments. This caused India to try to distinguish and to distance itself from China and avoid the pressures that China was beginning to face in the international arena.

Bali also allowed for the further elaboration of possible forms of mitigation actions for developing countries. Parties examined alternatives to the "Quantified Emission Limitation and Reduction Obligations" (QELRO or "QUERLOs") that had dominated the discussions in Kyoto for commitments from developed countries. Targets that would change with economic situation were discussed, including intensity-based targets—either measured as energy consumption or carbon emissions per unit of gross domestic product. Also discussed were targets that would cover only a portion of the economy, for example specific sectors like the electric power or the cement sector. Also discussed were policies and measures as a format for an international commitment, revising pre-Kyoto discussions of "Policies and Measures" (PAMs) but this time for developing rather than for developed countries. Discussions also explored how such actions could be coupled with financing, technology and capacity building as the Bali Action Plan specified, including ideas for multilateral technology funds, and for using carbon markets to credit reductions made by policy or sectoral commitments in developing countries.

Chaos in Copenhagen

As countries prepared for the climate talks in Copenhagen,[6] there were many big issues on the table, and by the 2008 negotiations in

Poznan it appeared as if there were too many to be resolved by December 2009. Countries that had targets under the Kyoto Protocol were to commit to a new round for the post-2012 period. The role that emerging economies would play had to be defined, along with the role of the now multi-billion dollar carbon offset regime, the Clean Development Mechanism (CDM), and deforestation.[7] And then there was the issue of how the United States, unlikely to ratify the Kyoto Protocol, would rejoin the new treaty.[8]

A full six and a half weeks of negotiations were held between March and November of 2009 to help countries prepare for Copenhagen, but the discussions moved slowly even with the looming deadline. As many negotiators realized that finalizing a new legally binding international treaty in Copenhagen was highly unlikely, political leaders began to lower expectations, calling instead for a political agreement (Todd, 2009). The negotiations were able to produce a political agreement now known as the Copenhagen Accord. Expectations of many observers around the world remained higher than political reality was prepared to deliver, however, leading to widespread disappointment following the conclusion of the meeting (Vidal et al, 2009; "Copenhagen Accord is branded," 2009).

While the role that the United States and China would play in the Copenhagen talks was expected to be important for the reasons discussed above, few realized how pivotal the negotiations between the two countries would be. By the close of the first week of negotiations, many remaining fundamental disagreements between the United States and China were coming to light. The two emerging make-or-break issues for the United States and China were funding commitments of developed countries to support mitigation and adaptation efforts in developing countries, and transparency surrounding the reporting of emissions.

The issue of financing began to heat up on the third day of the negotiations when Todd Stern, the U.S. Special Envoy on Climate Change, commented that he did not "envision public funds, certainly not from the United States, going to China," launching a bevy of media headlines such as "Envoy Says U.S. Won't Pay China to Cut Emissions," "U.S. Rules Out Climate Aid to China," and even "Summit Is Seen as U.S. Versus China" (Torello, 2009; Ward & Harvey, 2009; Ball, 2009). This comment elicited a response from China's lead negotiator, He Yafei, who alluded to Stern's lack of common sense and irresponsibility (Bom, 2009), inciting even more theatrical headlines such as: "China lashes out at U.S. Climate Conference," "China 'shocked' by U.S. climate stance," and "A China-U.S. Smackdown at Copenhagen?" (Winter, 2009; Harvey & Chaffin, 2009; Corn, 2009).

The *Financial Times* reported that in a follow-up interview with He, that China "had abandoned its demand for funding from the developed world to combat climate change," calling it "the first apparent concession by a major player at the Copenhagen talks" (Harvey, 2009). This report was not, however, supported by further clarifications made by He in response to the article, where he emphasized that China understands and values the special concerns of the least developed countries (LDCs), small island nations, and African countries and supports the priority access of these countries to climate funds from developed countries. He also said that while China has been willing to take action on climate change based on its own resources, it would do a better job if it had international support ("Chinese side concedes assistance," 2009). It should be noted that throughout this exchange, no substantial money was put on the table by the United States, so the posturing was purely hypothetical.

The conversation at Copenhagen shifted from the hypothetical to the tangible by the middle of the second week of negotiations. The funding conversation had abated just as discussions over the measurement, reporting and verification (MRV) of emissions pledges was heating up. The issue at hand was how developing country emissions mitigation actions taken domestically would be reported to the international community, and subsequently be subject to some form of international verification. Currently, developing countries only report their greenhouse gas emissions trends if they decide they have the resources to do so, which for many countries—including China—has led to highly infrequent, outdated emissions inventories.9 On Wednesday of the second week, Senator John Kerry gave a public speech explaining that the ability to verify that China, India and other countries achieve promised emission cuts is key to passing climate legislation in the U.S. Senate. Then the following day, Secretary of State Clinton joined the talks by announcing that the United States was prepared to work with other countries to jointly mobilize "$100 billion a year by 2020 to address the climate change needs of developing countries…in the context of a strong accord in which all major economies stand behind meaningful mitigation actions and provide full transparency as to their implementation" (Clinton, 2009).

Clinton's announcement in many ways was the final card that the United States had to play to remove the pressure it faced to deliver its part of a climate change agreement. It had now delivered both a target and funding (or at least the promise of both), shifting attention back towards China just as the heads of state were arriving in Copenhagen. Leaders who had arrived early worked on difficult negotiations that in the past were reserved for lower-level bureaucrats. During President Obama's day in Copenhagen he met several times with a group of about 20 countries comprised mainly of world leaders, but Premier Wen did not attend.[10] After this widely reported diplomatic snub from China, and when things did not seem to be progressing, President Obama reportedly tracked down Premier Wen, who was with leaders from Brazil, South Africa, and India, and joined their meeting. It was among these five countries that the deal was struck, which was then brought back to the larger group, and is now known as the Copenhagen Accord.

By the end of the Copenhagen negotiations it was clear that several things had changed since it had begun. First, not only had the developed-developing country divide begun to blur with the introduction of an accord that pledged emissions targets from members of both groups, but the developing countries of the "G-77," who up until the 11th hour had made great efforts to present a unified front before the larger developed countries, had clearly fractured in their positioning when it came to their support of the Accord.11 Second, China's role—not just in the climate negotiations, but also perhaps in the world—had shifted. While China may no longer wield the power it once did now that the G-77—which used to both side with and shield China—is fracturing,12 there was no question of China's power in the final hours of the negotiations when world leaders, including the President of the United States, struggled to get the ear of the Chinese negotiators (Lynas, 2009).13 Third, the ability of the UN climate negotiations to deliver a viable international climate treaty has been called into question. The fact that the 190-plus countries could not reach consensus on what is arguably the most significant international climate change deal to ever emerge from the UN process raises serious

The international negotiations are full of political posturing and colorful displays of diplomatic rhetoric camouflaging fundamental disagreements on the state of the world.

questions about the viability of the UN as a forum for developing the next stage in what eventually must become a legally binding, functional and effective international climate change agreement.

RECONCILING NATIONAL PERSPECTIVES ON MULTILATERAL AND BILATERAL ENGAGEMENT

Multilateral Perspectives

China is increasingly becoming a world power, and with that title comes a new era of global responsibility. A long proponent of multilateralism, China has been increasing its engagement and its seniority in various multilateral forums, including the United Nations. China has frequently called for a global climate solution to be reached under the UN umbrella, rather than in a smaller forum. Despite its elevated status and the important role it plays as a regional leader within Asia, China's reluctance to be a global leader has been reflected in climate negotiations.

The United States has played the role of a global leader in many forums for decades; however, in recent years it has been more hesitant to engage multilaterally, preferring instead smaller forums like the G8 or the G20. The United States has convened a smaller group of countries for climate talks in its Major Economies Forum[14] to supplement the United Nations discussions. Meetings of smaller groups of key countries can be a more effective way of working through challenging climate issues than trying to find agreement across the hundreds of UN member countries. In the UN process, however, many countries look to the United States for international leadership. A truly global climate solution will require a restructuring of entire economies and energy systems, and few if any countries will be willing to embark on this difficult journey if the United States does not seem willing to lead the way.

U.S.-China relations on climate change had been quite strong going into Copenhagen, bolstered by the series of high-level bilateral meetings in November 2009 that had led to the signing of multiple agreements. It was not a coincidence that the signing of these bilateral agreements occurred just days before the start of the Copenhagen talks. In Copenhagen, however, remaining points of disagreement on both sides came to light during the meetings, and U.S. and Chinese negotiators found themselves increasingly in contention.[15] In the end, several topics on which the United States and China could not agree threatened the viability of an international agreement, including the measurement, reporting and verification (MRV) of national mitigation actions and agreement on a long-term global mitigation target.

While some disagreements, such as over a long-term emissions reduction target,[16] were anticipated, U.S. negotiators were surprised by contention over issues they believed had been resolved in the bilateral discussions of the previous year. Much progress had been made on the "MRV" issue in, for example, the discussions that led to the signing of the Memorandum of Cooperation to Build Capacity to Address Climate Change between the U.S. EPA and China's NDRC. The MRV issue is sensitive for China, not only because of its longtime concerns about data quality (Lee, 2009) that have resulted in embarrassing confrontations,[17] but also because of the precedent that international verification sets for the negotiations going forward. While it was important to U.S. negotiators that China agreed to the international verification of its emissions pledges so that they could report back to Congress that China was now internationally accountable for its mitigation actions, they also wanted to eliminate as much differentiation as possible between the verification procedures applied to developed and developing countries. While it can be argued that China got much of what it seemed to want from the Copenhagen deal (Wong, 2009), China was not completely satisfied with the result of the meeting, particularly with the concessions it made on the topic of MRV.

There are several reasons why China's stance in this round of multilateral negotiations did not always reflect its position in the recent bilateral discussions with the United States. The international negotiations are full of political posturing and colorful displays of diplomatic rhetoric camouflaging fundamental disagreements on the state of the world. Another factor, however, was perhaps the remaining skepticism in China about the willingness of the United States to take strong actions to transition to a low carbon economy, given the lack of concrete actions in this direction. As a result, China was unwilling to concede too much when, from their perspective, so little action was on the table. In addition, while the Obama administration had made up for a lot of lost time with China on climate change relations, it had only been at it for a year. The Chinese leadership is no doubt still trying to figure out the Obama administration, and despite the numerous trips made by U.S. officials to Beijing this past year, few of the officials making those trips had strong relationships in China to build upon.

China, for many reasons, plays a very different role in the multilateral context than it does in a bilateral one. In a bilateral discussion with the United States, China wants to be seen as an equal, and as the global superpower that it has become. In the multilateral climate negotiations, however, China time and again has served in the role of spokesperson for the developing world. The relationship between China and the G-77 is a complex but symbiotic one. At the most basic level, the smaller developing countries are heard more loudly by the larger, developed countries when they speak in a common voice, and even more loudly when China is the spokesperson. China too benefits from being aligned with the many developing countries that experience similar challenges of poverty alleviation and economic development, rather than being singled out as the largest emitter in the world. Moreover, the growing economic interdependence between China and many African nations and strong geopolitical alliances between China and the socialist developing nations are playing an increasingly important role in defining China's relationship with the rest of the developing world (Crowe, 2009; Erikson & Minson, 2006).

Bilateral Perspectives

The tendency of the United States to deal directly with or in small groups of countries, rather than via the UN process, has led to a discussion of a new global group being formed: the G2, consisting of the United States and China. Since the United States is seen as the leader of today, and China as the leader of tomorrow, many believe such a grouping is well suited.

President Obama has called the relationship between the United States and China "as important as any bilateral relationship in the world" (White House, 2009a). From a U.S. perspective, it could be much simpler to work out a deal on climate change with China directly, and in doing so could ensure that it is on the same page with its major global trading partner and the world's largest emitter. There are many commonalities in dealing with climate change that the United States and China face, as discussed previously, that lend to fruitful opportunities for collaboration. In addition, direct bilateral agreements eliminate some of the concerns about trust and transparency that emerge in larger groupings.

One key problem with the G2 approach, however, is China's aversion to the idea. As one Chinese scholar stated recently, a "Pax Chimericana would invite international hostility, be impossible for China to sustain politically, undermine the United Nations and contradict its government's commitment to multilateralism" (Jian, 2009; Gillespie, 2009). While the U.S.-China relationship is symbiotic, it is asymmetrical, as China is an unevenly developed state. The G2 approach to climate change in particular conflicts with China's aversion to being singled out as a major emitter.

China is not the only country opposed to the G2 concept; many in the EU have expressed concern with being left out of such discussions, particularly as they relate to climate change, fearing that the United States and China will negotiate their own climate agreement and leave the rest of the world behind. The United States and EU are also aware that too much focus on China risks alienating other Asian states, including India. China is also a constructive participant in the ASEAN networks that have served to enhance Asian autonomy from the United States (Gillespie, 2009). The majority of the developing world is also averse to a G2 approach to climate change, recognizing that the success of an international climate regime that includes financing for mitigation and adaptation will require the active engagement of the United States and China.

While direct bilateral engagement between the United States and China cannot replace the participation of both countries in an international climate change agreement, such a partnership may be crucial to facilitating international talks. Bilateral forums provide important opportunities for the concrete demonstration of commitment through the establishment of joint projects and initiatives with tangible deliverables. They can focus on issues that are less politicized than climate change, such as clean energy, and can build bridges between government agencies and researchers outside of the diplomatic services of both countries.

Even a successful foundation of bilateral agreements between the United States and China appeared to have had little bearing on the discussions in Copenhagen—even the bilateral discussions—when 192 other countries were in the building. As a result, the discussions that President Obama held with Premier Wen in Copenhagen were far less positive than those he had a few weeks earlier with President Hu in Beijing. This reality illustrates the limits of bilateral discussions in moving the multilateral climate debate.

AN OUTLOOK FOR THE FUTURE

The conversation between the United States and China on climate change is in many ways just beginning. While bilateral activities have been in place for decades, and both countries are playing an increasingly central role in the multilateral climate negotiations, the role that both countries will play in the global climate change solution is just starting to be defined. Both countries have taken positive steps at home to promote low carbon energy sources and increase energy efficiency. Neither country, however, has adopted economy-transforming, mandatory restrictions on carbon emissions.

There clearly can be no solution to global climate change without the United States and China, and such a solution will depend on the ability of these two countries to see eye to eye. It will take them many years to build the trust needed to overcome their differences on this issue, to develop and adopt low-carbon technologies, and to transform their economies. As the entire world looks to the United States and China to make a move, the fate of the global climate system remains in their hands.

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Table 1. Timeline of US-China Clean Energy Climate Change Cooperation

Year	Name	Actors	Purpose
1979	Scientific and Technology Cooperative Agreement	Official bilateral governmental agreement established by President Carter and Vice Premier Deng Xiaoping	Began with a focus on high-energy physics and then served as an umbrella for 30 subsequent bilateral environment and energy protocols. Extended for 5 years in 1991.
1979	MOU for Bilateral Energy Agreements	U.S. DOE and the China State Development Planning Commission (SDPC)	Led to 19 cooperative agreements on energy, including fossil energy, climate change, fusion energy, energy efficiency, renewable energy, peaceful nuclear technologies, and energy information exchange.
1979	Atmosphere and Science and Technology Protocol	NOAA and Chinese Meteorological Administration	Promotes bilateral exchange on climate and oceans data, research, and joint projects.
1983	Protocol on Nuclear Physics and Magnetic Fusion	DOE and State Science and Technology Commission (SSTC)	Pursues the long-term objective to use fusion as an energy source.
1985, 2000. 2005-2010	Protocol on Cooperation in the Field of Fossil Energy Research and Development (the Fossil Energy Protocol)	DOE and Ministry of the Coal Industry (later Ministry of Science and Technology/MOST)	The first major bilateral agreement on fossil energy. Now includes 5 annexes: power systems, clean fuels, oil and gas, energy and environment technologies, and climate science. Protocol is managed by the Permanent Coordinating Group including members of both countries.
1987	Annex III to the Fossil Energy Protocol Cooperation in the Field of Atmospheric Trace Gases	DOE and Chinese Academy of Science (CAS)	Cooperative research program on the possible effects of CO_2 on climate change.

1988	Sino-American Conference on energy demand, markets and policy in Nanjing	Lawrence Berkeley National Laboratory (LBNL)/DOE and State Planning Commission (SPC)/Energy Research Institute (ERI)	Informal bilateral conference on energy efficiency that led to an exchange program between ERI and LBNL, and the first assessment of China's energy conservation published by LBNL in 1989.
1992	U.S. Joint Commission on Commerce and Trade	US Department of Commerce (DOC)	Facilitate the development of commercial relations and related economic matters between the U.S. and China. The JCCT's Environment subgroup supports technology demonstrations, training workshops, trade missions, exhibitions and conferences to foster environmental and commercial cooperation.
1993	U.S. Commercial Mission to China	DOE and DOC	For U.S. companies to promote their electric power technology services in China. Industry representatives identified a potential for $13.5 billion in U.S. electric power exports between 1994-2003 (not including nuclear power), equating to 270,000 high-salary U.S. jobs and an opportunity for introducing cost-effective, environmental sound U.S. technologies into China's electric power industry.
1993	Establishment of the Beijing Energy Efficiency Center (BECon)	ERI, LBNL, Pacific Northwest National Laboratory (PNNL), WWF, EPA, SPC, SETC, SSTC	The first nongovernmental, nonprofit organization in China focusing on promoting energy efficiency by providing advice to central and local government agencies, supporting energy efficiency business development, creating and coordinating technical training programs, and providing information to energy professionals.
1994	Annexes to the fossil energy protocol	DOE and SSTC	(1) To make positive contributions towards improving process and equipment efficiency, reduce atmospheric pollution on a global scale, advance China's Clean Coal Technologies Development Program, and promote economic and trade cooperation beneficial to both parties. (2) Cooperation in coal-fired magnetohydrodynamic (MHD) power generation.

1994	China's Agenda 21 Document Released	SSTC and China's National Climate Committee	Lays out China's request for international assistance on environmental issues. The U.S. agreed to support China through DOE's Climate Change Country Studies and Support for National Actions Plans programs.
1995	Series of DOE bilateral agreements signed by Secretary of Energy Hazel O'Leary	***Bilateral agreements on energy between DOE and ministries as noted below:*** (1) MOU on bilateral energy consultations (with SPC) (2) Research on reactor fuel (with China Atomic Energy Authority) (3) Renewable energy (with Ministry of Agriculture) (4) Energy efficiency development (with SSTC) (5) Renewable energy technology development (with SSTC) (6) Coal bed methane recovery and use (with Ministry of the Coal Industry) (7) Regional climate research (with the China Meteorological Administration) ***Also established:*** • Plan for mapping China's renewable energy resources (with SPC) • Strategies for facilitating financing of U.S. renewable energy projects in China (with SPC, Chinese and U.S. Ex-Im Banks) • Discussions for reducing and phasing out lead in gasoline in China (DOE & EPA with China's EPA & SINOPEC)	
1995 (some annexes in 1996)	Protocol for Cooperation in the Fields of Energy Efficiency and Renewable Energy Technology Development and Utilization	DOE and various ministries	This Protocol has seven annexes that address policy; rural energy (Ministry of Agriculture); large-scale wind systems (with SEPA); renewable energy business development (with SETC) and geothermal energy; energy efficiency (with SPC); and hybrid-electric vehicle development. Ten teams of Chinese and U.S. government and industry representatives work under this protocol focusing on: energy policy, information exchange and business outreach, district heating, cogeneration, buildings, motor systems, industrial process controls, lighting, amorphous core transformers, and finance.
1995-2000	Statement of Intent for Statistical information exchange (later became a Protocol)	DOE and China's National Bureau of Statistics (NBS)	Consisted of five meetings to discuss energy supply and demand and exchange information on methods of data collection and processing of energy information.
1997	U.S.-China Forum on Environment & Development	Established by Vice President Al Gore and Premier Li Peng	Venue for high-level bilateral discussion on sustainable development. Established four working groups: energy policy, commercial cooperation, science for sustainable development, and environmental policy. Three priority areas for cooperative work: urban air quality; rural electrification; and clean energy and energy efficiency.

1998-ongoing	Agreement of Intent on Cooperation Concerning Peaceful Uses of Nuclear Technology	DOE and SPC	Paved the way for the exchange of information and personnel, training and participation in research and development in the field of nuclear and nuclear nonproliferation technologies.
1997	Energy and Environment Cooperation Initiative (EECI)	DOE and SPC	Targeted urban air quality, rural electrification and energy sources, and clean energy sources and energy efficiency. Involved multiple agencies and participants from business sectors, and linked energy development and environmental protection.
1997	U.S.-China Energy and Environmental Center	Tsinghua University and Tulane University, with DOE and SSTC/MOST	An initiative centered at Tsinghua and Tulane Universities co-funded by DOE and MOST to: (1) provide training programs in environmental policies, legislation and technology; (2) develop markets for U.S. clean coal technologies; and (3) help minimize the local, regional and global environmental impact of China's energy consumption.
1998	Joint Statement on Military Environmental Protection	U.S. Secretary of Defense and Vice-Chairman of Chinese Central Military Commission	MOU provides for the exchange of visits by high-level defense officials and the opening of a dialogue on how to address common environmental problems.
1999	U.S.-China Forum on Environment & Development	The U.S. Ex-Im Bank, DOE, the China Development Bank, and the SDPC	The second meeting of the Forum in Washington, co-chaired by Vice President Al Gore and Premier Zhu Rongji. Two key agreements that came out of the meeting related to renewable energy included a MOU for the establishment of a $100 Million Clean Energy Program to accelerate the deployment of clean U.S. technologies to China in the area of energy efficiency, renewable energy, and pollution reduction, and a Statement of Intent on Cleaner Air and Cleaner Energy Technology Cooperation that focused on energy efficiency improvements in industrial coal-fired boilers; clean coal technology; high-efficiency electric motors; and grid-connected wind electric power.
1999-2000	Fusion Program of Cooperation	DOE and CAS	Plasma physics, fusion technology, advanced design studies and materials research.
2002-2003	U.S.-China Fusion Bilateral Program	DOE and CAS	Plasma physics, fusion technology and power plant studies.
2003	FutureGEN	DOE with many international partners	Initially a planned as a demonstration project for an Integrated Gasification Combined Cycle (IGCC) Coal plant with carbon capture and sequestration (CCS), the project was significantly restructured in January 2008 and now may provide federal funding to support CCS on a privately funded IGCC or PC plant , though the timeframe is highly uncertain.

2004	U.S.-China Energy Policy Dialogue	DOE and NDRC	Resumed the former Energy Policy Consultations under the 1995 DOE-SPC MOU. Led to a MOU between DOE and NDRC on Industrial Energy Efficiency Cooperation and includes energy audits of up to 12 of China's most energy-intensive enterprises, as well as training and site visits in the U.S. to train auditors.
2004	U.S.-China Green Olympic Cooperation Working Group	DOE, Beijing Government	Included opportunities for DOE to assist China with physical protection of nuclear and radiological materials and facilities for the Beijing Olympics as done in Athens.
2006	Asia-Pacific Partnership on Clean	U.S., China + India, Japan, Korea, Australia (later Canada)	Created public-private task forces around specific sectors: Aluminum, Buildings and Appliances, Cement, Cleaner Use of Fossil Energy, Coal Mining Power Generation and Transmission, Renewable Energy and Distributed Generation, and Steel
2006	U.S.-China Strategic Economic Dialogue (SED)	U.S. Treasury Secretary Henry Paulson and Vice Premier Wu Yi. Includes DOE, EPA, NDRC, MOST	Bi-annual, cabinet level dialogue that includes an energy and environment track.
2007	MOU on Cooperation on the Development of Biofuels	USDA and NDRC	Encourages cooperation in biomass and feedstock production and sustainability; conversion technology and engineering; bio-based product development and utilization standards; and rural and agricultural development strategies.
2007	U.S.-China Bilateral Civil Nuclear Energy Cooperative Action Plan	DOE and NDRC	To compliment discussions under the Global Nuclear Energy Partnership (GNDP) towards the expansion of peaceful, proliferation-resistant nuclear energy for greenhouse gas emissions-free, sustainable electricity production. Bilateral discussions include separations technology, fuels and materials development, fast reactor technology and safeguards planning.
2007	U.S.-China Westinghouse Nuclear Reactor Agreement	DOE, State Nuclear Power Technology Corporation (SNPTC)	DOE approved the sale of four 1,100-megawatt AP-1000 nuclear power plants which use a recently improved version of existing Westinghouse pressurized water reactor technology. The contract was valued at $8 billion and included technology transfer to China. The four reactors are to be built between 2009 and 2015.

2008	Ten Year Energy & Environment Cooperation Framework (SED IV)	DOE, Treasury, State, Commerce, EPA, NDRC, State Forestry Administration, National Energy Administration (NEA), Ministry of Finance, Ministry of Environmental Protection (MEP), MOST, and MFA	Establishes five joint task forces on the five functional areas of the framework: (1) clean efficiency and secure electricity production and transmission; (2) clean water; (3) clean air; (4) clean and efficient transportation; and (5) conservation of forest and wetland ecosystems.
2009	U.S.-China Strategic & Economic Dialogue	US Department of State and Department of Treasury, China Ministry of Foreign Affairs,	In April 2009 the SED was re-branded as the Strategic and Economic Dialogue (S&ED), with the State and Treasury Departments now co-chairing the dialogue for the United States. Treasury Secretary Timothy F. Geithner and Secretary of State Hillary Rodham Clinton were joined for the first Dialogue in July 2009 by their respective Chinese Co-Chairs, State Councilor Dai Bingguo and Vice Premier Wang Qishan, to cover a range of strategic and economic issues. The S&ED was convened again in Beijing in May 2010.
2009	Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and the Environment This MOU is to be implemented via the existing Ten-Year Energy and Environment Cooperation Framework, and a newly established Climate Change Policy Dialogue, as well as new agreements forthcoming.	DOE, State and NDRC	To strengthen and coordinate respective efforts to combat global climate change, promote clean and efficient energy, protect the environment and natural resources, and support environmentally sustainable and low-carbon economic growth. Both countries resolve to pursue areas of cooperation where joint expertise, resources, research capacity and combined market size can accelerate progress towards mutual goals. These include, but are not limited to: • Energy conservation and energy efficiency • Renewable energy • Cleaner uses of coal, and carbon capture and storage • Sustainable transportation, including electric vehicles • Modernization of the electrical grid • Joint research and development of clean energy technologies • Clean air • Clean water • Natural resource conservation, e.g. protection of wetlands and nature reserves • Combating climate change and promoting low-carbon economic growth

2009	Climate Change Policy Dialogue	Representatives of the two countries' leaders (TBD)	The United States and China will work together to further promote the full, effective and sustained implementation of the United Nations Framework Convention on Climate Change. The dialogue will promote: (1) discussion and exchange of views on domestic strategies and policies for addressing climate change; (2) practical solutions for promoting the transition to low-carbon economies; (3) successful international negotiations on climate change; (4) joint research, development, deployment, and transfer, as mutually agreed, of climate-friendly technologies; (5) cooperation on specific projects; (6) adaptation to climate change; (7) capacity building and the raising of public awareness; and (8) pragmatic cooperation on climate change between cities, universities, provinces and states of the two countries.
2009	Memorandum of Cooperation to Build Capacity to Address Climate Change	EPA and NDRC	In support of the MOU to Enhance Cooperation on Climate Change, Energy and the Environment, this five-year agreement includes: (1) capacity building for developing greenhouse gas inventories; (2) education and public awareness of climate change; (3) the impacts of climate change to economic development, human health and ecological system, as well as research on corresponding countermeasures; and (4) other areas as determined by the participants.
2009	U.S.-China Joint Commission on Commerce and Trade	Co-chaired by U.S. Dept of Commerce Secretary Gary Locke, U.S. Trade Representative Ron Kirk, Chinese Vice Premier Wang Qishan, with participation from many ministries/agencies from both countries	The Commission met in October 2009 in Hangzhou, China, and reached multiple agreements in many sectors, including, in the clean energy sector for China to remove its local content requirements on wind turbines.
2009	U.S.-China Clean Energy Research Center	DOE, MOST, NEA	First announced in July 2009 during U.S. Department of Energy Secretary Steven Chu's visit to Beijing and finalized during the November 2009 Presidential Summit, the Center will facilitate joint research and development of clean energy technologies by teams of scientists and engineers from the United States and China, as well as serve as a clearinghouse to help researchers in each country. The Center will be supported by public and private funding of at least $150 million over five years, split evenly between the two countries. Initial research priorities will be building energy efficiency, clean coal including carbon capture and storage, and clean vehicles.
2009	U.S.-China Electric Vehicles Initiative	DOE, MOST, NEA	Announced during the November 2009 Presidential Summit and building on the first-ever US-China Electric Vehicle Forum in September 2009, the initiative will include joint standards development, demonstration projects in more than a dozen cities, technical roadmapping, and public education projects.

2009	U.S.-China Energy Efficiency Action Plan	DOE, MOST, NEA	Announced during the November 2009 Presidential Summit, the plan calls for the two countries to work together to improve the energy efficiency of buildings, industrial facilities, and consumer appliances. U.S. and Chinese officials will work together and with the private sector to develop energy efficient building codes and rating systems, benchmark industrial energy efficiency, train building inspectors and energy efficiency auditors for industrial facilities, harmonize test procedures and performance metrics for energy efficient consumer products, exchange best practices in energy efficient labeling systems, and convene a new U.S.-China Energy Efficiency Forum to be held annually, rotating between the two countries. The first meeting was held in China late May 2010.
2009	U.S.-China Renewable Energy Partnership	DOE, MOST, NEA	Announced during the November 2009 Presidential Summit, the Partnership calls for the two countries to develop roadmaps for widespread renewable energy deployment in both countries. The Partnership will also provide technical and analytical resources to states and regions in both countries to support renewable energy deployment and will facilitate state-to-state and region-to-region partnerships to share experience and best practices. A new Advanced Grid Working Group will bring together U.S. and Chinese policymakers, regulators, industry leaders, and civil society to develop strategies for grid modernization in both countries. A new U.S.-China Renewable Energy Forum will be held annually, rotating between the two countries. The first was held in China late May 2010.
2009	21st Century Coal	DOE, MOST, NEA	Announced during the November 2009 Presidential Summit, the two Presidents pledged to promote cooperation on cleaner uses of coal, including large-scale carbon capture and storage (CCS) demonstration projects. Through the new U.S.-China Clean Energy Research Center, the two countries are launching a program of technical cooperation to bring teams of U.S. and Chinese scientists and engineers together in developing clean coal and CCS technologies. The two governments are also actively engaging industry, academia, and civil society in advancing clean coal and CCS solutions.

2009	Shale Gas Resource Initiative	DOE, MOST, NEA	Announced during the November 2009 Presidential Summit, this shale gas initiative will use experience gained in the United States to assess China's shale gas potential, promote environmentally sustainable development of shale gas resources, conduct joint technical studies to accelerate development of shale gas resources in China, and promote shale gas investment in China through the U.S.-China Oil and Gas Industry Forum, study tours, and workshops.
2009	U.S.-China Energy Cooperation Program	A public-private partnership, including 22 companies as founding members, including Peabody Energy, Boeing, Intel and GE.	Announced during the November 2009 Presidential Summit, the U.S.-China Energy Cooperation Program (ECP) will leverage private sector resources for project development work in China across a broad array of clean energy projects on renewable energy, smart grid, clean transportation, green building, clean coal, combined heat and power, and energy efficiency.
2010	U.S.-China Strategic & Economic Dialogue	U.S. Department of State and NDRC/NEA	26 specific outcomes were produced by the second round of the S&ED under the Strategic Track alone. Key outcomes addressing energy and climate issues specifically included MOUs on nuclear safety cooperation, EcoPartnerships, and Shale Gas; a joint statement on energy security; and three clean energy forums held each year.
2010	U.S.-China Energy Efficiency Forum	NEA/NDRC, MIIT, DOE/LBNL/ORNL/FERC, private sector participants	This first meeting of this Forum (established in the 2009 U.S.-China Energy Efficiency Action Plan) included the signing of an MOU on industrial energy efficiency between Lawrence Berkley National Laboratory, Oak Ridge National Laboratory and the University of Science and Technology, Beijing.
2010	U.S.-China Renewable Energy Forum	NEA/NDRC, DOE/NREL/FERC, private sector participants	The first meeting of this forum that was established in the 2009 U.S.-China Renewable Energy Partnership included a significant focus on potential cooperation opportunities between U.S. and Chinese renewable energy companies. The forum was followed by technical discussions that established three working groups on renewable energy, including: (1) planning, analysis and coordination; (2) wind technology; and (3) solar technology.
2010	U.S.-China Advanced Biofuels Forum	NEA/NDRC, DOE/NREL, private sector participants	The 8 MOUs signed under this forum focus on private sector partnerships in advanced biofuels research and deployment. Private sector partnerships include: Boeing and PetroChina jointly developing a sustainable aviation biofuels industry in China; an expanded research collaboration between Boeing Research & Technology and the Qingdao Institute of Bioenergy and Bioprocess Technology on algae-based aviation biofuel development; and an inaugural flight using biofuel derived from biomass grown and processed in China conducted by Air China, PetroChina, Boeing and Honeywell.

Sources: Asia Society & Pew Center, 2009; Price, 2008; Baldinger & Turner, 2002; DOE, 2006, 2008, 2009a, 2009b, 2009c, 2009d, 2009e, 2009f, 2009g, 2009h, 2009i, 2009j, 2010; State 2008, 2009, State, 2010; USTR, 2009; Treasury, 2008, 2009; White House Press Office, 1999, 2009a, 2009b.

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ENDNOTES

[1] Based on revised GDP figures for 2008 released by the National Bureau of Statistics at the end of 2009. Previously, a 4.59 percent decline in energy intensity had been reported for 2008 (Levine and Price, 2009).

[2] For more details on the restructuring of FutureGen see DOE, 2006 and DOE, 2008.

[3] The requirement for a purchase of international reserve allowances amounts to a carbon allotment associated with the amount of carbon embedded in the imported product on a per unit basis. These border adjustments specifically target greenhouse gas-intensive products including iron, steel, aluminum, cement, bulk glass, and paper.

[4] The Convention divides countries into groups according to differing commitments. Annex I Parties include the industrialized countries that were members of the OECD (Organization for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.

[5] The Berlin Mandate initiated a process to enhance the commitments of Annex I countries under the UNFCCC, but explicitly states that such a process will not introduce any new commitments for Parties not included in Annex I.

[6] The Copenhagen conference was officially the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change and the 5th Meeting of the Parties to the Kyoto Protocol (COP 15, COP/MOP 5).

[7] Referred to in the UN climate negotiations as REDD – "Reducing Emissions from Deforestation and Forest Degradation in Developing Countries."

[8] Among other important topics on the table included adaptation and technology transfer.

[9] The UNFCCC states "All Parties must report on the steps they are taking or envisage to undertake to implement the Convention (Articles 4.1 and 12). In accordance with the principle of 'common but differentiated responsibilities' enshrined in the Convention, the required contents of these national communications and the timetable for their submission is different for Annex I and non-Annex I Parties. Each non-Annex I Party shall submit its initial national communication within three years of the entry into force of the Convention for that Party, or of the availability of financial resources (except for the least developed countries, who may do so at their discretion)" (UNFCCC, 2009b). China's first and only national communication was submitted in 2004 and contained an outdated national emissions inventory from 10 years earlier (PRC, 2004).

[10] According to many reports, at the first session of the "leaders' meeting," He Yafei, the Vice Minister of Foreign Affairs, represented China, and later Yu Qingtai, the Special Representative for the Climate Change Negotiations, was sent even though Premier Wen Jiabao was in the building.

[11] In the wee hours of the negotiations, it became clear that while a handful of developing countries including Sudan, Venezuela and Bolivia did not support the accord, most did, including the members of the African Union, and the Alliance of Small Island States (AOSIS). While Brazil, India, China and South Africa were quiet during the late night plenary discussion, these countries' leaders had all reportedly agreed to the accord before it was brought back to the UN plenary session, so their support was assumed.

[12] As Yang Ailun, Manager of Greenpeace China's Climate and Energy Program, put it, the "cry of the most vulnerable developing countries for China to take more responsibility" caught China by surprise and "all of a sudden, the hat of 'developing country' was no longer such a convenient fit" (Yang, 2009).

[13] In the weeks following COP 15, it was further reported that the Chinese negotiating team had been internally divided in the final hours of the talks resulting in several uncharacteristic outbursts, though there was no evidence of any officials suffering any major repercussions from these actions.

[14] Formerly called the Major Economies Meeting under the Bush administration, it was renamed the Major Economies Forum by the Obama administration.

[15] While the government officials that lead the multilateral negotiations are not always the same ones who lead the bilateral discussions, there is now a higher degree of overlap between those involved in both tracks of discussions than in the past. The more technical agencies such as MOST and DOE play a larger role in the bilateral discussions, while the State Department and NDRC lead in the climate negotiations.

[16] According to several reports, including one by Mark Lynas (2009), it was China's representative who insisted that industrialized country targets, previously agreed as an 80% cut by 2050, be taken out of the deal.

[17] For example, in 2007 when the Netherlands Environment Agency announced that its researchers had calculated that China was now the largest emitter of CO_2, China's first response was that this was not true. They later realized that it was, in fact, an accurate assessment.

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FEATURE BOX

Choke Point: U.S.
Understanding the Tightening Conflict Between Energy and Water in the Era of Climate Change

By Keith Schneider and J. Carl Ganter

Energy industry executives, fortified by high prices for oil and natural gas, are investing tens of billions of dollars annually to develop oil-bearing sands and shales, and deep gas-bearing shales. The annual investment is far larger than what the nation is spending to make the transition to a clean energy economy. And each of the unconventional reserves produces more carbon emissions, uses more water, and damages more land than the conventional oil and gas reserves they are replacing.

This is one of the central findings correspondents from Circle of Blue uncovered in Choke Point: U.S., a four-month reporting project to better understand what is occurring in the places where rising energy demand collides with diminishing supplies of fresh water. Energy production is the second highest user of water among all industrial sectors. Other Choke Point: U.S. findings include:

Peak Oil: The year that "peak oil" occurs has certainly been extended and may turn out to be a less onerous problem than expected. The recoverable oil reserves contained in bitumen-saturated tar sands and oil shales amount to trillions of barrels and are greater than recoverable "conventional" reserves. Canada's tar sands are already the single largest source of exported oil to the United States, and production is increasing almost 10 percent a year. North Dakota is now the fourth largest oil- producing state because of reserves discovered in the Bakken Shale. Three years ago, North Dakota was barely in the top ten. In both places, producing this "unconventional" oil consumes billions of gallons of water, which is raising civic discontent and concerns about the security of freshwater supplies.

Carbon Capture: Carbon capture and storage technology, which is being tested in pilot projects around the world—particularly in China—and hailed as a potential fix to climate changing emissions, increases water consumption at conventional plants 40 to 90 percent.

In order to explore these and other examples of the under-examined water-energy nexus, Circle of Blue dispatched its multi-media reporters to the coal fields of southwest Virginia; the dry plains of South Dakota; the tar sands region of Alberta, Canada; the oil fields and solar generating deserts of southern California; and the biofuel production plants in the Midwest.

IMMINENT WATER DEFICIT

Circle of Blue's correspondents concluded that unless there are sharp changes in investment and direction, the transition to a clean energy economy will lead to severe water shortages from over extraction in the United States. With the exception of solar photovoltaics and wind, clean energy sources use more water per BTU generated than conventional fossil fuels and nuclear energy. In transportation fuels, every alternative—biodiesel, ethanol, shale oil and tar sands—boosts water consumption by at least

ROCHELLE, ILLINOIS, AUGUST 2010: The Illinois River Energy biofuels plant in Rochelle releases plumes of steam at sunrise. The ethanol plant processes over 40 million bushels of corn into 115 million gallons of fuel grade ethanol annually. The plant is one of hundreds around the country transforming corn into ethanol. It takes nearly 1,000 gallons of water to produce a gallon of ethanol from irrigated corn: four gallons from unirrigated corn.
Photo © J. Carl Ganter / Circle of Blue

two times, and as much as 6,500 times.

Choke Point: U.S. also raised important questions about the nation's ability to increase energy production by 40 percent to match the demand in 2050 without causing permanent damage to wide expanses of the nation's landscape and draining the nation's freshwater reserves.

The facts and insights gathered in Choke Point: U.S. point to the need to open a new national narrative on how the United States can quickly reconsider and realign much of its energy production policy and water management practices to avoid dire shortages of water and potential shortfalls in energy. None of the big energy producers or large water use sectors will be left untouched.

LAUNCHING OF CHOKE POINT: CHINA

In August 2010, Circle of Blue joined with the Wilson Center's China Environment Forum to begin the development of Choke Point: China, a companion to the Choke Point: U.S. study. This globally significant project will produce timely, original and credible front-line research, reporting and analysis about China's most important resource competition. That competition—within the urgent frame of climate change—pits China's immense and growing appetite for energy against the country's diminishing supplies of clean freshwater. The outcome of this project will be greater understanding in China, and around the world, about the consequences and opportunities of pursuing a new energy development strategy in an era of freshwater scarcity and climate change.

To see a discussion of Choke Point: U.S., please go to CEF's website (www.wilsoncenter.org/cef) to watch the September 22, 2010, meeting with Circle of Blue staff—J. Carl Ganter and Keith Schneider—who developed and edited the project, and Jeffrey J. Fulgham, chief sustainability officer and ecomagination leader at General Electric.

Circle of Blue is an international online news, science, design and convening organization that explores the global freshwater challenges. Articles, videos, photos and interactive info-graphics from Choke Point: U.S. can be found on Circle of Blue's website, www.circleofblue.org.

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金 木 水 火 土

FEATURE BOX

Advancing Clean Energy Investments in China's Electricity and Natural Gas Sector

By Diane Derby

During his visits to Beijing and Guangzhou in late May, Jon Wellinghoff, Chair of the U.S. Federal Energy Regulatory Commission, took part in a series of workshops and meetings that discussed the regulatory and policy initiatives behind energy efficiency and renewable energy programs in the United States and China.

Amid PowerPoint presentations titled "The Federal Role in Smart Grids" and "Transmission and Integration of Renewable Energy and Systems Operations," Chairman Wellinghoff spoke about recent reforms in U.S. wholesale markets that enable demand-side resources to compete against traditional supply-side resources to meet future energy needs. He also addressed how to overcome barriers to investing in what is the cheapest, most abundant, and least environmentally harmful energy resource available: efficiency.

Chairman Wellinghoff's audience included representatives of China's State Electricity Regulatory Commission, the National Development and Reform Commission, the State Grid Electric Research Institute, the State Grid Company, the China Southern Grid Company, and the Regulatory Assistance Project (RAP), which organized his visit with support from the Energy Foundation.

THE RAP ON RAP

Although not widely recognized among general audiences, the RAP acronym is well known among utility regulators and within other governmental agencies around the globe for its quiet, behind-the-scenes work in advancing policies that encourage cost-effective clean energy investments in the electricity and natural gas sectors, with particular emphasis on efficiency.

The Vermont-based non-profit has worked extensively in the United States since 1992 and in China since 1999 to provide technical and policy assistance to government officials and nongovernmental organizations. RAP recently expanded into the European Union, where its work includes contributing to the Roadmap 2050 project, and plans to initiate work in India in 2011. As advisor to the Asian Development Bank, RAP recently helped organize a two-day clean energy forum in Manila. Aided by the support of foundations and federal grants, RAP is able to provide much of its expertise at no cost to the recipient. One of RAP's supporters is ClimateWorks Foundation, which recently designated RAP as its Best Practices Network partner in the power sector.

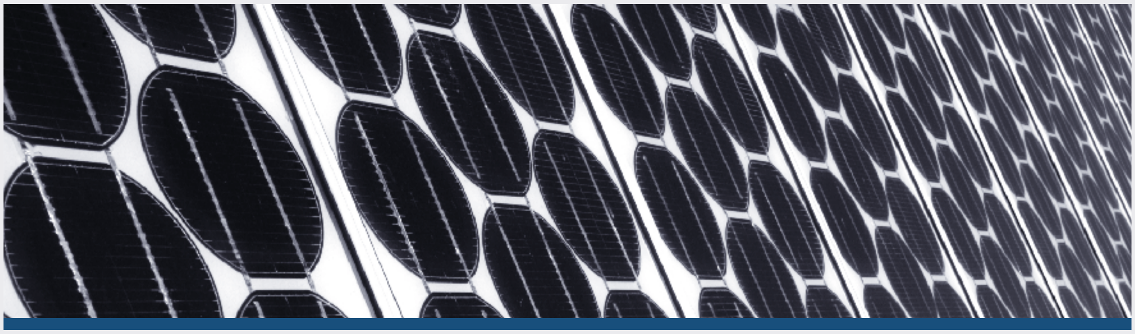
RAP defines its mission in terms of four goals: to promote economic efficiency; protect the environment; ensure system reliability; and allocate benefits fairly among consumers. In addition to offering customized technical advice and workshops, RAP publishes extensively, with its papers and presentations readily available for download from its website, www.raponline.org. Recent topics include smart grid, wind power, demand-side management (DSM), air quality regulation, and "Clean First"—an approach that aims to better align energy and environmental interests by weighing environmental costs in power sector decision-making.

RAP'S CHINA WORK

In China, RAP is working with regulatory bodies, industry, and nongovernmental organizations on many fronts to achieve substantial reductions in greenhouse gas emissions. These include:

- Power sector regulation: RAP assisted the government in designing China's State Electricity Regulatory Commission (SERC) and is advising the commission on transmission policy, pricing, and a range of other issues. (See RAP's China's Power Sector: A Backgrounder for International Regulators and Policy Advisors)
- Renewable resources: RAP helped design and implement the 2006 Renewable Energy Law that included a 15 percent renewable energy target for total energy consumption. The law also established a grid dispatch system that gives priority to renewable resources, created a special fund for renewable energy development, and set out preferential credit and tax policies.
- Regional air quality: RAP assisted in the development of China's new Regional Air Quality Management Rule, which was issued by China's State Council on May 11, 2010. The rule identifies three regions for aggressive air quality management. (See RAP's Recommendations for China's Forthcoming Regional Air Quality Management Regulation.) RAP is also working with the Ministry of Environmental Protection and other institutions to coordinate control strategies for greenhouse gas pollution, and is supporting regulators in Chongqing in developing a climate-friendly air-quality management action plan.
- Partnership for Climate Action: RAP joined the Institute for Sustainable Communities and World Resources Institute in the U.S. Agency for International Development-supported Partnership for Climate Action, which recently launched a major public-private initiative to reduce greenhouse gas emissions and promote energy efficiency in Guangzhou and Jiangsu provinces.

Jon Wellinghoff, Chair of the U.S. Federal Energy Regulatory Commission (Third from Left) posing with Chinese counterparts at the Sino-U.S. Wind Power and Smart Grid Development Seminar in Beijing in May 2010.
Photo Credit: Regulatory Assistance Project



NEW ENERGY EFFICIENCY WORKSHOPS IN CHINA

Just days after the Wellinghoff visit, RAP helped organize a training session in Beijing for staff of provincial government agencies to help them implement DSM and energy efficiency programs. It was the first of a series of workshops that RAP will offer with the Natural Resources Defense Council and Energy Foundation, with support from the China-U.S. Energy Efficiency Alliance.

Nearly 70 people gathered in a Beijing conference center for the first session, "Planning and Constructing an Efficiency Power Plant." An efficiency power plant (EPP) is a carefully selected portfolio of energy efficiency programs that provides a specified quantity of load reduction with a level of reliability similar to the output from a conventional power plant.

The first workshop included both Chinese and international experts to share best practices from China and the United States. Participants were also introduced to the "EPP Calculator," a software tool that enables the selection of energy efficiency projects for inclusion in an EPP based on economic analysis.

The EPP Calculator shows the logical progression of economic analysis that goes from a single energy efficiency measure at a single facility, to a group of measures at a facility, to a program of measures across several facilities, and finally to an EPP portfolio. Work is currently underway for the next two training sessions.

See a full listing of RAP's publications and presentations at www.raponline.org.

Copies of the presentations from the first workshop and of the EPP Calculator software will soon be available for download at http://china.nrdc.org/library/2010DSMTraining-en (English) or http://china.nrdc.org/zh-hans/library/2010DSMTraining (Mandarin).

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FEATURE BOX

Measuring and Reporting GHG Emissions in China

By Lucia Green-Weiskel

In the final days of the Copenhagen conference on climate change, efforts to reach an agreement between the 184 nations present shuttered to a halt over, among other issues, one concept represented by three letters: MRV (the Measuring, Reporting and Verification of greenhouse gas emissions). The fracture was between China and the United States—the world's first and second largest emitters, respectively. China agreed to reduce emissions in a verifiable way, as long as the verification (the V in the MRV) was executed by China, claiming that any other method would represent an unwelcome intrusion into Chinese sovereignty. The United States, citing concerns that China may submit inaccurate data, wants mitigating actions in China to be verified by international inspectors. Although many other issues loomed large, this apparent impasse was considered to mark the breakdown in negotiations in Copenhagen and was in large part the event that caused many observers to consider the negotiations a failure. However, it would be short-sighted to consider the entire event a failure based on this one hang-up. It is true that both countries shied away from making binding agreements and were criticized for failing as leaders. But top-level negotiations were not the only events happening in Copenhagen. Binding and ambitious agreements to reduce greenhouse emissions were made at the sub-national level and progress was made to set the stage for voluntary carbon reductions.

As the "world's factory," China has become a key target of climate change advocates in both the developed and developing worlds. But although China's total emissions have soared to the number one position worldwide, it rates far behind Western countries using other methods of calculation. China's per capita and historic emissions are much lower than Western countries. Additionally, nearly one-quarter of China's total annual emissions – approximately the size of Russian's total annual emissions – are directly caused by the manufacturing of products sold to export markets. When these facts are taken into consideration, it is clear that quantifying China's carbon footprint—or the carbon that China should take responsibility for – is not an easy task. Even more to the point is the example of wind and solar turbines. China is becoming a leader in the manufacturing of these products, which is undoubtedly bringing the price of these products down and increasing the world's renewable energy capacity. But the manufacturing of wind turbines and solar panels is a carbon-intensive product in and of itself. The reality is that as China contributes to the world's ability to have access to affordable alternatives to fossil fuels, its own carbon footprint is growing. All things considered, the question of who to blame for the large and growing cloud of greenhouse gases in the atmosphere over China is a complex question.

Agreement or no agreement in Copenhagen, China has set in motion plans to reduce the carbon-intensity of its economic activity. It has initiated large-scale programs to expand the capacity to generate renewable energy (solar and wind), build public transportation that is fast and efficient (high-speed trains and subways), increase energy efficiency in every sector of the economy, and establish what could be the world's preeminent electric vehicle industry. However, in order to determine how these programs translate directly into net reductions in greenhouse gases, a mechanism must be in place to measure emissions in a reliable, transparent, consistent and verifiable way. But as China has recoiled at the idea of international inspectors, the only alternative is a voluntary MRV program. Part of the solution is to set up voluntary registries that are run internally, but reflect a methodology that is as rigorous as international standards and methodologies. The world needs reliable evidence to show that a ton of carbon in China is a ton of carbon anywhere else in the world.

In response to this concern, many NGOs are working on ways to measure, report and verify emissions on a voluntary basis. The Innovation Center for Energy and Transportation (iCET), with support from the Rockefeller Brothers Fund and the Hewlett Foundation, has developed a concrete and practical tool to do just this. iCET is working in partnership with The Climate Registry of the United States (TCR) to develop an online energy and carbon registration tool to measure and report the energy use and greenhouse gas emissions from various domestic and multinational corporations as well as local economic development areas. Through this registry, companies, provincial governments and other reporting organizations can track and meet energy efficiency targets. With this information public and standardized, enterprises can begin to do the necessary work to reduce their emissions and overall energy use.

This online registration system and related methodologies is largely adopted from the California-based Climate Registry (www.climateregistry.org). The Climate Registry grew from a small initiative in the state of California and has now expanded to become an organization that includes members from many of the North American states, provinces, territories and Native Sovereign Nations. The Climate Registry establishes GHG emission reporting standards that are credible, accurate and consistent to be used by all industries across United States. The Registry is a voluntary tool to measure carbon emissions, although eventually legislation in the United States might make carbon reduction mandatory and thereby increase the relevance of The Climate Registry's tool.

iCET members presenting at a side event at the Copenhagen Climate talks in December 2009. Photo Credit: iCET Photo Credit: iCET

The methodology used by the European Climate Registry (ECR) is based on the GHG Protocol (www.GHGProtocol.org) developed by World Resources Institute and the World Business Council for Sustainable Development. Following their lead, the ECR protocol divides emission sources into "scopes." For example, when considering an entity's footprint, there may be:

- **Scope 1.** Direct emissions, or emissions that are within the control of the entity, defined as from stationary combustion, mobile combustion, chemical or manufacturing processes, or fugitive sources (unintentional releases).

- **Scope 2.** Indirect emissions, or emissions of which the consumption is controlled by the entity—but the generation is not—from purchases of electricity, steam, heating or cooling.
- **Scope 3.** Indirect emissions from everything else – emissions associated with the use of products that you manufacture, employees commuting to work or performing business travel.

In addition to the support from The Climate Registry, iCET has worked with Business for Social Responsibility, the California Air Resources Board, and the Chinese National Institute for Standardization. Membership in the Energy and Climate Registry includes opportunities for companies to give feedback on the reporting tool and the reporting methodology. It is becoming increasingly clear that smart tools like the Energy and Climate Registry are needed urgently in China to learn more precisely about origins of emissions. While China is the largest emitter of greenhouse gases, it is also disproportionately vulnerable to climate change, and, like all countries must take action now to mitigate the effects of climate change down the road. Guangdong province, for example, where much of the world's manufacturing is based is, on average, only 4 meters above sea level. According to a report by the Guangdong provincial weather authority, sea levels may rise by at least 30 centimeters by 2050. This means that an area of 1,153 square kilometers of Guangdong province could be submerged under water. The cities of Guangzhou, Zhuhai and Foshan – home to many of the major manufacturers of toys, electronics and other commodities – are predicted to be the worst affected. The climate expert who authored the report, Du Raodong said, "Climate change will negatively affect the economic development of Guangdong, which is currently one of the biggest consumers of energy and producers of greenhouse gasses."

The International Panel on Climate Change's (IPCC) predictions for the Pearl River Delta are even more grim. According to the IPCC'sFourth Assessment Report, sea levels could rise as much as 40-60 centimeters, flooding an area of 5,500 square kilometers in the province. Moreover, China is more vulnerable to climate change because agriculture – an industry that is highly susceptible to changes in weather – makes up a large percentage of its total economic activity. It is in China's own interest to learn more about the sources of its emissions. It is crucial that China take leadership on this issue now to protect the world – and itself – from the disasters of climate change.

ACKNOWLEDGEMENTS

The Energy and Climate Registry would not be possible without the generous support from the Rockefeller Brothers Fund and the Hewlett Foundation. We are also indebted to The Climate Registry in California and World Resources Institute for their technical support for the development of the protocol for the Energy and Climate Registry in China.

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FEATURE ARTICLE

Lessons For Industrial Energy Efficiency Cooperation With China

By Stephanie B. Ohshita and Lynn K. Price

China's energy hunger is immense and growing, especially in the energy-intensive industrial sector, which consumes roughly two-thirds of all energy in China. International cooperation since the 1990s has recognized the importance of improving energy efficiency in China's industrial sector, ranging from provincial pilot projects involving industry-government energy saving contracts, to the development of energy service companies nationwide; from cement sector benchmarking tools to energy performance standards for Chinese industry. When the country's energy consumption surged surprisingly in the early 2000s, the Chinese government has since adopted a more aggressive portfolio of energy strategies in the industrial sector, catalyzing numerous new international cooperative efforts. This paper examines those efforts to provide lessons learned and insights for ongoing collaboration. The most effective cooperation has created an active exchange of international best practices and connected individual projects with wide-reaching Chinese policies and more of this kind of cooperation is needed. In addition, cooperation needs emphasis on capacity building to improve industrial energy efficiency, such as assisting national and local energy conservation centers, increasing support for auditing and benchmarking tools, developing energy management guidance based on international best practice, establishing a program for certified energy managers, and—perhaps the most challenging—targeting new policy cooperation to address the structural roots of energy consumption. Such efforts could not only help China reduce its energy demand and CO_2 emissions, but also could help China, the United States and other countries develop energy efficient and low-carbon economies.

CHINA'S CHALLENGES IN PROMOTING ENERGY EFFICIENCY

China's policymakers have long focused on promoting energy efficiency, with early successes occurring between 1980 and 2002, when the country's energy use per unit of gross domestic product (GDP) decreased an average of 5 percent annually. These improvements were in large part due to government energy efficiency policies and programs, especially those focused on the industrial sector, which consumes roughly two-thirds of all energy used in China. Central to the success was the Chinese leadership's introduction of an energy strategy that prioritized resource conservation. Numerous policies and programs—including financial incentives for energy efficiency investments and establishment of over 200 Energy Conservation Centers (ECCs) throughout the country to help implement energy saving policies—successfully reduced energy use while the economy grew rapidly (Price et al., 2001; Sinton et al., 1998; Sinton et al., 1999; Sinton & Fridley, 2000; Wang et al., 1995).

The decline in energy use per unit of GDP suddenly reversed in 2002 and economic energy intensity increased an average of 3.8 percent per year between 2002 and 2005. There are many reasons for this reversal, but the dismantling of the energy efficiency policies and programs from the 1980s and early 1990s as China moved to a more market-oriented economy in the 1990s certainly played a role.

Recognizing the significant consequences of this trend in terms of energy security, environmental pollution, and the cost of energy as a share of GDP, the National People's Congress set a target within China's 11th Five-Year Plan (FYP) to reduce the energy intensity of China's economy by 20 percent from 2006 to 2010.[1] This target will be challenging to meet, because economic growth proceeded at a faster pace than expected from 2004 to 2008 (GDP growth rates of 9.6 to 13.1 percent), while structural shifts in the economy saw the rise of energy-intensive industries (Lin et al., 2006).[2] To achieve the national goal, provinces, cities and enterprises were also assigned targets, and significant efforts have been made to both enforce and realize this goal (Zhou et al., 2009).

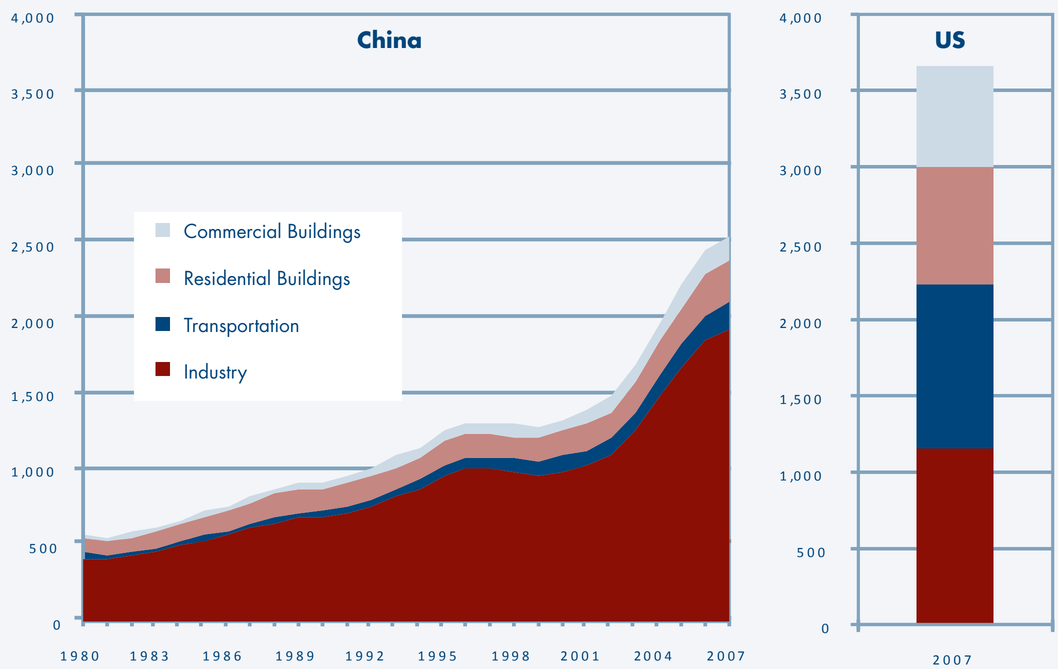
…national energy consumption levels in the United States and China are very close, while U.S. per capita energy consumption is still nearly five times higher than that in China

Reports on the progress towards the 20 percent intensity target have been issued and updated several times a year during the 11th FYP period. Official reports in 2009 found that energy intensity was reduced—1.79 percent in 2006, 4.04 percent in 2007, and 4.59 percent in 2008 (NDRC, 2009a; NDRC, 2009b). Thus, at the end of the third year of the 11th FYP, it appeared that close to 10 percent reduction had been realized, roughly half of the goal. Because changes in technology, energy management, and enterprise structure take time, it was not surprising that improvements would start slow and pick up speed. However, by the spring of 2010, the Chinese government and analysts were seriously concerned that the target might not be met. The cumulative intensity reduction was reported to be 14.38 percent through 2009, but the first quarter of 2010 witnessed an *increase* (worsening) of 3.2 percent, year-on-year (*China Daily,* 2010). In response, Premier Wen Jiabao called on officials to use an "iron hand" and increase efforts to close down inefficient enterprises and achieve the target. Also during this time (2009-2010), China's National Statistical Bureau was in the process of reconciling data from quarterly and annual reporting, with the large-scale and less-frequent census data. In July 2010, NBS released updated and revised statistics showing progress might yet be on track: revised year-on-year reductions of 2.74 percent in 2006, 5.04 percent in 2007, 5.20 percent in 2008, and 3.61 percent for 2009 (NBS, 2010), The progress updates indicate that cumulatively, energy intensity declined by 15.6 percent from 2006 through 2009, bringing the country closer to its target in 2010.

Even with China's efforts, energy use and energy-related carbon dioxide (CO_2) emissions continue to grow as the country meets energy demands related to urbanization and manufacturing goods for both domestic consumption and export. Figure 1 shows that China's total energy use more than quadrupled from 558 Mtce in 1980 to 2,539 Mtce in 2007 (NBS, various years) but still had not reached the energy consumption level of the United States (U.S. EIA, 2008a). Analysis in 2010 indicates that national energy consumption levels in the United States and China are very close, while U.S. per capita energy consumption is still nearly five times higher than that in China (BP, 2010; IEA 2010). Due to differences in fuel mix and efficiency, China's emissions of energy-related CO_2, however, surpassed those of the United States in recent years. (See Figure 2).

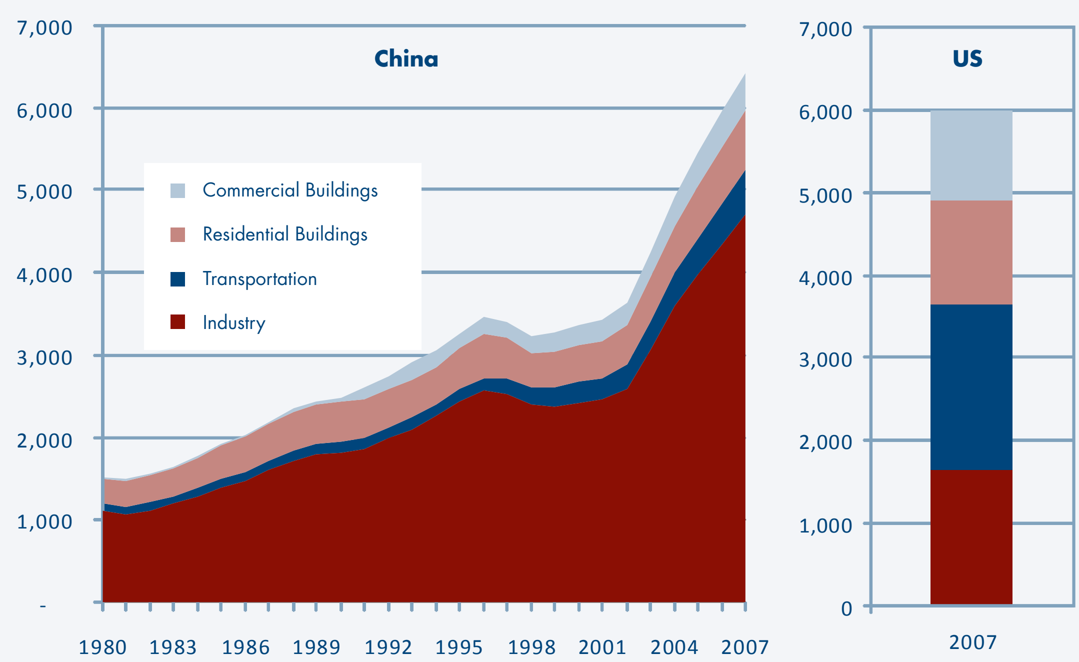
Central to this article is an exploration of the growing challenges China faces—along

FIGURE 1. ENERGY CONSUMPTION BY MAJOR END-USE SECTOR IN CHINA (1980-2007) AND THE UNITED STATES (2007)



Sources: NBS, various years; U.S. EIA, 2008a.

FIGURE 2. ENERGY-RELATED CO_2 EMISSIONS FOR CHINA (1980-2007) AND THE UNITED STATES (2007)



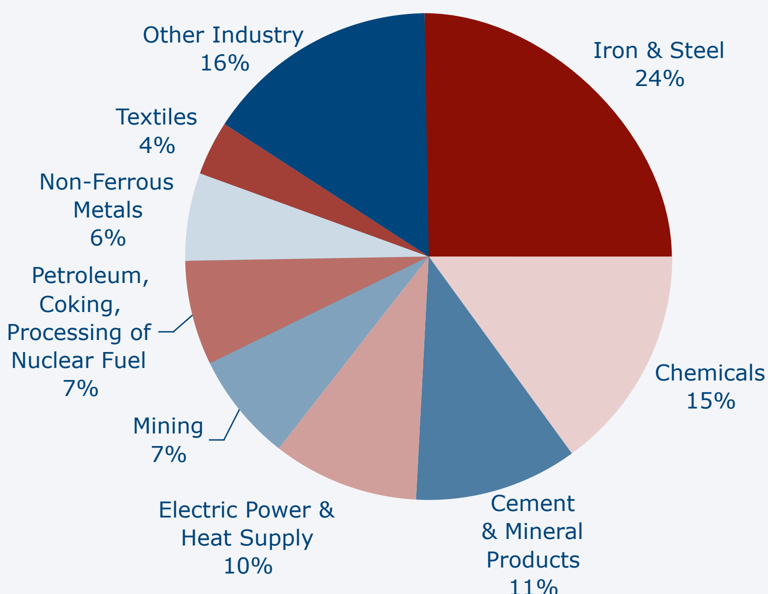
Sources: US EIA, 2008b. Note: China emissions calculated using 1996 revision of IPCC default carbon emission factors; commercial fuels only, not including biomass.

with its international cooperation partners—in strengthening industrial energy conservation in order to lower the sector's energy consumption and CO_2 emissions. We begin by examining Chinese energy efficiency initiatives in the industrial sector, from data reporting to energy saving contracts between government and enterprises. Next we analyze international cooperation with China on industrial energy efficiency, focusing on a few examples of cooperation led by multilateral, bilateral, and nongovernmental organizations, and synthesizing lessons learned. Recognizing the importance of capacity building for ongoing energy management, the article then highlights developments in Chinese energy conservation institutions, which sets the stage for concluding recommendations for future cooperation, especially between the United States and China, to improve energy efficiency of China's industrial sector.

CHINESE ENERGY EFFICIENCY INITIATIVES IN THE INDUSTRIAL SECTOR

For international cooperation to be effective in China, it must be based on a good understanding of China's own efforts and institutions. This section thus focuses on initiatives the Chinese government is taking to improve the energy structure of its economy, especially industrial production. Figures 1 and 2 above show the dominance of the industrial sector in both energy use and energy-related CO_2 emissions. In 2007, this sector was responsible for 75 percent of the country's energy consumption and contributed 73 percent of the energy-related CO_2 emissions. This growth in energy consumption and related emissions was driven by the fact that China's industrial sector is heavily based on production of energy-intensive commodities such as iron and steel (ferrous metals); chemicals; and cement (along with other non-metallic mineral products). As shown in Figure 3, those three sub-sectors accounted for half of China's industrial energy consumption in 2007. Table 1 shows that production of energy-intensive products grew significantly between 2000 and 2007. Even though the energy efficiency of production improved during this period (see Table 2), the rapid growth in absolute volume of industrial production overwhelmed the efficiency gains.

FIGURE 3. CHINESE INDUSTRIAL ENERGY CONSUMPTION, BY SUB-SECTOR (2007)



Source: NBS, 2008

TABLE 1. INDUSTRIAL PRODUCTION GREW RAPIDLY, 2000 - 2007 (MT)

Product	2000	2007	Average Annual Growth Rate
Cement	597	1361	12%
Plate Glass	184	539	17%
Crude Steel	129	489	21%
Chemical Fertilizer	32	58	9%
Paper & Paperboard	25	78	18%
Primary Plastic	10.9	31.8	17%
Soda Ash	8.3	17.7	11%
Caustic Soda	6.7	17.6	15%
Ethylene	4.7	10.3	12%

Source: NBS, 2008.

TABLE 2. ENERGY INTENSITY IMPROVED IN CHINESE INDUSTRY, 2000 - 2007

Product	Unit	China 2000	China 2007	International Advanced Level
Steel *comparable energy consumption*	kgce/t	784	668	610
Cement *comprehensive energy consumption*	kgce/t	181	158	127
Ethylene *comprehensive energy consumption*	kgce/t	1125	984	629
Electrolytic aluminum *comprehensive AC electricity consumption*	2 kWh/t	15480	14488	14100
Power supply *Coal consumption for coal-fired electricity*	gce/t	392	356	312

Source: Feng Fei et al., 2009.
Notes: [gce/t] = grams coal equivalent per metric ton of product; and [kgce/t] = kilograms coal equivalent per metric ton of product.

The 11th FYP period has been a dynamic time for energy conservation efforts in Chinese industry. In support of the 20 percent energy intensity improvement target for 2010, the government promoted Top Ten Priorities and Ten Key Projects for Energy Conservation that were outlined in the 2004 *Medium and Long-Term Energy Conservation Plan* (NDRC, 2004). The Top Ten Priorities are:

1) Establish a system for monitoring, evaluating, and public reporting of energy intensity;
2) Eliminate and/or reduce production from inefficient industrial processes, technologies and facilities, reduce production from inefficient industrial facilities, encourage high technology industry, and shift production away from energy-intensive industries;
3) Implement Ten Key Projects;
4) Implement Top-1,000 Enterprises Energy Efficiency Program;
5) Strengthen existing and create new financial incentives for energy efficiency, including preferential tax policies on energy conservation;

6) Strengthen energy conservation laws, regulations and standards (e.g., mandatory appliance labels; more aggressive enforcement of building energy codes);
7) Strengthen government programs to gather energy data;
8) Establish a national energy conservation center;
9) Promote energy efficiency and conservation in government agencies; and,
10) Expand media programs; strengthen training of energy conservation professionals.

Table 3 lists the Ten Key Projects, along with their stated goals and the expected energy savings and related CO_2 emissions reductions that these projects will realize during the 11th FYP.

TABLE 3. TEN KEY PROJECTS FOR ENERGY SAVINGS

	Key Projects	11th FYP Stated Energy-Saving Goals	Energy Savings During 11th FYP (Mtce)	CO_2 Emission Reductions During 11th FYP ($MtCO_2$)
1	Renovation of coal-fired industrial boilers	35 Mt of coal	25	60.5
2	District level combined heat and power projects	35 Mtce/yr in 2010	85	205.7
3	Waste heat and pressure utilization	7 Mtce/yr in 2010	21	50.8
4	Oil conservation and substitution	38 Mt of oil	8	19.4
5	Motor system energy efficiency	20 TWh/yr in 2010	7.5	18.2
6	Energy systems optimization	Not stated		
7	Energy efficiency and conservation in buildings	108 Mtce	100	242
	Energy-efficient lighting saving	29 TWh	3.56	8.6
9	Government procurement of energy efficient products	Not stated		
10	Monitoring and evaluation systems	Not stated		
	Total		250	605.2

Source: NDRC, 2006a.
Note: Values are based on final (site, or end-use) electricity, electricity generation, transmission, and distribution losses are not included; value for oil conservation and substitution includes only 8 Mtce for oil conservation because 7 of the 8 efforts outlined focus on fuel substitution, while only one focuses on oil saving. Conversions: 2.42 $MtCO_2$/Mtce; 1 tce = 29.7 GJ = 27.8 MBtu.

Reporting and Analysis of Energy Consumption and Conservation

The collection and analysis of high-quality data to monitor progress provides the foundation for implementation and evaluation of any energy policy. In support of two of the Top Ten Priorities that focus on strengthening systems and programs related to energy intensity data collection, in 2007, China's State Council announced an implementation scheme and methods for collection of statistics, monitoring, and evaluation of energy intensity reduction work (NDRC, 2004; NDRC, 2007a). In addition, *China's Energy Conservation Law* of 2007 formally established the responsibility of local governments to implement an energy statistics collection and reporting system. The law required that energy-consuming enterprises develop systems for energy measurement and collection of energy statistics, and mandated that large energy-consuming enterprises report their energy consumption annually. The National Bureau of Statistics has developed online energy data collection forms to facilitate reporting by the country's top 1,000 energy intensive enterprises.[3] The reporting requirements and energy intensity goals encourage enterprises and local officials to give more attention to energy efficiency; for example, Shandong and Guangdong provinces have developed robust programs, beyond the national requirements. However, only a subset of reported data is made available publicly, so it is difficult to affirm the energy levels that correspond to reported intensity improvements. International experience with balancing publicly available data and business-sensitive information can offer approaches for China as it strengthens its data gathering and reporting procedures (WRI, 2009; Seligsohn, 2010).

Top-1000 Enterprises Program

Launched in 2006, China's Top-1000 Enterprises Energy Efficiency Program aims to achieve significant energy savings in China's largest energy consuming industries. The program involves voluntary agreements, or energy contracts, between the large enterprises and local governments. (See Box 1). The goal of the program is to save 100 Mtce in 2010 (relative to projected increases), which translates to energy savings of about 20 Mtce per year (NDRC, 2006b). If the program is successful, it could contribute somewhere between 10 and 25 percent of the energy savings needed to reach China's 20 percent target in 2010.[4]

Top-1000 Program components include: energy audits, benchmarking, energy reporting,

Cement Sector Energy Efficiency Cooperation through the Asia-Pacific Partnership. Onsite Assessment of Cement Plant, Shandong Province, October 2009.
Photo credit: Tom Zhou, United Nations Industrial Development Organization-International Center for Materials Technology Promotion (UNIDO-ICM)

development and implementation of energy action plans, and monitoring by local governments. Two international cooperation programs—the China Sustainable Energy Program (CSEP) and the End-Use Energy Efficiency Program (EUEEP) that are detailed below—have provided funding, technical assistance, and project management for a number of activities focused on these 1,000 large enterprises. Discussion is underway among China's decision-makers to expand the Top-1000 Program to include additional enterprises under the 12th FYP. Already, many provinces have extended the program to cover additional enterprises; for example, Shandong and Jiangsu provinces have both implemented Top-100 programs targeting the 100 largest local energy-consuming enterprises in addition to the Top-1000 enterprises in their province.

Some weaknesses of this program include: (1) the lack of a detailed assessment of enterprise energy efficiency potential as a basis for target-setting; (2) difficulties with energy auditing and implementation of benchmarking; (3) lack of a central repository or mechanism for information dissemination; and (4) the need for continual improvement in the area of monitoring, reporting, and verification of data in China (Price et al., 2009; National Audit Office, 2009). Even with these weaknesses, evaluations by NDRC and NBS showed that the Top-1000 enterprises saved 20 Mtce in 2006 (NDRC & NBS, 2007); 38 Mtce in 2007 (Zhao, 2008); 36 Mtce in 2008 (NDRC, 2009c); and 29 Mtce in 2009 (NDRC, 2010). These savings represent avoided energy consumption due to improvements in energy intensity, indicating that the large Top-1000 enterprises have achieved savings beyond their targets.

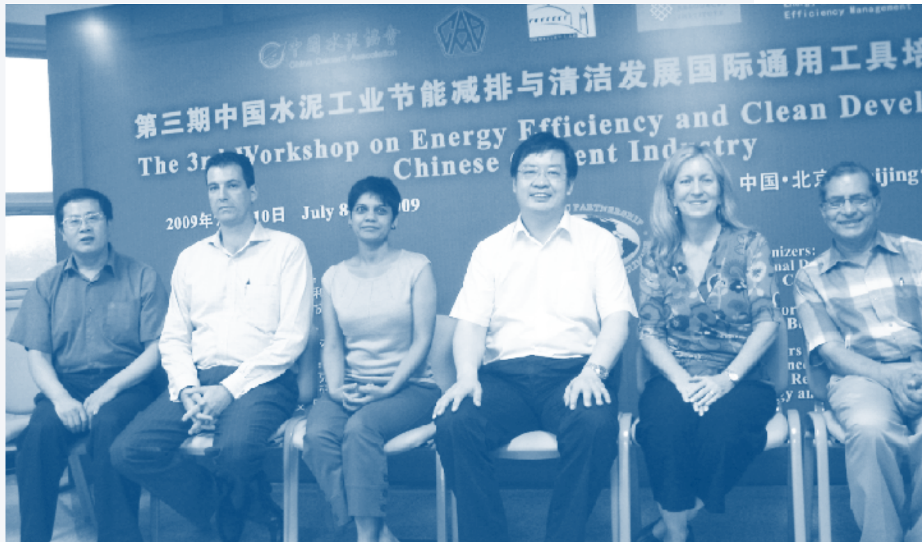
Auditing & Benchmarking at Industrial Enterprises

Recent activities in industrial sector energy auditing and benchmarking were driven by a National Development and Reform Commission (NDRC) requirement that the

Box 1. Energy Efficiency Contracts with Industry (Voluntary Agreements)

In 2003, the Economic and Trade Commission (ETC) of Shandong Province undertook a target-setting energy-efficiency agreement pilot project with two iron and steel enterprises that was modeled after successful international industrial voluntary agreement programs. The main participants in the pilot project were two iron and steel enterprises in Shandong Province—Jinan Iron and Steel (Jigang) and Laiwu Iron and Steel (Laigang)—and the Shandong ETC; State Economic and Trade Commission (SETC); and the China Energy Conservation Association (CECA). The agreements had a base year of 2002 and set performance targets for 2005. Over this period, Jinan Iron and Steel saved 292,000 tce (8.6 PJ) and reduced energy consumption per ton of steel by 9.5 percent. Laiwu saved 130,000 tce (3.8 PJ) and reduced its energy intensity by 9 percent. The pilot was considered a success due to the achievement of the targets along with the knowledge gained related to establishing targets, energy management within the companies, making energy-efficiency investments, and establishing energy-efficiency policies at the provincial level. The pilot was used as a model for the Top-1000 program (Hu, 2007; Price et al., 2003; Price et al., 2004; Wang Liting, 2007).

Top-1000 enterprises undertake such activities as key elements of the program. In October, 2006 NDRC conducted a series of training sessions for the Top-1000 enterprises in five locations across China covering enterprise energy auditing, an example of energy audits in a power plant, and the application of benchmarking in large-scale power plants (Dai, 2007; NDRC, 2006c).[5] *The Guide to the Enterprise Energy Auditing Report and the Enterprise Energy Conservation Plan Auditing Report* provides guidelines and training materials for undertaking an energy audit (NDRC, 2006d). In 2007, the China National Institute of Standardization (CNIS) began the process of developing an energy auditing standard (Dai, 2007).



Cement Sector Energy Efficiency Cooperation through the Asia-Pacific Partnership. Train-the-trainers workshop (Beijing, October 2009), which focused on training participants in three tools: LBNL BEST-Cement energy saving tool; WRI/WBCSD GHG Protocol under the Cement Sustainability Initiative (CSI); and the DOE/E3M PHAST tool for energy saving in process heating. Photo Credit: Lawrence Berkeley National Laboratory

In 2007, the Top-1000 enterprises undertook energy audits that documented current energy consumption levels and identified energy efficiency opportunities. While some Top-1000 enterprises had the expertise to conduct audits and identify opportunities, a number lacked qualified auditing personnel and needed to hire outside experts, whose technical expertise and abilities varied widely, with some in need of significant training (Lu, 2006; Jiang, 2006). Although the quality of audits was uneven, the number conducted has been impressive: by August 31, 2007 a total of 967 energy audit reports and 836 energy conservation plans had been completed and submitted to NDRC by the 30 provincial level governments (Dai, 2007).

Several provinces have expanded energy auditing activities beyond the Top-1000 program. For example, in Jiangsu Province, the city of Suzhou developed high-quality energy auditing procedures and reporting guidelines for nearly 400 enterprises (NDRC, 2009d). Top-1000 enterprises in the city, along with other "key energy companies" consuming more than 5,000 tons coal equivalent (tce) per year, are included in the auditing program (Suzhou ECC, 2009). NDRC has promoted Suzhou's example nationwide, and especially recommended its audit report format as a template to other localities.

In 2007, NDRC issued the *Plan for Implementing Energy Efficiency Benchmarking in Key Energy Consuming Enterprises* (NDRC, 2007b). Although NDRC's guidance to the Top-1000 enterprises indicated that benchmarking should be undertaken in all sectors covered by the program, benchmarking efforts to date have focused only on the most energy-intensive steel, cement, and chemicals sectors. (See Box 2 for benchmarking initiatives in China's cement sector).

Both the CSEP and EUEEP programs have provided financial and technical support for these efforts, and the Energy Research Institute (ERI)—a think tank within NDRC—has coordinated the project activities. Achievements to date, including development

Box 2. BENCHMARKING TOOLS FOR ENERGY SAVING IN CHINA'S CEMENT INDUSTRY

Benchmarking activities in the cement sector were coordinated by the China Cement Association (CCA). For the End-Use Energy Efficiency Program (EUEEP) effort, the CCA developed Implementation Guidelines for Energy Efficiency Benchmarking of Cement Enterprises, provided training and information dissemination and developed analysis tools for use by cement enterprises. Four cement enterprises participated in a benchmarking pilot project (Zhou, 2009; Zeng, 2009). China Sustainable Energy Program (CSEP) provided additional funding (along with the U.S. EPA, U.S. State Department, and Dow Chemical Company) to expand the cement benchmarking effort to include international assistance from Lawrence Berkeley National Laboratory (LBNL) and the China Building Materials Academy (CBMA).

LBNL, CBMA, CCA, and Energy Research Institute (ERI) developed the Benchmarking and Energy-Saving Tool (BEST) for the cement industry in China. BEST-Cement benchmarks a cement plant's energy use to an identical hypothetical plant that uses best practice to identify those processes with the largest gaps between actual and best practice energy use. Both domestic (China) and international best practice values are used. BEST-Cement for China also provides information on approximately 50 energy-efficiency measures, including their initial capital cost, energy savings, and simple payback time.

of benchmarking guidebooks and experiences with pilot plants testing the benchmarks, as well as difficulties encountered were discussed at the 2009 *International Workshop on Energy Efficiency Benchmarking* (Ma, 2009; Zhang Chunxia, 2009; Zhang Jintong, 2009).

Industrial Energy Efficiency Standards

The establishment of energy efficiency standards for industrial processes and products complements auditing, benchmarking, and energy-saving contracts with individual enterprises. Energy efficiency standards can reach across industry, shifting the mix of energy intensity and improving the overall efficiency of the industry.

During 2007-2008, China's General Administration of Quality Supervision, Inspection and Quarantine developed and published energy efficiency standards for 22 industries—ranging from caustic soda and steel to flat glass and synthetic ammonia industries. The standards recommend energy efficiency levels for existing, new, and advanced enterprises, with advanced levels comparable to international best practice. For example, China's Ministry of Construction approved a revised standard that establishes maximum allowable energy consumed per unit of cement (or conversely stated, minimum energy performance standards, known as MEPS), as well as specified targets for improved energy intensity. The standards were delineated for coal and electricity consumption, for different cement processes, and for different sized plants (MOC, 2007).

Even when standards are established, significant effort is needed for implementation and enforcement. To that end, the Chinese government, with international support, has been developing guidance documents and holding training sessions for industrial enterprises and local government officials for the 22 developed standards. Work in progress includes standards for: industrial boilers, kilns, air conditioning, motor systems, insulation, electric transformers, draft fans, and air compressors (see section on EUEEP for further discussion).

Financial Incentives for Energy Conservation

The overall government budget for energy efficiency improvement and pollution abatement in 2007 was 23.5 billion (B) Yuan ($3.08B)[6] (MOF, 2008). Specifically, this funding was allocated to support implementation of the Ten Key Projects, elimination of inefficient facilities, and installation of environmental protection measures. In 2008, the government budget for these activities increased to 27B Yuan ($3.91B) (MOF, 2008) and includes 7.5B Yuan ($1.087B) for the Ten Key Projects and 4B Yuan ($580M) for phasing out inefficient plants. China Construction Bank contributed additional funds of 14.8B Yuan ($2.15B), resulting in total financing of 41.8B Yuan ($6.059B) (MOF, 2008). This public spending leveraged investments of over 50B Yuan ($6.5 B) for over 8,000 energy-saving projects by the Top-1000 enterprises alone in 2007 (Zhao, 2008). The magnitude of additional spending by other industrial enterprises as well as in other sectors of the economy is not known. Even so, it appears that energy efficiency investments are climbing toward the recommended yearly private sector investment levels of 150B to 200B Yuan ($20B to $26B)[7] that are needed to reduce the growth rate of energy use to half of the projected growth rate of the economy over the next 15 to 20 years (Lin, 2005; Levine, 2005).

A portion of the overall funding is being used by the Ministry of Finance (MOF) and NDRC to award enterprises 200 to 250 Yuan ($26 to $33) for every ton of coal equivalent (tce) saved in east and midwest China, respectively, for the implementation of five of the Ten Key Projects (Lu 2007; Jiang, 2007). MOF allocated 7 billion Yuan to support 546 industrial energy efficiency projects in 2007 ("Central Fiscal Fund," 2007; Central Government Website, 2008). The rewards and rebates are paid to enterprises with energy metering and measuring systems that can document proven savings in 2007 of at least 10,000 tce (0.29 PJ) from the 546 energy saving technical transformation projects. Assuming an average emissions factor for China of 2.42 tons CO_2 per ton coal equivalent, this funding is equivalent to $12 to $15 per ton of CO_2 emissions reduced.

As a means to reform energy costs to push conservation in industries, in 2004, the Chinese government instituted a differentiated electricity pricing policy, in which electricity prices can be set based on the enterprise energy intensity level for high energy-consuming industries (such as electrolytic aluminum, ferroalloy, calcium carbide, caustic soda, cement, and steel).

… officials will not be promoted if their jurisdiction fails to meet energy conservation targets.

Enterprises fall into one of four categories based on their level of energy efficiency—encouraged, permitted, restricted, and eliminated—and are charged increasingly higher electricity rates (with surcharges up to 30 percent of the average price of electricity per kWh) in order to phase out inefficient enterprises (Moskovitz et al., 2007). Between 2004 and 2006, approximately 900 firms in the eliminated category and 380 firms in the restricted category had closed, invested in energy efficiency, or changed production processes. Not all provinces embraced the differentiated pricing policy—for example, Inner Mongolia still favored heavy industry with lower electricity prices. In 2007, the policy was adjusted to allow local provincial authorities to retain revenue collected, providing stronger incentives to enforce implementation (Moskovitz, 2008). The pricing reforms are a crucial element in promoting conservation and warrant international cooperation and support.

The State Council also aimed incentives for meeting efficiency targets at government personnel. In November 2007, the State Council established an evaluation system stating that officials from regions, organizations and companies must meet their energy conservation reduction targets in order to participate in annual rewards programs or to be conferred honorary titles. Similarly, leaders in state-owned or state-controlled enterprises must meet targets to be considered for annual evaluation award programs. In addition, officials will not be promoted if their jurisdiction fails to meet energy conservation targets (Zhou et al., 2009). While ambitious on the surface, in practice these financial incentives for energy efficiency indicate a small, but notable shift away from China's "apparent unwillingness to use economic and financial incentives… [and] to integrate energy efficiency into other sector policies" (Andrews-Speed, 2009). There thus exist many opportunities for international organizations to work with policymakers on designing stronger financial incentives.

Challenges Ahead: Economic Structure, Urbanization and Climate Change

Along with incremental energy efficiency improvements in industry, the Chinese central government recognizes that larger changes in economic structure are needed to meet its energy and environmental targets. During the 11th FYP period, efforts at structural change included financial mechanisms (e.g., tax changes, small changes in electricity pricing) to discourage inefficient, energy-intensive enterprises, as well as outright industry closures. China's small plant closure policy requires certain outdated capacity to be retired during

TABLE 4. SMALL PLANT CLOSURES AND PHASE-OUT OF OUTDATED CAPACITY -- RESULTS (2008)

Industry	Unit	11th FYP Capacity Closure Targets	Realized Capacity Closures 2006-2008*	Share of Target Achieved 2006-2008
Cement	Mt	250	140	56%
Iron-making	Mt	100	60.59	61%
Steel-making	Mt	55	43.47	79%
Electricity	GW	50	38.26	77%
Pulp & paper	Mt	6.5	5.47	84%
Alcohol	Mt	1.6	0.945	59%
Monosodium glutamate	Mt	0.2	0.165	83%
Electrolytic aluminium	Mt	0.65	0.105	16%
Citric acid	Mt	0.08	0.072	90%
Coking	Mt	80	n/a	n/a
Ferroalloy	Mt	4	n/a	n/a
Calcium carbide	Mt	2	n/a	n/a
Glass	M weight cases	30	n/a	n/a

Sources: State Council, 2007; Feng Fei et al., 2009; *NDRC, 2009a and 2009b.
Notes: [Mt] = million metric tons of production; [M weight cases] = million weight cases of glass, in which there are 50 kg per case.

the 11th FYP in 13 industrial sub-sectors, which will save an estimated 118 Mtce.[8] Table 4 lists the targeted and realized capacity closures for these industries.

However, past experience with the closure of inefficient, polluting enterprises has proven challenging. In the late 1990s, plant closures to reduce pollution were often short-lived, as small enterprises—important to local economies—would secretly reopen, leading the State Environmental Protection Administration (SEPA, now elevated in status and called the Ministry of Environmental Protection) to describe the situation as "glowing embers rekindling" (*si hui fu ran*). Thus it remains to be seen how long the current round of plant closures will hold. Other policy mechanisms explicitly aimed at a structural shift away from heavy industry are still needed.

Another important driving force behind the rise of industrial energy consumption is the rapid pace of urbanization in China. The production of iron, steel and cement—energy-intensive materials essential for new buildings and roads in China's expanding urban centers—accounted for more than one-third China's industrial energy consumption in 2007. (See Figure 3). Between 1990 and 2007, 290 million rural residents moved into China's cities, resulting in an urbanization share of 45 percent. ERI predicts that urbanization will grow to 67 percent by 2025, with China's urban population expanding from 594 million in 2007 to 958 million people in 2025. Thus, urban planning and structural economic shifts are urgently needed, along with energy efficiency measures in industry, to temper massive increases in energy demand.

In addition to energy intensity, carbon intensity is gaining attention as the Chinese government is showing greater leadership on climate change. As illustrated in Figures 1 and 2, China's industrial sector is responsible for an especially large share of the country's energy-related CO_2 emissions due to the extremely high proportion of coal in the energy mix (73 percent in 2005). In August 2009, China's National People's Congress (NPC) issued statements expressing China's commitment to participate in international climate change negotiations and at the domestic front, the NPC remarked:

We should make carbon reduction a new source of economic growth, and change the economic development model to maximize efficiency, lower energy consumption and minimize carbon discharges ("Top legislature endorses," 2009).

Attention to carbon intensity, along with energy intensity and urbanization, albeit challenging, could provide even greater impetus for energy conservation in China.

INTERNATIONAL COOPERATION ON INDUSTRIAL ENERGY EFFICIENCY

The Chinese government has long engaged in international partnerships to address energy and environmental challenges. As international cooperation with China grows with the challenges of energy security and climate change, it is important to learn from past experience—both successes and failures—to carry out effective cooperation. The analysis here focuses specifically on industrial energy efficiency cooperation, i.e., efforts to reduce energy use in industrial sectors such as iron and steel, cement, chemicals, and other heavy industries. The reasons for this emphasis are twofold: (1) the significant share of industrial energy consumption in China's economy (75 percent in 2007); and (2) the ability of energy efficiency and conservation to address multiple goals of energy security, economic strengthening, air quality, water quality and conservation, and climate change. Cooperation in other sectors—such as buildings, transport, appliances, and city planning for low-carbon development—is important but is not the focus of our paper. Similarly, cooperation on carbon capture and storage (CCS), which does not save energy but rather enables ongoing consumption of polluting fuels and mining operations, is not included here.

Within the realm of industrial energy efficiency, we examine international cooperation programs with China that have been in place long enough to have some results to evaluate. We identify newer initiatives that have begun in the past few years, and highlight promising aspects, but their actual results can only be revealed with time. For a typology of cooperation efforts, we draw on comprehensive comparative analyses of energy efficiency cooperation (e.g., WEC, 2004; Sugiyama & Ohshita 2006), as well as current analysis of industrial programs. Rather than say very little about many programs, we chose to highlight lessons learned from a sub-set of programs. The programs highlighted represent a rich variety of international organizations and differing forms of cooperation with a wide spectrum of Chinese partners. The types of cooperative efforts (with examples) include:

On-site Energy Assessment and Training at a Cement Plant in Henan Province, through Asia-Pacific Partnership.
Photo Credit: Lawrence Berkeley National Laboratory

- **Type of cooperating organization:** multilateral (United Nations Development Programme [UNDP]); regional (Asia-Pacific Economic Cooperation [APEC]); bilateral (government-to-government); nongovernmental; and coalitions of international organizations.
- **Mode of cooperation:** policy development; market development (financial mechanisms); technical assistance; technology development (installations, research, or demonstration projects); training and capacity building for government officials, enterprise managers, technicians, financiers; and public education and outreach.
- **Chinese partners:** central government (NDRC, Ministry of Environmental Protection [MEP]); national research institutes (ERI, China Building Materials Academy [CBMA]); universities (Tsinghua, Tongji); provincial governments (Jiangsu, Shandong); Energy Conservation Centers; city-level governments (Suzhou); industry associations and enterprises.

In terms of evaluation criteria, we looked for cooperative efforts that contributed to systemic change and large savings of energy and carbon, which include: (1) studies that led to new standards and policies; (2) development of procedures and tools for policy implementation; (3) pilot projects at the local level that led to provincial and national programs; (4) development of greater expertise and stronger institutions (i.e., capacity building); (5) enhanced engagement of businesses and the financial sector; and (6) technological cooperation that led to substantial energy and carbon savings. We also looked for programs that contributed to the development of both high-level and working-level relationships among partners, since effective strategies come out of understanding and respect on all sides. Cooperation promoting a shared sense of purpose is especially needed between the United States and China, which together and apart are the world's largest energy consumers and carbon emitters.

Table 5 provides a list of major cooperative

TABLE 5. INTERNATIONAL COOPERATION ON INDUSTRIAL ENERGY EFFICIENCY IN CHINA[1]

Cooperation Program	Lead Foreign Organizations[2]
Multilateral Cooperation	
End-Use Energy Efficiency Programme (EUEEP)	United Nations Development Programme (UNDP)/ Global Environment Facility (GEF)
Energy Conservation Project on Energy Service Companies (ESCOs)	World Bank/ Global Environment Facility (GEF)
China Utility-Based Energy Efficiency Finance Program (CHUEE)	International Financing Corporation (IFC), Finland, Norway
Efficient Motors Program	United Nations Industrial Development Organization (UNIDO)
Energy Efficiency Indicators Project	International Energy Agency (IEA)/ World Bank
Regional Cooperation	
Energy Conservation and Resource Management – Demand-Side Management (DSM)	Asian Development Bank (ADB)
Asia Pacific Partnership (APP) for Clean Development and Climate	Australia, Canada, China, India, Japan, South Korea, and the US
Energy and Environment Programme (EEP)	European Union (EU)
Bilateral Cooperation	
US-China bilateral cooperation • U.S.-China 10-Year Energy and Environment Cooperation Framework • US-China Partnership for Climate Action	US State Dept., Dept. of Energy (DOE), Dept. of Commerce (DOC), US Environment Protection Agency (EPA) US Agency for International Development (US AID), Institute for Sustainable Communities (ISC), World Resources Institute (WRI), Lawrence Berkeley National Laboratory (LBNL)
California-Jiangsu cooperation on DSM and Efficiency Power Plants (EPP)	State of California, Natural Resources Defense Council (NRDC), US-China Alliance to Save Energy
Japan-China bilateral cooperation • Technology cooperation on clean and efficient energy technology • Japan-China Energy Conservation and Environment Forum • Human Resource Training for Energy Conservation	Ministry of Economy Trade and Industry (METI), New Energy Development Organization (NEDO), Energy Conservation Center Japan (ECCJ), Institute for Energy Economics Japan (IEEJ), Japan External Trade Organization (JETRO), Japan International Cooperation Agency (JICA)
UK-China bilateral cooperation • -"Low Carbon High Growth" projects, Low Carbon Development Zones • - Cement sector efficiency • - Business carbon auditing, de-carbonization of supply chains, low-carbon technology funding	British Foreign & Commonwealth Office (UK FCO) - Strategic Programme Fund; British Dept. for International Development. (UK DFID)
Nongovernmental Cooperation	
China Sustainable Energy Program (CSEP) – Industry Program	US Energy Foundation, LBNL
Cement Sustainability Initiative (CSI)	World Resources Institute (WRI), World Business Council on Sustainable Development (WBCSD)

Notes: This list includes major cooperation efforts on industrial energy efficiency in China during the past ten years, but is not fully comprehensive. For a more comprehensive view of energy efficiency cooperation in China and East Asia, see: World Energy Council (2004); Sugiyama and Ohshita (2006); Ohshita (2008).

efforts focused on industrial energy efficiency in China. A brief description and analysis of six of these cooperative efforts is given below, highlighting the reasons for success and challenges encountered.

Example 1. China Sustainable Energy Program—Industry Program

One of the most extensive and effective industrial energy programs run by a U.S. organization is the Energy Foundation's China Sustainable Energy Program (CSEP). Started in 1999, CSEP focuses on policy development cooperation, providing grants to Chinese and international experts to promote sustainability in China's energy system, supporting energy efficiency and renewable energy. As an independent nongovernmental organization (NGO) with a strong network of energy experts, the Energy Foundation has been remarkably effective in China. By funding Chinese institutes and international policy practitioners to work collaboratively, CSEP fosters the sharing of international best practices and the development of policies suited to local conditions. Grants are awarded based on a project's ability to promote Chinese priority policy objectives, and deliver policy change that leads to CO_2 emissions reductions. With grant decisions made three times per year, CSEP grantees are able to act quickly and contribute to the development of timely policies.[9]

One key reason for CSEP's effectiveness is the guidance provided by two high-level Chinese advisory groups: a Senior Policy Advisory Council (PAC) composed of minister-level officials; and a group of Dialogue Partners composed of directors-general of pertinent ministries. The PAC meets annually to focus on policy objectives and strategies.[10] These two advisory groups set the direction of CSEP and provide project feedback to ensure that policy development activities are politically salient. CSEP funding is then channeled to Chinese research institutes and universities that develop national policies. The "top-down" national policy efforts are then complemented by "bottom-up" pilot initiatives at the provincial and local levels, where implementation mechanisms can be tested and strengthened (Ogden, 2005; Sugiyama & Ohshita, 2006).[11]

Another organizational feature that contributes to the program's success is the Beijing office of CSEP. The office is staffed with full-time Chinese energy policy experts—each focused on a specific program area—who facilitate close connections to key government officials and academic researchers in Beijing and elsewhere in China. The office provides significant support for collaborative efforts, from matching domestic and international experts, to providing a physical meeting place with decision-makers.

One example of CSEP industrial cooperation is benchmarking in the cement sector. A team of organizations, including ERI, CBMA, China Cement Association (CCA), and Lawrence Berkeley National Laboratory (LBNL), worked together to develop the BEST-Cement energy efficiency assessment tool for China in support of China's Top-1000 Program and the 20 percent energy intensity savings goal (Perlin, 2008). In order to train cement plant engineers in its use as well as to disseminate the tool throughout China, CSEP funded the project team to conduct four workshops in 2008 in Shandong, Hebei, Shanxi, and Sichuan provinces in which about 300 cement plant staff from over 200 cement facilities were trained in the use of BEST-Cement. This work through the Energy Foundation has led to further efforts supported by the U.S. government, noted below. In addition, experts working on CSEP cement efficiency projects communicated and coordinated with related international efforts, such as the large UNDP efficiency program, also described below.

Example 2. End-Use Energy Efficiency Programme

Another significant industrial energy initiative is the End-Use Energy Efficiency Programme (EUEEP), which is a four-phase, twelve-year effort to improve energy efficiency in China's major end-use sectors: industry and buildings.[12] Implemented by the UNDP and China's NDRC, the Programme draws funding from the Global Environment Facility (GEF), UNDP, the Chinese government, and the private sector.[13] The EUEEP utilizes an integrated approach, combining policy development cooperation with capacity building and market development. The impetus for the Programme came from China's 1998 *Energy Conservation Law*, and the Programme aims at providing direct, comprehensive and sustained support for this and other Chinese energy policies (Heggelund et al., 2005). If fully implemented, the cumulative emissions reduction from this UNDP-NRDC initiative is estimated to range from 42.4 to 76 million tons of carbon over the 12-year program lifetime (Kan, 2008; GEF/UNDP, 2002).

The EUEEP has been conducting industrial sector activities in four main areas (Kan, 2008):

(1) supporting the implementation of enterprise energy agreements for the Top-1000 Program, including energy benchmarking, target setting, and actions;

(2) energy efficiency design codes for industrial facilities (e.g., cement plants and related equipment) in support of China's Ten Key Projects;

(3) energy efficiency standards and systems for equipment in the industrial, residential, and service sectors (e.g., design standards, labels, and training on industrial motors), in support of China's Medium- and Long-Term Energy Conservation Plan; and,

(4) energy information system for reporting and management, for energy-intensive industries in the Top-1000 Program.

Relevant cross-cutting activities include support for eight Energy Conservation Centers, training materials, and the development of energy efficiency financing options.

The EUEEP experienced a slow start up as it created its Project Management Office (PMO) and established procedures and priorities with NDRC. Activities then increased rapidly and by November 2007, the EUEEP PMO committed $9.2 million to 67 signed sub-contracts with domestic and international experts.[14] Those sub-contracts included benchmarking projects coordinated by ERI and the China Energy Conservation Association (CECA), which led to the launch of six benchmarking projects with two enterprises each in three sectors—chemical, cement, and iron and steel. The objective of the benchmarking has been to use pilot projects to develop sector-specific tools that can be shared widely with other enterprises. The EUEEP PMO is coordinating with other benchmarking cooperation efforts (including European Union and LBNL activities through the Energy Foundation), and in August 2009, the EUEEP held an international seminar to share results on the development and piloting of energy benchmark guidelines.

With EUEEP support, the China Cement Association developed energy conservation design codes for cement making, specifying minimum energy performance standards (coal and electricity) for clinker and cement production (MOC, 2007). The Ministry of Construction approved the codes in November 2007, marking an important step for energy conservation in China's large highly energy intensive cement sector. The cement standards went into effect in May 2008, leading the way for other industry system codes (Kan, 2008).

By 2009, EUEEP achievements on motor system standards included the completion of 40 plant assessments and 16 case studies by four motor system service organizations. Those organizations, along with ten Energy Conservation Centers, sent 1,015 energy engineers for training on the energy optimization of fan, pump, motor, and air compressor systems (Kan, 2008). These achievements build on work started in 1997 by LBNL and U.S. Department of Energy (DOE), which then led to support by the United Nations Industrial Development Organization and the Energy Foundation for the China Motor Systems Energy Conservation Program conducted between 2001 and 2004 (LBNL, 2006; Williams et al., 2005).

Training materials for cement and other sectors have been developed, including boilers, kilns, motor systems, and energy management and financing in the industrial sector. CECA prepared materials for boilers and kilns, while Tsinghua University prepared energy management materials. The EUEEP funded the China National Institute of Standards (CNIS) and others to develop standards and guidance documents on electric transformers, draft fans and air compressors. More than 360 trainees have benefited from direct training under the Programme, and over 2,000 trainees have been involved indirectly (Kan, 2008).

Example 3. World Bank/GEF Energy Conservation Project (ESCO Project)

In 1997, the World Bank/GEF Energy Conservation Project introduced the concept of Energy Service Companies (ESCOs) to China to facilitate financial and technical aspects of energy efficiency improvements. The two-phase project represents a large, sustained effort to create a new energy efficiency institution in China, particularly in the industrial sector. During Phase I of the project, three ESCOs (also known as Energy Management Companies or EMCs in China) were established in Shandong, Liaoning, and Beijing. Phase I of the project had funding of $51 million, from the World Bank, GEF, the European Commission, and the NDRC.

Phase II of the project, running from 2002 to 2010, has already witnessed significant growth of ESCO organizations in China. A World Bank news report from January 2008 noted that, "ESCOs in China saved about as much energy in 2006 and 2007 as France would have consumed in standard-grade coal in the last two years" (World Bank, 2008a). Chinese ESCO projects started in 2006 led to energy savings estimated at 21 Mtce. The 2006 energy savings were the result of about 100 ESCOs financing over 400 energy conservation projects in 16 provinces, totaling $280 million in investment. Bob Taylor, China energy expert formerly with the World Bank who was integral in launching this ESCO program, noted that rapid growth in ESCOs in 2007 resulted in investment levels twice as large as those seen in 2006.

External observers and those involved in the World Bank China ESCO effort have noted key challenges in China (Blanchard, 2005; Dressen, 2003), including:

- Lack of local project financing;
- Small capitalization and lack of credit history of emerging ESCOs; and,
- Huge need for industrial energy efficiency projects, but financing terms for building-sector projects have been more favorable.

Recognizing that China's fledging ESCOs still need better access to capital, the World Bank and NDRC launched a follow-on Energy Efficiency Financing Project in 2008 (World Bank, 2008b). The project will use an additional $200 million World Bank loan and $13 million GEF grant. The financing project works with three Chinese national banks to foster the development of large-scale energy efficiency loan programs. The banks, in turn, target lending in the $5-10 million range for ESCO projects in heavy industries.

The Asian Development Bank, U.S. Department of Commerce, Japan, and others have also been engaging in ESCO cooperation and funding mechanisms aimed at industrial (and building sector) energy efficiency projects in China. Further discussion on the institutional development of ESCOs in China is provided in the next section.

Example 4. U.S.-China Bilateral Cooperation

As in many bilateral efforts, larger political dynamics between the two countries influences cooperation. Until recently, Congressional restrictions have strongly limited the activity of the U.S. Agency for International Development (USAID) in China, resulting in other countries and multilateral institutions taking the lead in environmental and energy cooperation with the Asian giant. Nevertheless, several federal agencies have supported cooperation efforts to advance energy efficiency in Chinese industry, namely: DOE, the Environmental Protection Agency (EPA), the Department of State, and the Department of Commerce. National research institutes have also played a crucial role.

U.S.-China energy cooperation has become a higher priority over the past year, with a turning point taking place in July 2009, when both countries signed the U.S.-China Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and the Environment (U.S. Department of State, 2009). The MOU states the intent of both countries to:

> *…strengthen and coordinate our respective efforts to combat global climate change, promote clean and efficient energy, protect the environment and natural resources, and support environmentally sustainable and low-carbon economic growth.*

The July 2009 MOU laid the foundation for a suite of agreements Presidents Barak Obama and Hu Jintao signed in November of the same year, just prior to international climate negotiations in Copenhagen. These agreements have encouraged further bilateral engagement between the countries on energy and climate cooperation, which indicates emerging joint cooperation on industrial energy could hold more promise. (*Editor's Note: For a fuller review of U.S.-China energy cooperation, see Feature by Joanna Lewis in this CES issue*). Highlights of bilateral cooperation over the past five years in the industrial energy sphere are reviewed below.

U.S.-China Energy Policy Dialogue and Projects

In 2004, the U.S. DOE and China's NDRC initiated the U.S.-China Energy Policy Dialogue as a means for discussing energy cooperation between the two countries. The dialogue enables the United States and China to exchange information on energy security measures, including strategic petroleum reserves and energy policies to attract investment in infrastructure development. The dialogue also enables the exchange of views on other energy issues of concern to both countries, such as the use of market and regulatory measures to promote energy efficiency and reduce environmental impacts.

In 2007, the dialogue led to the signing of a Memorandum of Understanding (MOU) on further energy efficiency cooperation in China's industrial sector. The DOE conducted industrial energy auditing activities under the MOU in support of China's Top-1000 Program (U.S. DOE, 2007). A team of DOE-assembled industrial energy efficiency experts worked with a counterpart Chinese team to conduct on-site plant energy efficiency assessments at Top-1000 Program enterprises. NDRC identified the China Standards Certification Center (CSC) as the counterpart for the DOE team, which was led by Oak Ridge National Laboratory with assistance from DOE energy experts and LBNL. The teams—which included a DOE-qualified expert on steam systems and a crosscutting expert from DOE's Industrial Assessment Centers—completed facility screening worksheets along with energy assessment of one ammonia plant. As part of the energy assessment, the DOE team provided auditing equipment to CSC. In addition, DOE translated and modified its "Quick PEP" tool, which provides an overview of the amount of energy a plant purchases and generates, identifies major energy-consuming industrial systems at the plant, and describes the plant's energy-saving potential (U.S. DOE, 2008).

U.S.-China Cement-Sector Cooperation

Another example of industry-focused efficiency collaboration between the United States and China is an effort led by the EPA. Since 2004, the EPA and China's MEP pursued a bilateral agreement to evaluate and control the unintentional releases of dioxins and furans from cement kilns in China. Much of the focus of this effort was on incomplete combustion in the kiln, which can be mitigated by improving the kiln's energy efficiency. EPA funded LBNL, CBMA, and a DOE energy expert to undertake a detailed energy audit of two cement kilns in Shandong Province and make recommendations for energy efficiency improvements. The two plants implemented a number of the recommendations, improved their energy efficiency, and reduced their emissions of persistent organic pollutants. Unfortunately, the EPA's ability to engage in international cooperation with China—especially related to industrial efficiency—was limited by budget cuts over the past several years. To fill the gap, nongovernmental funders stepped in to enable much-needed collaboration on energy efficiency. As one example, the Energy Foundation supported translation and localization of EPA's EnergyStar industrial efficiency guidance manuals in China. These sector-specific manuals include the energy-intensive cement, steel, and chemical sectors.[15] Beyond the manuals, other elements of the EnergyStar for industry program are valuable resources for cooperation with China and an untapped opportunity. Since 2008, multiple U.S. government agencies have support energy efficiency cooperation in China's cement sector, building on earlier efforts supported by government and private foundations. The BEST-Cement tool developed by LBNL is being used to develop baseline energy consumption information as well as to identify energy-efficiency improvement opportunities in 42 of China's largest cement plants through the U.S. State Department-funded project.

Comprehensive Program to Improve Energy Efficiency, Increase the Use of Alternative Fuels and Raw Materials, and Reduce Emissions in the Cement Sector in China.

The managers in the 42 plants also are being trained in the use of the Cement Sustainability Initiative's (CSI's) cement-sector specific CO_2 Quantification Protocol, developed by the World Resources Institute and the World Business Council for Sustainable Development, as well as apply the U.S. DOE Process Heating Assessment and Survey Tool (PHAST). Initial training in the use of these tools took place during a three-day workshop in Beijing in July 2009. In October/November 2009, international experts accompanied selected trainees as well as collaborators from the China Building Materials Academy and the China Cement Association to three cement plants located in three Chinese provinces to conduct on-site assessments using the tools. Chinese experts are completing similar assessments at the remaining 39 plants during 2010.

BEST-Cement and the CSI cement sector tools are also being used for training in Guangdong and Jiangsu provinces in October 2010 as a component of the Partnership for Climate Action Program funded by USAID and managed by the Institute for Sustainable Cities (ISC) and World Resources Institute (WRI).

Pollution Prevention and Energy Efficiency (P2E2) Financing Program

The Pollution Prevention and Energy Efficiency (P2E2) environmental financing program involving the U.S. EPA and Department of Commerce in China illustrates bilateral cooperation focused on financing mechanisms (U.S. Commercial Service, 2007). Launched in June 2006, the P2E2 program is based on an eight-year cooperative framework agreement between the EPA[16] and MEP. This public-private financing program utilizes Hong Kong's legal and financial systems to mobilize private sector capital together with management and technology from the United States, China and other countries for energy conservation projects in China. The P2E2 program became a regular part of the annual agenda of the U.S.-China Joint Commission on Commerce and Trade, and a component of U.S. trade missions to China (U.S. Commercial Service, 2007; U.S. DOC, 2008), as well as U.S. activity through the Asia Pacific Partnership (U.S. Commercial Service, 2008). In mid-2007, the U.S. Commercial Service noted at least 20 Hong Kong ESCOs carrying out P2E2 projects in the Pearl River Delta and elsewhere in China in numerous industries (e.g., aluminum, cement, electronics, food processing, iron and steel, power generation, real estate and textiles) (U.S. Commercial Service, 2007). Unfortunately, these P2E2 projects have not reported estimates of energy saved or pollution reduced.[17]

The U.S.-China P2E2 program has some overlap with the World Bank ESCO program in China, and makes use of World Bank (IFC) guarantees and Asian Development Bank funding. But, based in Hong Kong, the EPA's P2E2 utilizes a different institutional framework and includes an environmental component[18] along with energy services. The P2E2 program also differs from many international energy efficiency cooperative efforts by originating from an agreement with China's MEP, rather than NDRC. China's banks and industries have been interested in the program because of stronger energy conservation policies under the 11th FYP. Thus the U.S. trade-focused P2E2 program benefits from policy development cooperation work by other U.S. and international organizations. The P2E2 program has now evolved into a private-sector effort, highlighting a promising new trend in U.S.-China energy cooperation.

U.S.-China Partnership for Climate Action

One new and promising initiative, launched by USAID in December 2009, is the U.S.-China Partnership for Climate Action. This is the first major cooperation effort by USAID with China focused on climate change and including an industrial component. The partnership seeks to promote energy efficiency and reduce greenhouse gas emissions in three arenas: (1) the industrial sector, (2) the electric power sector, and (3) at the city level. To develop and test approaches, the initiative will take place in two Chinese provinces—Guangzhou and Jiangsu—and work with provincial and national government agencies. The three-year effort has $6 million in U.S. government funding, supplemented with $3.4 million from the private sector. Key implementing organizations include the U.S.-based Institute for Sustainable Communities and World Resources Institute (WRI), along with the GE Foundation, the Regulatory Assistance Project (RAP), and LBNL. On the Chinese side, partners include: Guangdong Economic and Trade Commission, the China Electricity Council, the Energy Research Institute, the China Clean Development Mechanism Fund, and Tsinghua University (USAID, 2009).

The Partnership is quite new, and time will tell if its promising start is sustained and bears fruit. The Partnership's industrial component is still relatively small and would do well to increase activities on industrial energy conservation. Projects that make even stronger connections across: (1) urban demand for energy and infrastructure; (2) industrial production in response to that demand; and (3) electric power production for both cities and industry, would be productive.

Emerging Opportunities for U.S.-China Industrial Energy Cooperation

Since 2010, new developments in U.S.-China cooperation indicate some progress for the promotion of industrial energy efficiency. In March 2010, U.S. Energy Secretary Steven Chu announced $37.5 million of DOE funding for a new U.S.-China Clean Energy Research Center (CERC). The effort will leverage an additional $75 million of funding from grantees and from

China. The CERC, to be housed in existing facilities, will focus on technology research in three areas: building energy efficiency; clean coal (including carbon capture and storage); and clean vehicles (DOE, 2010). While this is an exciting development in U.S.-China energy technology cooperation, the new Center does not have a focus on industrial energy efficiency. Substantial enhancement of industrial energy efficiency can come from improved energy management and operations, and from technology already available. Yet collaboration on even more efficient industrial technology is still needed, and is an area for future cooperation.

In May 2010, in conjunction with the U.S.-China Strategic and Economic Dialogue, the two countries held the first U.S.-China Energy Efficiency Forum in Beijing. Whereas other U.S. institutions (e.g., LBNL, DOE, EPA) have been engaged in efficiency cooperation with China for years, this was the first high-level bilateral forum with efficiency as its main theme. The Energy Efficiency Forum was accompanied by a Renewable Energy Forum and a Biofuels Forum, all led by DOE (WRI ChinaFAQs, 2010). The Energy Efficiency Forum, with NDRC as the lead Chinese agency, drew more than 200 participants from government agencies, research institutions, and industry. The plenary session of the forum focused on energy-efficiency policies, measures and progress in both the United States and China. The forum also included four separate sessions on building energy efficiency, industrial energy efficiency, appliance energy efficiency, and the ESCO market (LBNL 2010).

One notable outcome from the Energy Efficiency Forum for industrial energy efficiency was the signing of an MOU on university-based alliances with industry. China's newly formed University Alliance for Industrial Energy Efficiency (UAIEE) was modeled in part on the U.S. Industry Assessment Centers (IACs), a network of 23 university-based centers affiliated with DOE. The IACs have been conducting energy audits in U.S. industries and educating energy professionals since 1976.19 Formation of the new Chinese Alliance came about with support of the Energy Foundation, following an initial meeting of Chinese university representatives and IAC Directors in 2008. LBNL and Oak Ridge National Laboratory facilitated the new China-U.S. partnership and signed the MOU on behalf of U.S. IACs. This partnership has potentially large significance, as it could foster vast institutional capacity for industrial energy efficiency in China, with thousands of Chinese engineering students and professors working with thousands of staff in enterprises and local governments.

Example 5. Japan-China Bilateral Cooperation

Japan's energy efficiency cooperation with China has been ongoing for over 20 years, and has had a strong technology focus (e.g., technology-related feasibility studies and demonstration projects, and training) (Ohshita, 2003; Ohshita, 2008). Japan's early energy efficiency cooperation in China began in the 1980s and involved training and infrastructure as one component of development aid. During the 1990s, the Japanese government spent billions of Yen annually in China on technology-focused cooperation, in the areas of energy efficiency, cleaner coal technologies and photovoltaics (NEDO, 2007).

Between 1992 and 2002, Japan's Ministry of Economy Trade and Industry and the affiliated New Energy and Industrial Technology Development Organization led 18 industrial energy efficiency technology demonstration projects in China. Nine of the 18 projects targeted the iron and steel industry; other projects spanned several industrial sub-sectors, including chemical, petrochemical, cement, and electric power. Heat recovery technologies were prominent, such as Japan's coke dry-quenching (CDQ) technology.[20] The cooperation efforts were successful in technical terms, but unfavorable policy and market conditions did not encourage technology diffusion in China during the 1990s and into the new millennium (Ohshita & Ortolano, 2006). By 2009, however, spurred by 11th FYP energy goals, nearly 100 CDQ units were in operation in Chinese steel plants. The CDQ units were mainly manufactured through Japan-China joint ventures or by Chinese manufacturers, rather than imported from Japan (Ueno, 2009).[21]

On-site Energy Assessment and Training at a Cement Plant in Henan Province, through Asia-Pacific Partnership.
Photo Credit: Lawrence Berkeley National Laboratory

Recognizing the importance of technical training and capacity building, Japan has provided training related to energy management and policy, mainly implemented by the Energy Conservation Center of Japan (ECCJ). As one example, the Japan International Cooperation Agency and ECCJ established a pilot Energy Conservation Technology Training Center during the 1990s in the port city of Dalian (JICA, 2004). The Dalian center was equipped with energy monitoring devices and typical industrial machinery (e.g., motors, pumps, boilers), and Japanese engineers held multiple rounds of training sessions. However, as the Chinese government shifted budget priorities and reduced funding to send trainees, the Dalian training center had difficulty sustaining itself.

In some ways, Japan's energy technology cooperation with China was ahead of its time, seeking to build awareness and promote the diffusion of efficient technology before policy requirements and incentives were in place in China. The lack of technology diffusion during the timeframe of the cooperation programs (1992 to 2002), China's rapidly growing economy, Japan's slowing economy, and concerns about protection of intellectual property, led Japan to reevaluate its mode of cooperation with China. Since 2006, Japan has emphasized business-to-business activities and promotion of Japanese technology in its energy conservation cooperation with China (ANRE, 2007; 2008). The Japanese government is also giving more attention to 'soft' cooperation in the form of high-level policy dialogue—through large, formal forums—and policy research exchange among government research institutes (e.g., China's ERI and the Institute for Energy Economics in Japan). Examples of Sino-Japanese cooperation are provided in Table 6. Thus for Japan, its mode of cooperation with China has shifted toward government-to-government policy exchange and business-to-business technology exchange. Important lessons learned from the Japan-China experience are that Chinese enterprises will purchase efficient technologies that meet their needs and circumstances. Foreign technology providers and governments would do well to learn and carefully consider those needs and circumstances, and market suitable technology in response, as well as engage in policy cooperation to promote standards and incentives for energy efficiency.

Example 6. UK-China Cooperation

As another example of bilateral cooperation involving energy efficiency and conservation in Chinese industry, the UK has been developing a

TABLE 6. EXAMPLES OF SINO-JAPANESE OPERATION ON ENERGY CONSERVATION

March 2010	**5th Japan-China Energy Conservation and Environment Forum** METI and NDRC signed two Memoranda of Understanding, to continue the annual Forum, and to continue Training for Human Resources for Energy Conservation, to grow the capacity of Chinese Energy Managers.
November 2009	**4th Japan-China Energy Conservation and Environment Forum** Japan and China agreed to cooperate on 42 projects in the areas of energy saving and environmental protection, including 22 Business Promotion Model Projects. The Energy Conservation Center Japan (ECCJ) also signed and agreement with its Chinese counterpart, to develop the capacity of the National ECC in China.
February 2009	**Sino-Japan Energy Saving Policies Seminar.** Organized by China's Energy Research Institute (ERI) and the Institute for Energy and Economy, Japan (IEEJ).
September 2007	**2nd Japan-China Energy Conservation and Environment Forum (Beijing).** Nearly 1,000 people attended, including ministerial-level and working-level officials. Agreed on 10 Business Promotion Model Projects, including: • Energy efficiency retrofit of a textile factory in Xian (Kyushu Electric) • Energy Efficiency Financing Scheme (JBIC, Mizuho Bank, and China's Exim Bank) • ESCO cooperation with Japanese Association of ESCOs and China's Energy Management Company Association (EMCA)
April 2007	**Joint Research on Energy Policy (China's ERI and Japan's IEEJ).** Japan and China agreed to launch the first joint energy policy research between the two countries' top energy research institutes with a 3-year MOU.
October 2006	**Chinese Study Missions on Energy Efficiency Policy to Japan.** Study missions in support of China's Energy Conservation Law; Chinese central, local, and energy conservation center officials to study design and implementation of energy efficiency institutions, and development of energy efficiency standards.
May 2006	**1st Japan-China Energy Conservation and Environment Forum (Tokyo).** Led by Ministry of Economy, Trade and Industry (METI) and NDRC, with nearly 850 people attending, the Forum included ministerial-level dialogue and sectoral discussion sessions (e.g., steel, autos). Agreed upon several study missions to exchange ideas on energy efficiency promotion.

Note: This table provides a few examples. For a more comprehensive list and discussion, see: ANRE, 2008 and Ohshita, 2008.

strong and consistent effort through its climate cooperation with China. Formally launched with the signing of an MOU in 2006, the UK has a robust climate change program, with over twenty staff stationed in China across the British Embassy in Beijing and the Consulates–General in Hong Kong, Guangzhou, Shanghai and Chongqing.[22] Funding comes from multiple sources, primarily the Foreign Cooperation Office Strategic Programme Fund, and from the Department for International Development.[23] As an important component of the UK Strategic Programme Fund, climate change cooperation involves several efforts, notably the *Low Carbon High Growth Programme,* which includes industrial efficiency projects. Other UK-China climate change cooperation includes: (1) a program on impacts and adaptation, in conjunction with the Swiss Development Agency; (2) collaborative energy research projects on *New and Renewable Energies and on Cleaner Fossil Fuels* funded by more than £14 million; (3) projects coordinated with the UK-China Sustainable Development Dialogue; and (4) a £10 million fund for supporting low-carbon technology start-ups.[24]

The Low Carbon High Growth Programme alone supports 37 policy research projects with Chinese partners. Funding through 2009 exceeded £8 million with a further £1 million for new projects in 2010 (roughly $1.6 million in 2010 just for this one program). Examples of program outcomes include: (1) identification of low-carbon pathways for seven cities and three provinces in China; (2) sharing international best practice on tracking emissions in China's carbon-intensive cement industry; (3) identifying opportunities for clean energy technology in China; and (4) developing standards for tracking and reducing carbon emissions in industry and other sectors.

While industrial energy efficiency is but one component of UK-China cooperation, the structure and modes of cooperation are worth noting for their effectiveness. With staff on the ground in China in multiple economic centers, the cooperation is informed by a deeper understanding and by relationships developed over time. Cooperative efforts look to new directions (emphasizing carbon management and the response of economic activities to climate change) and still are connected to Chinese domestic policies and priorities (e.g., FYP goals). Projects under the programs are required to have specific and measurable performance indicators.[25] In stark contrast to many U.S. efforts in China, for UK initiatives the funding keeps flowing, enabling multi-year programmatic efforts. Coordination is sought for efforts that touch on activities of multiple government agencies in both countries, thereby avoiding contradictory or duplicative efforts.

After four years of living and working in Beijing in the UK Embassy Climate Change team, James Godbar (2010) shares insightful advice for cooperation with China:

> *The means is often as important as the end and 'learning by doing' is critical to ensuring a shared understanding. China's willingness to undertake small-scale pilots allows policies and ideas to be adapted to the China context. Developed nations can learn from this and we should be careful not to expect any country to simply take our models and policies and apply them without first adapting them.*

Summary and Findings on International Cooperation

This review of international programs has highlighted important successes and challenges in the increasingly robust bilateral and multilateral industrial energy efficiency programs in China. By combining the above review with previous analyses of energy efficiency cooperation with China (Baldinger & Turner, 2002; WEC, 2004; Sugiyama & Ohshita, 2006; Ohshita 2008); as well as drawing on analyses of U.S.-China cooperation more broadly (Lieberthal & Sandalow, 2009; Pew Center-Asia Society, 2009; NRDC, 2009; Wolfson, 2009), we have identified factors for success, which can be drawn upon to inform new and ongoing U.S.-China cooperation efforts. (See Table 7). The new Obama-Hu agreements plus expanding activities by the U.S. DOE offer opportunities for more ambitious cooperative efforts with China on energy and climate, particularly in the industrial energy sphere. There is still a need for even more U.S.-China cooperation on efficiency and conservation in industry, including efforts to reduce demand for energy-intensive industrial products, and efforts to strengthen the capabilities of Chinese energy institutions. The following sections of the report offer more information for capacity building efforts, and conclusions and recommendations for future cooperation.

TABLE 7. FACTORS FOR SUCCESS – INDUSTRIAL ENERGY EFFICIENCY PROGRAMS IN CHINA

Top-Down Approaches: Working jointly on policy development cooperation at the central government level to create a "top-down" push and incentives that foster market development to complement technology cooperation.
Bottom-Up Approaches: Working jointly on programs and pilot projects to support local-level ("bottom-up") implementation of policies to connect individual projects to specific policy initiatives.
Joint Strategy Setting: Working jointly with Chinese partners to develop strategies that are suited to Chinese institutions and conditions (beyond 'one-way' information transfer).
Building Relationships at Multiple Levels: Fostering relationships with key Chinese decision-makers, through choice of working-level partners, high-level advisory boards, and regular communication. Fostering long-term relationships among working-level experts ("on-the-ground" presence) is crucial.
Enhancing Capacity: Focusing on personnel capacity building and strengthening of Chinese institutions.
Targeted Plans and Tools: Developing sector-specific implementation plans and tools that can be used across the country (e.g., benchmarking tools and audit guidelines).
Financing: Complementing policies with financing mechanisms to leverage business resources and enable local implementation.
Coordination: Including coordination with other international cooperation efforts, leveraging limited government resources available for energy conservation.

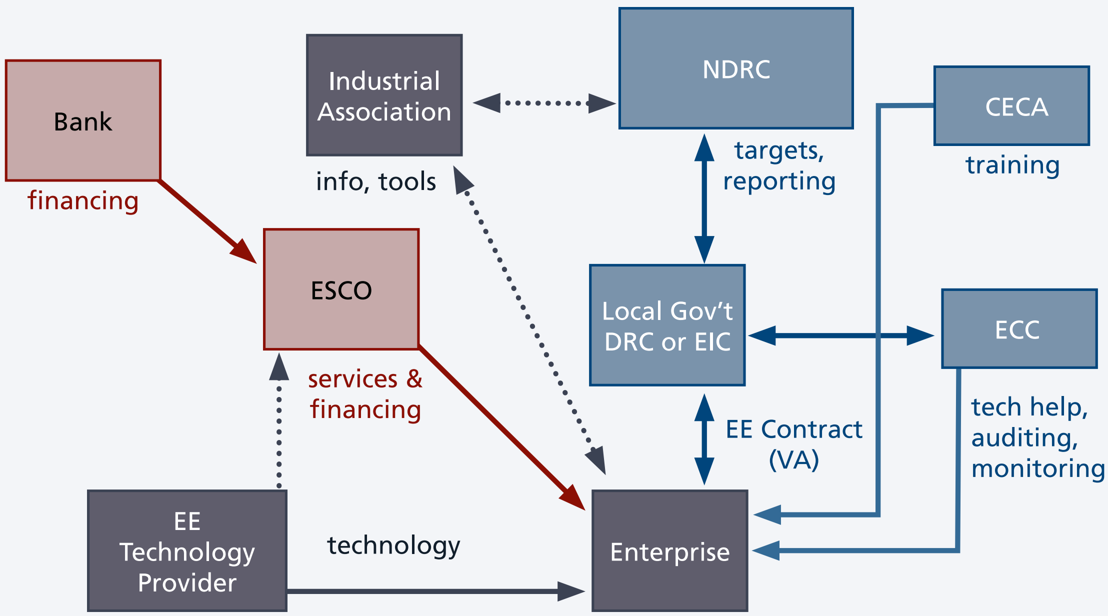
Based on Sugiyama and Ohshita, 2006; Ohshita, 2008

A KEY LINK IN ADDRESSING CHINA'S INDUSTRIAL ENERGY CHALLENGE: STRENGTHENING ENERGY EFFICIENCY INSTITUTIONS

Energy and environmental cooperation has shown that technology and money are not always the limiting factors; often, strengthening institutions and personnel capabilities—through training, policy support, and more staff dedicated to energy efficiency—are crucial elements for success. The term 'capacity building' is frequently used in cooperation, but is often used loosely, making it difficult to see the shape and outcome of capacity building. The best capacity building efforts clearly identify: who is engaging in training or exchange; their role in implementing policy or carrying out efficiency initiatives in enterprises; exactly *what knowledge or skills* they are acquiring; and *how* the newly gained capacity connects with the *priorities* of the institution and government policies.

In order to ensure sustained effectiveness of current energy-saving programs in China, the country's energy efficiency institutions need strengthening. Figure 4 illustrates the interaction among Chinese energy efficiency institutions at present. The following discussion highlights the development of some of these institutions

FIGURE 4. ENERGY EFFICIENCY INSTITUTIONS IN CHINA: COMMON RELATIONSHIPS



Source: Authors. Notes: The relationships among these institutions take varying configurations across China and frequently change; this is one snapshot.
NDRC = National Development and Reform Commission; CECA = China Energy Conservation Association; ECC = Energy Conservation Center; DRC = local Development and Reform Commission; EIC = local Economic & Information Commission (reports to MIIT); EE = Energy Efficiency; ESCO = Energy Service Company.

both at the national and local levels. These institutions are a fascinating mix of domestically-conceived organizations and those created with the help of international cooperation, yet always with Chinese characteristics.

Energy Conservation Centers

China's Energy Conservation Centers (ECCs) are a collection of government agencies at the provincial, municipal and city level that help industrial enterprises save energy through assistance with reporting requirements, audits, monitoring and training. Established in the 1980s, ECCs originally reported up through the industrial ministries. In the 1990s, energy intensity declined, but ECCs weakened and lost financial resources when the industrial ministries were disbanded during bureaucratic restructuring. National attention shifted away from energy conservation and between 2002 and 2003, a 22-year trend—in which energy use per unit of GDP declined each year—was reversed (NBS, various years).

In 2005, ECCs started a period of revitalization with encouragement from the central government and assistance from international organizations to achieve national energy conservation goals. The capabilities of ECCs vary widely across provinces (Price et al., 2008). The ECCs in several coastal provinces and municipalities are showing renewed leadership, with the strongest activity in Shanghai, Jiangsu, Beijing, Guangdong, Shandong, Tianjin, Fujian, and Hebei. Those same eight centers have been engaged in international cooperation with UNDP/GEF EUEEP involving: support for energy audits; co-financing of auditing equipment (electricity meters for motors; combustion monitors for boilers, kilns); and training for center staff.[26] Some of the eight centers have also engaged in cooperation projects with Energy Foundation's CSEP, Japan's ECCJ, and others. The Chinese government itself has been increasing investment in energy conservation institutions. In 2007, the government provided funding to twenty ECCs to support energy auditing and monitoring activities.[27]

Even with this support, ECCs in many provinces are still in need of more funding, staff, training, equipment and national coordination. The centers are granted authority from the national level, but their staff and budget are mostly controlled at the local level (a typical *tiao-tiao kuai-kuai* administrative organization).[28] In addition, there is no national center to coordinate activities and information. The China Energy Conservation Association (CECA) provides training and materials to local ECCs and industry, but it is a fairly small stand-alone association rather than a coordinating government agency. Moreover, CECA does not have local offices. As such, CECA takes a "train-the-trainers" approach in its work with local government, local ECCs and enterprises.[29]

One of China's Top Ten Priorities, announced in 2004 as part of the *Medium and Long-Term Plan for Energy Conservation* (NDRC, 2004), is the establishment of a new National Energy Conservation Center that would develop energy conservation policies, regulations, research programs; provide energy conservation training programs and coordinate international cooperation. However, limitations on the size of central government agencies, as well as deliberations about which ministry would have dominant control, slowed efforts to launch the center. Wishing to fill the gap, the Energy Foundation—in cooperation with China's ERI—created the Center for Industrial Energy Efficiency (CIEE) in 2008. This nongovernmental, nonprofit center has the mission of promoting industrial energy efficiency through information sharing, coordinating cooperation and training and providing consultation to support policy implementation.[30] As one example of CIEE activities, in July 2009, CIEE worked with ERI, the Energy Foundation, and the Energy Management Company Association (EMCA) to organize an industrial energy efficiency workshop in Chengdu, involving enterprises, government officials and international experts. NDRC did proceed with establishing a new National Energy Conservation Center (NECC), announced in 2008. This center's role is still evolving; for example, NECC is charged with helping to implement energy saving goals of the Five-Year Plan, but does not yet oversee energy audits or local ECCs. The NECC signed an MOU with its Japanese counterpart (ECCJ) in 2009, engaging in training efforts and development of energy management systems. U.S. government support and exchange with the new Center could further enhance its development.

Energy Management Companies

As noted earlier, the development of Chinese ESCOs began with three pilot companies in Shandong, Liaoning and Beijing in 1997, through the support of the World Bank and the GEF (World Bank, 2003). China's 20 percent energy intensity goal has been a boon for ESCO

institutions, as they are sought out by local governments and enterprises under pressure to deliver measurable energy savings by 2010. From its fledgling start in 1997, China's ESCO industry has grown substantially in the past few years. By 2008, roughly 50 core companies were active, 185 ESCOs31 had joined China's Energy Management Company Association (EMCA), and nearly 400 firms had reported some experience with energy performance contracting (World Bank, 2008c). Investment has also grown rapidly; energy performance contracting investment rose to $1 billion in 2007, to $1.5 billion in 2008, and early estimates indicate ESCO investments were significantly higher in 2009.32

Chinese ESCOs have mainly followed a shared savings model, especially in the buildings sector (Zhao, 2007). Under the shared savings model, ESCOs provide technical services and financing to their clients, bearing both performance and credit risk, and sharing the savings. (See Figure 5). The ESCOs also obtain insurance and coordinate design, equipment and construction for their clients. For industrial clients in China, a guaranteed savings model—dominant outside of China—is becoming more common, where the client obtains financing from a bank and technical services from an ESCO, thereby spreading the risks of a project. By 2007, a survey by EMCA showed that shared savings contracts accounted for 66 percent of projects (in number) but only 25 percent in investment value, while guaranteed savings contracts had a smaller 38 percent share in number but a larger 71 percent share in investment value (World Bank, 2008c). This difference in share is explained by project size: building sector energy efficiency projects have an average size of $400,000, while industrial projects have an average size of $1.7 million (World Bank, 2008c).

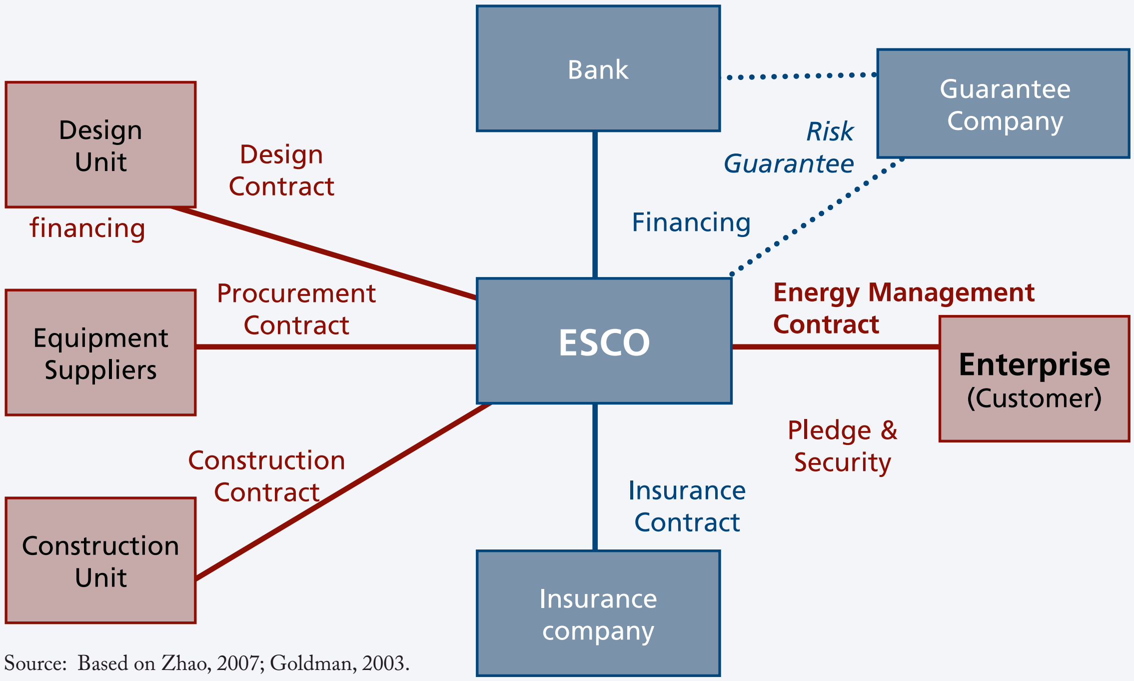
Capacity-Building Needs for China's ESCOs

In terms of institutional development, China's ESCO industry needs ongoing outreach to spread the concept and practice of energy performance contracting. The concept is still unfamiliar to many potential clients, financial professionals, and energy technology providers. Because many of China's ESCOs are relatively small firms (roughly half have registered capital less than $670,000), financial and technical capacity are weak. All of China's ESCOs need improved access to financial institutions and further support of government policy, including contracts with more government-owned enterprises. Even China's strongest ESCOs would benefit from more interaction with international markets and training, as well as ongoing technological innovations (World Bank, 2008b). For example, if Chinese ESCOs could expand their portfolio of services, and be better supported by financing from both banks and customers, their capabilities would be greatly enhanced. Cooperation efforts are needed at multiple levels (central, provincial, enterprise) to further strengthen this growing institution in China.

Industry Associations

Industry associations can serve an important function of exchanging information on energy efficient equipment and best management practices among member companies as well as playing the important role of a go-between for industry and government, facilitating policy dialogue and target-setting for industrial sectors (not just individual enterprises), and in international collaboration. Chinese industry associations are in a transitory stage and are still developing their role. In the 1990s, Chinese industry associations were government agencies, both overseeing and managing state-owned enterprises. With administrative reforms implemented over the past decade, including the disbanding of industrial ministries, NDRC has taken on the oversight functions once held by government-run industry associations and it has shifted management down to the enterprises.

FIGURE 5. ESCO STRUCTURE IN CHINA: SHARED SAVINGS MODEL



Source: Based on Zhao, 2007; Goldman, 2003.

With this transition, Chinese industry associations are facing problems of unclear status, limited responsibility, and weak authority. Moreover, some staff are former government officials rather than employees with direct industry experience.[33] Other industry association staff may be highly respected company presidents, such as Xie Qihua, chairwoman of the China Iron and Steel Association (CISA) and Shanghai Baosteel Group Corporation.[34] In this transitory stage, Chinese industry associations are gaining experience with activities such as information exchange and coordinating activities. For example, in 2005, Japan Iron & Steel Federation (JISF) and CISA held the first large business-to-business gathering focused on energy conservation and environmental protection. Nearly 200 attendees participated, including representatives from Japanese and Chinese iron and steel companies as well as high-level government officials from both countries.[35] Subsequent meetings of the two steel associations have addressed methodologies for data gathering and analysis, energy and water saving technologies, and other related concerns.[36] Chinese industry associations are becoming stronger and exerting more influence among enterprises and in government policy, so engagement with them is important. U.S. and Chinese industry associations have been interacting under the auspices of the Asia-Pacific Partnership. However, concerns over competitiveness add tension in some industrial sectors, such as steel. Facilitation by research institutes, NGOs, and nonprofit business-focused organizations (such as the World Business Council on Sustainable Development) can help with industry association interactions.

Enterprise Energy Managers

In order for an organization to effectively manage any resource or task, it needs knowledgeable staff with decision-making authority. Managing energy resources is no exception. As part of China's Top-1000 Program, most participating enterprises established an energy management office and assigned one or more staff to the office.37 The skill level of newly assigned energy managers varies greatly. Many have undergone one-time training through workshops offered by CECA or provincial ECCs, but do not have other specialized training. Some energy management staff are high-level engineers certified through the Chinese system.38 Some enterprise technical staff and managers, as well as local government officials, have participated in energy efficiency training programs through international cooperation with Japan, EUEEP, Energy Foundation, EPA, DOE, and others.

Draft versions of China's Energy Conservation Law required enterprises to have energy managers and created a certification system.[39] The draft provisions were modeled in part after Japan's Energy Law and the Japanese system of requiring certified energy managers in energy-intensive enterprises. But the provisions were not included in the final version of the law. Bilateral and multilateral dialogue concerning development of an energy manager system in China is ongoing. The NDRC initiated two pilot projects, in Tianjin and Shandong, underway in 2010. Those pilot projects have some engagement with Japan (through ECCJ) examining and adapting elements of Japan's comprehensive energy management system, such as a certification program for energy managers. The outcome of the pilot projects will inform new national initiatives in China.[40]

Further exchange with China on the U.S. experience with energy management training and tools is an option, such as DOE's government-focused Industrial Facilities Initiative under the Federal Energy Management Program, and voluntary training for the private sector under the DOE Industrial Technologies Program (ITP).[41] Exchange involving the DOE Superior Energy Performance programs is also being explored.[42] It is crucial that the exchange become two-way; the different structure of Chinese industry and industry-government relations necessitates an approach adapted for China. Both the United States and China could benefit from establishing a national training and certification system for energy managers in industry.

LESSONS LEARNED AND RECOMMENDATIONS FOR U.S.-CHINA COOPERATION

Recent recommendations for increased U.S.-China cooperation emphasize a topical focus on energy efficiency as a means of addressing energy, economic and environmental challenges in both countries (Lieberthal & Sandalow [Brookings Institution], 2009; Pew Center-Asia Society, 2009; NRDC, 2009; Wolfson, 2009). For example, the Pew Center-Asia Society "roadmap" for cooperation (2009), calls for U.S.-China cooperation on "best practices for energy efficiency standards and labeling programs, as well as for benchmarking programs targeting energy intensity in heavy industry." Recommendations also emphasize the need for capacity building and the importance of monitoring and enforcement.As to the structure of cooperation, recent briefings call for better use of existing working groups—as well as new forums—to sustain activities and relationships.

The next step is to develop more details for realizing these recommendations, drawing insights from the challenges and successes of international projects taking place in China's industrial energy sector. Cooperation involving the development of efficiency standards and policy implementation plans has already yielded results and has promising potential. Lessons learned from experience in capacity building should be heeded in ongoing cooperation. Future efforts should also take note of the most effective working groups and forums, paying attention to who is involved, how agendas are set, and how interactions are structured. Most importantly, Sino-American cooperation on industrial energy conservation must aim for large savings of energy and carbon emissions.

In this article, we have reviewed China's energy trends, examined initiatives to reduce energy intensity and analyzed China's experience with international cooperation to identify factors for successful industrial energy efficiency programs. (See Table 7). We further examined the development of Chinese energy conservation institutions, to better understand needs for capacity building. Among the most important lessons learned are:

Future efforts should also take note of the most effective working groups and forums, paying attention to who is involved, how agendas are set, and how interactions are structured.

- **Cooperation must be a two-way exchange, adapting international experience to fit Chinese conditions.** Successful cooperation involves working jointly with Chinese partners to identify needs and resources. Cooperation initiatives with poor outcomes have frequently been one-sided, with an external push of one country's agenda or technology without regard for Chinese needs and conditions. Trade promotion disguised as cooperation has often backfired. Rather, cooperation based upon international best practice and adapted to the Chinese context has worked well. In terms of technology cooperation, foreign and Chinese firms have benefited from assessments of the Chinese market and matching of best-fit technology.
- **Cooperation projects should be programmatically linked to Chinese policy initiatives ("top-down" push, including economic incentives)**. Isolated efforts, conducted without the support of a policy framework, may yield limited results or quickly fade. It is necessary to conduct pilot projects to spur policy development; and for lasting results, pilot projects should be connected with policy cooperation. Technology cooperation in the absence of policy or economic incentives has produced disappointing results. Cooperation that starts and stops due to political funding cycles can also fall short of fulfilling expectations. Individual projects conducted as part of an overarching program, such as the UNDP End-Use Energy Efficiency Programme, have proven most effective.
- **Cooperation must be sustained by fostering relationships through regular forums and requires competent, highly qualified staff.** The most successful cooperation involves ongoing working-level relationships between international experts and Chinese partners, as well as regular high-level dialogue. The Energy Foundation's China Sustainable Energy Program is a prime example of productive, ongoing relationships among experts. Large, formal meetings are important stepping stones, but they need to be complemented with on-the-ground, sustained interaction among experts and practitioners. Limited results occur when either side awards positions based on political rather than professional considerations.
- **Local-level initiatives, in addition to national cooperation, must be carried out to realize implementation of Chinese policies ("bottom-up" approach).** Policy statements and circulars are essential steps, but alone, they do not achieve results. The most successful cooperation efforts have conducted local-level implementation projects, such as the Shandong pilot project on Energy Efficiency Contracts with Industry, which led to China's Top-1000 program. (See Box 1). This on-the-ground experience can be used to enhance and inform policy, thereby encouraging broader achievements in energy conservation.

Based on the lessons learned from cooperation experience to date, and considering the needs and resources of both the United States and China, we make the following recommendations for future cooperation on industrial energy conservation:

- **Align U.S. cooperation efforts with China's policies and programs.** Directly connect U.S. cooperation to the implementation of specific Chinese policies to maintain the support of Chinese partners.
- **Support the new National Energy Conservation Center, and support the capacity building of existing local Energy Conservation Centers.** A National center would enable better coordination and information sharing among local-level centers. Development of sector-specific or equipment-specific capabilities at ECCs is also needed. Ongoing working-level collaboration (e.g., LBNL and ERI, California and Jiangsu) should be used as a foundation. The initial exchange between U.S. Industrial Assessment Centers (IACs) and their Chinese counterparts in July 2009—and subsequent signing of the MOU by China's University Alliance for Industrial Energy Efficiency (UAIEE), LBNL, and Oakridge National Laboratory (on behalf of U.S. IACs)—is a promising development.[43]
- **Increase cooperation with important Chinese industrial associations and research institutions** to develop and deliver sector-specific information for energy audits, energy benchmarking and identification of energy-efficient technologies and measures. Groups such as the U.S. Business Council for Sustainable Development, WBCSD, WRI, and LBNL can facilitate exchange with industrial associations.
- **Increase support for auditing and benchmarking tools in conjunction with sector associations, and in coordination with other international cooperation efforts.** We recommend greater support for international collaborative efforts such as translating and "localizing" guidelines from the EPA Energy Star industry program, and the DOE Industrial Technologies Program.
- **Develop detailed energy management guidance based on international best practice.** Such guidance could include developing a framework to standardize, measure and recognize industrial system optimization efforts. The guidance should consider international standards and Chinese circumstances to be effective.
- **Establish a program for certified energy managers at large energy-consuming enterprises and continue support for energy management training in the United States and China.** Training and study tours should be closely connected to implementation of specific Chinese policies. They should be aimed specifically at enterprise and government personnel that are playing a lead role within the Top-1000 Program and in other key energy conservation policies and programs.
- **Develop new policy cooperation programs to address the structural roots of China's energy and carbon upswing.** Both the United States and China could benefit from analyzing international experience (e.g., Europe and Japan) in this arena. In particular, a focus on urbanization is needed to address the demand for energy-intensive industrial products (cement, steel, glass, plastic). More U.S.-supported programs should promote urban planning for sustainable land use, green building design, efficient transportation (especially public transit), and urban energy conservation in both China and the United States. Bilateral programs that target China's goals to promote a Low-Carbon Economy are also needed to realize structural change. British cooperation programs offer a good example of cooperation to promote a shift toward low-carbon production, green technology, and information and service sectors. The new U.S.-China Partnership for Climate Action, supported by USAID, is a good move in this direction, and U.S. bilateral programs can do more

In closing, we highlight the goals and strategies noted in the July 2009 U.S.-China Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and the Environment (U.S. State Department, 2009), which are consistent with the recommendations offered here. The MOU states:

Both countries commit to respond vigorously to the challenges of energy security, climate change and environmental protection through ambitious domestic action and international cooperation. Toward this end, both countries intend to transition to a low-carbon economy, carry out policy dialogue and cooperate on capacity building and research, development and deployment of climate-friendly technology.

Both countries resolve to pursue areas of cooperation where joint expertise, resources, research capacity and combined market size can accelerate progress towards mutual goals.... Wherever possible, cooperation should seek to include expertise from all sectors of society and provide incentives for engagement at the sub-national level as well as by the business and academic sectors and non-governmental organizations.

In comparison to other international cooperation efforts with China, the U.S. government engagement on energy efficiency and climate needs greater effort and considerably more consistency over time. The July 2009 MOU, which led to the November 2009 Obama-Hu agreements, the May 2010 U.S.-China Energy Efficiency Forum, and associated new efforts related to energy saving in industry are very welcome developments. This renewed cooperation could produce multi-year funding flows, enabling U.S. and Chinese counterparts to work together, fostering working-level relationships that will need to be maintained over the years. As the two countries move forward on industrial energy cooperation we encourage that both sides keep in mind the lessons learned and recommendations offered here and we look forward to much-needed energy savings that can come from mutual cooperation.

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ENDNOTES

1 Energy intensity of the economy is defined as the amount of energy per unit of economic output, often expressed in China as metric tons of coal equivalent per 10,000 RMB (in fixed currency).

2 The target was based on an annual economic growth rate of 7.5 percent, which indicated that 640 million tons coal equivalent (Mtce) should be saved by 2010. With GDP growth 8.5 or 9.5 percent, energy savings of 670 or 700 Mtce, respectively, would be needed (Feng, 2007).

3 Online energy data collection forms cover: 1. Basic Information of Key Energy-Consuming Enterprises; 2. Energy Consumption Structure; 3. Energy Balance Table (Physical Quantity); 4. Comprehensive Energy Consumption Per Unit of Product; 5. Explanation of Factors Affecting Energy Consumption Per Product/Production; 6. Completion of Energy-Saving Targets; 7. Self-Assessment of Energy Conservation Targets Responsibility; 8. Major Energy-Consuming Equipment; 9. Implementation Situation of National Standards on Reasonable Energy Consumption; 10. List of Scheduled Energy Conservation Technological Transformation Projects; 11. Changes in Energy Conservation Projects Comparing to Previous Year; 12. Summary Table of Key Energy-Consuming Enterprises.

4 The variation in energy savings is due to the fact that the required energy savings depends upon trends in GDP growth.

5 The training materials are available at: http://hzs.ndrc.gov.cn/jnxd/t20061108_92567.htm.

6 Based on a currency conversion factor of US $1 = 7.63329 RMB (average rate in June 2007).

7 Based on a currency conversion factor of US $1 = 7.63329 RMB (average rate in June 2007).

8 It is assumed that this represents net energy savings.

9 For more information on Energy Foundation's China Sustainable Energy Program, see the program website: http://www.efchina.org.

10 For example, the CSEP 10th PAC Meeting, focused on "Enhancing Implementation of China's 2010 20% Energy Efficiency Target," was held in Tianjin in November 2007.

11 For more information on the China Sustainable Energy Program, see the program website: http://www.efchina.org

12 More information about the UNDP/GEF EUEEP can be found on the program's Chinese-language website: http://www.eueep.cn. Much of the information presented in this report comes from personal communication with staff of the UNDP Beijing Office and staff of the EUEEP project management office (PMO) in Beijing.

13 The first phase of the Programme (June 2005 to December 2009) had a budget of US $80 million, of which $17 million was funded by the GEF, $31 million by government, and $32 million from the private sector (Kan, 2008). An additional $156 million of leveraged funding was expected from the private sector, for total financing of $236 million for the first phase (UNDP-NDRC EUEEP PMO, 2007).

14 Personal communications with EUEEP PMO staff in Beijing, and He Ping of the UNDP Beijing office, 12 – 14 November 2007.

15 The EPA EnergyStar industrial efficiency manuals can be found at: http://www.energystar.gov/index.cfm?c=industry.bus_industry_info_center#industry_resources

16 For more information on the 2003 MOU, which established the Working Group on Clean Air and Clean Energy between the EPA and China's currently-named Ministry of Environmental Protection, see: http://epa.gov/international/air/chinaair.html.

17 For current information on US DOC efficiency financing cooperation with China, the P2E2 program, see: http://www.buyusa.gov/hongkong/en/p2e2.html.

18 USAID has also launched a Sustainable Buildings Partnership with China For information about USAID activity in China, including energy efficiency and climate work, see: http://www.usaid.gov/rdma/countries/china.html.

1 7 Personal communication with Ahmad Ganji, Professor and Director of the San Francisco State University IAC. 5 May 2010, San Francisco. See also the IAC website: http://www1.eere.energy.gov/industry/bestpractices/iacs.html

1 8 Coke dry quenching technology, or CDQ, recovers heat energy from red-hot coke used in steel making. Rather than quenching with water, CDQ uses inert gases and a heat exchanger to cool the coke and utilize the heat energy to generate steam or electricity. The process yields higher quality coke as well as energy and water savings.

19 For more information on the domestic and international activities of the Energy Conservation Center of Japan, see the ECCJ website: http://www.eccj.or.jp/index_e.html.

20 For more information about UK climate change cooperation efforts with China, especially under the Strategic Programme Fund, see: http://ukinchina.fco.gov.uk/en/about-us/working-with-china/spf

21 For further information on UK-China climate cooperation from the British Embassy in Beijing, see: http://ukinchina.fco.gov.uk/en/about-us/working-with-china/climate-change/uk-china-cooperation/

22 For an overview of UK-China climate collaboration, see: http://hi.baidu.com/jarryinbeijing/blog/item/59527cadb0bda2c07cd92ab7.html

23 Requirements for project proposals under UK-China Low Carbon High Growth cooperation can be found

at:http://ukinchina.fco.gov.uk/en/about-us/working-with-china/spf

24 Based on personal communications with staff of CECA, UNDP/GEF EUEEP PMO, and Japan's ECCJ; Beijing and Tokyo, 2006 – 2009.

25 Funds allocated included 4M RMB ($571,000) each to: Xinjiang, Ningxia, Qinghai, Gansu, Yunnan, Guizhou, Sichuan, Shanxi and Guangxi; 3M RMB (US $429,000) each to: Jiangxi and Neimeng; 2.4M RMB (US $343,000) each to: Liaoning, Helongjiang, Jilin, Hubei, Henan, Shannxi, Hunan, Anhui and Chongqing (Price et al., 2008).

26 Chinese administrative structure is often referred to as tiao-taio kuai-kuai, a system of vertical and horizontal hierarchies. For example, the National Development and Reform Commission (NDRC) has a network of local-level Development and Reform Commissions that report up to the national level (vertical structure). However, decision about local-level DRC staffing and salaries are often made by other local-level government offices (horizontal structure). As a result, the administrative structure has both tension and balance.

27 Personal communication with Jiang Yun, CECA, 13 November 2007, Beijing; and 29 July 2009, New York.

28 Personal communication with Wang Jianfu, Deputy Director, CIEE. 30 July 2009, New York. For more information on CIEE, see their website (in English and Chinese): http://www.cieec.org.cn.

29 To be categorized as an ESCO, a firm must be a "commercial, profit-seeking company that invests in, or facilitates investments in, energy efficiency projects in other [host] enterprises, using energy performance contracting" (World Bank, 2008a).

30 Recent estimates of ESCO investment come from the World Bank-NDRC Energy Conservation Project Management Office.

33 Based on observations during multiple workshops and field visits in Beijing, 2005 – 2007, as well as interviews with Japanese industry associations active in China.

34 Xie Qihua is known as the 'iron lady' in China and among the global steel community. See, for example, http://www.chinadaily.com.cn/bizchina/2006-01/07/content_597789.htm.

35 A brief English-language summary of the meeting is available on the JISF website: http://www.jisf.or.jp/en/activity/warm/meeting/index.html.

36 Personal communications with members of JISF and Nippon Steel, Tokyo and Beijing, 2005 – 2007.

37 Personal communication with Jiang Yun, CECA, 13 November 2007, Beijing.

38 Personal communication with staff of ECCJ, 21 February 2008, Tokyo.

39 Personal communication with Jiang Yun, CECA, 13 November 2007, Beijing; and 29 July 2009, New York.

40 Personal communication with Bo Shen, LBNL, 2 August 2010, Berkeley, CA.

41 For more information on the US DOE Federal Energy Management Program for industry, see: http://www1.eere.energy.gov/femp/program/industrial_facilities.html.

42 For announcement in July 2010 of international collaboration involving the U.S. DOE Superior Energy Performance program, see: http://www.energy.gov/news/9233.htm

43 For more information on the US network of university-based Industrial Assessment Centers, see http://www1.eere.energy.gov/industry/bestpractices/iacs.html.

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FEATURE BOX

Role Models: Young and Old Community Members in China Inspire Local Action to Save Energy

By Matthew A. DeGroot

In Doumen Township, not far from Macau in southeastern China, Zhao Jingjing helps her neighbors identify household energy savings opportunities. She explains how low-energy appliances, turning off unneeded lighting, managing thermostats, and calibrating water heaters can lead to lower energy bills. She circles back regularly to answer questions and check on their progress. Each month, she checks her apartment complex's electric meter to compare readings, and runs calculations to convert their energy savings into greenhouse gas (GHG) emissions. So in addition to helping her neighbors save energy—and money—she tracks how they have helped reduce climate disruption.

Zhao is one of 400 "Green Guardians" in Doumen, a new volunteer force committed to educating their fellow citizens about energy use and the dangers of climate disruption. The Green Guardians have undergone extensive training in the science, economics, ethics and mechanics behind energy efficiency and climate change, and have become respected and sought after experts. Just in the last six months, they helped their community reduce its residential energy use by more than 10 percent.

They also happen to be nine-years old.

The Green Guardian education initiative is one part of the Guangdong Environmental Partnership (GEP) program, a unique public-private partnership that targets energy and GHG reductions in Guangdong, China's most industrialized province and "factory to the world." This component of GEP focuses on building the capacity of grassroots stakeholders to collaborate on identifying and implementing priority energy and environmental projects in their communities.

Many environmental initiatives in China focus on identifying a "silver bullet" solution at the macro level—a stronger policy, newer technology, or better business practice that will magically spark a wave of change and result in better environmental performance across the country. While critical, these top-down measures often fail to account for the challenges and barriers to implementing complex new programs at the provincial and local levels. They can also ignore or discount the diversity and richness of local environmental actions already underway in China.

Zhao and her fellow Guardians are demonstrating the power of coordinated grassroots action, and their community is taking note. Part of a pilot initiative at Nanmen Elementary School in Doumen, their efforts have proven so successful that local officials, business leaders, and school administrators have committed to scaling up the program in every primary and middle school in the township in the coming year. Moved in part by Doumen's experience, other townships and urban neighborhoods across Guangdong will soon initiate their own "Green Guardian" pilot programs. All told, their efforts will mobilize close to 3,000 Guardians and reach over 20,000 families and citizens by 2011.

While inspiring, the Green Guardian initiative is just the beginning. "We engage stakeholders from all backgrounds in the target communities in solving their own problems," says Wan Yang, program manager for the Institute for Sustainable Communities (ISC), which designed and is implementing the GEP program. "Government officials, business owners, citizen leaders, educators—all have a role in setting priorities, identifying the most critical energy projects, and managing them through to completion." ISC helps each community establish a "multi-stakeholder committee" with representatives from each constituent group, to oversee local initiatives. By facilitating non-traditional partnerships, the program helps communities discover and draw on a diverse array of local resources and expertise. The committees also help ensure local ownership of the projects and their successes.

While Doumen's multi-stakeholder committee chose to focus initially on public outreach and residential energy efficiency, the impact of the Green Guardian program has kindled a new awareness of what is possible. Local factories and businesses are now planning an initiative to reduce energy use in their manufacturing processes. Public officials are eyeing a solid waste management project that would divert organic waste from landfills to a new composting operation, reducing the cost and emissions associated with chemically produced fertilizers. Schools are reaching out to local businesses to get them directly involved in supporting their new curriculum on sustainable development. These new relationships and activities are producing a critical mass of momentum toward reducing energy use,

Zhao Jingjing, a student in China, is reducing her family's carbon footprint and recording the results on this calendar. Over the next 3 years, "Green Guardians" like Jingjing will educate 20,000 family and community members on how to prevent climate disruption. "I'm so proud of my daughter," said Zhao's father. "What you are doing really means a lot to us." Photo Credit: Wu Qiubo decreasing GHG emissions, and improving environmental health.

Other GEP demonstration communities include Sanjiao, which is training factory managers to increase energy efficiency and has already secured commitments from several local manufacturers to reduce energy use by 20 percent in the coming year. Urban Guanlan, near Hong Kong, is installing green roofs on more than 1,000 residential apartment buildings, mitigating their "heat island" effect and reducing demand for air conditioning in the summer months. The three demonstration communities also benefit from each other. As noted above, Sanjiao and Guanlan will soon replicate Doumen's Green Guardian program in their own schools. Meanwhile, Doumen's factories are learning from the successes of Sanjiao's industrial efficiency initiative.

The communities are also demonstrating that, while government policies and new business practices are critical, people from all walks of life have something to contribute in driving positive change. They are finding that the power of this collective achievement is transformative—when people witness their neighbors taking action and achieving a real impact, it produces a ripple effect that inspires everyone to get involved. Together, these communities are creating new models for locally driven energy and climate actions in China that can be replicated across Guangdong and eventually, the entire country.

The Institute for Sustainable Communities is a Vermont-based NGO that gives passionate, committed people the tools and skills they need to inspire active citizenship, protect the environment, and take on climate change. Their projects combine technical expertise and leadership training with strategic investments in local organizations around the world, in order to spark creative solutions and lasting change around the world. ISC is currently focused on strengthening democratic institutions and citizenship in transition countries, helping communities in the US and China become more resource efficient and transition to low-carbon economy, and supporting sustainable community development—particularly in areas recovering from natural disasters or vulnerable to climate disruption.

ISC has been working in China since 2007. The community-based portion of the Guangdong Environmental Partnership program is made possible through generous financial contributions from the U.S. Agency for International Development, the Rockefeller Brothers Fund, the Citi Foundation, and the Japan Foundation Center for Global Partnership. For more information on ISC's China work see: http://www.iscvt.org/where_we_work/china/

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FEATURE BOX

Building New Clean Water Networks in China: Challenges and Opportunities for Protecting Lake Tai

By Kexin Liu and Peter Marsters

GOING GREEN

Green is "in" today in China—green five-year plans, green energy policies, green banking, and green cities are all the rage. Over the past year columnist Tom Friedman of The *New York Times* has written countless op-eds on China's green revolution. However, after nearly all of China's major lakes turned green from toxic algae, the public response and newspaper headlines were clearly less positive.

China's lakes are facing a pollution crisis and the most publicized on this front is Lake Tai, China's third largest lake that lies on the border of Jiangsu and Zhejiang provinces. Despite years of investment in pollution control, Lake Tai remains stubbornly green with toxic cyanobacteria blooms stemming from the multitude of industrial, agricultural, and municipal pollution sources. This large yet shallow 2,250 square kilometer lake is the lifeblood of the surrounding provinces and for Shanghai as well. The Lake Tai basin is China's second most prosperous industrial and agricultural area, producing 17.4 percent of the country's GDP in 2009. The lake supplies water to 30 million people in the watershed and also supports a rich fishing industry.

In August 2009, the China Environment Forum (CEF) at the Woodrow Wilson International Center for Scholars and its partners—the Institute of Developing Economies (IDE) in Japan and the Center for Environmental Management and Policy (CEMP) at Nanjing University—began a two-year project that aims to build a network of U.S., Japanese, and Chinese business, civil society, research, and government representatives to explore market, public-private partnership, and multi-stakeholder strategies to stem pollution problems in Lake Tai. The project is supported by a grant from the Japan Foundation's Center for Global Partnership and internal resources from the three partners. The exchanges as well as research by the project partners will inform a trilingual brief—due out in mid-2011—on strategies and tools for lake protection that are applicable to China and outline specific opportunities for international—especially joint U.S.-Japanese—water cooperation in China.

ASSEMBLING THE TEAM FOR BUILDING A CLEAN WATER NETWORK

The first activity carried out for this project was a two-day workshop at Nanjing University in January 2010 that brought together a diverse group of government, NGO, industry, and research professionals from the Lake Tai watershed to participate in highly interactive discussions with their international counterparts. Participants learned about some of the key drivers of Lake Tai's complex pollution problems and discussed possible policy, market, transparency, and scientific strategies used in the United States and Japan that could prevent and/or remediate pollution in Lake Tai.

Following the Nanjing workshop, CEF and its partners formed a tri-national research team to participate in two exchanges to explore water pollution prevention strategies in lakes in the United States and Japan. The Chinese team includes Nanjing University researchers, local government officials, grassroots green groups, and one proactive businessman. Many on the team are participants in CEMP's community roundtable in Yixing, which aspires to create multi-stakeholder dialogues to promote better lake protection efforts and inform the design of a water pollution trading pilot project. Japanese researchers from IDE have been assisting CEMP in joint research on the community roundtable project.

BAY AND LAKE RESTORATION IN THE UNITED STATES

The second major activity of the project concluded in August 2010 with Chinese and Japanese members of the Lake Tai research team visiting Washington, DC; Annapolis, Maryland; Chicago, Illinois; and Northern Indiana to study strategies, partnerships, and lessons learned in controlling water pollution in the United States. The group kicked off their exploration by visiting the Chesapeake Bay Foundation and the EPA's Chesapeake Bay Program in Annapolis—meetings that the Washington, DC-based World Resources Institute helped arrange. Like Lake Tai, the Chesapeake Bay suffers from excessive nitrogen and phosphorus pollution, with most coming from municipal waste and agricultural runoff. In another parallel to Lake Tai, the Chesapeake Bay's water quality has continued to drop despite years of investment and progress in lowering point source pollution from industry and municipalities. Stormwater, a very expensive problem, is the only source of pollution that is growing in the Chesapeake Bay. While urban runoff faces strict regulation, the same is not true for agricultural runoff. Discussions in Annapolis introduced the Lake Tai team to the environmental scorecard tool that was developed by Chesapeake Bay Foundation to help broadly and clearly distribute information about the bay's environmental quality in order to galvanize more effective action by all stakeholders.

In workshops in Washington, DC the group learned about the evolution of water pollution regulation under the Clean Water Act and gained insight into progress and challenges facing water pollution trading pilot projects in a handful of U.S. states. In a number of meetings in Washington, DC and Chicago, the growing role of NGO-business partnerships was a theme that intrigued the Chinese and Japanese participants, for in China the business community has rarely engaged in multi-stakeholder water protection activities or acts of environmental leadership.

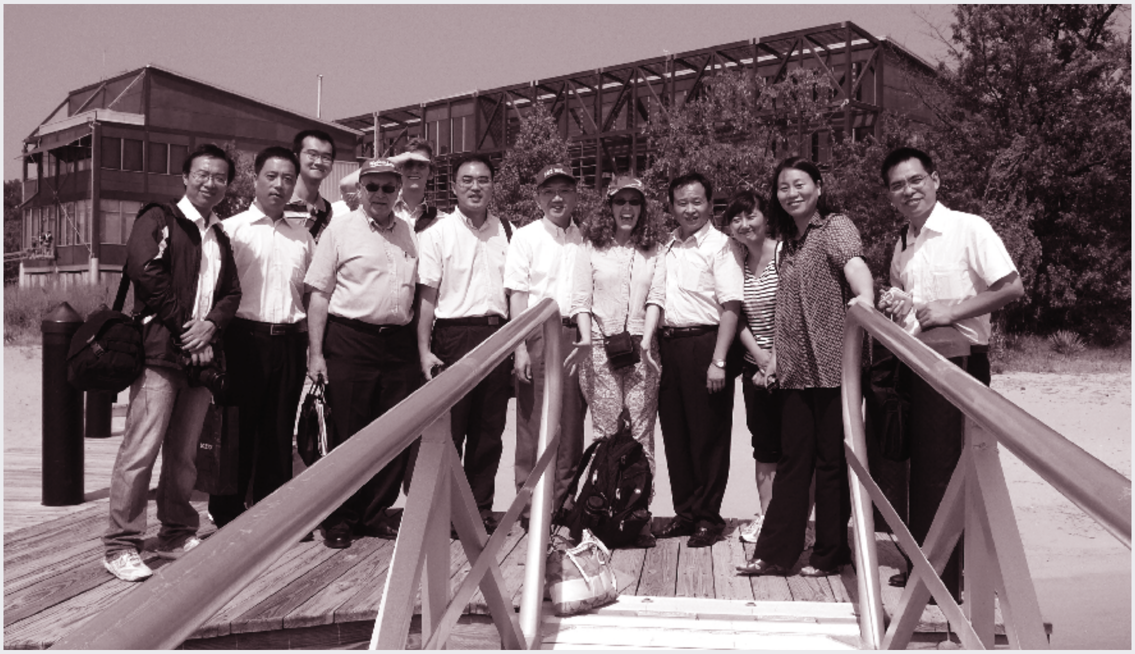
The two days of talking to researchers, NGOs, and business representatives who have been key in driving the creation and implementation of the Great Lakes Restoration Plan in Chicago and Northern Indiana exposed the Lake Tai group to a unique model of multi-stakeholder cooperation that has improved the governance of the largest lake basin in the United States. Andy Buchsbaum, a key organizer of the Chicago meetings, illustrated the magnitude of the challenge in bringing together so many players to agree on restoring the Great Lakes by noting that the water from the basin could cover China with eight inches of water. While strolling next to the shoreline of Lake Michigan outside the Shedd Aquarium where the daylong workshop took place, the Chinese participants expressed their awe to see such an enormous city coexisting next to a large and clean lake—a rarity in China.

The group exchanged views with prominent scholars and professionals about the protection of the Great Lakes. Welcoming the group was special assistant to Richard Daly, the Mayor of Chicago, Joe Deal, who highlighted how the Mayor's office has been a key convener of city officials from Lake Michigan's basin to promote exchange and collaboration in lake protection. The daylong discussions painted a clear picture of how the business and NGO communities in the Great Lake Basin came together to push for the creation of the Great Lakes Water Resource Compact. John Austin, Director of the Great Lakes Economic Initiative of the Brookings Institution, introduced the study commissioned by the Great Lakes Business Council that carried out an extensive cost-benefit analysis of protecting the basin. Andy Buchsbaum explained that the Brookings study along with duel pressure from the business and NGO communities in the basin helped break political logjam among the eight U.S. states and two Canadian provinces in the basin, which led to the finalizing and signing of the Compact. Because the basin is so large and the problems so diverse, nearly 400 NGOs have come together to form the Healing Our Waters Coalition to oversee the implementation of the compact. Jon Allan, a senior executive at CMS Energy, a major utility provider in Michigan, and Doug Roberts from the Michigan Chamber of Commerce talked about how and why the business community has been proactive in multi-stakeholder initiatives to protect the Great Lakes.

Despite the Compact, pollution threats to the lake still continue, an issue illustrated by Henry Henderson from the Natural Resources Defense Council as he described the ongoing conflict around the BP Whiting oil refinery plant expansion that began in 2008 and is expected to be completed in 2011. Both the expansion, which was undertaken to process oil mined from Canada's tar sands, and the State of Indiana's permit allowing BP Whiting additional discharges into Lake Michigan were met with fierce opposition and legal action from a coalition of local NGOs and politicians out of concern these emissions will seriously degrade the water and air in Lake Michigan. A boat tour of the shore of the heavily industrialized northwest Indiana showed members of the Lake Tai research team some of the lingering challenges facing the southern shore of Lake Michigan. The group also learned about some impressive examples of lakeshore revitalization and protection in conversations with representatives from local businesses, government agencies, and NGOs in Northern Indiana, and from a visit to the Indiana Dunes National Park that directly neighbors massive steel facilities, spreading miles along the lakeshore.

WRAPPING UP

The second and final year of this project will



The Lake Tai study group poses before the Chesapeake Bay Foundation office in August 2010. Photo Credit: Ran Liping wrap up with a research exchange in Japan that will include a one-day symposium in Tokyo and one day of meetings with business, government, and NGOs working on clean water policies and projects and green supply chains in Tokyo. The group will also take a two-day trip to meet with experts who have worked to promote multi-stakeholder initiatives to clean up Lake Suwa and Lake Biwa. Additionally, CEF will produce a trilingual policy brief which will highlight U.S. and Japanese market, public-private partnership, and public participation strategies and tools that are applicable to China, outlining specific opportunities for joint U.S.-Japanese water cooperation in China. The brief will target policymakers, practitioners, and research audiences. Additionally, summaries and media of the project will be posted online and in the *China Environment Series* issue 12.

While the group of participants from China is small, the team comprises key stakeholders in lake and water protection and we hope that our research, workshops, and networking will help empower them to truly "green" Lake Tai.

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FEATURE BOX

Cooperative Competitors: Building New U.S.-China Climate and Energy Networks

By Peter Marsters

CROUCHING SUSPICIONS, HIDDEN POTENTIAL

Over the past five years, China has taken considerable steps towards low-carbon development, with aggressive targets, policies, and investments focused on the renewable and energy efficiency sectors to help address the country's huge energy consumption and stem severe air pollution problems. As the global leader in clean energy investments, China has become the world's largest exporter of solar panels, and Chinese wind power companies have begun to enter the global market. China's progressive energy policies and priorities to decarbonize its economy have attracted considerable international investment, giving rise to pilot projects in nearly every type of energy technology—renewables, cleaner coal, biofuels, and shale gas. On the greenhouse gas front, China has the world's largest laboratory for clean technology projects and carbon capture and sequestration pilots.

In the United States, China's "green revolution" has sparked a broad range of reactions ranging from calls for U.S. action to create policies and promote investments to help the U.S. clean technology market catch up to China to complaints that the Chinese government provides its wind and solar industry with excessive subsidies that give Chinese companies unfair competitive advantage in the global clean energy markets. Unfortunately, perceiving China's progress in advancing cleaner energy as a win-lose situation could lead the United States to focus solely on protectionism and competition, rather than passing energy and climate legislation to develop domestic markets. Moreover, the view that China is "stealing" green jobs overlooks the opportunities for fruitful areas of bilateral clean energy cooperation that could enable the United States to take advantage of a growing global market.

In November 2009 just after Presidents Obama and Hu met in Beijing to sign nine new bilateral energy agreements, the Wilson Center's China Environment Forum (CEF) launched a new initiative—Cooperative Competitors: Building New U.S.-China Climate and Energy Networks. This initiative, made possible through seed funding from Blue Moon Fund and Rockefeller Brothers Fund, as well as support from USAID and Vermont Law School, builds on CEF's thirteen years of convening dialogues of diverse policy, business, NGO, and research experts to examine China's energy and environmental challenges.

Through examination of topics such as black carbon, sub-national climate cooperation, power sector decarburization, smart grid, solar power, and green transportation, the meetings and publications under the Cooperative Competitors initiative have begun to explore the true benefits and challenges facing U.S-China clean energy cooperation. By helping to promote dialogues among energy practitioners in both countries, CEF hopes to help identify some promising areas of clean energy and climate collaboration that can benefit the environment and promote more sustainable energy production for both countries.

THE U.S.-CHINA CLEANER COAL CHALLENGE

The Cooperative Competitors meetings have drawn expertise from business, government, research, and NGO communities to discuss a broad spectrum of climate and clean energy issues facing the United States and China. With both countries highly dependent on coal—comprising roughly 50 percent of electricity production in the United States and 80 percent in China—many meetings have focused on cleaner coal issues. The project has stimulated broader and more in-depth discussion about how private and public stakeholders in the United States and China can collaborate to deliver favorable outcomes in mitigating climate change, addressing increasing energy demand and maintaining economic growth. The "Cleaning Up King Coal" meeting held on May 12, 2010 illustrated the potential benefits of private sector cooperation, featuring speakers from Clean Air Task Force (CATF) and Future Fuels LLC who discussed how Chinese technology can offer cleaner coal solutions to the United States in the form of carbon capture and sequestration ready coal fired power plants. Future Fuels is the exclusive U.S. licensee of an advanced coal gasification technology developed by China's Thermal Power Research Institute. As Ming Sung, Chief Representative in the Asia Pacific for CATF, stated, "investments by one country can reduce the cost of a technology worldwide, increasing the likelihood that carbon capture and storage will be deployed widely in time to help avert the worst consequences of climate change."

At CEF's "Electricity with Chinese Characteristics" meeting on June 24, 2010, Jim Williams from the San Francisco-based environmental consultancy E3, explained that one of the major challenges facing China's efforts to promote renewable energy and energy efficiency is the difficulty in assessing the actual cost of decarbonizing the power sector. The gap in understanding these costs is due to a lack of "soft technology"—analytical methods, software models, and institutional processes. Without the ability to assess the true costs of electricity, policymakers in China are unable to determine the level of greenhouse gas reductions that

could be achieved in the power sector for a given cost. U.S. Federal Electricity Regulatory Commission Chairman Jon Wellinghoff, who has made several visits to China to meet with his counterparts, believes that collaboration in the power sector could be mutually beneficial, resulting in net climate and economic benefits for both the United States and China.

MIND THE (WATER-ENERGY) GAP

While most of the Cooperative Competitors meetings have focused on new or emerging business, NGO, or bilateral energy partnerships or challenges facing energy policy and governance in China, a session on September 22, 2101 highlighted a striking gap in the United States and China on the clean energy front. In both countries there is little or no understanding about the impact that new energy investments will have on freshwater resources. At the September meeting speakers from Circle of Blue (COB) presented the results of their investigation into the water footprint of shale gas, tar sands, biofuels, solar power, and dams in the United States. To meet the projected 40 percent increase in energy demand by 2050, the United States is developing a massive number of non-conventional fuel projects that will have a crippling impact on the nation's water security. Soy biofuel gas uses 6,000 times more water than conventionally refined petroleum-derived fuel. Freshwater protection and energy development are not being looked at as a single issue; COB speaker Keith Schneider noted that as rising energy demand collides with declining water supplies, the United States is facing but not yet addressing a national choke point. CEF will be embarking on research and meetings to identify and examine the water-energy choke points in China.

CEF research briefs that distill the insights gained from Cooperative Competitors research, meetings, and networking will be posted online in English and Chinese.

Peter V. Marsters has been CEF's assistant for over a year, focusing his research on green cars and the water-energy nexus in China and the United States. He can be reached at: peter.marsters@wilsoncenter.org.

Some speakers in our Cooperative Competitors meeting series in 2010 included (L to R): Ming Song (Clean Air Task Force); Jim Williams (E3); Fritz Kahrl (E3); and Keith Schneider (Circle of Blue). Photo Credit: David Hawxhurst.

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FEATURE ARTICLE

Advancing Carbon Capture and Sequestration in China: A Global Learning Laboratory

By Craig Hart and Hengwei Liu

China's dependency on coal fuels the country's phenomenal economic growth but at a major cost to the country's air and water quality, ultimately threatening human health and the country's continued economic growth. The Chinese government's efforts to put China onto a cleaner, low carbon development path have been substantial; however China's pollution and greenhouse gas emissions continue to grow. In an attempt to develop its own advanced coal generation technologies to improve the country's air quality and energy efficiency, the Chinese government is investing heavily in gasification and other technologies that can be employed in carbon capture and sequestration (CCS) applications. This investment has turned China into a global laboratory for CCS pilot projects, attracting foreign governments, multilateral institutions, nongovernmental organizations, and business partners. China's leadership in developing CCS technology could ultimately help lower its costs and promote its commercialization globally, representing a major step forward to solving the global climate dilemma.

China has the most coal-dependent economy on earth, which has fueled the country's phenomenal economic growth. But this coal-fueled growth has come at a major cost to air and water quality, and China is now the leading emitter of carbon dioxide (CO_2). Although China's leadership has adopted aggressive policies to promote energy efficiency and renewables, as well as ambitious greenhouse gas (GHG) reduction targets, the country's pollution and GHG emissions continue to grow, albeit at a slower rate. In order to substantially curb China's CO_2 emissions, the Chinese government must implement carbon capture and sequestration (CCS) technology on a massive scale over the next few decades.

Geologic CCS involves the capture, transport and injection of CO_2 into subsurface geologic formations (principally saline formations); depleted oil and gas reservoirs; and deep uneconomically mineable coal seams. The CO_2 would be captured at a power plant or any industrial facility that emits it in high concentrations. CCS can potentially make a significant contribution to lowering GHG emissions by permanently storing CO_2 underground.

CCS technology is advancing through pilot projects in Europe, the United States, Africa, Australia, Japan and China. China's efforts to develop CCS technology put it among the leading nations in the industry.

Before surveying the various efforts to develop CCS in China, we first discuss the coal challenge that drives China's leadership to invest in alternative energy, energy efficiency, and low carbon technology. Next we discuss China's domestic efforts to develop policies, technology and projects that have fomented the development of the country's emerging supply chain to support CCS. We then describe how China has become a laboratory for CCS pilot projects, attracting foreign governments, multilateral institutions, nongovernmental organizations (NGOs), and business partners. We close with a discussion of key steps that China's decision-makers could take to support the adoption and diffusion of CCS in China.

CHINA'S ENERGY AND CO_2 CHALLENGE

China's phenomenal economic growth since it began its reform and opening-up policy in 1978 has produced an average annual growth rate of approximately 10 percent over three decades, far in excess of the world annual average of three percent. From 1978 to 2008 China increased its gross domestic product (GDP) by 83 times (NBS, 2009), and lifted 235 million of its citizens out of poverty (*People's Daily Online*, 2008).

Much of China's dramatic growth benefits the rest of the world. China produces only six percent of the world's GDP, though its industry consumes a much larger percentage of global energy resources in order to supply commodities to the world. As of 2009, China was the world's largest energy consumer, accounting for almost 20 percent of global primary energy consumption, 47 percent of global coal consumption and 10 percent of global oil consumption, almost half of which is imported from other countries (BP, 2010; NDRC, 2009). China deploys its resources to supply 48 percent of global cement production, 49 percent of global flat glass production, 35 percent of global steel production, and 28 percent of global aluminum production (Rosen & Houser, 2007). Industry accounts for over 70 percent of China's final energy consumption, while the residential, commercial and transportation sectors only account for ten, two, and seven percent, respectively (Rosen & Houser, 2007).

China's efforts to develop CCS technology put it among the leading nations in the industry.

China's energy consumption and CO_2 emissions have more than doubled between 1990 and 2006, and will double again by 2030 if unabated (IEA, 2009). Although its emissions are only a quarter of U.S. emissions on a per capita basis, over the last few years China surpassed the United States as the world's largest emitter of CO_2 and its emissions continue to rise rapidly. Without major advances in decarbonizing its economy, China will account for about 23 percent of global energy consumption and 29 percent of global CO_2 emissions by 2030 (IEA, 2009).

International Climate Talks as Catalyst for Greater Action

China does not have a quantified emission reductions obligation under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). However, pursuant to the Bali Action Plan adopted at COP 13, China and other developing countries agreed to undertake "nationally appropriate mitigation actions" (NAMAs) under a post-2012 agreement to address climate change.[1] The Bali Action Plan calls for deep and urgent cuts in GHG concentrations based on Intergovernmental Panel on Climate Change findings that concentration levels should be kept below 450 parts per million (ppm) CO_2-equivalent to avoid dangerous climate change. To achieve this goal, developed countries must reduce emissions by 25 to 40 percent of 1990 levels by 2020, and 85 to 95 percent of 1990 levels by 2050.

The Copenhagen Accord adopted in December 2009 reaffirmed the objective of the UNFCCC to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, and recognized that the global temperature should remain below 2°C. To achieve these goals, large, rapidly growing developing countries must also emit less than their business-as-usual projections. China, in particular, will need to make dramatic reductions in its emissions.

Driven by concerns over domestic energy security, air pollution problems from coal, and the need to address climate change, China has announced its own goal to reduce its carbon intensity by 40 to 45 percent of 2005 levels by 2020. This is in addition to its target to improve energy efficiency by 20 percent of 2005 levels by 2010, and its targets for renewable energy (see Table 1) and fuel switching. The Chinese government is implementing an impressive array of policies to achieve these targets, including:

- providing capital and other incentives for renewable energy and energy efficiency;
- forcing industry to upgrade or close highly polluting, inefficient power and industrial facilities; and,
- entering into voluntary agreements with industry to reduce emissions and increase efficiency.

The government's steadily growing investment in cleaner energy further supports these aggressive low-carbon policies. In 2009, China ranked as the number one clean technology investor, investing $34.6 billion, almost double U.S. investment that year (Pew Charitable Trusts, 2010). Even with these policies, however, China's ambitious carbon intensity and energy efficiency targets will be difficult to achieve. [2]

TABLE 1. CHINA'S TARGETS FOR KEY RENEWABLE ENERGY TECHNOLOGIES

Technology	Type	2010 Target	2020 Target
Hydropower	Large scale	190 GW	300 GW
Bioenergy	Generation	5.5 GW	30 GW
	Biofuel pellets	1 million tons	50 million tons
	Biogas	19 billion m3	44 billion m^3
	Bioethanol	2 million tons	10 million tons
	Biodiesel	200,000 tons	2 million tons
Wind	Generation	5 GW	30 GW
Solar	On-grid solar PV	150 MW	1.5 GW
	Off-grid solar PV	150 MW	0.3 GW
	Solar thermal	150 million m2	300 million m^2

Source: NDRC, 2007b.

CCS as Key to Reducing China's Emissions

Notwithstanding the Chinese leadership's efforts to put the country onto a low carbon development path, China's ability to successfully reduce its GHG emissions will ultimately depend on reducing emissions from coal.

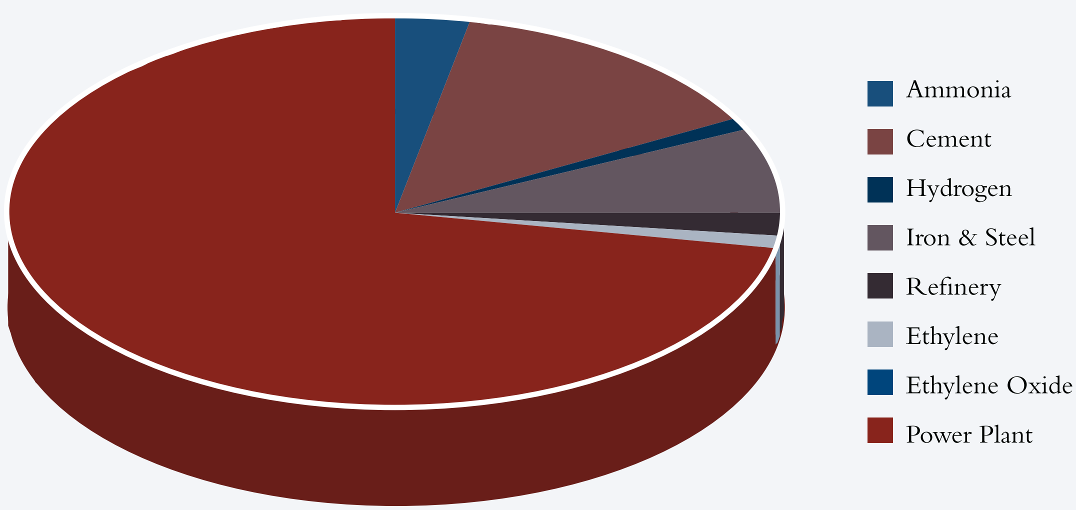
China is both the world's largest producer and consumer of coal, accounting for more than 48 percent of global coal production in 2008 (Asian Development Bank, 2009). Coal accounts for over 70 percent of China's total energy consumption, and will remain its main energy source in the coming decades (BP, 2010). Over 80 percent of China's electricity is generated by coal-fired power plants (CEC, 2009; Rosen & Houser, 2007).

The likelihood of China decreasing its dependence on coal is low due to rapid urbanization and rising energy use by China's growing and increasingly wealthy middle class. Even if China meets its targets for energy efficiency improvements, renewable energy and fuel switching, the country would rely upon coal for more than 50 percent of its power generating capacity through 2030 (Liu & Gallagher, 2009).

After energy efficiency and fuel switching, CCS will be China's primary option for reducing emissions in the power, chemical and other industrial sectors that depend on fossil fuels. The main driver of China's increasing CO_2 emissions is rapid growth in the power sector. China's installed capacity increased from 57 gigawatts (GW) in 1978 to 793 GW in 2008 (Tian, 2008; IEA Clean Coal Centre, 2010) (See Figure 1 for overview of main CO_2 point sources). An estimated 1,062 GW of new capacity will be installed in China by 2030, resulting in a total installed capacity of 1,936 GW—equivalent to the current installed capacity of the United States and European Union combined (IEA, 2009). Assuming China continues to rely on coal for power generation, CCS must be widely deployed in order to keep global greenhouse concentrations below 450 ppm CO_2-equivalent (Liu & Gallagher, 2009).

Beyond the power sector, CCS presents China with opportunities to reduce emissions from industrial sources of CO_2, particularly chemicals, petrochemicals, steel and cement. Opportunities for application of CCS in the chemical industry are especially promising, as chemical production produces high volumes of relatively pure CO_2 streams that could significantly reduce China's CO_2 emissions at modest cost if captured.

FIGURE 1. CONTRIBUTIONS OF LARGE POINT SOURCES OF CO_2 IN CHINA



Source : Dahowski et al., 2009.

Box 1. INTEGRATED GASIFICATION COMBINED CYCLE (IGCC) (PRE-COMBUSTION)

IGCC technology converts solid fuels (such as coal, oil, biomass and waste) into synthetic gas (syngas) for the purposes of generating electricity and/or feedstock for the production of chemicals and fuels. In a gaseous state, carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrous oxides (NOx), mercury and particulates can be more easily and cost-effectively removed. Once these substances are removed, the syngas can be used to power a gas turbine for the generation of electricity. In a combined cycle plant, waste heat from the gas turbine is then run through a steam turbine to generate additional electricity.

The process of transforming solid coal into syngas takes place in a gasifier in two distinct processes: gasification and an optional shift-reaction to increase the energy content of the product. Coal fuel is fed to the gasifier through one of a number of methods including fixed-bed, fluidized-bed, and entrained–flow. Coal or other feedstock is subjected to high temperatures (between 1,400° and 2,800° F) and pressure, and mixed with carefully controlled amounts of steam and air or oxygen, which is supplied by an oxygen plant. The gasification process breaks apart the chemical bonds of the coal and results in a syngas consisting of a mixture of carbon monoxide (CO), CO_2, hydrogen (H_2) and other trace substances. If the syngas is shifted in a water-gas reaction (syngas reacts with water vapor to produce hydrogen and carbon dioxide in an exothermic reaction: $CO+H_2O$ CO_2+H_2), the reaction produces H_2, which enriches the gas or liquid fuel, and CO_2 that becomes highly concentrated in high pressure gas. The highly concentrated CO_2 can be separated from the syngas prior to being supplied to the gas turbine, at lower variable cost than compared to post-combustion removal from flue gases in conventional pulverized coal plants, where CO_2 is at lower pressure and diluted with other exhaust gases. IGCC also enables the economically efficient removal of sulfur, nitrogen oxide, mercury, and particulates from the syngas using such methods as activated carbon filtration and sorbents, resulting in much less pollution than conventional coal-fired power plants.

IGCC plants currently in operation can achieve efficiencies of 40 to 45 percent on a lower heating value basis (Liu et al., 2008; Higman, 2009). If waste heat is used in industrial processes or to heat buildings, efficiencies potentially could be increased to as high as 85 percent (American Council for an Energy-Efficient Economy, 2010).

There are over twenty IGCC plants for power production that burn coal, petcoke and/or oil operating in Europe, the United States and Asia. However, the power industry still has limited operational experience with IGCC plants. Some of these plants have taken years to reach their maximum availability, which is still lower than conventional pulverized coal units. There is general consensus that another five to ten plants are necessary to provide the learning and testing required to optimize the operation of IGCC technology.

Box 1. CONTINUED

SELECTED COAL-FIRED IGCC POWER GENERATION PLANTS IN OPERATION TODAY

Power station	Buggenum	Wabash River	Tampa Polk	Puertollano	Vresova
Country	Netherlands	USA	USA	Spain	Czech Republic
Time of operation	1994	1995	1996	1997	1996
Net capacity MW	253	265	250	300	400
Gasifier	Shell	Destec	Texaco	Prenflo	Lurgi
Gas Turbine	V94.2	GE-7FA	GE-7FA	V94.3	GE-9E
Efficiency % (LHV)	43.3	40	37.8	45	Not available
Availability	86.1%	>80%	77%	66.1%	90%+

Source: Liu et al.., 2008; Higman, 2009

Box 2. GASIFICATION TECHNOLOGY IN CHINA

Gasification technology has been used for many years in China in the chemicals industry. GE Energy (formerly Texaco technology) has issued 38 licenses, Shell has licensed 19 plants, and Siemens is building 5 coal gasification plants for chemical production in China (IEA Clean Coal Centre, 2010; Cai, 2010). Experience gained through the construction and operation of imported gasifiers has helped China develop its own large capacity gasifiers for chemicals and power generation. Chinese gasifiers include the "Opposed Multi-burner Coal-water Slurry Gasifier" developed by East China University of Science and Technology (ECUST) based on a GE/Texaco gasifier; the "Two-staged Dry Feed Pressurized Coal Gasifier" developed by the Xi'an Thermal Power Research Institute (TPRI) based on a Shell design; and the "Two-staged Water-coal Slurry Gasifier" developed by Tsinghua University based on a GE/Texaco gasifier (Liu et al.,. 2008).

Box 3. POST-COMBUSTION, OXY-FUEL AND CHEMICAL LOOPING TECHNOLOGIES

Post-Combustion

Post-combustion separation and recovery of CO_2 involves the treatment of flue gas, usually through a chemical solvent absorption method (such as monoethanolamine). Reuse of the chemical agent requires low-pressure steam to break the bonds between the absorbent and the CO_2, and the compression of the recovered CO_2 into a supercritical liquid state (about 100 atmospheres) to facilitate transport and sequestration. Removal of sulfur dioxide, nitrogen dioxide and particulates occur in separate processes, such as limestone absorbent for desulfurization and bag-type particulate removal. The largest post-combustion capture demonstration plant is in China and other smaller projects are taking place in North America and Europe:

• 845 MW China Huaneng Power Plant in Beijing;
• 180 MW AES Warrior Run coal-fired power plant in Cumberland, Maryland;
• 300 MW SaskPower Oxyfuel lignite-fired power plant in Canada; and,
• 280 MW power and 350 MW heat Statoil natural gas combined heat and power plant at Mongstad, Norway.

Oxy-Fuel Combustion

Oxy-fuel combustion technology utilizes oxygen instead of ambient air for combustion of fossil fuel. Oxy-fuel processes involve the removal of nitrogen from ambient air, producing a near pure stream of oxygen that is used as an oxidant for fossil fuel combustion. The resulting flue gas contains high concentrations of CO_2 (generally exceeding 80 percent by volume), water vapor and small volume particulates, NOx, SOx and trace elements. These elements can be removed from the flue gas, resulting in a CO_2 stream available for other applications or sequestration. Oxy-fuel combustion also reduces NOx emissions, due to the reduced nitrogen content in the combustion chamber. The oxy-fuel process is advantageous for power generation and industrial processes such as glass and metal production that require high temperatures. The higher efficiencies associated with combustion at higher temperatures and higher concentrations of CO_2 in the flue gas offer the potential to reduce the overall cost of CCS as compared to other capture technologies. No pilots using this technology have yet been completed in China.

Chemical Looping

Chemical looping combustion for CO_2 capture is technology currently being developed at pilot scale that releases energy based on chemical reaction through the indirect contact of fuel and air without flame combustion. In its basic form, metal oxide (MexOy) and metal (Me) are circulated in a loop in two continuous reactions. In the air side reaction, oxygen is separated from air and then combined with metal to form metal oxide. In the combustion side reaction, metal oxide is then combined with fuel (typically coal) to produce CO_2, H_2O in steam form, and regenerated metal (Me). The fuel obtains oxygen for combustion from the metal oxide without direct contact with air, eliminating the potential introduction of N2. The reaction takes place at low-temperature, which reduces the corresponding production of NOx. The resulting combustion product is high-concentration CO_2 and steam, from which CO_2 can be separated

Box 3. CONTINUED

and recovered through steam condensation. The steam is used to drive a steam turbine in power applications. Chemical looping is less capital intensive compared to IGCC because the oxidation process eliminates the need for an air separation unit and the capture process can be highly efficient because it produces a relatively pure stream of CO_2 and steam, from which CO_2 can be separated simply by condensing the steam without the energy penalty associated with IGCC.

Air side reaction

$$Me + O_2 \longrightarrow MexOy$$

Combustion side reaction

$$Fuel + MexOy \longrightarrow CO_2 + H_2O + Me$$

TABLE 2. ENVIRONMENTAL PERFORMANCE OF IGCC AND SELECTED COAL-FUELED TECHNOLOGIES

Parameter	Pulverized Coal with Advanced Pollution Controls*	Atmospheric Fluidized-Bed Combustion with Selective Non-Catalytic Reduction (SNCR) for NO_x Reduction	Pressurized Fluidized-Bed Combustion (Without SNCR)	IGCC Plant
SO2 (lb/MWh)	2.0	3.9	1.8	0.7
NO_x (lb/MWh)	<1.6	1.0	1.7 – 2.6	0.08
PM10 (lb/MWh)	<0.3	0.12	0.13 – 0.26	<0.14
CO_2 (lb/kWH)	2.0	1.92	1.76	1.76
Chloride as HCl (lb/MWh)	0.01	0.71	0.65	0.007
Flouride as HF (lb/MWh)	0.003	0.05	0.05	0.004
Cyanide as HCN (lb/MWh)	0.0003	0.005	0.005	0.00005
Ammonia (lb/MWh)	0	0.001	0.001	0.004
Water Use (gallons/MWh)	1,750	1,700	1555	750 – 1,100
Total Solids (lb/MWh)	367 (Ash and Gypsum)	494 (Ash and Spent Sorbent)	450 (Ash and Spent Sorbent)	175 (Slag and Sulfur)

Source: Ratafia-Brown et al., 2002. CO_2 emissions are based on coal with 67% total carbon content.
**Pulverized coal with selective catalytic reduction, electrostatic precipitator, and flue gas desulpherization.*

CCS POLICY AT A CROSSROADS

Until recently, China had not elaborated a domestic policy to promote the development and deployment of CCS. In 2005, CCS technology was first integrated into *China's National Medium- and Long-term Science and Technology Development Plan*, which guides science and technology development during the 2006 to 2020 period. In 2007, China's National Climate Change Program set a goal to strengthen the development and dissemination of advanced technologies, including CCS (NDRC, 2007a). That same year, *China's Scientific and Technological Actions on Climate Change* prioritized research, development and demonstration (RD&D) of CO_2 capture, utilization and sequestration technologies.

Notwithstanding these policies, China's leadership has not yet mandated implementation of CCS as a part of its policy for reducing CO_2 emissions (MOST et al., 2007). China's Ministry of Science and Technology (MOST) has advanced CCS-related RD&D through its administration of China's technology development programs. As CCS technology enters the deployment stage, the National Development and Reform Commission (NDRC), which is responsible for economic planning and climate change policy, exercises jurisdiction over CCS projects through its implementation of China's low carbon and energy efficiency targets, setting electricity tariffs and approving new power plants and industrial facilities. To date, GreenGen is the only IGCC power project that has received NDRC approval. According to a former NDRC official, China's policymakers are unlikely to require CCS, or approve it for broad deployment, until technological advances resolve the loss of energy efficiency resulting from the additional energy requirements of carbon capture, reduce the high capital costs of CCS, and address concerns regarding the safety of CCS when deployed at large scale (Tian, 2010). China's embracing CCS technology to reduce its carbon emissions will ultimately depend upon further technology development.

Yet, the extent of CCS activity taking place in China puts China's CCS policy at a crossroads. The government, through the National Energy Administration, NDRC and other agencies, is working with stakeholders such as the World Bank and the Asian Development Bank on CCS projects and capacity building for the power sector. All five large state-owned utilities (Huaneng, Datang, Huadian, Guodian and China Investment Power Corporation) are actively pursuing carbon capture projects that incorporate sequestration components. Shenhua Group and PetroChina expect to complete China's first CCS facility by 2010. In addition to the 863 Program RD&D projects described in this article, MOST, NDRC and industry stakeholders have announced plans for fourteen additional IGCC plants for power, liquid fuel and/or chemical production that are in the early definition and design stages (Cai, 2010). While broad implementation of CCS domestically would require advances in technology, the number of projects being implemented and planned in China strongly suggests that China's policymakers are expanding China's leadership role in developing CCS technologies, and that these CCS activities will ultimately cause policy to evolve.

CHINA'S CCS TECHNOLOGY DEVELOPMENT EFFORTS

China's CCS activities currently focus on technology development and domestic capacity building, as well as knowledge sharing through demonstration projects and international cooperation. China's RD&D programs focus on developing capture technology for power and industrial gas applications, utilizing CO_2 for revenue generating activities such as recovering hydrocarbons, and assessing and testing China's geological sequestration capacity. China is developing various capture technologies with emphasis on pre-combustion IGCC technology. Enhanced oil recovery (EOR) and enhanced coal bed methane recovery are also being considered to support CCS because these applications provide additional revenue to offset its cost. Increasing attention is being placed on geologic assessment while the development of policy and regulation are in the early stages. China has yet to start the development of a CO_2 transportation network, such as dedicated pipelines, which would be required for full-scale deployment of CCS. Our review focuses on RD&D projects sponsored by MOST and other selected projects that are at the implementation stage.

DRIVING DOWN CAPTURE COSTS

China's RD&D programs are appropriately designed to increase the efficiency and to reduce the overall cost of CCS, primarily by focusing on capture technology, which accounts for approximately 90 percent of the cost of CCS (Al-Juaied & Whitmore, 2009). There are four types of carbon capture technologies currently being developed for application in CCS and other industrial processes in China and other countries: (1) integrated gasification combined cycle (IGCC) (pre-combustion); (2) post-combustion capture; (3) oxy-fuel combustion; and (4) chemical looping.

IGCC is the focus of several pilot projects in China. (See Box 1). Gasification technology has been used in China's chemical industries for many years. (See Box 2). It potentially offers the best economic and environmental performance of any other existing pollution control technologies, particularly in terms of lower SO_2 and NOx emissions, water use efficiency, and solid waste production. (See Table 2). Post-combustion capture and chemical looping technologies are also being developed in China. (See Box 3).

China's Pilot Projects for Capture Technologies

The Chinese government's 863 Program advances a wide range of strategic technologies with the goal of making China technologically independent. MOST, which administers the 863 Program, has mandated and partially funded the development and construction of two IGCC coal-to-liquids plants, three IGCC demonstration power plants, and one gas turbine demonstration project for use with IGCC. MOST is providing up to 350 million Yuan in seed funding for these projects. None of the plants will sequester carbon dioxide upon completion; sequestration would require further modifications to these plants and development of transportation and sequestration infrastructure. However, these projects are an important step in developing the capture component of CCS in China.

TABLE 3. 863 PROGRAM COAL-TO-LIQUIDS DEMONSTRATION PLANTS

Company	CTL Capacity	Location
Yankuang Group	100,000 tons/year	Yulin, Shaanxi Province
Lu'an Group	160,000 tons/year	Lu'an, Shanxi Province

863 Program Coal-To-Liquids Demonstration Plants

The 863 Program supports two coal-to-liquids demonstration projects that use IGCC technology (See Table 3). These projects may be adapted to produce power by diverting a portion of the syngas through a turbine to generate electricity. Coal-to-liquids and other industrial applications provide easier to operate, lower cost plants to demonstrate CO_2 separation using IGCC technology, relative to power generation and polygeneration (See discussion of polygeneration below).

TABLE 4. 863 PROGRAM IGCC DEMONSTRATION PLANTS

Power Generation	Company	Gasifier	Location
250 MW GreenGen	China Huaneng Group	TPRI Two-Staged Dry-feed Pressured Coal Gasifier	Tianjin, China
230 MW Greenfield	China Huadian Corp.	ECUST Opposed Multi-nozzle Water-coal Slurry gasifier	Hangzhou, Zhejiang
800 MW Greenfield	Dong Guan Power & Chemical	To be	50 million tons

Program 863 IGCC Demonstration Plants

Huaneng GreenGen Demonstration Project

China Huaneng Group, the largest power generation company in China, initiated the GreenGen project in 2004 to research, develop and demonstrate a near-zero emission coal-based power plant. The project's first phase is to develop a 250 MW, 2,000 tons of coal per day IGCC plant using domestic gasification technology and GE 9E-class gas turbines. Xi'an Thermal Power Research Institute (TPRI), which is part of the China Huaneng Group, developed the dry-feed gasifier used in the plant and provides systems integration and technical expertise. During the first phase, GreenGen will also research and test key technologies for the next stages, including hydrogen production through coal gasification, fuel cells, and CO_2 capture and sequestration. GreenGen's first phase may also include a 30,000-ton CO_2 test injection into a nearby oil field. The second phase (2012–2014) will optimize the gasification technology. Further research and development will be conducted on CCS technologies, including EOR with PetroChina. The third phase (2014–2016) will be the construction of a 2×400 MW IGCC for power generation with CCS. The plant will release nearly zero emissions, capturing 1 million tons of CO_2 per year and injecting it for EOR.

GreenGen is 52 percent controlled by the state-owned Huaneng Group. GreenGen's other owners, each holding a 6 percent share, are China's other large power producers (Datang Group, Huadian Corp, Guodian Corp and China Power Investment Corporation), top coal mining companies (Shenhua Group, China Coal Group), China's State Development and Investment Corporation (SDIC), and U.S.-based Peabody Energy Corporation. GreenGen is projected to cost about 7 billion Yuan. The 863 program provided startup funding and the Asian Development Bank provided construction loans and grants (described below).

Huadian Banshan 230MW Greenfield Project

Huadian Power International Corporation is developing a 230 MW IGCC plant at the Huadian Banshan power facility located in Hangzhou city, Zhejiang province. The plant is tentatively set to start operation in 2010. The facility employs a single water-coal-slurry gasifier with a capacity to burn about 2,000 tons of coal per day. The total cost of the project is expected to be 2 billion Yuan. The project research team includes the National Power Plant Combustion Engineering Technology Research Center, the Institute of Engineering Thermophysics of the Chinese Academy of Sciences, East China University of Science and Technology, Zhejiang Electric Power Design Institute and Hangzhou Huadian Banshan Power Generation.

Dong Guan Power & Chemical Company 800 MW Sun State Project and 120 MW Tian Ming Retrofit Project

Dong Guan Power & Chemical Company (DGPC), a majority privately-owned power company located in Dong Guan city, Guangdong province, received an 863 award to develop and construct an 800 MW IGCC facility, known as the Sun State Island IGCC Power Station ("Sun State"), in Dong Guan. DGPC plans to commence construction in 2011. Sun State will use four GE 9E gas turbines, each of which will produce 200 megawatts of electricity, and has not yet selected the gasifier supplier. It is expected to cost approximately 6.1 billion Yuan.

In late 2009, DGPC started retrofitting its existing Tian Ming power plant to a 120 MW IGCC facility. Although not part of the 863 program grant, the Tian Ming facility will provide DGPC with valuable experience in developing the much larger Sun State IGCC project. In addition to generating electricity, the Tian Ming plant will be equipped to divert a portion of the syngas for use as feedstock for chemical production (methanol and ammonia). The project is the only stand-alone IGCC retrofit of a power plant anywhere in the world to our knowledge. The Tian Ming project will employ a combination of domestic Chinese technologies and a gasifier developed by the U.S. firm Kellogg, Brown & Root to be built primarily in China. The plant will use its existing GE gas turbines, locally made steam turbines and locally made heat recovery systems. Chinese firms will provide engineering design services and control systems.

Shenyang Gas Turbine/ IGCC Demonstration Project

The Shenyang IGCC project, located in Shenyang, Liaoning province will have 1,000 MW capacity consisting of 2×200MW IGCC units and 2×300MW conventional units. This demonstration project is listed in the 863 Program as "Fabrication of R0110 Gas Turbine Based on Mid-/Low-Heat Value Fuels and Its Application in Engineering of IGCC Power Station." One of the objectives of the project is to test the China-made heavy-duty R0110 gas turbine with medium- and low-caloric fuels in an IGCC power station. The managing committee of Shenyang High Tech Industrial Development Zone and China Power Investment Corporation oversees this project.

863 Program Polygeneration Projects

A polygeneration IGCC plant produces electricity and diverts a portion of the synthetic gas from electricity generation as a feedstock to produce chemical elements and compounds for liquid fuels and other chemical products. Common chemical products include ammonia (fertilizer), methanol (fuel) and hydrogen. By producing high value chemicals, polygeneration could potentially improve the economic performance of IGCC power plants, and allow greater operational flexibility to optimize a project for market conditions.[3] However, cycling an IGCC plant for changing power demand and chemicals production involves significant engineering and operating challenges, which must be mastered in order to achieve potential gains from polygeneration.

China has developed two IGCC polygeneration plants in collaboration with the Chinese Academy of Sciences and industry stakeholders, and a number of other polygeneration plants are under development. The Yankuang IGCC plant in Shandong province produces 60 MW of power and up to

240,000 tons of methanol and 200,000 tons of acetic acid per year using coal. The facility uses a gasifier developed by the East China University of Science and Technology based in part on a GE/Texaco gasifier design. The plant began operation in April 2006, and started generating power in May 2008. According to the company, this plant operates at approximately 36 percent thermal efficiency as a power generator.

The second IGCC polygeneration project in Quanzhou City, Fujian province commenced operation in 2009. It was developed by the Fujian Refining & Chemical Company with Fujian province, ExxonMobil, Sinopec, and Saudi Aramco as joint partners. The project produces 280 MW of power and several chemical products.

Huaneng Post-Combustion CO_2 Capture Demonstration Projects

China completed its first Post-Combustion Capture (PCC) demonstration project in July 2008, in collaboration with the Australian Commonwealth Scientific and Research Organization (CSIRO) and China's TPRI, under the Asia Pacific Partnership for Climate and Development. TPRI built and operates the PCC pilot plant at the Huaneng Beijing Thermal Power Plant, using domestically made amine capture equipment based on technology licensed by CSIRO. The facility is recovering more than 85 percent of CO_2 from flue gas that is run through the capture process; however, most of the flue gas is vented. The plant captures only one percent of total CO_2 —or about 3,000 tons of CO_2 annually, which will be used in the soft drinks industry. We understand that this system captures CO_2 at $40/t (Friedmann, 2009), which would be significantly less expensive than other commercial capture systems for power plant applications.

Based on the Huaneng-CSIRO project, a second PCC project is being built at the Huaneng Shidongkou No. 2 Power Plant in Shanghai. The project is expected to achieve annual capture of 100,000 tons of CO_2—about three percent of the total CO_2 emitted from the plant. Like the Beijing project, the CO_2 will be used for industrial purposes.

CPIC Post-Combustion CO_2 Capture Project

In early 2010, China Investment Power Corporation completed a post-combustion capture facility at its coal-fired Hechuan Shuanghuai Power Plant in Chongqing, capable of processing 50 million cubic meters of flue gas (less than 1 percent of total flue gas). The system was designed and built with domestic equipment by Yuanda Environmental Protection Engineering Company Ltd, a CPIC subsidiary at a reported cost of 12.4 million Yuan. The facility can produce up to 10,000 tons of CO_2 per year at a cost of 394 Yuan per ton. With prevailing prices for CO_2 of 620 Yuan per ton, the facility is expected to generate a profit, with a payback period of 5 to 6 years (Cockerill, 2010).

Shenhua Coal-to-Liquids Project

Shenhua Group, the world's largest coal company, developed and operates a $1.46 billion direct coal liquefaction plant with a hydrogen facility in Ordos, Inner Mongolia employing Chinese-developed technology. The liquefaction plant was completed in late 2008, started limited operations in December 2008, and became fully operational in 2010. China National Petroleum Corporation, the country's largest oil producer, designed the capture part of the plant, which will be completed by 2010 at an estimated cost of 210 million Yuan (*China Daily*, 2010). The project plans to inject into the Ordos Basin 100,000 tons of CO_2 per year, and 2.9 million tons per year from the hydrogen facility by 2012 (Friedmann, 2009), making it the first sequestration facility in China. The project has been supported by collaboration between the NDRC and U.S. Department of Energy (DOE), with technical support from West Virginia University, the National Energy Technology Laboratory and Lawrence Livermore National Laboratory (described below).

Oxy-fuel Combustion and Chemical Looping

Several Chinese research institutes are developing oxy-fuel combustion and chemical-looping technology. Zhejiang University, in collaboration with the French company Air Liquide and Tsinghua University, is developing oxy-fuel combustion processes. The Chinese Academy of Sciences' Institute of Engineering Thermophysics and Southeast University, Nanjing are researching chemical looping technology.

CHINA'S CARBON UTILIZATION INITIATIVES

Chinese and foreign companies and government institutions are researching enhanced oil recovery (EOR), enhanced gas recovery (EGR), and enhanced coalbed methane recovery because these applications are significant revenue-producing economic activities that at the same time can sequester CO_2. EOR and EGR in particular, could be important during the early stages of development of CCS in oil and gas fields as preparation for deployment in saline formations (See Box 4).

National Basic Research Program of China (973 Program): Geologic Carbon Storage with Enhanced Oil Recovery (2006–2011)

China's 973 Program conducts basic research on the geological, physical and chemical aspects of geologic carbon sequestration and EOR, non-linear flow mechanics problems of EOR and carbon capture and anti-corrosion problems. Funding for the research program is 35 million Yuan. The program's objectives are to enhance oil recovery ratios through the use of CO_2, increase profitability of oil operations and mitigate CO_2 emissions.

PetroChina

PetroChina conducted CO_2 injections in its oil fields before discontinuing the practice due to a shortage of CO_2 resources. PetroChina has also conducted CO_2 injections for EOR in cooperation with MOST and several research universities. Experimentation with EOR has been conducted in the Jiangsu fields, the Jilin fields, the Changun fields, the Zhongyuan fields, the Ordos Basin (Inner Mongolia), and the northern Tarim Basin (Xinjiang province) (Liu et al., 2008; Friedmann, 2009). PetroChina has also experimented with CO_2 injection for enhanced coal bed methane recovery (Friedmann, 2009).

China-Japan EOR Project

China and Japan will commence a project to capture 1 to 3 million tons of CO_2 annually from the Harbin Thermal Power Plant in Heilongjiang province, and possibly other plants, transport it 100 km by pipeline, and inject it into China's Daqing oil field for both EOR and permanent sequestration. The oil field currently produces over 40 million tons of oil annually; the project is expected to increase production by 1.5 to 2 million tons and to demonstrate the field's ability to permanently sequester over 150 million tons of CO_2 in the future. Japan's Research Institute of Innovative Technology for the Earth, Toyota Motor Company, JGC Corporation, and China National Petroleum Corporation also participate in the project (Gasnova, 2008a and 2008b).

China Coal Bed Methane Technology/ CO_2 sequestration project

China's Ministry of Commerce, China United Coal Bed Methane Corp. and the Canadian government completed a project to transfer Canadian technologies to assess coal beds for the recovery of methane and sequestration of CO_2. The project involved site identification, small- and large-scale tests, evaluation and training, and contributes to improved environmental management and safer working coal-mining practices in China (Alberta Research Council, 2007).

Box 4. ENHANCED OIL RECOVERY AS A DRIVER FOR CCS

In enhanced oil recovery (EOR), CO_2 is injected into an oil reservoir in order to increase well pressure and reduce the viscosity of oil, thereby increasing the flow of oil and production. CO_2 floods can increase a field's production by 7 to 15 percent of original oil in place and extend the life of a field by 15-30 years (Moritis, 2001). One ton of CO_2 can lift anywhere from 1.5 to 6.5 barrels of oil, with an average of about 2.5 barrels (Martin & Taber, 1992). Results vary by field characteristics: porosity, permeability, miscibility, gravity of the oil, operating depth, original and current reservoir pressure, location of oil in reservoir, operating temperature of reservoir, and geologic structure (e.g., dolomite, sandstone, carbonaceous).

Results also depend on operating decisions whether CO_2 injection is conducted solely to enhance oil production or also to achieve CO_2 sequestration. A portion of the CO_2 is separated and recovered from the lifted oil and re-injected into the reservoir; the remaining portion of the CO_2 is trapped in the reservoir. Through repeated cycles, a significant portion of the CO_2 can be permanently sequestered, depending on operating decisions. A similar process is followed for recovery of natural gas in fields.

By some estimates, first generation CCS plants will add 8-12 ¢/kWh to the cost of electricity produced compared to conventional plants, or approximately $120-180/ton of CO_2 avoided. Based on a hypothetical plant assuming 2008 capital costs, EOR revenues can offset the additional cost of CCS with an oil price of approximately $75 per barrel (Al-Juaied & Whitmore, 2009).

GLOBAL PARTNERSHIPS EXPLORE CHINA'S GEOLOGIC STORAGE POTENTIAL

Although China has not yet completed a comprehensive geologic survey for CCS, Chinese and foreign oil companies, research institutions and government laboratories have conducted geologic assessments that provide a starting point for assessing China's sequestration resources.

China's Ministry of Science and Technology, together with the Australian government's Geoscience Australia, launched the China Australia Geological Storage of CO_2 (CAGS) project to develop China's capacity to assess potential CO_2 sequestration sites. CAGS is funded by the Australian government under the Asia Pacific Partnership for Clean Development and Climate. The Administrative Centre for China's Agenda 21, China's Academy of Sciences, China Geological Survey, and China University of Petroleum also participate in CAGS.

Researchers from the Chinese Academy of Sciences, Institute of Rock and Soil Mechanics and the Environmental Studies Department of China University of Geosciences together with the Battelle-Pacific Northwest National Laboratory are estimating China's sequestration capacity based on publicly available data originally produced by Geoscience Australia. Results show that China has over 3,000 gigatonnes of CO_2 sequestration capacity, with deep saline formations accounting for 99 percent of the total capacity. Even if only 10 percent of total theoretical capacity is available for sequestration, China has enough capacity to store over 100 years' of its CO_2 emissions from large point sources. Importantly, over 90 percent of the country's large CO_2 point sources (defined as emitting at least 100,000 tons of CO_2 per year) are within 100 miles of onshore sequestration reservoirs and, for a majority of the sites, costs of transport, storage and monitoring are estimated between $2 to $9/tCO_2 (Dahowski et al., 2009).

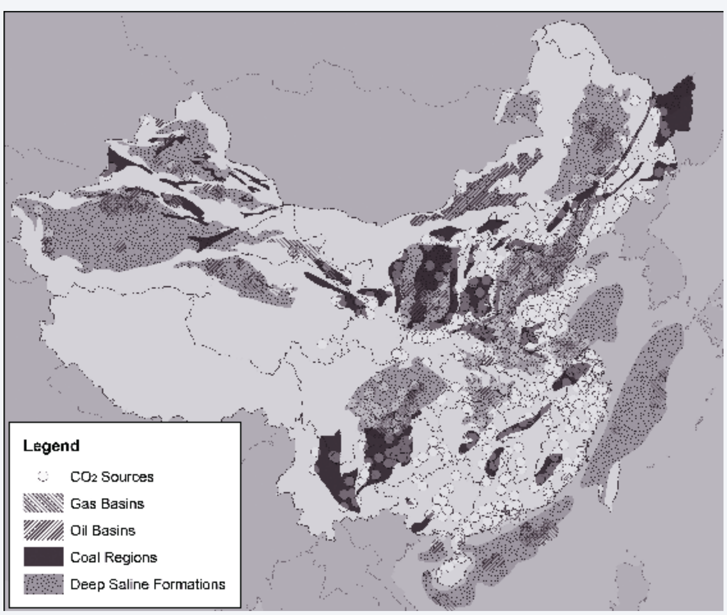
In 2009, Stanford University's Global Climate and Energy Project awarded nearly $2 million to initiate an international collaboration with Peking University, China University of Geosciences at Wuhan and the University of Southern California to address fundamental issues associated with large-scale sequestration. The three-year program integrates geological modeling, reservoir simulation and laboratory experiments to develop methods for sequestration of CO_2 in saline aquifers in China.

Researchers from West Virginia University and Lawrence Livermore National Laboratory are modeling the Ordovician in the Ordos Basin, located in the western part of China's northern table, as part of an effort to assess its potential sequestration capacity to support the Shenhua Group coal liquefaction project (described above). The modeling is based on a hypothetical 10,000 ton per year CO_2 injection into a reservoir approximately 3,500 meters below the surface and estimates water chemistry, permeability, plume size and saturation.

INTERNATIONAL KNOWLEDGE SHARING

Chinese government, business, and research institutions are engaged in a number of international efforts to foster cooperation on the development of CCS. Outlined below are some of the more significant partnerships that are specifically dedicated to supporting CCS development in China. China also participates in other collaborative efforts that are designed to promote CCS globally (See Table 5).

MAP 1. POTENTIAL SEQUESTRATION SITES IN CHINA



Dahowski, R., Xiaochun Li, Casie Davidson, Ning Wei, and James J. Dooley. (2009). Regional Opportunities for Carbon Dioxide Capture and Storage in China: A Comprehensive CO_2 Storage Cost Curve and Analysis of the Potential for Large Scale Carbon Dioxide Capture and Storage in the People's Republic of China. Pacific Northwest National Laboratory.

Cooperation Action within CCS China-EU (COACH) is a Sino-EU research project aimed at creating ongoing cooperation between China and Europe. COACH was launched in 2006 with funding from the EU's 6th Framework Program for Research. Focused on developing new energy technology options for China that employ CCS, including use of CO_2 in enhanced oil recovery and enhanced coal bed methane recovery, COACH's key objectives include preparing the implementation of large-scale clean coal energy facilities by 2020 and coordinating activities performed under the EU-China Memorandum of Understanding on Near Zero Emissions Coal.

UK-China Near Zero Emissions Coal (NZEC) is a joint venture initiative between the United Kingdom's Department of Environment, Food and Rural Affairs and Department of Trade & Industry, and China's MOST, to explore options for near-zero emissions coal in China, build capacity for CCS and construct and operate a CCS demonstration plant. COACH and NZEC are part of the EU-China Partnership on Climate Change. Chinese partners include the Administrative Centre for China's Agenda 21, Tsinghua University, Zhejiang University and GreenGen.

UK-China CAPPCCO Project. Chinese Advanced Power Plant Carbon Capture Options (CAPPCCO) is sponsored by the United Kingdom's Department for Business, Enterprise & Regulatory Reform, MOST and China's Environmental Transformation Fund. CAPPCCO seeks to develop and define options for integrating capture technologies with advanced Chinese pulverized coal power plants to allow rapid CO_2 emission reductions, assess performance of advanced non-CO2 pollutant control technologies on Chinese coals, and identify and engage key stakeholders to facilitate information transfer. CAPPCCO also plans to finance capture ready and capture retrofit plants. Participants include Imperial College London, University of Cambridge, Doosan Babcock, Alstom, Harbin Institute of Technology, National Power Plant Combustion Engineering Technology Center, Harbin Boiler Company, Yuanbaoshan Power Plant, Datang International Power Generation Company and Xi'an Jiaotong University.

The U.S.-China Joint Clean Energy Research Center launched in July 2009 by the U.S. and Chinese governments will conduct CCS research.

The IEA Clean Coal Technology Centre conducts ongoing research and exchange on CCS in China. **The IEA Working Party on Fossil Fuels** is launching a CCS financing initiative with a focus on China.

Harvard-MOST IGCC Initiative. In 2002, Harvard University's Kennedy School of Government, together with MOST, established a series of dialogues between Chinese and U.S. academic and government officials on cooperation in the areas of clean coal technologies, IGCC and CCS. The initiative has sponsored research by Chinese academics and government officials in the United States on clean coal technology and policy, and has been instrumental in supporting U.S. government policy development on clean coal in China. The initiative is now operated with Tufts University's Fletcher School of Law and Diplomacy.

Natural Resources Defense Council is preparing a study identifying facilities that produce pure CO_2 streams in China, primarily in the chemicals and natural gas industries that could be captured at low cost and sequestered. The study is intended to help potential project developers jump-start CCS in China (Qian et al., 2009).

Asia Society and **Center for American Progress** are jointly developing a roadmap for U.S.-China cooperation on CCS research, development and demonstration projects. This roadmap is an effort to help facilitate government-to-government cooperation.

Business-to-Business Collaboration. International business-to-business collaboration is essential to technology transfer and development, and the ultimate adoption and diffusion of CCS technology. Business-to-business collaboration is well developed in China's coal-fired power sector in general (IEA Clean Coal Centre, 2010), and is increasing in CCS-related applications, for example, Kellogg, Brown & Root's involvement in the DGPC Tian Ming project and Peabody Energy's participation in GreenGen, both described above. In addition, China's largest power producer, Huaneng, and the third largest power producer in the United States, Duke Energy, signed a memorandum of understanding in August 2009 to develop technology for coal-based CCS. The Chinese energy company ENN Group and Duke Energy established a collaborative relationship in September 2009 to share information and develop coal-based carbon capture technology using algae and other clean energy technologies.

INTERNATIONAL CCS FINANCING

The **European Union** and the **United Kingdom** have funded CCS research and project development in China through their COACH, NZEC and CAPPCCO projects (described above). In 2009, the European Commission announced it will fund a scoping study examining the feasibility of up to three CCS plants in China. The Commission plans to expand these funds in order to provide financing of between 300 to 500 million for the development of a commercial-scale CCS project in China (Carbon Capture Journal, 2009; Marin, 2010).

The **Asian Development Bank** (ADB) provided a loan of $135 million to the GreenGen project to be used towards construction costs, and an accompanying grant of $5 million from its Climate Change Fund to finance long-term maintenance contracts for the coal gasifier and gas turbines, and civil works associated with the air separation unit

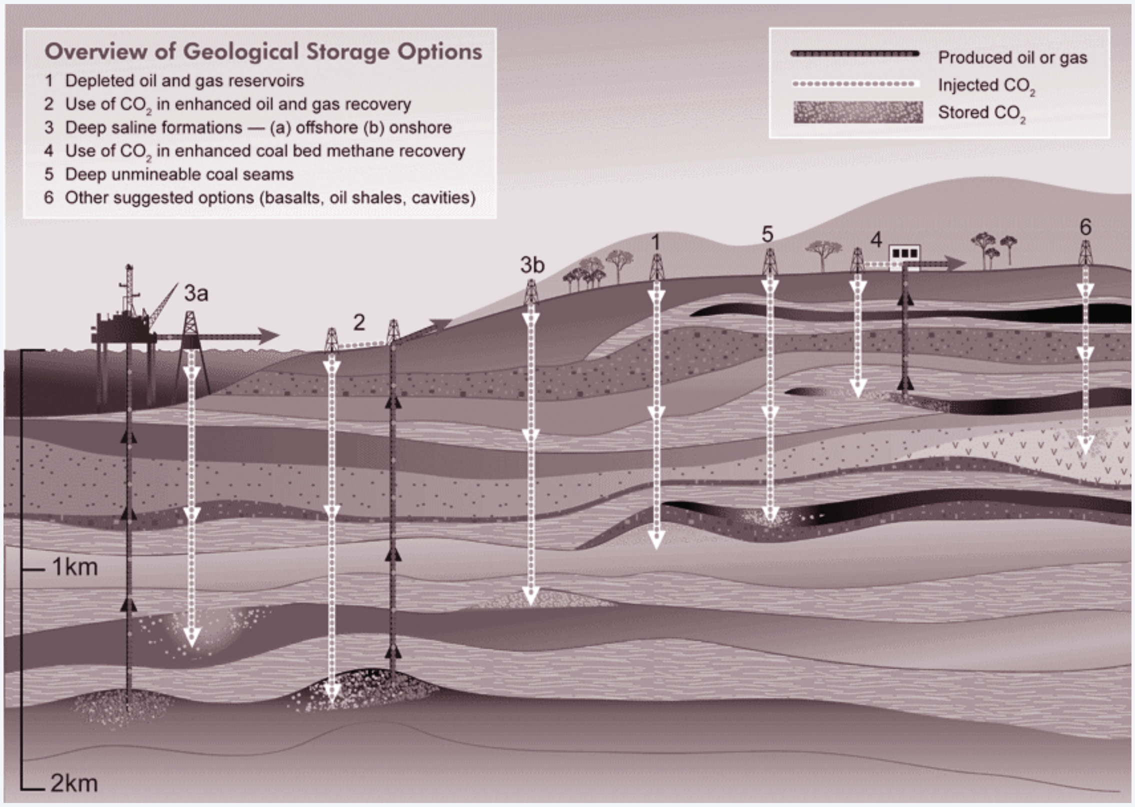


Photo Credit: The Cooperative Research Centre for Greenhouse Gas Technologies

TABLE 5. CHINA'S PARTICIPATION IN INTERNATIONAL COLLABORATIVE INITIATIVES

Carbon Sequestration Leadership Forum	Ministerial-level international climate change initiative focused on the development and diffusion of improved cost-effective technologies for CCS through collaborative efforts.
FutureGen Alliance	Public-private partnership to build a coal-fueled, near-zero emissions power plant in the United States with support from U.S. Department of Energy. Members include nine power producers and electric utilities. China Huaneng is a member of the alliance.
Asia-Pacific Partnership (APP)	Voluntary partnership among seven major Asia-Pacific countries—Australia, Canada, China, India, Japan, Korea and the United States—to address increased energy needs and the associated issues of air pollution, energy security and climate change. APP supports development and deployment of cleaner, more efficient technologies.
GeoCapacity	Provides sequestration capacity data required for broad adoption of CCS in Europe and a framework for international cooperation and technology transfer for countries undertaking similar efforts. MOST joined GeoCapacity as a full project partner, and coordinates the participation of Tsinghua University and the Chinese Academy of Sciences in GeoCapacity research projects.
CO_2 Capture Using Amine Processes: International Cooperation and Exchange (CAPRICE)	CAPRICE is an international research project on amine and membrane capture technology among governmental, private sector and research organizations from ten countries. Tsinghua University participates on behalf of China.

and chemical island plant. ADB also provided $1.25 million from its Climate Change Fund to support the NDRC, the Chinese Academy of Sciences and GreenGen to develop a CCS technology roadmap for China, which will include technological, legal/regulatory, financial and institutional capacity aspects. At the request of the Carbon Sequestration Leadership Forum,[5] ADB's Climate Change Fund also provided a $350,000 technical assistance grant to support a study of barriers to implementing CCS demonstration projects in developing countries.

The World Bank launched its CCS Trust Fund in December 2009 to help spur CCS in developing countries, with initial funding of $8 million contributed from Norway and the Global CCS Institute. In China, the CCS Trust Fund will strengthen the institutional capacity of China Power Investment Corporation, one of the five large state-owned power companies in China, for the development and piloting of CCS technology, and to strengthen the technical capacity of the National Energy Administration and the NDRC for the assessment of IGCC, CCS and carbon capture and utilization proposals. The World Bank is working with China Power Investment Corporation, which is currently planning four IGCC projects, and intends to pilot CCS and carbon capture and utilization. The World Bank is funding Tsinghua University, through a grant to the NDRC, to develop a methodology to credit emissions reductions from polygeneration IGCC facilities under the Clean Development Mechanism. The methodology would credit emissions reductions resulting from power generation and production of feedstock for chemicals and liquid fuels (but not reductions from storage of CO_2).

The Global CCS Institute, launched

in 2009 and supported financially by the Australian government, is funding a wide range of CCS activities in China, including the ADB's CCS program that is developing a CCS roadmap for China, the World Bank's CCS fund, and studies conducted by private sector and nongovernmental organizations on CCS in China. These efforts are part of its broader capacity building efforts, which span technical, regulatory, financial, public engagement, and knowledge sharing aspects of CCS. Ultimately, the Global CCS Institute is seeking to help finance demonstration-scale projects globally, including in China.

BUILDING UP CCS REGULATIONS AND POLICY

The development of CCS technology has moved faster than supporting policy, which could explain some of the gaps in China's CCS supply chain. To help fill these gaps, the World Resources Institute, together with Tsinghua University and Chinese experts, is developing guidelines for deployment of CCS technology in China based on the guidelines WRI developed in the United States. The guidelines will include provisions for capture, transport and sequestration. The project is partly funded by the U.S. Department of State under the Asia Pacific Partnership.

The EU's Support to Regulatory Activities for Carbon Capture and Storage (STRACO$_2$) Project, which supports the development and implementation of a comprehensive regulatory framework in the EU for CCS, includes a program to build EU-China cooperation on CCS under the EU and China Partnership on Climate Change. The program focuses on capacity building for China's policymakers and the identification of future joint activities in the CCS area. STRACO$_2$'s China CCS program is coordinated with the Administrative Centre for China's Agenda 21.

PRIORITIES FOR DEVELOPMENT OF CCS IN CHINA

China's efforts in CCS are nascent, yet impressive. In order to advance CCS, we identify five priority areas that require action by policymakers to develop, adopt and diffuse CCS technology in China.

Making the Policy Case. China's CCS strategy must serve its development priorities, including technological and energy independence. CCS programs that emphasize the development of export markets for Chinese-developed technologies, enable the country to exploit domestic coal reserves, and produce environmental co-benefits beyond climate change, such as cleaner air and water, exemplify the factors necessary to attract support within Chinese policy circles. Ultimately, to gain support among policymakers, China's RD&D efforts must reduce the capital cost of CCS using domestic technology and increase its efficiency to reduce the energy penalty associated with CCS in power applications, or exploit the lower costs of capture in carbon-intensive industrial gas applications.

Driving Down Capture Costs. The first CCS plants in developed countries are expected to be expensive, adding 8-12 ¢/kWh to the cost of electricity compared to conventional plants, or approximately \$120-180/tCO_2 avoided, based on 2008 capital costs. By some estimates, the capital costs for initial plants will be 70 percent higher than those of conventional plants, due to increase in costs associated primarily with the capture portion of the plant and decrease in net power output (Al-Juaied & Whitmore, 2009). To place this in perspective, for a 630 MW power plant built in North America, CCS would increase capital costs by approximately \$1.5 billion over that of a conventional plant.

The capture component is projected to account for over 90 percent of the cost of CCS. China's current efforts in CCS are appropriately focused on capture technologies, with projected capital and operating costs substantially lower than those in the United States and Europe. China's projected costs for constructing IGCC plants are approximately one-third to one-half that of projects in the United States and Europe based on projects we have surveyed. This lower cost structure offers an opportunity for industrial collaboration. The development of domestic CCS technologies at low cost is also critical to adoption of CCS by China's policymakers and industry. One of China's potential contributions to combating climate change can be to scale up its industrial production of capture technologies so that they become affordable globally.

Demonstration Projects. Demonstration projects are an essential way to prove technology, identify and assess risks, test geologic conditions, and foster collaboration and learning. China's demonstration projects also promote the development of a supply chain that is necessary to build a domestic CCS industry. While they have appropriately focused on capture technology as a priority for reducing the cost of CCS technology and increasing its efficiency, China must broaden these projects to include geologic assessment, sequestration and eventually the construction of pipelines for CO_2 transportation if China is to adopt and broadly diffuse CCS technology. Programs such as the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP) and the U.S. Department of Energy's Regional Carbon Sequestration Partnerships program could provide technical assistance and other resources for China's efforts to expand its demonstration projects to include assessment and sequestration.

Regulatory Framework. The adoption of CCS in China will require a regulatory framework appropriate to China's institutional and legal system. A regulatory system that could support widespread diffusion of CCS would at a minimum include guidelines governing the following areas:

- Performance requirements for CO_2 capture;
- Safety, operation and access standards for CO_2 transportation pipelines;
- CCS site selection, permitting, operation and closure;
- Long-term monitoring, remediation and financial responsibility for CCS sites;
- Health, safety and environmental liability; and,
- Liability for CO_2 leakage, including for CO_2 reduction credits or obligations.

Financing and Technology Collaboration. The future development of CCS in China provides an important opportunity for international collaboration to address climate change. We believe that high-profile international financial resources and cooperation can play an important role in China increasing its investments in domestic CCS programs. This is particularly important for demonstration projects that lack full financial resources from China's central government, or are not fully compensated through electricity tariffs.

CCS also presents an opportunity to promote collaboration in the joint development of technology and intellectual property. As CCS is a rapidly evolving field with significant potential for innovation and growth in the near future, joint technology collaboration could benefit both Chinese and foreign companies. Governments and international institutions must place a higher priority on financing technology collaboration and transfer in order to promote the adoption of CCS in China and other advanced developing countries.

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ENDNOTES

[1] Actions by developing countries under the Bali Action Plan are conditional upon their receiving adequate financial, technical and capacity building support—all while developing their economies in order to achieve poverty reduction.

[2] Xie Zhenhua, former head of China's state environmental protection agency and now the country's chief climate change negotiator, said that there is still a large gap in meeting the 2010 energy efficiency targets. Additionally, Zhang Lijun, China's Vice Minister in China's Ministry of Environmental Protection, noted in early June 2010 that China's sulfur dioxide emissions had risen by 1.2 percent year-on-year in the first quarter of 2010 -- the first jump since 2007. He stated that this trend has sounded the alarm for China's emissions reduction work and indicates "that the prospects of emissions cuts are not very optimistic" (AFP, 2010).

[3] One study concluded that polygeneration could potentially reduce capital expenditure by 11 percent for methanol and single-generation power systems (Liu et al., 2008).

[4] The Ordovician is a geologic period that lasted between 490 and 443 million years ago.

[5] The Carbon Sequestration Leadership Forum is a ministerial-level international climate change initiative that facilitates the development and deployment of technologies for CCS. For more information see: www.cslforum.org.

[6] Authors' calculations are based on figures from Al-Juaied & Whitmore (2009).

金 木 水 火 土

FEATURE BOX

It's Hard to Build a Skyscraper from the Sky Down:
Paving the Way for Subnational Cooperation on Climate Action Planning in the United States and China

By Thomas Peterson, Anne Devero, and Zach Friedman

While the results of the December 2009 global climate talks were widely viewed as a failure, the Copenhagen Accord and related developments clarified the importance and effectiveness of subnational policy advancement as a reliable method for building and enacting national commitments and, in turn, the international agreements. In short, a bottom-up approach to climate policymaking is clearly needed as a precursor to higher-level commitments. As former President Clinton has remarked more than once regarding the Kyoto Protocol negotiations "it's hard to build a skyscraper from the sky down."

In the United States, the majority of leadership and innovation on climate policy in the last decade has occurred at the sub-national level, and going forward, state and local implementation efforts will be central to achieving real-world greenhouse gas (GHG) emissions reductions. In November 2008, within days after his historic election, then President-Elect Barack Obama gave much-publicized remarks at an international conference of sub-federal leadership convened by climate leader Governor Arnold Schwarzenegger that established a new U.S. policy of engagement and pursuit of national GHG targets that are consistent with and based largely upon the work and commitments of U.S. states.

If China and the United States—the world's two largest emitters of GHGs—deliberately and cooperatively advance sub-national climate actions, the spillover effects to national commitments in both nations, as well as actions by other key nations, are likely to be significant.

Since 2000, 34 U.S. states have undertaken or completed comprehensive climate action plans, including 24 plans facilitated by the Center for Climate Strategies (CCS)—a nonpartisan, nonprofit organization established in 2004 to help governments and their stakeholders tackle climate change issues by fostering consensus-based actions through collaboration and advanced technical assistance. Recent actions implemented by U.S. states are estimated to remove 535 million metric tons carbon dioxide equivalent by 2020. Scale-up analysis by CCS shows that full implementation of existing state action plans by all U.S. states would reduce GHG emissions to 27 percent below 1990 levels by 2020, with a net gain of 2.5 million jobs and $248 billion in gross domestic product, while cutting household energy prices.

Historically, many national laws and policies in the United States originate at the state level and are followed by federal actions that create national frameworks, programs and governance (e.g., Clean Air Act, Clean Water Act, Civil Rights Act, Consumer Protection). The United States is not alone in this phenomenon; many countries, including China, base many national policies on local-level policy actions.

The role of the state and provincial actors was apparent at the UNFCCC COP-15 meeting in Copenhagen. The presence of governors, mayors and state agency officials from around the world constituted the second largest delegation at COP-15. The numerous side-events and behind-the-scenes negotiations gave testimony to the increasing agenda to reduce GHG emissions at the sub-national level. Along with many other organizations, CCS and its strategic partner in China, the Global Environmental Institute (GEI), jointly presented side-events focused on the need to build a strong China-U.S. partnership on mitigating climate change at the subnational level. At the next UNFCCC COP-16 in Mexico, CCS and GEI plan to engage a wider range of global actors to promote the need for more ambitious climate mitigation initiatives at the sub-national level.

Full implementation of existing state action plans by all U.S. states would reduce GHG emissions to 27 percent below 1990 levels by 2020, with a net gain of 2.5 million jobs…

CHINA'S CARBON INTENSITY AND ECONOMIC GROWTH TARGETS

China is in the process of developing its 12th Five-Year Plan that starts in 2011. China's 11th Five-Year Plan had overall energy efficiency targets of 20% by 2010 for its provinces that were directed at the most energy intensive power and industrial sectors. The Chinese government is implementing a phased approach to fulfill its 40-45 percent carbon intensity reduction target by 2020. For the first time, the 12th Five-Year Plan will have carbon intensity targets incorporated at the provincial level. In terms of absolute GHG emissions reductions, when compared against baselines, carbon intensity targets can be translated to GHG reductions and will require significant new actions by China.

Carbon intensity targets can be more complicated than energy efficiency targets and require better data collection, economic analysis, stakeholder engagement, and comprehensive planning. Chinese central and provincial level officials responsible for reaching these targets will need assistance from experts who have experience facilitating these processes and performing analyses in order to achieve the twin goals of economic growth and emissions reductions.

China's central and provincial governments need a way to reduce GHG emissions while continuing to grow the economy. Beyond domestic and international pressure to reduce greenhouse gas emissions, China faces the immediate need to bring its large rural population out of poverty and continue with the three decades of economic development that has occurred since China's reform and opening up policies. Within the framework of its Five-Year Plans and cadre evaluation and promotion system, China puts a premium on economic growth, attracting investment, and industrialization. Provincial officials have great leeway to structure and reform both their province's economy as well as energy production and use. Yet, local governments in China are often unaware of how to balance development of the economy with environmental protection and emissions reductions. Thus, there is a need for a climate action planning process at the provincial and/or city level that will construct consensus on the most cost effective climate policy options that will promote economic expansion of the new energy economy, realize energy savings, promote environmental sustainability and reduce GHG emissions.

By working with U.S. states and stakeholders through comprehensive planning processes, CCS has demonstrated how the joint attainment of economic growth and GHG emissions reductions can be met through specific sector-based policies and measures. The tools and techniques used to achieve these results in the United States can be helpful to China's provinces in meeting their future GHG emissions reduction and economic growth goals. The transfer of these innovative processes to China will require an intensive exchange to acculturate the program to China's needs and local context, and will require support from CCS and key U.S. states.

CENTER FOR CLIMATE STRATEGIES WORK IN CHINA

In October 2009, CCS was invited by GEI to give several presentations in China on the CCS Climate Action Planning process used by over 24 U.S. states. GEI, a highly regarded environmental civil society organization in China, has strong programs at both the national and provincial levels. Through its work, GEI has developed a good working relationship with influential government institutions, particularly the National Development and Reform Commission (NDRC), China's top economic and climate policy planning body. GEI has excellent convening power and a strong history of guiding international organizations in China. GEI believes that CCS brings a unique set of tools to the challenge of advancing sound climate change policy. Prime among these are:

Jin Jiamen, founder of Global Environmental Institute, speaks about U.S.-China subnational climate action planning cooperation at a July 2010 meeting at the China Environment Forum.
Photo Credit: David Hawxhurst

- An extensive track record of successful consensus building and policy development in all regions of the United States involving over 1,500 stakeholders and technical working group members from a variety of representative interests and organizations.
- World-class CCS microeconomic and macroeconomic modeling capabilities to analyze cost-effectiveness, macroeconomic impact, and economic co-benefits, including advanced use of the Regional Economic Models, Inc. Policy Insight Plus (REMI PI+) model.
- A well recognized, multi-disciplinary network of issue experts from key sectors such as electricity and energy supply; residential, industrial, and commercial; transportation and land use; agriculture, forestry and waste management; and climate adaptation.
- Substantial expertise in the development of GHG emissions inventory and forecasting techniques at the sub-national level.
- A comprehensive and tested database of over 1,000 climate policy options in all economic sectors, levels of government, and policy instruments, as well as a modeling system that allows scaling of sub-national to national level action, and the ability to extrapolate results from one geographic region to others.

A THREE-PART PLATFORM FOR CLIMATE ACTION PLANNING IN CHINA

CCS and GEI envision a three-part platform for sub-national climate action planning in

China. This three-part platform is designed within the framework of the CCS Climate Action Planning Process properly adapted to the Chinese context. The planning period for this multi-year program will be designed to coincide with China's Five-Year Planning cycle.

1. Policy and Technical Exchange Platform. This platform will be created for conducting ongoing match-ups between policy and technical experts in U.S. states and Chinese provinces. CCS will be conducted the first such match-up between Guangdong Province and the city of Chengdu in Sichuan Province and New York, Pennsylvania, and Maryland in July 2010. It is envisioned that this will be the first of many such match-ups.

2. Capacity Building Platform for the Climate Action Planning Process. It is envisioned that a five-year capacity building program will be developed in at least the following areas:

a. Designing the climate action planning process for cities/provinces
b. Managing/facilitating the climate action planning process
c. Defining the GHG emissions baseline (in both current and forecast years) at the city/provincial level
d. Microeconomic and macroeconomic analysis of policy options and co-benefits
e. Institutional capacity required for implementation

3. Pilot Projects and Best Practice Sharing Platform. GEI and CCS plan to jointly conduct pilots to demonstrate the viability with the relevant government agencies and institutions of using the CCS Climate Actions Planning Process at the province/city level in China. During the first two years and annually thereafter, GEI and CCS will conduct workshops to promote provincial/city level official-to-official information sharing. This will facilitate more accurate information about what other provinces and states are doing on climate and better inform capacity building programs.

For more information on CCS activities please see: http://www.climatestrategies.us.

CCS and GEI's strategic partnership is supported by the Rockefeller Brothers Foundation and the Blue Moon Fund.

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COMMENTARY

Greening Their Grids: U.S.-Chinese Cooperation on Electricity from Renewables

By Derek Vollmer

As the world's top two energy consumers and carbon emitters, the United States and China will play a decisive role in a clean energy future. Experts agree that renewable energy is a key area in which the United States ought to "significantly enhance" its cooperation with China, pointing out that the two countries will have no alternative but to become far more active partners in developing low-carbon economies (CFR, 2007; Asia Society & Pew, 2009. Both countries are motivated by a set of related goals, namely job creation, energy security, and pollution reduction, making renewables development a strategy with wide-ranging implications. Given the size of their electricity markets, any substantial progress made between the two countries will mean important progress on the technological learning curve, and immediate benefits for the global community. As major technology exporters, they are poised to jointly lead the way in fostering a worldwide transition to renewable energy-based economies.

The U.S. and Chinese Academies of Sciences and Engineering have a history of close collaboration spanning more than a decade and have jointly conducted several bilateral studies on energy and the environment. These reports reach a diverse audience, including national policymakers, academic researchers, environmental managers, industries, and local decision-makers, and have influenced policy such as China's recent decision to pursue a regional air quality management strategy and regulate ozone and fine particulate matter ($PM_{2.5}$). The Academies' current bilateral study, which will be released in the fall of 2010, focuses on opportunities for deeper collaboration on electricity from renewable resources,[1] and is being delivered on the heels of the Copenhagen discussions and in time to influence China's next Five Year Plan. Expert committees from both countries have been working collaboratively since December 2008, conducting meetings and site visits in both countries in order to better understand the complex, on-the-ground challenges of increasing the scale of renewable energy development. Their bilateral report provides recommendations to the governments of both countries and to the clean energy community writ large, on priorities for enhancing U.S.-Chinese cooperation in this field.

CURRENT STATUS OF RENEWABLES DEVELOPMENT

Given their large land mass and coastal populations, the United States and China share similar resource profiles and associated challenges of transmitting renewable power to load centers. Conventional hydropower is currently the predominant source of electricity from renewables, and though both countries are focusing on increasing the share of other renewable resources, China expects to continue developing hydropower as a source of baseload power. Massive solar and wind resources exist in remote regions of each country, but large-scale transmission has not yet been built, and there is considerable debate as to how much of these resources can and will be exploited cost-efficiently. Biomass, particularly in the form of wood, agriculture, and municipal waste, offers another substantial resource, though in many cases it may be preferentially used to develop liquid fuels (e.g., ethanol). Other resources, such as geothermal and hydrokinetic, are being exploited to provide some baseload generation as well as other energy services (heat and cooling). Both countries also possess resources at smaller scales, which are better distributed among population centers and generally more accessible by existing transmission and distribution systems. The challenge in scaling up these distributed resources is generally a function of (1) their costs compared to conventional generation and (2) their ability to be tied to the grid.

Existing technologies are sufficient in both countries to support accelerated deployment. Real progress will need to be measured in terms of kilowatt hours (kWh) generated, not merely gigawatts (GW) of installed capacity. The challenges in achieving more renewable power generation will have to do with integrating them into the current grids, and balancing intermittent generation within a service area. China in particular has taken impressive strides to improve its manufacturing capability and capacity in wind turbines and solar photovoltaics (PV), though the latter are almost exclusively being sold as exports. The United States has recently become the world's top market for wind turbines, and a leading supplier of second-generation, thin-film PV materials. Much of the growth in renewables in both countries will be in wind installations, as well as some larger-scale solar generation. Due to its emphasis on PV manufacturing, China favors PV for central station plants, whereas the United States relies more on solar thermal technologies for central stations, and PV for distributed applications (including large installations on commercial roofs). Storage will be important as each country moves beyond 20 percent of its generation coming from intermittent sources—up to that point, however, utilities should be able to incorporate and utilize new generation sources coming online.

While the two countries exhibit similarities in terms of their resource base and technology focus, their policy approaches have been markedly different. This reflects different governing styles and policy priorities, but it also provides an opportunity for mutual learning. Both countries are seeking to support and build their clean energy industry, despite abundant supplies of domestic coal, and comparatively low prices for conventional electricity generation. In the United States, inconsistent policies have hampered a transition to renewables. Current rates of development and deployment are the result of state-led portfolio standards as much as federal policy. Federal production and tax credits have had a substantial impact on the industry, but it has been cyclical, rising and falling as the short-term credits expire before being reauthorized. China's national government, on the other hand, has given more clear and consistent signals to support the nascent industry. Its Renewable Energy Law, adopted in 2005, is the most aggressive national law among developing countries, calling for 20 percent of electricity to come from renewable resources by 2020. This law offers financial incentives, including a national fund to foster renewable energy development, discounted lending, and tax preferences for renewable energy projects. Other mandates require a certain percentage of domestically-manufactured components for installed units (e.g., a wind turbine). These policies have undoubtedly contributed to China's surge in installed wind capacity, though the low prices offered for wind concessions have arguably distorted the industry and may challenge its long-term growth.

CHALLENGES IN ACHIEVING SCALE

As noted above, meaningful progress in the United States and China will have to be measured in terms of renewable power generated (and utilized), which will signal that demand is being increasingly met by clean, sustainable sources. Excluding conventional hydropower, renewables' share of generation in both countries is still quite small (less than 3 percent from non-hydro sources), as is the scale of most renewable power projects, in comparison to fossil-fuel power stations. In China, despite grand announcements of large-scale renewable power plants, most installed capacity has been in small-scale or off-grid generation. Deploying more small-scale projects would be easy, but both countries must now direct their focus on increasing the scale of these efforts. This does not preclude significantly more distributed generation (e.g., rooftop PV systems), but it does signify the need to expand the scope of such projects, moving from individual homeowner initiatives to citywide programs capturing abundant local resources, including solar, waste, and other renewables.

…there is a tremendous opportunity for the United States to learn from China as the latter rapidly builds new transmission capacity and incorporates it into a nationalized grid.

As both countries make this transition to clean energy economies, deployment issues will come to the fore. Ancillary requirements in workforce development (skilled manufacturers, installation technicians, and equipment operators) must be addressed if these technologies are to be widely deployed. Operating experience will also become a valuable tool—utility and grid operators in both countries have much to gain from sharing their experiences in integrating and managing larger shares of renewable power generation. Renewables will be competing with more-established industries, and so this growing industry must share best practices in forecasting, and balancing intermittent resources, among other things. In this regard, there is a tremendous opportunity for the United States to learn from China as the latter rapidly builds new transmission capacity and incorporates it into a nationalized grid. Current U.S. projects to incorporate components of the "smart grid" will need to be evaluated, scaled-up, and widely deployed to further enable more renewables coming on line.

Consistent and supportive policies should help both countries' industries, but over the long-term renewable power will need to focus on becoming cost-competitive. Clearly, a price signal for carbon should help favor renewables over most conventional alternatives. However, access to capital could be a limiting factor—renewable power technologies are capital-intensive. Innovative financing mechanisms for these projects, which have lower operating costs over their lifetime, could help overcome this challenge.

Large-scale use of renewable power should yield many positive environmental benefits, but there are legitimate concerns about potential negative consequences. Land-use is often cited as a drawback of central-station renewable power plants. However, numerous studies and experience have shown that these obstacles can be overcome through a combination of land optimization (e.g., wind turbines on animal grazing land, or PV on building facades) and resource optimization (e.g., concentrator lenses for PV cells, or waste biomass utilization rather than dedicated crops). Production processes are also an area of concern, particularly for silicon PV manufacturing. As China continues to position itself as a world-leading manufacturer of PV products, it will need to work closely with environmental regulators and learn from industrial best practices to manage any emissions of silane, silicon tetrachloride, hydrofluoric acid and other acids used in cleaning wafers.

Photo Credit: Joanna Lewis

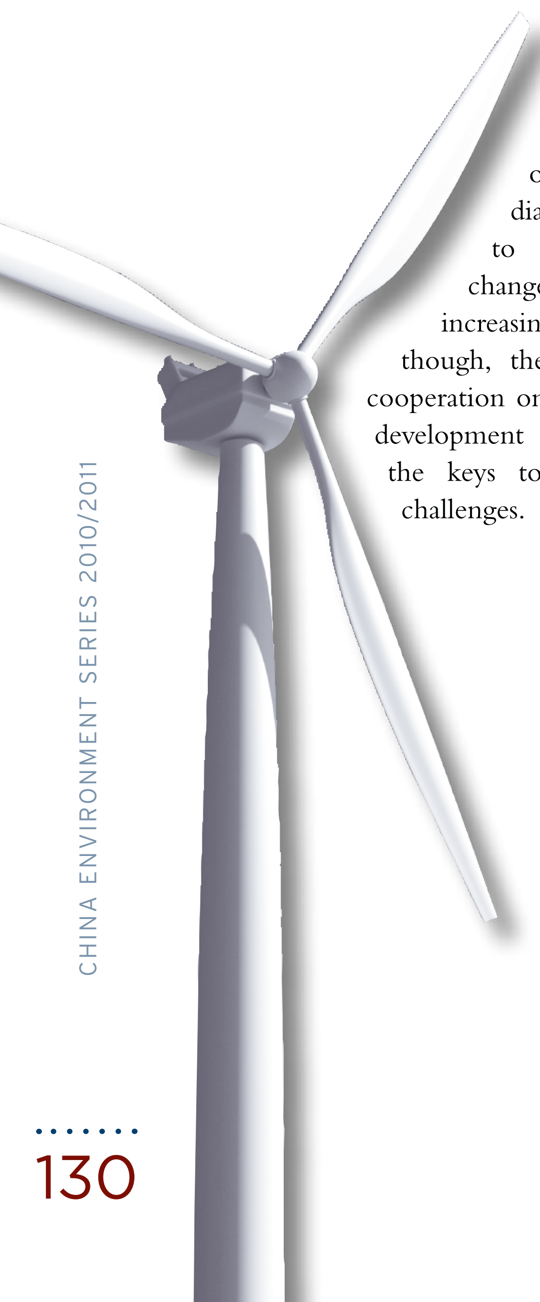
Failure to do so could undermine the industry, particularly in the global marketplace, since nearly all of China's PV materials are sold as exports.

FUTURE DIRECTIONS

The United States and China are entering an interesting period, where they will need to be both collaborators on critical global challenges as well as primary competitors in the marketplace. This signals a change from typical modes of cooperation—broad memoranda of understanding and technology transfer projects—to much more sophisticated collaboration, involving sustained intergovernmental dialogue matched by closer cooperation among industry and NGOs. Both countries recognize that it is in their mutual interest to support one another's efforts to be leaders in developing and deploying clean energy, and they are poised to guide the way in scaling up electricity from renewable resources.

In addition to short-term goals, such as sharing best practices in deploying and operating specific renewable power technologies, there is a need for enhanced U.S.-Chinese cooperation on key enabling technologies that could form part of a sustainable energy structure, which will have important medium and long-term impacts. Chief among these is the implementation of smart grid technologies, which address intermittency issues and manage increased shares of distributed or on-site renewable power generation. Energy storage techniques could also benefit renewables as they reach a much larger share of generation capacity. The United States has experience with several techniques, such as pumped hydro and compressed air storage, which may be applied to the grid to maximize production from renewable resources. Both countries might collaborate on, for example, linking new renewable power to existing hydropower (which can be used as a storage medium). Finally, considering the high degree of urbanization in the United States, rapid urbanization occurring throughout China, and the role of motorized vehicles in both countries, there may be an opportunity for deeper collaboration on electric vehicles, particularly vehicle-to-grid technologies that enable battery storage.

Substantial U.S.-Chinese collaboration in renewable energy development could have significant impacts in the near-term (e.g., cost reductions) and the longer-term (e.g., by supporting research, development, and commercialization of frontier technologies). Progress on this front will most certainly benefit the global community, by slowing and then reducing greenhouse gas emissions, and enabling more renewable energy to be harnessed cost-effectively in every country. The United States and China will continue to pursue national priorities of economic development and energy security, and there will be ongoing multilateral dialogues about ways to mitigate climate change. As both countries increasingly acknowledge, though, their leadership and cooperation on renewable energy development will be one of the keys to addressing these challenges.



Derek Vollmer is Program Officer for the Science and Technology for Sustainability Program at the National Academies. He has organized and directed several international cooperative activities, among them the National Research Council's consensus study Energy Futures and Urban Air Pollution: Challenges for China and the United States *and the newly released study on U.S.-China renewable energy (www.nap.edu/catalog/12987.html).*

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[1] The bilateral study (and this commentary) draws significantly upon the report, *Electricity from Renewable Resources: Status, Prospects, and Impediments*, a U.S.-focused study published by the National Research Council in 2009.

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FEATURE BOX

The Clean Air Task Force China Project:
U.S.-China Collaboration as a Pathway to Clean Coal Technology

By Jonathan F. Lewis

The Clean Air Task Force (CATF) is working in China and elsewhere in Asia to speed a global transition to low-carbon coal technology, by facilitating the development of joint business ventures between innovative energy companies and research institutions in Asia and the West.

COAL PRESENTS ENORMOUS CLIMATE CHALLENGES…

We need decarbonized coal if we want to stabilize the global climate. Carbon dioxide emissions from coal-fired power stations are the single largest driver of global warming on the planet, accounting for about 40 percent of human-made CO_2 emissions from energy use. If carbon emissions from coal power are not reduced substantially in the next two decades, global warming cannot be effectively addressed.

Coal, however, will remain a key source of energy for years, especially in some of the world's largest economies. The United States and China, which together produce half of the world's coal-fired power emissions, control almost one third of the world's coal reserves and have built their energy sectors around large fleets of coal-fired generating stations. Coal use by China is expected to double in the next 20 years.

… AS WELL AS "CAN'T-MISS" OPPORTUNITIES

Because coal-based power is responsible for such a large share of global CO_2 emissions, the development and deployment of technologies that allow us to get energy from coal without the emissions will be a huge step toward climate change mitigation.

CATF believes that partnerships between companies from China and the West are crucial to accelerating the commercialization of low-carbon coal-based energy generation. The world's shared reliance on coal creates many challenges—along with some critically important opportunities. Energy companies in North America, Asia, Europe, and Australia have enormous experience and expertise working with coal, and are similarly motivated to develop technologies and techniques that will preserve a role for coal in a carbon-constrained world.

Moreover, the environmental and economic benefits of transitioning to clean energy will be smaller and slower to materialize if Western and Chinese companies do not work together. The climate challenge will be solved by multiplying opportunities for rapid development and deployment of low-carbon generating technologies, not by restricting engagement between companies in the world's most dynamic economies. Investments by one country reduce the cost of that technology worldwide, increasing the likelihood that carbon capture and sequestration (CCS) will be widely deployed in time to help avert the worst consequences of climate change.

CHINA PROJECT—MAIN ACTIVITIES

The China Project at CATF builds on China's current leadership in low-carbon coal technologies that will be essential to addressing climate change and energy security. For example, the first commercial scale integrated gasification combined cycle (IGCC) power plant with CCS, called GreenGen, is under construction in Tianjin and will feature gasification technology developed by the Thermal Power Research Institute (TPRI). TRPI technology is also being used to retrofit a Shanghai power plant with one of the world's largest post-combustion capture systems. An underground coal gasification (UCG) pilot and commercial project (coal to methanol) built by ENN Group in Inner Mongolia is helping to demonstrate UCG's ability to significantly lower the cost of coal-to-power with CCS. Meanwhile, Shenhua Company Ltd. is developing a large-scale geologic carbon sequestration project at a new large coal-to-liquids plant in the Ordos Basin, and the East China University of Science & Technology has successfully licensed its gasification technology to Western project developers (as has TPRI).

Through an ongoing series of meetings, conferences, and briefings in the United States and China, CATF is working to familiarize key companies and institutions in the West with these kinds of projects and, more broadly, with the technological and industrial prowess found in the Chinese energy sector. CATF's efforts have also provided Western technology developers—especially those looking for opportunities to commercialize advanced gasification systems—with a platform for engaging potential Chinese partners.

To coordinate these efforts, CATF founded the Asia Clean Coal Initiative (ACCI) in 2007 and the Asia Clean Energy Innovation Initiative (ACEII) in 2009. ACCI and ACEII have hosted invitation-only Executive Roundtables in Beijing, Cambridge, Palo Alto, and Hangzhou, and have co-sponsored broader events in the United States and China. The roundtables assemble the most innovative and entrepreneurial companies in the field, and have helped bring about several promising joint enterprises.

This effort—building strategic cross-border partnerships that can reduce low-carbon coal technology costs and accelerate CCS deployment—is the crux of CATF's China Project. By combining the extensive work CATF has done envisioning and developing a pathway to widespread CCS deployment in the United States with our substantial engagement with Chinese energy leaders (spearheaded by CATF's Ming Sung), CATF has played a key role in bringing about some of the most interesting recent ventures between North American and Chinese energy companies. These partnerships include:

- **Southern Company / KBR – Dongguan Tianming Electric Power Company.** The Atlanta-based Southern Company will deploy the KBR-developed Transport Integrated Gasification technology (TRIG) in a commercial-scale coal gasification plant operated by Dongguan Tianming Electric Power Co. in China. Coal gasification systems, including IGCC facilities, are particularly amenable to carbon capture and sequestration because they separate the CO_2 (along with several other pollutants) from the process stream prior to combustion. The terms of the agreement include technology licensing, engineering, and equipment to use TRIG technology at a new 120 MW power plant. Operation is expected to begin in 2011.
- **Duke Energy – ENN Group.** The initial September 2009 agreement between Duke and ENN Group of China promotes joint development of a variety of technologies, from CCS-relevant systems including underground coal gasification to solar, biofuels, and energy efficiency. In a

follow-on agreement, ENN Group agreed to make capital investments in commercial solar projects operated by Duke Energy Generation Services.

- **ZEEP – ENN Group.** Zero Emission Energy Plants Ltd. (ZEEP) and ENN Group reached an agreement in September 2009 to design and construct a commercial-scale power plant in Shandong Province featuring Connecticut-based Pratt & Whitney's Rocketdyne gasification system.
- **Future Fuels – Thermal Power Research Institute.** Houston's Future Fuels is the exclusive North American licensee of TPRI's multi-stage, dry-feed, waterwall coal gasification system, which is also being installed at the GreenGen IGCC project in Tianjin. Future Fuels plans to use the technology at its Good Spring IGCC project in Pennsylvania, which it expects will deliver 270 megawatts of electricity while capturing over 50 percent of the CO_2 output initially and nearly 100 percent by 2020. The companies have also signed an agreement to share technical data from Future Fuels' Good Spring plant and TPRI's GreenGen facility.
- **Duke Energy – China Huaneng Group.** Potential focus areas of technology-sharing that were part of a Memorandum of Understanding (MOU) signed in August 2009 include: (1) clean coal power generation with the focus on IGCC and Ultra Supercritical power generation; (2) CO_2 Capture and Sequestration (CCS) including pre-combustion capture, post combustion capture, enhanced oil recovery, and geologic sequestration; (3) energy saving and emission reduction in coal-fired power plants, (4) renewable energy power generation including wind, biomass, solar and other energy sources. According to a Duke spokesperson, "We both have the scale and mass to push the global industry forward in the development of clean technologies."
- **HTC PureEnergy – Suntracing Clean Energy.** Canada's HTC is working with Suntracing in China to demonstrate modular technology developed by HTC that uses CO_2 captured from power applications to produce a fire-suppressing foam; the foam is

Todd Glass, Ming Sung, and John Thompson of the Asia Clean Energy Innovation Initiative consult with a Chinese official during a visit to the Hangzhou Boiler Group in May 2009. The Hangzhou facility is fabricating coal gasifiers for power plants in China and the United States. Photo Credit CATF.

then used to put out coal seam fires, which are common in China and a significant contributor to global CO_2 emissions.

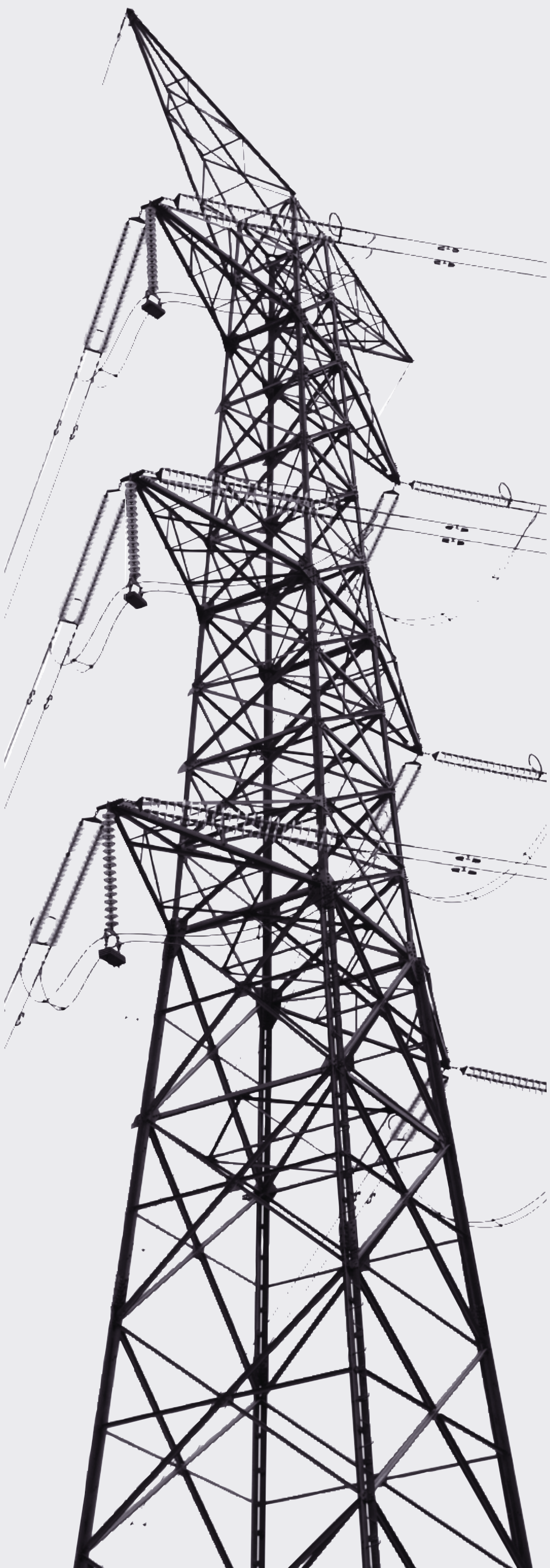
- **Duke Energy – State Grid Corporation (in negotiation).** Duke Energy and State Grid, China's largest electricity distributor and one of the world's largest companies in terms of revenue, are reportedly pursuing a partnership to build highly-efficient high-voltage transmission lines in the United States. The venture would also provide Duke with access to financing and to State Grid's transmission technology and equipment, while State Grid will gain insight into the "smart grid" technology Duke is developing.

In addition to the project facilitation work described above, CATF frequently meets policymakers and key stakeholders in the United States and China to discuss the opportunities associated with CCS-related joint ventures between companies in both countries.

U.S. companies have decades of experience pipelining CO_2 and injecting it deep underground for enhanced oil recovery, and the country's capacity for entrepreneurship and innovation has produced a range of companies developing advanced CCS technologies. Companies in China are unparalleled in their ability to scale-up technologies quickly and inexpensively. China has more experience with coal gasification (a key CCS technology) than any other country, and it is rapidly commercializing gasification for electricity generation.

The shared reliance on coal creates challenges and opportunities for the United States and China. Energy companies in both countries have enormous experience and expertise working with coal, and are similarly motivated to develop technologies and techniques that will preserve a role for coal in a carbon-constrained world.

Jonathan Lewis is a staff attorney and a climate policy coordinator for the Clean Air Task Force, a Boston-based nonprofit organization dedicated to restoring clean air and healthy environments through scientific research, public education, and legal advocacy. He can be contacted at jlewis@catf.us.



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FEATURE BOX

Environmental Mass Incidents in Zhejiang Province

By Ada Wu

2005 was destined to be an eventful year for Zhejiang provincial government officials. On March 10, thousands of people rallied together at Zhu Xi Chemical Industrial Park located in Huashui Township in eastern Zhejiang Province to protest against the pollution caused by a chemical factory. Almost at the same time, more than 3,000 people from Beilun, Ningbo took control of a heavy polluting stainless steel manufacturer for ten days. In 2005, hundreds of villagers in Shengzhou who were angered by the dumping of chemical wastes attacked a pharmaceutical plant and the confrontation evolved into a bloody clash with police. In addition, a lead-acid battery manufacturer was attacked by furious villagers in Changxin County of Zhejiang Province. [1]

These four large-scale "mass incidents" were not organized or coordinated by any environmental nongovernmental organization (NGO), yet they occurred almost simultaneously in various parts of Zhejiang. As one of the richest provinces in China, provincial government officials were proud to be the first province in China that announced that no counties in their jurisdiction are in the poverty-county list of the central government. But these environmental mass incidents almost shattered the hard earned reputation that Zhejiang government had been building over the years.

As pressures from local residents and central government were mounting, the provincial government officials felt inclined to reinforce its environmental policies. Four industries were singled out to be the target of regulatory crackdowns: pharmaceutical, chemical, cement and poisonous matter producers. After the protests, Dai Beijun, director of the Zhejiang Provincial Environmental Protection Bureau, said "Authorities will closely examine the potential effect of industries' projects on the environment before giving the green light on construction. Companies causing environmental problems will be forced to shut down," in an interview with English-language newspaper *China Daily*.[1]

The crackdown on environmental violators came as Zhejiang Province struggles to balance environmental protection and economic development, a challenge faced by all Chinese leaders. While no one would acknowledge openly the tradeoff between the two, the majority of Chinese officials, from central to local levels, believe that the tradeoff is unavoidable and priority has to be given to economic development rather than promoting environmental protection.

The mass incidents launched by local residents or villagers were not sophisticated or well organized. Protesters' demands were simple: the polluting factories should stop ruining the people's land, polluting the rivers and harming public health. They were willing to let the protest get worse or even out of control because it was the only way to let their voice be heard by government. That's why protesters in one incident chanted the stirring slogan, "We would rather be beaten to death than polluted to death."[3]

Whether these protests will herald a major shift toward provincial government's better environmental governance remains to be seen, but these incidents did succeed in grasping the attention of government. They also exerted a chilling effect on the polluting enterprises. For those factory owners, one of the lessons that won't be forgot soon is that if they continue to pollute, they could potentially be torn down by the local people or shut down by government.

Ada Y. Wu worked as a research assistant with China Environment Forum from September 2009 to June 2010. Her research focused on China's environmental and energy policies and US-China cooperation in renewable energy. She is now based in Beijing working at WWF-China. She can be reached at adaywu@gmail.com.

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FEATURE ARTICLE

Green Bounty Hunters: Engaging Chinese Citizens in Local Environmental Enforcement

By Xuehua Zhang

China's environmental governance system has long relied on top-down emission standards and penalties to stem the country's rising air and water pollution. But such strategies have often failed due to powerful local governments that protect industries and undermine weak environmental protection bureaus. Besides strengthening pollution regulations, the central government has passed laws and regulations that expand public participation as a tool for better environmental policy enforcement. Such bottom-up public participation strategies have proliferated over the past decade and include complaint systems, expanded rights to participate in environmental impact assessment hearings, and an increased ability to bring polluters to court and access pollution information. There is also a little-heralded cash-reward informant program created in 2000 in Fuyang city in Zhejiang Province that offers insights into how Chinese citizens can be effective watchdogs of polluting industries. In the first few years of implementation, the program generated a large number of valid reports that uncovered the violations committed by 80 percent of the enterprises regulated by local environmental authority in Fuyang. Moreover, this green bounty hunter program has increased the compliance rate of polluting enterprises, improved local air and water quality, and promoted public participation in local environmental enforcement.

GROWING CHANNELS FOR CITIZEN PARTICIPATION

Chinese environmental governance institutions have been a work in progress over the past thirty years, shifting from mainly command-and-control policies to the adoption of new policy tools, market incentives, and open information measures to address the country's growing pollution problems. Another notable trend has been the promulgation of a growing number of laws and regulations that create specific channels for Chinese citizens to be involved in environmental policy processes. While not always fully implemented, channels and institutions for public participation have increased and range from complaint systems to legal rights for pollution victims to bring class action cases, from requirements for public environmental impact assessment hearings to measures that give citizen rights to access environmental information from government and industries.

The most commonly used channel of participation in China is the environmental complaint system. The system—commonly referred to as "letters and visits" (*xinfang*)—was originally established to provide an avenue for citizens to voice their concerns about environmental protection matters (Warwick, 2003; Brettell, 2003, 2007 & 2008). To make complaints, citizens register concerns with complaint offices within the local people's government,[1] the people's congress, or the environmental protection bureau through visits, letters and, increasingly, telephone hotlines and emails.

The Chinese central government has increasingly emphasized the importance of public participation to improve local environmental enforcement and compliance and has taken some measures to encourage citizens to report environmental violations by polluting sources. In many regions, acknowledging and responding to citizen complaints has become the priority of the local environmental protection bureaus (EPBs).

In 1990, China's lead environmental administration passed the *Regulation Concerning the Management of Environmental Protection Complaints* (*Huanjing Baohu Xinfang Guanli Banfa*), which went into effect in February 1991 and required EPBs to establish mechanisms to handle citizen complaints. Some EPBs were making records of complaints even in the 1980s (Brettell, 2003). Starting in 1997, the State Environmental Protection Agency (SEPA, the predecessor of Ministry of Environmental Protection) required that each local EPB establish an environmental hotline, known as "Green 110," to handle citizen reports of potential environmental violations. This hotline was done in cooperation with the local Public Security Bureau (PSB). In early 2001, SEPA set up a unified, toll-free hotline number, 12369, for receiving reports on environmental violations throughout the nation.[2] Some cities have placed this hotline within the special Citizen Reporting Center, which accepts all kinds of violation reports and distributes them to relevant government agencies.

Reports related to environmental issues are passed along to local EPBs where environmental inspectors are required to be on duty 24 hours a day to accept, inspect, and resolve reports. After resolving reports, inspectors are required to inform complainants of the resolution whenever possible.[3] If a complainant is not satisfied with the resolution, he/she can appeal either to EPB officials, local government, or a higher-level EPB. Unlike the traditional system of "letters and visits," which are mostly citizen complaints about noise pollution and other environmental issues that directly affect them or their property, the environmental reporting system (*huanbao jubao*) encourages citizens to discover and report unlawful behavior of pollution sources.

Cash-Reward Programs Emerge

As the role and importance of citizen participation in environmental enforcement has increased, new programs have been created, including a cash-reward informant program (*youjiang jubao*), in which informants are paid when they report significant pollution violations. These informants are sometimes referred to as "bounty hunters," similar to a green informant program in California.[4] The first Chinese bounty hunter program emerged in June 2000 in Fuyang city,[5] a county-level city of Hangzhou municipality in the northwest part of Zhejiang Province, one of the richest coastal regions in China where air and water pollution has become quite severe. (Editor's Note: See Feature Box on Environmental Mass Incidents in Zhejiang in this issue of CES as well as Environmental Mass Incidents in Rural China feature in CES 10 to read more about Zhejiang citizens protesting pollution). Under the Fuyang program, if a citizen's report is valid and results in an administrative punishment including a penalty for the pollution source, the government will grant a monetary reward to the citizen who first notified the EPB. The types of violations that qualify for cash rewards are those which have a large impact on local environmental quality and are often difficult for local EPBs to detect. Noise pollution complaints, which make up a majority of reports through the "letters and visits" program, are not eligible for financial rewards.

By the end of 2003, three and half years since of the start of the program, the Fuyang EPB had received 3,074 reports.[6] The EPB deemed that 1,103 of the reports were valid and qualified for rewards. As a result, the EPB collected roughly 8.5 million Yuan ($1 million in 2004) in penalties and granted the informants 1.9 million Yuan ($237,000) in rewards. As of 2007, a total of approximately 3 million Yuan of rewards had been issued (*China Environmental News*, 2008). Given a population of 620,000 people and 432 enterprises subject to the reward program in Fuyang, the number of valid reports and the amount of rewards granted are astonishing.

After Fuyang's experience was publicized nationwide, many provinces and cities adopted a similar program.[7] Jiangsu was the first to introduce a province-wide cash-reward program on February 1, 2001. Subsequently, Zhejiang, Hebei, Shandong, Shanghai,[8] and Sichuan adopted province-wide programs; each program provides a reward in the range of 200 to 5,000 Yuan. However, not all of the programs appear to be as successful as the Fuyang program in terms of the number of reports received. For example, only 27 reports were received between 2001 and 2003 during the initial implementation of a reward program in Nanjing City (the capital of Jiangsu Province). In Qingdao City, the capital of Shandong Province, only nine reports were received within half a year after a reward program was instituted (*Qingdao Daily*, 2001). In contrast, the Fuyang EPB received 14 reports involving eight polluters during the very first day of the implementation of the program, and citizens continue to participate in the program, even as pollution violations have dropped.

There has been virtually no in-depth investigation of any of these reward programs. This article examines the emergence and impacts of the Fuyang program, how it was created and implemented and what incentives the program generated for the involved parties. Although this paper is only a single case study, it offers insights into future examination of public participation in China's environmental sphere. The primary data sources in the paper are interview notes and EPB documents collected during field research conducted in Fuyang in July 2004. The relevant Chinese journal articles and media reports are also analyzed to provide additional evidence of the continuing impact of the program.

…the Fuyang EPB received 14 reports involving eight polluters during the very first day of the implementation of the program…

After a brief introduction of the structure and shortcomings of China's environmental enforcement institutions, this article shifts to a discussion of the creation and successes in Fuyang's innovative cash-reward system. The cash-reward system represents a promising mechanism to help strengthen China's weak environmental enforcement. In order to highlight lessons relevant for other cities in China with similar program, the last sections of the article identify the key factors contributing to the successes of the Fuyang program.

INSTITUTIONAL FRAMEWORK OF ENVIRONMENTAL ENFORCEMENT IN CHINA

While the Chinese central government has passed a plethora of laws, regulations, and standards to control pollution, enforcement has always been weak, largely due to powerful local governments and underfunded and small environmental protection bureaus (EPBs). Thus, for the past three decades the Chinese government has been building the foundation for a more comprehensive organizational infrastructure to circumvent powerful local governments in order to better enforce environmental laws, regulations, and standards (Jahiel, 1998; Moore & Warren, 2006). The National Environmental Protection Agency (NEPA) was officially upgraded to a ministry-level agency in March 1998 and renamed SEPA. Ten years later in 2008, China's environmental watchdog was further upgraded to the Ministry of Environmental Protection and given a ministerial rank. However, since the program investigated in this study took place before 2004, SEPA is used in the rest of this paper. Under SEPA, every province, autonomous region, city, and county has a local EPB responsible for policy implementation. As of 2008, approximately 3,000 EPBs with about 180,000 staff members were working at the sub-national level throughout the China (MEP, 2009).

…many polluters simply turn on the pollution control facilities when EPB inspectors arrive—even for "surprise" visits—and switch them off once inspectors leave.

Like most local government agencies in China's unique bureaucratic system, local EPBs must be responsive to two leaders: the administratively higher tier environmental institutions and the local governments where they reside (Lieberthal, 1997). Under this "dual leadership," EPBs at and below the provincial levels serve as SEPA's enforcement agencies, responsible for monitoring, keeping records, and collecting fees. SEPA and provincial EPBs provide city EPBs with policy directives and guidance for the implementation of national and provincial environmental laws and regulations. District and county EPBs are below the city level in the Chinese institutional hierarchy and receive guidance from city EPBs. However, it is local governments, not the higher tier environmental agency that provide local EPBs with their annual budgetary funds, approve institutional advancements in rank, appoint the bureau directors, determine increases in personnel, and even allocate such resources as cars, office buildings, and employee housing (Jahiel, 1998). The local government is the more powerful of a local EPB's two administrative leaders.

Each EPB usually includes an administrative office and its subsidiaries, such as environmental inspection stations, which are mainly responsible for administrative enforcement of environmental regulations. In principle, local EPBs have jurisdiction over: (1) issuing warnings, fines, unlawful gains confiscation, and stoppage of production or use orders; (2) revoking permits (or permit-like certificates); and (3) ordering enterprise closure or relocation. EPBs, in turn, entrust environmental inspection stations with this task; the stations can then apply sanctions within their entrusted jurisdiction in the name of the EPB. However, in practice, the EPB does not have jurisdiction for the use of the severest sanctions—closing down a polluter, revoking its discharge license, or ordering it to stop production. For the use of these sanctions, only the respective local governments have jurisdiction.

The main tasks of an EPB inspection station include: (1) on-site inspection of polluting sources; (2) collection of pollution levies; (3) investigation of environmentally polluting and destructive accidents; and (4) assistance for investigating and settling environmental disputes within an EPB's jurisdiction.[10]

EPB inspection stations have spent a substantial amount of their resources on conducting extensive on-site inspections of polluting sources.[11] There are two types of EPB on-site inspections—routine and surprise. Routine inspections are scheduled regularly—once a month for key polluting sources and less frequently on medium- and small-scale polluters—or can be more thorough announced inspections to facilities, which typically involve a comprehensive examination of how well pollution control facilities are working and whether various environmental requirements are being met.

The surprise inspections can be initiated by EPB inspectors themselves or by complaints from citizens. The purpose of EPB-initiated surprise inspections is to discover the illegal behavior of polluters. The most commonly identified violations are non-operation of pollution control facilities and illegal discharge of pollutants. However, it has been increasingly difficult for EPBs to uncover these violations, for many polluters simply turn on the pollution control facilities when EPB inspectors arrive—even for "surprise" visits—and switch them off once inspectors leave.

Unannounced inspections triggered by citizen complaints started becoming more common in the mid-1990s. Interviews of EPBs in three provinces during my 2004 fieldwork revealed that many regions have transferred the entire responsibility of accepting and handling complaints and reports to the local inspection stations. Since EPB inspection stations are generally understaffed and underfunded, they have increasingly depended on citizen complaints to detect environmental violations. One city EPB reported that in 2002 citizens identified about 60 percent of the administrative penalties.[12] The Fuyang cash-reward informant program was created to enhance the effectiveness of citizen complaints in uncovering substantial violations and encouraging the continuous compliance with environmental requirements by polluters.

LAUNCH OF FUYANG'S GREEN BOUNTY HUNTER PROGRAM

The idea of creating an economic incentive for citizens to uncover significant environmental violations emerged under a special political, social, and environmental circumstance. The Fuyang EPB with local government support created a green bounty hunter program to support an ambitious national environmental campaign that required all enterprises to meet emissions standards by the end of 2000. The creation of this cash-reward program also reflects the Fuyang government's commitment to tapping public participation in order to improve environmental enforcement and compliance.

To supplement its enforcement efforts, the Chinese government frequently launches nationwide campaigns focused on raising environmental awareness and punishing polluters.[13] On August 3, 1996, the State Council issued *the Decision on Several Problems Concerning Environmental Protection*, hereafter referred to as the Decision.[14] The Decision contains two main goals. The first stated that all 15 types of small polluting enterprises should be shut down before September 30, 1996. This policy is usually referred to as "The Fifteen Small" (*shiwu xiao*). (See Box 1 that defines this and other green "number" policies and standards).

A second goal was to have all of China's industrial enterprises meet the national and regional standards by December 31, 2000, known as "Meeting Two Standards" (*shuang dabiao*). Unlike the "The Fifteen Small" campaign, this one was directed at larger industrial enterprises, many of which were still state-owned and had not been targets of previous enforcement actions. It required that the local government at the county level or higher close, stop production or relocate industries with pollution discharges exceeding the limits.

The Decision brought a landmark change in environmental enforcement. Although it left the responsibility for the implementation of the two goals with the local governments, the State Council explained how the goals were to be met. In particular, the severest administrative sanction to counter industrial pollution was to be used: abatement deadlines, to be followed by the forced closure of polluting industries. Before the Decision, this sanction was rarely used. Local EPBs often had great difficulty in seeking the local government's approval to either close down or stop production of heavily polluting enterprises. The Decision planted the seeds for the success of the national campaign.

Drivers of Fuyang's Reward Program

The Fuyang city government issued abatement deadlines to a total of 461 enterprises. Among them, 120 were listed as key pollution control enterprises. By end of 1999, the city invested 83 million Yuan ($10.3 million) in industrial pollution control. About 299 enterprises installed pollution reduction facilities. However, a significant number of enterprises that constructed control facilities and met the abatement plans did not operate the facilities on a regular basis or maintain them. In order to reduce production costs, many enterprises turned the facilities on during EPB inspections and switched them off after the inspectors left. Untreated discharges, whether intentional or accidental, were very common.

In addition, paper mills formed the backbone of the Fuyang's industrial structure and the number of small-scale paper mills grew rapidly.[15] It was extremely difficult for the Fuyang EPB to ensure full compliance with the "Three Synchronizations" (*santongshi*) pollution control requirements among those small enterprises. Some new projects or expansions of existing projects started operating without meeting the requirements (See Box 1). In addition to the problems with paper mills, some small polluting enterprises that were ordered to close down were reported to have reemerged.[16]

As a result of these enforcement gaps, the environmental quality in Fuyang city continued to decline and the number of citizen complaints continued to rise. Mr. Hongtai Guo, the former

Box 1. DECIPHERING THE NUMBERS BY ADA WU AND XUEHUA ZHANG

In the course of issuing countless environmental policies, regulations, and campaigns every year, the Chinese government often gives them names with numbers that can be easily remembered and used in slogans. Some of the policies mentioned in this article are explained below.

The Fifteen Small Enterprises (shiwu xiao) is a policy that refers to 15 types of small polluting enterprises that were identified in State Council Decision on Several Problems Concerning Environmental Protection issued in 1996. They are usually heavily polluting township and village enterprises (TVEs). They include small paper manufacturers that produce less than 5,000 tons of paper from raw materials and less than 10,000 tons of paper from chemical pulp a year; small tanneries that treat less than 30,000 hides a year; dye factories that produce less than 500 tons of dye a year; coking enterprises and sulfur smelting enterprises using backward technologies; enterprises that use backward methods to smelt arsenic, mercury or lead-zinc, oil refinery without being approved by State Council, gold extraction factories; factors that produce pesticides without permission, bleaching and dying service providers, backward electroplating factories; and enterprises that produce radioactive and asbestos products.

Meeting Two Standards is a campaign that was part of the 1996 State Council Decision that put forward three goals: (1) all industrial pollution sources must meet national and local emission standards; (2) key environmental protection cities must meet air and water quality standards; and (3) several major catchments had to carry out water pollution control according to the local catchment's requirements. The first and second targets were to be met

Box 1. CONTINUED

by the end of 2000, which is why the campaign is called "Meeting Two Standards.

Three Synchronizations is a unique pollution control policy that was first mandated in 1973 and later incorporated into the 1979 (trial) and 1989 (revision) of China's Environmental Protection Law. This policy aims to ensure that all the new construction projects include pollution abatement facilities that meet state emission and effluent standards. This program requires that design, construction, and operation of pollution treatment facilities be conducted at the same time as the design, construction, and operation of the overall project. It also applies to major expansion or retrofitting of the existing plants.

Two Lines of Revenue and Expenditure Rule was first proposed by the State Council in 1993 and applicable to all government agencies. It requires that all non-tax fees collected by government agencies go to local finance bureaus as a part of local revenue. Each agency then proposes an annual budget to be approved and allocated by the finance bureaus of local governments. According to this rule, local EPBs are responsible for issuing a pollution levies or penalties, which are then paid through local banks to the finance bureaus. The money is listed as environmental protection fund in the local government annual budget and allocated for pollution treatment. Thus, EPBs can no longer directly keep a portion of the levies and penalties collected for their own use. Disconnecting EPB budget allocations from levy and fine collection was supposed to help local EPBs to focus their enforcement efforts on supervising polluters and reducing pollution instead of on generating revenue.

Party Secretary of Fuyang city (1999-2003), was so concerned about the situation that he asked the Fuyang EPB to seek legal support for creating a cash-reward program.[17] Recognizing the insufficient enforcement capacity of Fuyang EPB, he sought to utilize the 620,000 Fuyang people to help detect severe violations. Mr. Guo believed that the public, who had strong concerns about Fuyang's industrial pollution, would be motivated to uncover and report such violations if a reward was set high enough.[18] The watchful public eyes would in turn strengthen EPB enforcement and improve the compliance rate.

Through careful examination of the related legal provisions, the Fuyang EPB concluded that there was sufficient legal support for establishing a cash-reward informant program.[19] Article 6 of the *Environmental Protection Law* explicitly grants Chinese citizens the right to legal remedies: "Citizens have the right to make a complaint or an accusation against work units or individuals who pollute or damage the environment." Article 8 stipulates, "Local governments should reward working units and individuals with outstanding contribution in protecting and improving the environment." In addition, Article 34 of the "Rules for Environmental Letters and Visits" issued by SEPA in 1997[20] clearly states that local EPBs can honor or reward citizens who discover and report unlawful environmental practices that help improve local environmental protection work. The laws appear to have left it up to local discretion to determine the form of rewards.

Design and Implementation of the Program—Citizens Begin to Fill Enforcement Gaps

On June 5, 2000, the Fuyang city government and Party Committee decided to jointly launch a cash-reward informant program built on the existing environmental reporting system in order to improve compliance and to consolidate the aims of the national campaign that required all enterprises to meet emissions standards by the end of 2000. Immediately following this decision, the government issued the *Notice of Conscientiously Carrying Out Environmental Protection Work by Mobilizing All Societal Forces*, henceforth referred to as Notice, and detailed implementation rules.

The Notice became effective on June 15, 2000. Any citizen who first reports the following four types of environmental illegal behaviors is entitled to a cash reward. Under these circumstances, those citizens are regarded as environmental informants.

- Violating "Three Synchronizations" requirements.
- Not operating or not regularly operating pollution control facilities.
- Resuming production without EPB's approval. This often applies to "The Fifteen Small" enterprises that were ordered by the city government to close down or to stop production.
- Not meeting abatement deadlines but nonetheless continuing production. This often applies to enterprises that were given abatement deadlines by the city government.

The scope of the rewards program was designed to ensure the long-term effects of the national campaign. As one interviewee pointed out,[21] in practice, the people who obtain rewards are mainly the ones reporting on illegal discharges of wastewater.[22] Under this green bounty hunter program citizens were encouraged to report the reemergence of the 15 types of small enterprises that do not operate polluting treatment facilities on a regular basis. The program also addresses violations of the "Three Synchronizations" that are mostly related to small-scale paper mills. In total, there are 432 enterprises in the chemical engineering, paper, dye, and electroplating industries that are subject to the program and these are the main enterprises in Fuyang. The Fuyang rewards program opted to focus on this limited range of violations and did not incorporate all the kinds of violations specified in China's expansive environmental laws and regulations.[23]

At the start of the program, the reward was 1,500 Yuan (~$185) for problems that occurred at night (12 to 6 a.m.) and 1,000 Yuan (~$125) for daytime violations. The penalties charged to polluters as the result of a citizen's report ranged between 5,000 and 50,000 Yuan ($630-$6,300).[24] The reward for night problems was higher because such pollution events are considered more difficult for citizens and regulators to discover. No evidence shows that the size of a reward was set by any theoretical or economic calculation. Mr. Guo, then Party Secretary, recalled that the size was set to be 1.5 or 2 times the monthly salary of an average employee in Fuyang city in order to provide a sufficiently high monetary incentive.[25] Meanwhile, the Fuyang EPB also decided that the size of a reward should be in the middle range of the rewards established by other governmental agencies such as Public Security Bureau, Anti-Corruption Bureau, and People's Procuratorial Bureau. Those rewards were generally in the range of several hundred to 2,000 Yuan.[26]

Finalizing the Reporting Infrastructure

Paralleling the cash-reward program, in 2000 the Fuyang EPB established a special 24-hour hotline (63318301) for informants. This hotline proceeded SEPA's national hotline (12369) that was established in 2001. Fuyang maintained the old number as well for citizens were already familiar with it. When receiving a report, inspectors are required to arrive on site within an hour (two hours for remote areas) to carry out an investigation. Once the report is verified, the informant is given a cash reward within 10 days. If an enterprise continues to discharge pollutants that exceed standards 24 hours after being reported and investigated, citizens can report the violation again and obtain another reward. If the same enterprise is caught three times violating emission standards the EPB is supposed to take severe measures.[27]

Informants can also report to the local People's Procuratorial Bureau (PPB) if EPB officials: (1) neglect to investigate a citizen pollution report, (2) give confidential information to the enterprise under investigation, or (3) reveal the identity of the informant. The PPB can issue disciplinary sanctions to EPBs that are found guilty of these violations.

The EPB drafted about ten implementation rules including the *Acceptance and Inspection Procedures and Security Rules*. All these detailed rules, together with the Notice, lend solid support to the EPB's implementation of the program and guarantee its legitimacy.

Before full implementation of the program in June 2005, the Fuyang EPB repeatedly published a notice advertising the bounty hunter program in the *Fuyang Daily* and broadcast it on the Fuyang TV station several times a day for five days in order to increase publicity. Simultaneously, the EPB established a command center and a rapid response system. In the first month after the cash-reward program was established, all 60 EPB staff members were required to work on the program.[28] Seven special teams were established to: (1) accept citizens' reports and conduct and supervise on-site inspections, (2) make legal examinations and analyze monitoring results, and (3) release news about successful reports.

In the first month after the cash-reward program was established, all 60 EPB staff members were required to work on the program.

After a one-month trial in June 2000, an environmental reporting center was formally established and staffed by a total of 21 EPB employees, essentially all the staff of the Fuyang Inspection Station, who formed three groups working in rotation to accept and handle the flood of reports.[29] The center was equipped with two cars, six cameras, and one video camera.

In the first six months of the program (June to December 2000) 332 of the total 544 reports were found to be valid and actionable pollution violations. Citizens continued to turn in reports in the subsequent three years that this study examined, but the rate of valid reports were highest (61 percent) in the first half year.[30] The reports in the first six months indicated that approximately 80 percent of the enterprises in Fuyang were continuously in violation of pollution emission standards.[31] As it became apparent that large numbers of enterprises were concealing their unlawful emissions, in 2001 the Fuyang city government raised the reward to 3,000 Yuan a day to fire up the enthusiasm for citizens to be informants. Again, there was no solid reasoning or analysis regarding why the reward was raised to that level. According to Mr. Guo, the reward increase mostly demonstrated the determination and confidence of the Fuyang Party Committee and city government to control pollution and improve local environmental quality.[32]

CATALYZING A VIRTUAL CYCLE: OUTCOMES OF THE BOUNTY HUNTER PROGRAM

Table 1 below shows the basic statistics of the

Fuyang program, which reveals no obvious decline in the number of reports over the first four years. However, the percentage of valid reports did drop dramatically likely due to several factors.[33] First, Fuyang EPB officials noted that there had been a huge drop in illegal discharge of wastewater due to increased environmental awareness of entrepreneurs. Second, a growing number of polluting industries were willing to correct mistakes when they discovered that wastewater treatment facilities were not operating normally. Third, some informants withdrew their reports when an EPB investigation revealed there was no illegal discharge of wastewater.

The decline in valid pollution reports and potential explanations suggest that the reward program has worked well. The Fuyang EPB interviewees in my 2004 fieldwork provided a detailed account of their perceptions of the success of the program.[34]

Improvement in Operations of Pollution Treatment Facilities. The Fuyang EPB claims that pollution treatment facilities were operated more frequently after the start of the bounty hunter program. By 2003, the EPB found through their routine supervision that the normal operation rate of the treatment facilities had increased from 30 to 95 percent. Over the first four years, citizen watchdogs reported on approximately 80 percent of the enterprises within the city. The Fuyang EPB officials believed that the active public participation in the bounty hunter program was a substantial motivator for nearly all the city's enterprises to comply with pollution control laws. For example, many enterprises established an operation responsibility system for pollution treatment facilities and designated one or more full-time employees to operate the facilities and made efforts to fix design and construction problems at their facilities. Some enterprises even started voluntarily notifying the EPB when facilities broken down or needed repair to avoid violating the pollution emission rules.

Rising Environmental Quality. The Fuyang EPB claims that the air and water quality in the city have notably improved since the implementation of the bounty hunter program.

TABLE 1: OUTCOMES OF THE FUYANG PROGRAM, JUNE 2000 - DECEMBER 2003

Time Period	Number of Accepted Reports	Number of Valid Reports	Percentage of Valid Reports	International Advanced Level	Received Penalties (USD)
June-Dec. 2000	544	332	61	83,000	415,000
2001	782	318	40		
2002	916	252	27	74,000	344,000
2003	832	201	24	79,500	296,000
2007	138	32	23	n/a	n/a

Notes: 1. The data were drawn from Fuyang EPB. 2003. Procedure, Institution, Rules, Summary, and Notice of the Cash-Reward Informant Program Compiled by Fuyang Inspection Station.
2. "Valid reports" are the ones that are proved to be true after on-site investigation. Some of them might not be in the scope of the reward program. It is unclear what the percentage of the valid reports is subject to a reward and how many informants actually received the rewards. My 2004 fieldwork indicates that some informants refused to accept the money.

Before 2000, the water quality of the two small rivers running through the city was listed as class five quality—the next to lowest ranking of water quality.[37] With reporting from informants, the EPB discovered and closed down 13 severely polluting enterprises located along one of the two rivers (*People's Net*, 2001). By 2003, the water quality of the river with many plant closings rose to class three quality and that of the other to the class four quality. In addition, many citizens have observed the improvements in air quality. It is difficult to prove that the rewards program is directly responsible for all the drops in pollution, as the city was simultaneously implementing other pollution control policies. However, EPB officials regarded the bounty hunter program as a significant improvement in their enforcement capacity, and enterprise managers also claimed the program pressured them to meet the standards.

Enthusiastic Participation by Citizens—A "Virtual Cycle." The Fuyang EPB believes that the program has greatly improved public participation in local environmental enforcement and has increased public confidence in the local government. Some citizens not only strived to report environmental violations in their neighborhoods but also traveled to remote areas and rivers to find violations. The EPB's fast response to reports in terms of quick investigation and timely issuance of rewards largely inspired the general public to discover and report violations. The program also demonstrated the local government's strong commitment to strictly punish environmental violations, which in turn, increased the public's confidence in the local government and EPB.

Professionalization of Informants. Some citizens in Fuyang became professional informants, specializing in discovering and reporting valid violations in the city within the program's first year. The Fuyang EPB considered this trend an indicator of the program's success. More than 10 professional informants were involved in reporting pollution during the first three years of the program. One professional informant received a total of $12,500 rewards in 2003 alone. Another one successfully reported more than 10 violations within the first four months of the program and was rewarded about $2,500. This informant mentioned that he even thought about registering as an environmental reporting company.[38] Though detailed information on individual informants is strictly confidential, the Fuyang EPB interviewees described the following characteristics of informants, which offer insights into these empowered citizens.

> *With reporting from informants, the EPB discovered and closed down 13 severely polluting enterprises located along one of the two rivers*

- Most of the informants are farmers and not whistleblowers from inside the polluting company.
- Though some informants reported violations and refused to receive money, most informants participated to get rewards.
- Many informants started reporting violations in their neighborhoods.
- Professional informants equipped themselves with necessary tools such as bikes, motorcycles or cars and carried cameras and emergency lights.
- Professional informants managed to increase the accuracy of their reporting by learning about the polluting conditions of enterprises, relevant environmental knowledge, regulations, and policies. Some established close contacts with the Fuyang EPB.
- Many informants often went searching for violations at night, which is a common time for enterprises to illegally discharge pollutants.

- Some of the professional informants developed special tactics to effectively catch violators. One claimed that he paid close attention to the polluting enterprises exposed by the media. While most people might think these enterprises would subsequently comply with regulations, he watched them closely and actually caught one enterprise three times in a row after it was cited in the newspapers.

While this paper is an in-depth review of the initial three and a half years of the Fuyang program, it merits mention that the Fuyang EPB has continued this bounty hunter program and views it as an effective deterrent to polluters. According to a *China Environmental News* (2008) report on the Fuyang bounty hunter program, the number of citizen reports on polluters has continued to decline significantly. In 2007, the Fuyang EPB received 138 reports and only 32 of them were verified to be valid. The report attributed the decline in reports to the effectiveness of the bounty hunter program. Over the first seven years of the program vigilant citizens—some of whom refused the reward payments—had forced polluting enterprises to increase investments in wastewater and air emission control facilities and to improve the operation and management of those facilities and helped improve the water quality in Fuyang.

KEYS TO THE REPORTED SUCCESSES OF THE FUYANG PROGRAM

The key factors contributing to the success of the Fuyang program in generating a large number of citizen reports (many of which were valid) and helping to turn around water degradation trends include: solid local government support, guaranteed funding for rewards and the program operation, sufficient implementing resources, publicity, transparency, and confidentiality.[39]

Solid Governmental Support[40]

When Fuyang decided to provide a monetary incentive for environmental reporting, the Fuyang city government, party committee, and EPB were prepared to sacrifice 2 to 3 percent of GDP growth.[41] This is a fundamental departure from the dominant practice of "economic development first, environmental protection second" in many Chinese cities. There was an intense debate among the leaders of the city government and party committee before this consensus was reached. The supporters, under the leadership of the former Party Secretary Mr. Guo, believed that a reward program would impose tremendous pressure on the paper mills, the major polluters that caused the severe water pollution at that time. They also argued that adopting such a program demonstrated the determination of the city government and party committee to control pollution. More importantly, Mr. Guo highly valued the merits of public participation and regarded the public as an under-utilized enforcement resource. The threat of being reported and exposed by the public increased compliance among potential polluters and spurred the Fuyang EPB to boost its enforcement efforts.

Opponents argued that a reward program would increase the production cost of enterprises and reduce their competition in the market. This would in turn affect negatively the city GDP, which is a key indicator of the city government performance. They also argued that the program would hurt enterprises' cooperation with the government. In addition, the program would effect the reelection of prominent leaders in the city government and party committee. Many entrepreneurs whose enterprises would be subject to scrutiny under the reward program are representatives with voting power.[42]

As indicated previously, there are no explicit legal provisions in the existing laws and policies that prohibit a bounty hunter program, but it is up to local government discretion to issue regulations to create such a program to empower citizens. In theory, local EPBs in China could issue a departmental rule guiding a reward program. But EPB rules do not have strong legally binding force and polluting enterprises could ignore the rules if the local government does not back them up. Thus, a bounty hunter program's legitimacy depends on strong regulation and support from the local government.

The former Party Secretary was fully aware of the importance of the unified support of all major leaders in the local government. He summoned four formal meetings to discuss the advantages and disadvantages of a reward program and encouraged an open discussion in the local media. No opponent was willing to openly express his opposition to the program in public. Several months later, the last meeting reached a consensus to carry out the reward program.

Guaranteed Funding

As the Fuyang experience shows, granting rewards in a timely manner is important to keep the program effective. It is also essential to ensure credibility. When a reported violation is verified, the EPB is required to grant a reward within 10 days, which is usually before an administrative penalty is actually collected. The fast payment of rewards cannot be guaranteed without sufficient funding.

A guaranteed funding source is particularly important given the fact that an EPB does not directly collect penalties. *The Management Regulation of Collection and Utilization of Pollution Levies* (Management Regulation) promulgated by the State Council in 2003 stipulates that all EPB's revenue and expenditures have to strictly follow the rule of "Two Lines of Revenue and Expenditure." According to the Management Regulation, local EPBs are only responsible for verifying violations, assessing and issuing a pollution levy or penalty, and demanding that polluting enterprises to pay. Levies and penalties are actually paid directly to local banks and finance departments. All EPB expenditures are locally financed with local government approval, which places stringent limitations on an EPB's use of money to pay informants in the reward program.[43]

To obtain funding for rewards, local EPBs need either to budget estimated expenditures at the beginning of a year or to apply for extra funding after rewards are granted. Both approaches need local government approval. The second approach leaves the EPB much more vulnerable. If enterprises do not pay penalties—a common phenomena in many regions of China—the EPBs would be unable to get reimbursed by local governments. As one interviewee pointed out, local governments might simply refuse to reimburse EPBs because there is no explicit legal provision for such a reward in the Management Regulation.[44] As a result, EPBs might well end up paying informants out of their tight budgets.

To ensure sufficient funding, the Fuyang city government set up a special fund that came entirely from local finances and is used only for rewards and the operation of the program. This way, the issuance of rewards is unrelated to penalties the reward program generated.

Sufficient Implementing Resources

The program implementation and the vast volume of reports indicate a compelling demand for human resources.[45] The complex procedures of accepting, investigating, resolving, and responding to reports have imposed a significant amount of extra monitoring, inspection, and administrative burden on the Fuyang EPB. For example, the Fuyang government established a special enforcement institution—an environmental reporting center with 21 staff. The center was equipped with necessary inspection materials such as cars and cameras.

The lack of enforcement personnel is a widely identified problem in China (Sinkule & Ortolano 1995; Jahiel, 1994; Zhang, 2001).

While the Fuyang EPB appeared to have more enforcement personnel compared with EPBs in other regions at the same time, the interviewed EPB inspectors admitted that the reward program has made the shortage of enforcement personnel even more keenly felt. The Fuyang EPB actually had to hire additional staff in the first year of the program. They were able to do so as a result of the strong government support that led to extra funding designated to the program operation. With proper training, the additional staff was assigned to accept phone calls, work on logistics and paperwork, and assist EPB inspectors in on-site monitoring and inspection. This significantly reduced the EPB's workload and made more effective use of the already constrained enforcement resources.

Publicity, Transparency, and Confidentiality

Fuyang EPB officials emphasized that publicity and transparency are crucial to the success of the Fuyang program.[46] The Fuyang EPB spent five days intensively publicizing the program in local newspapers and TV stations before formal implementation. As a result, many citizens became familiar with the specific provisions and procedures of the program, which provided a solid basis for wider public involvement.

To help citizens identify the violations that are qualified for a reward, the Fuyang EPB regularly publishes the list of polluting sources that were ordered by the city government to close down or to stop production, as well as those that were given abatement deadlines.[47] This provides essential information for citizens to effectively locate the potential violators. The Fuyang EPB also publishes updates on citizens' reporting, EPB investigations, and resolutions in the local media quarterly.[48] This puts pressure on polluting enterprises and increases the transparency of the program. Some polluting sources were reported to beg the EPB not to disclose their identities and violation behaviors in the media.[49] To many Chinese companies, the bad publicity that comes from being tagged as a pollution violator in the bounty hunter program is often more important than the fines that are applied.

While publicity and transparency are quite important to the success of the Fuyang program, they could not be achieved without cooperation from local media. All media in China is controlled by the state. Without approval from the local government, a program is not able to receive extensive coverage from mainstream sources. This reinforces the importance of local government support.

The confidentiality of informants' identities is also crucial in generating a sense of security for informants and maintaining their participation in the program. To protect informants, the Fuyang EPB formulated a rule governing confidentiality. The *Detailed Implementation Rule* clearly states that "the staff members who need to know an informant's identity…cannot disclose the relevant information to anyone (including families and other EPB staff) at any time or place."[50] The rule also stipulates that "other governmental employees who are not directly involved in the reward program cannot use any excuses to inquire into any information on informants and how the reports are handled from any informed staff."[51] Fuyang EPB staff claims that there has not been a single case where an informant's identity was disclosed to a reported enterprise.[52]

REFLECTING ON BROADER APPLICATION

Environmental governance in China has long been dominated by top-down policymaking that has attempted to circumvent powerful local governments and force better compliance. The national government has increasingly emphasized the importance of public participation and established a national hotline to accept and handle complaints, mandated industries and local governments to disclose pollution information, and required that citizens be given the right to participate in environmental impact assessment hearings—these and other policies serve to empower citizens.

Fuyang's cash-reward informant program is unique in that it was a local policy innovation—admittedly created to sustain the outcomes of the 1996 national campaign that required all polluting sources to meet emission and effluent standards. Although it was a top-down requirement that catalyzed this ambitious green bounty hunter program, it was local officials who made it a sustainable program that even today is helping to reduce pollution and increase citizen involvement in environmental governance.

Key to the program's success was the former Party Secretary who helped shepherd the program's development so it was sustainable, transparent, and sufficiently staffed and funded. Ultimately, the other key to the program's success was the citizens' enthusiastic response, which bespeaks a growing desire of Chinese citizens to be proactively involved in environmental governance. This desire to participate was built on China's long-standing environmental complaint system, which is still the most commonly used channel for public participation in China's environmental enforcement. As pollution protests continue to grow in China, the Fuyang program, while unique, does offer a model for Chinese local governments to better enforce pollution control laws and increase public confidence in the local government.

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ENDNOTES

[1] Here a local government means a governmental body, which has authority over a local EPB in the same jurisdiction. For example, at municipal level, a complainant can appeal to mayor's office, municipal People's Congress, and municipal Party Committee.

[2] *China Environmental News*, July 27, 2001 reported that all regions that already established other environmental telephone hotlines such as "Green 110" are required to gradually switch to "12369." In particular, provincial EPBs and EPBs in key cities are required to have "12369" installed before July 31, 2001. Other EPBs at and above county levels should do so before December 31, 2001.

[3] If a complainant refuses to disclose her or his identity and does not call back demanding a resolution, EPB inspectors are not obligated to deliver the resolution.

[4] According to a *New York Times* report (Liptak 2007), California deputizes bounty hunters, who get to keep a quarter of any penalties they recover for the state to help enforce environment laws.

[5] Fuyang is a county-level city under the jurisdiction of Hangzhou City. In some large Chinese cities, there are some counties with relatively large population. They are referred as cities but are equivalent to counties, which are one-tier lower than cities in the Chinese administrative hierarchy system.

[6] The data in this paragraph are drawn from a document published by the Fuyang Inspection Station (2003).

[7] The information in this paragraph on the adoption of a cash reward informant program throughout the nation is largely drawn from *China Environmental Yearbook: Environmental Supervision Information* (2004-2008).

[8] Shanghai, Beijing, Tianjin, and Chongqing (after 1997) are the centrally controlled municipalities in China. Geographically, they are not provinces. Politically and administratively, they enjoy a status equivalent to provinces.

[9] Other EPB subsidiaries could include monitoring stations, research institutes, environmental engineering companies, environmental propaganda and education centers and environmental information centers.

[10] The "Provisional Rules for Environmental Supervision Work" were issued by NEPA in 1991.

[11] The discussion in this section is drawn from the interviews with the Fuyang EPB officials.

[12] Notes from the author's 2003 field trip in Zhenjiang City of Jiangsu Province.

[13] This section largely draws from Zhou & Zhou (2003). The first author was the vice-director of Fuyang EPB who was responsible for the implementation of the program and the author was able to interview him during the field research in 2004.

[14] The official reasoning for initiating this national campaign was increasing environmental degradation and the low environmental compliance rate (State Council, 1996).

[15] Interview: 040310.

[16] This problem is not unique in Fuyang. Together with the non-operation of pollution control facilities, they are the widely identified problems in maintaining the long-term effects of the national campaign throughout the entire nation. For details, see Benjamin Van Rooij, (2002).

[17] According to an EPB official (Interview 0407131), it was indeed Guo's idea to create a reward program.

[18] Interview 0407161.

[19] Interview 0407131.

[20] It is the most important rule (revised in 2006) dedicated to all types of environmental complaints such as letters, visits or phone calls. The rule defines the rights and responsibilities of both complainants and EPBs and can be found at: www.sdein.gov.cn.

[21] Interview 0407121.

[22] In fact, wastewater discharges are usually continuous. Therefore the illegal discharges often maintain for a while and are easy to discover and be verified by the EPB. In contrast, air pollutant emissions are often instantaneous. The illegal emissions do not last very long and usually stop when the EPB rushes to the sites.

[23] An examination of legal liability sections of all environmental laws and regulations would reveal many violations of polluting sources that were not included. Examples could be reporting false polluting information, illegal import of toxic substances from overseas, and removing pollution control facilities without EPB's approval.

[24] Interview 0407122.

[25] Interview 0407161.

[26] Interview 0407131.

[27] It is unclear what severe measures might be in this specific program. The term "severe measures" usually appears in Chinese laws and policies and grants the government considerable discretion to handle extreme cases.

[28] Interview 0407131.

[29] Interview 0407131. It was mainly due to a decrease in the volume of reports.

[30] Fuyang EPB (2003).

[31] Interview 0407161.

[32] Ibid.

[33] Fuyang EPB (2003).

[34] Interviews: 040310, 0407131, 0407161, 0407121, 0407122.

[35] Notice that this is one-time compliance rate, not the continuous compliance. The frequency of EPB routine inspection on one polluting source is four times a year at maximum.

[36] Interview 0407161.

[37] According to China's water quality standard, water quality is ranked from the cleanest (1st) to the worst (6th).

[38] This informant gave up the idea because he was afraid of exposing himself to polluting sources. In addition, the Industrial and Commercial department did not have a precedent to go by and did not know which regulation or rule should be applied to register such a company. This information was provided by EPB interviewees. EPB officials refused to let me interview any informants in order to fully ensure the confidentiality of those informants' identity.

[39] According to the original purpose of the reward program, whether the program was truly successful should be evaluated based on whether or not it has improved local environmental quality. At minimum, whether the program has truly improved the compliance rate of polluting sources should be assessed based on more reliable empirical data, instead of the Fuyang EPB's judgment. However, the relevant data are not available for analyzing the probable relations between reporting and compliance with available data at the present. So I used the number of the reports as a very preliminary indicator of the success of the program.

[40] This section is mostly drawn from the interview 0407161 conducted with the former Party Secretary of Fuyang city Mr. Hongtai Guo, who created and supported the reward program.

[41] This seems to suggest that massive violations of the environmental laws were going on.

[42] Interview 0407161.

[43] Levies have been the major funding source of local EPBs since the implementation of the pollution levy system. Before the Management Regulation, local EPBs were able to directly collect levies and enjoy considerable discretion for usage.

[44] Interview 0402121.

[45] This section is mostly drawn from the interview 0407131.

[46] Interviews: 040310, 0407131, 0407161, 0407121, 0407122.

[47] Interview 0407122.

[48] Interview 0407131.

[49] Ibid.

[50] Article 8 of the work discipline of the "Detailed Implementation Rule of the EPB's Reporting Center."

[51] Article 9 of the work discipline of the "Detailed Implementation Rule of the EPB's Reporting Center."

[52] This claim is difficult to believe given the fact that EPBs and enterprises have a long-established cooperative relationship. But it is hard to verify without interviews with informants.

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FEATURE BOX

Exploring for Solutions to the Water Challenges on the East Mountain Plateau in Yunnan Province

By Patricia Kambesis

The East Mountain Plateau, within Yunnan's Mengzi and Kaiyuan counties, is a remote rural region in southwest China where some 30,000 people live in scattered small farm villages and where, during the dry season, serious water supply shortages pose significant hardships to the daily life of the residents. (See Photo 1). The East Mountain Plateau is also within southwest China's extensive limestone karst region where water sinks into the limestone landscape and flows underground through extensive cave systems, inaccessible at the surface, especially during the winter dry season when it might not rain for weeks at a time.

Cave systems, which are natural conduits that carry underground rivers, present a unique challenge to the understanding and management of ground water resources in karst regions. With the exception of cave entrances noted on some topographic maps, most caves are not apparent from topographic maps, satellite and LANDSAT imagery, or aerial photographs—the tools that many earth scientists, hydrologists, and resource managers use to visualize the shape, form and, orientation of landforms, and to study the regional hydrology. Caves and their features exist in an environment with no natural light and contain a myriad of physical and psychological obstacles. Specialized methods in hydrogeologic investigations are required to exploit safe drinking water sources in karst regions.

One of the most effective techniques for understanding the movement of groundwater in a karst area is to physically map the underground conduits. This method involves small groups of survey teams who traverse the underground system and record geographic measurements and diagrammatic field sketches of the route. In addition to the subsurface work, the teams also conduct surface inventories of karst features. The data from both field activities are georeferenced, processed, and then integrated into three-dimensional representations that illustrate the relationship between the surface topography, cave systems, and their associated surface karst features.

A significant challenge to the hydrologic field work is the fact that many of the cave systems in southwest China extend deep below the ground surface and accessing them requires specialized skills for negotiating vertical shafts that range from 10 meters to more than 300 meters in depth. Traversing the vertical routes require ropes with complex rigging and related equipment and a high level of associated skills in order to collect the mapping data, a prerequisite for the exploitation and protection of karst water resources.

A major effort of Western Kentucky University's (WKU) China Environmental Health Project (CEHP) is to provide training in each these technological areas to researchers and students at Chongqing's Southwest University (SWU). With major support from the U.S. Agency for International Development and the ENVIRON Foundation, the longstanding partnership between WKU and SWU has provided the backdrop for a series of week-long training workshops in basic underground survey methods, single rope techniques with a strong emphasis on safety, karst resource inventory methods and associated GIS computer mapping applications that were conducted on the SWU campus.

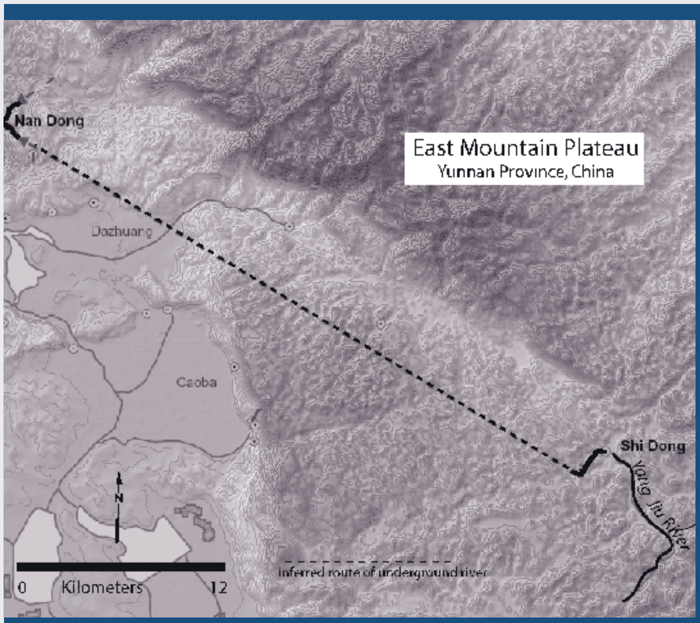
Each round of training workshops was followed by a 10-day hands-on expedition where the students and researchers, under the tutelage of their CEHP instructors, conducted karst feature inventories, and negotiated and mapped limestone shafts and their associated river passages. After each field day the students and researchers processed their data and added it to the ever-growing geographic/hydrologic database used to study local karst hydrology and its relationship to water supply and quality.

The East Mountain Plateau proved to be a challenging demonstration site for hydrologic work because of its remoteness, the depth of the water table, and the sheer size of its catchment area. The Yangjiu River is the only surface stream of any significance and it sinks at Shi Dong (Rock Cave) becoming an underground river once it passes under the cave dripline. The river reemerges as the spring waters of Nan Dong, a show cave located some 32 kilometers away. This connection was established during a water tracer study conducted in the mid-seventies where salt was injected in Shi Dong and detected in Nan Dong. Though the tracer study established the hydrologic relationship, the actual flow route of the underground river can only be inferred (see map 1)—successful access to the subterranean water, which many thirsty communities need, cannot be based on inferences. The cave passages of Shi Dong are traversable for three kilometers before the cave ceiling drops to meet the cave stream. Without specialized cave diving expertise and equipment, this route cannot be followed. The challenge of the expedition was to find and map other routes from the top of East Mountain Plateau down to the subterranean river some 400 meters below.

There is no dearth of potential entry points as the East Mountain Plateau is pierced by literally hundreds of shafts, sinkholes and small cave entrances. Any and probably more than one of these can lead to the underground river. The sheer size of the catchment area makes that an almost "needle-in-the-haystack" proposition. However, this is the nature of cave exploration and documentation—in addition to the skills necessary to map and explore one also needs a heavy dose of persistence.

It is a brisk, cool day in February 2008 and the Chinese-U.S. team has been working on the East Mountain Plateau for the past week, looking for potential entry points into the subterranean river system that they know lies beneath their feet. Dozens of vertical shafts have been located during the preceding week so team members have reorganized into small survey parties whose job is to descend and map each underground route until they reach either a terminus or an underground river. "On rope!" shouted Zhang Qiang as he rigged his descending device to the 9mm thick piece of rope that would take him to the bottom of a 30-meter limestone shaft and to the rest of his survey team. (See Photo 3). This is the fourth

Photo 1: Dry-season winter landscape of the East Mountain Plateau. Photo Credit: Pat Kambesis



Map 1: Topographic overlay showing relationship between Yang Jiu River after it sinks into Shiu Dong, its inferred underground route, and the spring resurgence at Nan Dong. Map by M. Futrell and Pat Kambesis 2009.

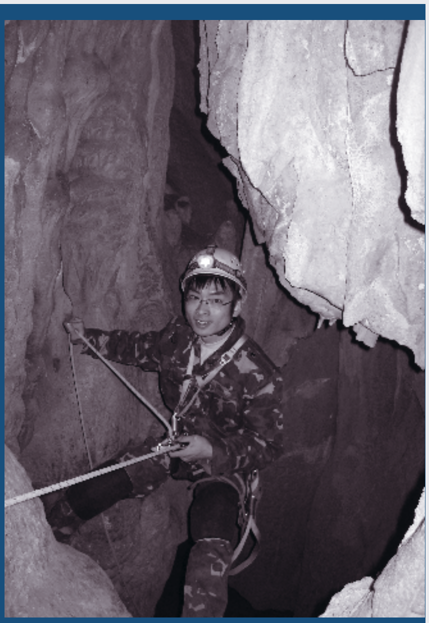


Photo 2: Zhang Quang descending a limestone shaft into the East Mountain Plateau. Photo: Pat Kambesis

shaft that the team has documented and explored this day and it looks promising. With painstaking effort Zhang and his mapping team spend the rest of the day charting a route that they hoped might lead to the elusive underground river beneath the East Mountain Plateau. At the end of their day they noted that the cave passage did not end so they left a labeled flag where the survey could be resumed the next day. That evening as Zhang and his team processed their field data and transformed it into a working base map, the pattern of the cave system and its relationship to the surface topography began to emerge. Though the ultimate destination of the segment of underground river that they mapped was some 30 kilometers way, it was a strong beginning towards helping to understand and alleviate the water shortages that are so prevalent in the karst regions of south central China.

Patricia Kambesis is the Associate Director of Education at Hoffman Environmental Research Institute at Western Kentucky University (WKU). She oversees WKU's Karst Field Studies Program which offers week-long field courses during the summer months. She also teaches GIS and karst field methods. Kambesis has extensive experience exploring, mapping and documenting caves systems in the US and internationally. She began working in the vast karst regions of southwest China in 1991 and has continued that work through the China Environmental Health Project. She can be reached at Pat.Kambesis@wku.edu.

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COMMENTARY

Benchmarking Existing Building Performance: China's Green Building Movement Gets a Critical Asset

By Xu Wei and Don Anderson

With greenhouse gas emissions on par with the United States, China's mandate for mitigation is strong but challenging for such a fast growing economy. Building energy consumption accounts for approximately one-third of China's total emissions.[1] With rapid economic growth and urbanization, the building sector is expected to account for even higher emissions in the near future. Presently, China's existing building stock is 43 billion square meters, with annual new construction of 2 billion square meters, equivalent to building 50 new Manhattan office inventories each year, which accounts for more than 40 percent of world's new construction. Despite the massive amount of construction in Chinese cities, buildings in China represent one of the largest and most achievable targets for responding to current energy challenges and reducing associated greenhouse gases.

Mitigation is particularly challenging in the building sector in China because the speed of construction and desire for high performance energy technology is often followed by marginal product support that can produce inefficient operation. For example, many building service providers in China supply modern energy-efficient technology to a building but fail to provide adequate training to ensure proper use of the equipment to deliver energy savings over the life of a building. Moreover, designers of high-profile buildings may not stick around long enough to ensure that occupants understand building systems and building energy performance meets design intent. Such designers may not even be established players in the Chinese marketplace or just do not take the time to develop an understanding of what happens after design, such as how implementation causes operational challenges that impact energy performance.

The concept of "green buildings" can be confusing and sometimes against flashy new "green designs" may miss practical opportunities for buildings to be truly green—namely, be efficient in use of energy and water resources over the life of the building. Buildings represent one of China's key focal points for environmental performance improvement that includes energy, carbon and water, so establishing functional, verifiable market approaches to promote green buildings is critical.

VALUE OF BENCHMARKING TOOLS

There have been many multi- and bilateral projects focused on sustainable urban development in China, but most focus on transport or on a single green building. The popularity of U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification is growing in China, with an estimated 300 projects certified or registered,[2] but to date, only the U.S.-China Sustainable Buildings Partnership (SBP) has focused on providing policymakers and the marketplace with free tools and frameworks to drive large-scale action. Initiated in 2008, SBP is a collaboration between ICF International, China Academy of Building Research (CABR), Tongji University, and Q&S Engineering with funding from the U.S. Agency for International Development and the Energy Foundation China Sustainable Buildings Program. The work of these partners focuses on three long-term goals that will evolve into fundamental assets to serve China's green buildings movement for years to come:

1. Create a building energy performance benchmarking tool that will allow Chinese owners, designers, and managers to compare their buildings and designs to similar Chinese buildings.
2. Promote green buildings concepts associated with existing buildings to ensure that the green buildings movement aggressively achieves verifiable results—energy and water savings—over time.
3. Develop practical, proven, and accessible guidance resulting in significant energy savings that can be tracked across China's massive standing stock of commercial buildings.

These three goals are complimentary. A benchmarking tool can inform potential savings and provide an environment for setting performance targets, tracking progress and rewarding achievement. As large portfolios of buildings move to benchmark and track performance, Chinese policymakers will have data to fill a void that has hampered their ability to see and act on the opportunities to promote better preformance across the built environment. These goals are also designed to move China beyond simple performance improvement mandates, which has been the primary approach to performance improvement to date. In the building sector, these mandates, including the current national call for 20 percent energy intensity reductions per unit of GDP, have proven difficult to enforce or monitor and are historically delivered without a "how to" component. Thus the benchmarking tools can also be utilized to measure the peformance of local governments in meeting central government energy efficiency and GHG reduction targets.

STEPS TOWARDS EVALUATING CHINESE BUILDINGS

A benchmarking tool can also be useful to the Ministry of Housing and Urban-Rural Development (MOHURD) for analyzing and developing national building sector policies and programs, and is complimentary to its current effort of building data collection in cities throughout China. MOHURD promulgated *Criteria of Evaluation of Green Buildings* in March 2006, by which green buildings may be classified into three levels, from one to three stars, with three as the highest. According the *Criteria*, buildings are evaluated on six aspects including energy savings, water savings, materials, indoor environment and operations management. Each aspect includes controlled, general, and optional items. The controlled items— like meeting national standards for indoor air temperature and humidity—are mandatory, while the general and optional items—such as incorporation of design features that promote natural ventilation[3] and installing cutting-edge or harder to implement items, like having more than 10 percent on-site renewable power generation[4] — have more flexibility. However all are used for evaluating and rating the buildings.

In March 2008, the China Green Building Council was established, initiating technical research and evaluation on green buildings. In 2007, MOHURD launched *Guideline for Building Energy Performance Rating* and six national-level building energy efficiency rating organizations were set up. In each province and municipality directly under central government, two or three local building energy efficiency rating organizations have been formed. According to the requirements of the State Council's *Administrative Regulations on Energy Conservation of Residential Buildings*, the energy efficiency of all governmental office buildings and large public buildings must be evaluated, and other buildings may be rated on voluntary

Left - New commercial office buildings tower over older low-rise buildings in Shanghai, China's largest and fastest-growing commercial building market. Photo Credit ICF Consulting; Right - China Benchmark Development Workshop at China Green Buildings Council on August 20, 2009. Photo Credit ICF Consulting.

basis. According to MOHURD's requirements, buildings must be benchmarked as energy efficient as a prerequisite to green building labeling. Benchmarking is a useful means of evaluating building energy efficiency, as well as a helpful tool to analyze public building energy consumption. Therefore, the introduction of a benchmarking tool for China's building stock will promote energy efficiency and facilitate growth of green buildings in China.

Promotion of green building operations as the follow-on to green design for existing buildings is also critical. This will ensure that real savings accrue as the green building movement matures and provides focus on China's huge standing stock, where operational improvements can reduce building energy use by over 15 percent using proven techniques.

In 2008, under MOHURD's guidance, the China Green Building Committee was established, on which both authors serve. One of this committee's first activities was a workshop on benchmarking of existing building performance, setting the stage for a formal, high-level approach that moves beyond green design.

U.S. ENERGY STAR BENCHMARKING TOOL

In the United States, a similar benchmarking initiative funded by the Environmental Protection Agency (EPA) has created Portfolio Manager,[5] a web-based tool currently used by facility managers for 140,000 sites, and enthusiasm for mandated use in California and other state and municipalities should increase the tools market penetration considerably. The web-based delivery of this benchmark allows a variety of market entities to make decisions with a comparative eye toward environmental performance. This benchmark is used by the ENERGY STAR program as a fundamental element of program participation and recognition. Partners are encouraged to start by understanding how their buildings' performance compares, and use this comparison to guide expectations for improvement. At the same time, partners with large portfolios of buildings can get a single benchmark value for the entire portfolio, which is a good indicator for how their operational costs compare to peers and competition. In addition, designers can use the benchmark to set a future performance target for their designs, to be checked after one year of occupancy. The U.S. Green Building Council's LEED program uses the EPA benchmark to convey credits associated with existing building green certification. The State of California is mandating benchmarking of state buildings using utility data and will eventually extend this requirement to other buildings. This initiative, where utility data "feeds" a benchmarking function is innovative and, according to one of China's largest residential portfolio owners, a possible option for China.

CHINA BENCHMARKING TOOL DEVELOPMENT

China Academy of Building Research and Tongji University have carefully examined these U.S. applications of a national benchmark and will move forward with a solution that meets China's needs. To start, data is being analyzed in Shanghai and Beijing to develop city benchmarks that can be prototyped using Excel and easily applied, tested and refined. Both cities have had aggressive promotion of techniques primarily associated with existing office building performance improvement, so there are many individual buildings and some portfolios that will be available to test the benchmark. ICF's partnership with property management companies like Savills has raised their capacity to manage billions of square meters of commercial buildings in China. In the case of Savills, techniques for reducing existing building energy use have been proven and documented using utility data in Beijing and Shanghai. As part of their business model, Savills is offering both energy efficiency services and a utility bill tracking solution developed by ICF International to set and check targets over time. As the prototype benchmark is rolled out for testing, companies like Savills will be a ready audience with data for testing the benchmark.

At the same time, CABR is working with ICF International in Shenzhen, Guangzhou, Chengdu and other cities to provide tools and resources for improving performance, including tracking options that will contribute to the ability of these cities to use a prototype benchmarking tool. In addition, these cities have collected data in coordination with MOHURD that will be useful in both developing and testing benchmarking algorithms. Tongji University also has building performance data and experience in developing a pilot benchmarking web resource in Shanghai. Working together with ICF International, this team will build collective expertise that will move a functional and accessible benchmarking asset into the Chinese marketplace.

Showcasing and initial training on the benchmarking tool in several major cities has drawn much attention from government agencies, technical institutions and property management organizations that are interested in building energy savings and green buildings. Trial benchmarking in some buildings revealed comparative energy performance, helped identify ways to save energy and motivated facility staff to action. Many municipal governments have expressed interest in applying the benchmarking tool as part of their energy-efficient management and innovation for local large public buildings.

In the future, China will need to aggressively promote the application of a benchmarking tool, including recruiting new trial cities and trial buildings and updating a building energy consumption database. The tool will initially be localized, including identification of appropriate variables and the development of a methodology applicable to Chinese building energy consumption patterns. Development will be phased to include, at first, commercial office and mixed use buildings, then public sector buildings, followed by hospitals and schools. Finally, the local district heating systems in northern China will be included. As more cities and building types are included, China will move toward a national tool that is available to an increasingly meaningful majority of buildings, and, a critical resource for addressing greenhouse gas emissions.

Since 2006, Professor Xu Wei has served as the director of Institute of Building Environment and Energy Efficiency at the China Academy of Building Research. He is the Chairman of China Committee of Heating Ventilation & Air Conditioning , the Vice President of Chinese Association of Refrigeration, Vice Chairmen of National HVAC and Cleaning Equipment Standardization Technical Committee, the Vice President of National Technical Committee on Building Energy Efficiency of Standardization Administration of China, and Commissary of Building Energy Saving Expert Committee of the Ministry of Housing and Urban-Rural Development.

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SPOTLIGHT ON NGO ACTIVISM IN CHINA

Dams, Glaciers, and Ecological Migration: GreenRiver's Work Protecting China's Rivers

By Deng Wen (Translated by Ada Yue Wu and Kexin Liu)

China is a country defined by its two greatest rivers—the Yangtze and the Yellow. Both rivers have shaped the country's cultural, social, and economic development since ancient times and today their waters support much of the country's agriculture and drinking water, and provide transport and electric power to help fuel China's economic growth. To get a sense of scale, the Yangtze is the world's third longest river and its mighty flow runs through 13 provinces of China. On an annual basis, major grain production along the Yangtze River Basin accounts for about half of the total domestic production. However, the unprecedented magnitude and pace of China's urbanization and industrialization over the past thirty years has come at a great cost to water quality and quantity in these two great rivers. As pollution and over extraction grows, the ecological health of China's two "lifeblood" rivers is compromised, threatening the water security of the entire country.

The worsening water quality and water shortages in these and other rivers have gained the attention of policymakers, the news media, and the general public in China, sparking new laws, regulations, investment, and projects. Many of the new policies to protect China's rivers have not yet been as effective as intended, in great part because implementation at the local level is by and large disconnected from the decision-makers in Beijing. In part to address this local-center policy gap, a growing number of grassroots organizations have emerged to target river basin protection. One of the oldest Chinese environmental nongovernmental organizations (NGOs) that work in this area is GreenRiver, which was founded in 1995 in Sichuan Province.

Over the past 15 years, GreenRiver has been collaborating with a number of domestic and international partners in three main arenas: (1) studying the ecological impacts of various human and industrial activities on the Yangtze River; (2) educating the public of their findings; and (3) advocating for actions from policy, academic, and business communities. In the past few years, GreenRiver has expanded its work to address the striking lack of information on how climate change is impacting the river ecosystems on the Yangtze and Yellow rivers. Described below are a few of GreenRiver's recent projects that have focused on ecological migration, glacier retreat, and dam building.

FIELD STUDY OF YANGTZE RIVER SOURCE REGION'S ECOLOGICAL MIGRATION (2006-2010)

Sanjiangyuan in the south of Qinghai Province is a unique convergence of the headwaters of three great rivers in Asia—Yangtze, Yellow, and Lancang (Mekong). Dubbed as "China's water tank," this relatively undeveloped region in western China is characterized by particularly fragile and sensitive ecosystems.

So far the Chinese government has issued various sustainable development policies and initiated a number of projects aimed at protecting the ecological environment of the Sanjiangyuan area. These policies are designed not only to promote a healthy interplay between the environment and economic development in the area, but also to further safeguard the ecological security and sustainable development of the middle and lower reaches of China's major rivers. One of the key initiatives is the two-year *Ecological Protection and Construction Project* that was launched in August 2008 to limit development, including animal husbandry in order to protect the fragile Sanjiangyuan area. The project has already relocated 7,921 herder households (43,000 individuals) and represents the largest and most costly ecological reconstruction project in China's history. According to the government's plan, it will take five years to complete the relocation of all the remaining herdsmen and their families, who will depend on the government to provide them job training and to assist them in finding new jobs and adapting to the new urban life. After relocation is complete, Sanjiangyuan will become completely unpopulated.

In 2006, with the support the U.S,-based foundation Blue Moon Fund and Beijing-based NGO Global Environment Institute, GreenRiver launched a five-year investigation of ecological migrants in the source region of the Yangtze River. GreenRiver's team of eight carried out the research on impact the Chinese government's migration policies have had on communities and the environment in the Sanjiangyuan area. The project is the longest field study GreenRiver has undertaken with team members—who were a mixture of seasoned anthropologists, graduate students, and a videographer—spending an average of one month in the field every year.

In 2009 after years of investigating the migration policies, the area's ecological environment, the social issues triggered by the massive resettlement program, and the status of indigenous culture, GreenRiver's issued a final report with a number of recommendations to relevant government agencies. This report contained highly valuable research findings that were captured not only in writing, but also in photos and video clips.

In addition to conducting surveys of the environmental health and living conditions of relocated communities, GreenRiver also attempted to help the resettled herders adapt faster to urban life. For example, in a migration village located in Ge Er Mu Kun Lun of Qinghai Province, GreenRiver volunteers provided urban living skill and knowledge training sessions to new migrants. Volunteers also helped herders launch a website to better communicate their needs and promote their culture. During the process, GreenRiver volunteers also helped herders look for new jobs or for business opportunities, such as marketing Mani stones. Mani stones are stone plates, rocks and/or pebbles, inscribed with the six syllable Tibetan Buddhist prayer mantra *Om mani padme hum* (hence the name "Mani stone").

GLACIER RETREAT MONITORING IN THE YANGTZE RIVER SOURCE REGION (2005- 2010)

With glaciers melting and sea level rise, people living on lowland coasts and islands will very likely be forced to abandon their homes in the near future. The international community has already taken proactive measures by mobilizing aid and assistance to deal with this threat, but GreenRiver believes the fate of the communities who live at high altitudes has not been given the level of attention they deserve from both domestic and international experts as well as aid organizations. Due to global warming, the glaciers in the Yangtze River source region have been undergoing substantial recession since 2004. Glaciers are the blood of mountains. Once glaciers disappear, mountainous areas will soon lose their most critical source of water. Extreme weather conditions and natural shocks will also become more frequent. Herders living in the valleys in mountainous areas could also lose their homeland as a result of glacier melt.

In 2005, partnered with staff scientists from China Academy of Science's Cold and Arid Regions Environmental and Engineering Research Institute, GreenRiver's volunteers formed a Yangtze River source region glacier inspection team and later launched a project on glacier retreat monitoring. Through surveying, photographing and videotaping, the team studied the evolution of glaciers and their impact on the surrounding areas. GreenRiver plans to publish the survey results with the hope of raising public awareness about glacier retreat in the Yangtze River source region, and to influence the Chinese government's policymaking for China's high altitude areas.

Since 2005, GreenRiver volunteers have been traveling back and forth to the Yangtze River source region to study and collect data on the glaciers. One major initiative has been for volunteers to set up markers to record the speed and magnitude of movement of glacier retreat. These markers are not only for scientists who study glaciers and climate change, but also to provide a compelling demonstration for the broader public on the impact of global climate change on glaciers in the ecological fragile Yangtze River source region.

INVESTIGATION OF ENVIRONMENTAL IMPACT OF UPSTREAM DAM BUILDING ON THE YANGTZE RIVER (2008-ONGOING)

About 2,000 dams have been built or are currently under construction in the Yangtze River Basin. However, the planning and construction of these dams have been proceeding without a systematic study of the environmental, cultural, and social impacts on the submerged areas. GreenRiver believes that ecological and cultural diversity in the region are facing serious threats from highly questionable dam projects that show no sign of slowing down.

To understand the environmental impact of upstream dam building on the Yangtze River, in 2008 and 2009, GreenRiver staff, scientists, and volunteers investigated 50 dams on the upstream of the Yangtze that had either been completed or were under construction. GreenRiver's team visited the submerged areas around the construction zones of dams on the Jingsha, Dadu, and Ming rivers and their tributaries. Where possible the team collected information about the geological distribution of local plants and animals before and after the construction of those dams, using satellite data, photos, videotaping, and site samples. While gathering this data the team became much better acquainted with the daily lives and culture of the local people. In addition, GreenRiver also provided technical and educational support to local communities.

Through the news media, GreenRiver began to raise public awareness of the environmental and cultural impact of dam building and also to urge the government to speed up its efforts in the protection of the ecology and culture in the reservoir areas near dam construction projects in the upper Yangtze.

In the next five years, GreenRiver plans to complete the investigation and publicize information on the ecological and cultural impacts of 150 other dams in the Yangtze Basin. The team will follow up the changes in ecological patterns around dam areas after each dam is completed. GreenRiver will also keep track of the life of local people and make comparative studies based on information collected before and after the construction of dams. The final products of this project will include academic papers, books, and documentaries. With these, GreenRiver hopes to gain insights about dam building related ecological and cultural protection issues in China and to be able to provide recommendations to relevant government agencies.

2010 YANGTZE RIVER GLACIER RESCUE INITIATIVE (LAUCHED MAY 22, 2010)

Cosponsored by the China Environmental Fund, GreenRiver, Chinese Mountaineering Association and several other research and news media partners, this initiative consists of six core activities that aim to increase understanding of glacier melt in the upstream of the Yangtze River. Through field surveys, GreenRiver and its partners plan to collect data and build mathematical models of glacier melt and retreat in these ecological fragile headwaters. By demonstrating the process of glacier retreat, the initiative is expected to promote scientific studies, civil society participation, and to draw media attention to this ecological crisis. The key goal of this initiative is to promote the protection of the headwater area. The six core activities of this initiative are a mixture of scientific research, policy outreach, and public education.

(1) New Glacier Markers. GreenRiver will recruit mountain climbers and glacier explorers to climb up to the major summit in the source region of the Yangtze River, Ge La Dan Dong summit, in the aim to closely observe the glaciers and to set up the fifth marker set up by GreenRiver to record glacier retreat.

(2) Eco-anthropological Study. GreenRiver will invite glacier researchers, botanists, and anthropologists to explore Quer Mountain, to study glaciers, forestation and the traditional cultural activities of local herding communities and how they are being impacted by glacier melt.

(3) Youth Education. University students from other parts of China will be guided onto the Xuebao Summit to witness firsthand the recession of glacier and will attend a "Youth and Climate Change Future Forum" organized by GreenRiver.

(4) Business Outreach. GreenRiver will invite Chinese entrepreneurs to form two mountain climbing groups to investigate glacier retreat and discuss CRS-related issues at a forum organized by GreenRiver.

(5) Journalist Involvement. GreenRiver will invite news media members to join in an event that includes climbing and crossing the Gong Ga Glacier and report on glacier retreat along the trip.

(6) Public Outreach. This final activity will feature a series of events, the core of which being a music concert held in Si Gu Liang Hill located in Xiaojin, Sichuan Province. GreenRiver plans to invite musicians and music fans in major cities across China to play simultaneously one identical song with the theme of environmental friendliness. All of the participating groups are expected to perform in a natural setting and the entire event will be broadcasted nationwide.

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GreenRiver staff and volunteers in the field placing glacier markers for the Yangtze River Glacier Rescue Initiative.
Photo Credit: Deng Wen/GreenRiver

FEATURE BOX

Danish-Chinese Partnerships: Increasing the Use of Renewable Energy in China

By Leah Strauss

A SHIFTING WIND FOR RENEWABLES IN CHINA

Although the first wind farm in China was built in 1968, no surveys were made or reports published on the performance of any farms until 2006.Indeed, renewable energy was not a major government priority until the passage of the Renewable Energy Law in January 2006, which set ambitious renewable energy targets. In January 2007, the wind power targets approved were 5GW and 30GW in 2010 and 2020, respectively. Even though this law represented a pivotal moment for wind farms, the potential for ineffective development was great due to the insufficient capacity of stakeholders and a lack of understanding of the past and future effectiveness of wind farms. Enter the Danish-Chinese Wind Energy Development Program (WED), a three-year project to address these and other pressing issues surrounding the effective harnessing of wind energy in China.

With the support of Danish International Development Assistance (DANIDA), the WED program, from 2006 to 2009, used knowledge transfer and capacity development to enhance the sustainable use of wind energy in China. WED also aimed to further develop the regulatory framework for wind energy at the national level and establish networks for stakeholders. Key government legislation central to the project included the Renewable Energy Law, which entered into law in January 2006. Working at the national and provincial level, the WED program included a triad of main elements: (1) wind energy planning, (2) supporting institutes of expertise, and (3) training of stakeholders. The WED program started in the three Northeastern provinces of Heilongjiang, Jilin and Liaoning with the goals of ensuring high quality of data, improving methodologies in project design, and bettering management and operation.

Wind Energy Planning and Evaluation

Under the WED, two projects unfolded for the wind energy planning and evaluation component which consisted of the development of a Feasibility Study Template (based on feasibility studies in the three provinces) and a best practices example based upon a Post Construction Evaluation Study on six large-scale wind farms. Within China, establishing effective feasibility studies was of great concern due to two problematic factors: namely, that energy production was repeatedly inconsistent with predictions, and the average full load hours were below 2000 hrs per year. Therefore, WED instituted a modified template for feasibility studies specifically for large-scale wind farm projects above 50 MW. The Post Construction Evaluation Study was created to contribute to a more transparent base for decision-making of stakeholders in the Chinese wind sector, including developers, investors and government.

Supporting Institutes of Expertise

The China Meteorological Administration (CMA) is the major implementing institution with regards to wind resources. The CMA is currently engaged in project activities in wind resource assessment, including a nationwide 5-year program to assess the wind resources of China in its entirety called the "High Resolution Wind Energy Assessment Project." The WED project contributed to the improvement of the quality of modeling techniques for the application of the project's results. Throughout the WED program, knowledge was shared with the CMA regarding: the concept of MESO-scale wind models; the use of the WAsP model (Wind Atlas Analysis and Application Program); conduct training in wind measurement techniques; wind data analysis; and the preparation of wind atlases and micro-siting. Risø National Laboratory, Technical University of Denmark (Risø DTU) developed, among others, the WAsP software, a microscale modeling tool for wind farm energy calculations.

Grid Integration

One of the main restrictions to the scale-up development of wind power in China is grid integration. In partnership with China Electric Power Research Institute (CEPRI) –the institution responsible for implementing wind power grid integration nationally—WED focused on improving a dedicated Grid Code for wind farms and a standard for wind power grid integration. Through the transfer of Danish technology and cooperation on capacity building between Denmark and China, the program established the assessment methodologies for grid integration and capacity in order for the grid to accommodate wind power.

Training of Stakeholders

The WED program revolved around capacity building of institutions. Implicit with this bolstering of institutional capacity was the training of stakeholders. Through the course of the program, all methodologies, procedures, models etc. were developed with the goal that they would be made available to all interested parties in the public and private sector.

THE RENEWABLE ENERGY DEVELOPMENT PROGRAM

The Renewable Energy Development (RED) program aims, like WED, to enhance the development of the renewable energy sector in China. Yet, the RED program goes beyond being a continuation of Chinese-Danish cooperation on wind energy. Running from 2009-2013, it will support the establishment of the National Renewable Energy Comprehensive Research Center (RE Center), in China and promote the use of not only wind, but biomass and solar energies.

The RED program, through the creation of the RE Center, aims to address the government's goals in regards to renewable energy development and climate change. The RE Center will be responsible for policies and strategies, regulatory frameworks, technology R&D, and the promotion of the commercialization of technologies.

China's 11th Five-Year Plan (2006-2010) called for greater energy conservation measures and environmental protection, along with the furthering of renewable energy sources development. The aim is for the share of RE in total energy consumption to reach 10 percent by 2010 and 15 percent by 2015.

Two components comprise the RED program, the first of which consists of supporting the development and implementation of sub-sector strategies for wind, biomass and solar energies, in partnership with China's planning institutions. It also includes the establishment of a Renewable Energy Information and Analysis Center. The second component involves the development and implementation of innovative renewable energy technologies. This will be done by ensuring that Danish-Chinese institutional and business partnerships are in place for further cooperation.

One major new initiative of the program involves RED's dissemination strategy. In an effort to make RE knowledge more accessible to the wider public and broaden the reach of the program, RED is being taken to the elementary school level. In two popular videos explaining the story of Danish wind-power, pupils in China learn about wind power in Denmark. The videos are also being shared widely with provincial governments as well as power and grid companies.

For more information see: WED website www.dwed.org.cn and RED website www.cnred.org.cn

For WED program documents search for The Wind Energy Development on the Ministry of Foreign Affairs of Denmark website: http://www.danidadevforum.um.dk/en/

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金 木 水 火 土

COMMENTARY

Towards a More Sustainable Chinese Aluminum Industry

By Louis B. Schwartz and Ryan N. Hodum

RECOGNIZING THE CONUNDRUM

The primary aluminum industry is one of the six largest users of energy in China. Out of the nearly 3.43 trillion kilowatt-hours (kWh) of electric power consumed in China in 2008, China's primary aluminum industry accounted for more than 5 percent of the total, or approximately 182 billion kWh. On average, power consumption per metric ton (MT) of output of primary aluminum in China was approximately 14,500 kWh/MT as of early 2008, not much higher than the world average.[1] As of early 2008, with then current technology, energy costs accounted for roughly 35 percent of the total cost per MT of primary aluminum production in China.

China's aluminum smelting capacity has increased dramatically from approximately 2 million tons per year in 1997 to nearly 20 million tons per year as of the end of 2009. China's output of primary aluminum has grown from approximately 6.5 million MT in 2004 to approximately 13 million MT in 2008. Because of the repercussions of the economic downturn resulting from the worldwide financial crisis beginning in the fall of 2008, the 2009 aluminum output (~12.6 million MT) was slightly less than 2008 output—as of mid-year 2009 approximately 41 percent of China's aluminum smelting capacity was idle.[2] However, by mid-2010, China's output of primary aluminum had rebounded sharply with a 45.6 percent increase year-on-year. Chinese aluminum output is now on track to exceed 16 million MT for all of 2010.

Though China now both produces and consumes approximately one-third of the world's aluminum, at 6.5kg/person (as of 2007), China's per capita consumption is only 25 percent of per capita consumption in the United States; this presages continued growth in both aluminum production and energy consumption by the Chinese aluminum industry in the years ahead.

The growing power requirements of the fast developing primary aluminum industry over the past decade have contributed to the rapid development of the power industry in China, which remains dominated by coal-fired power plants.[3] For many years power usage in the Chinese primary aluminum industry was exacerbated by preferential power pricing at the local level—a technique widely used by local governments to entice development of new smelters. An important consequence of the heavy consumption of power by the Chinese primary aluminum industry has been the drive by aluminum producers to build their own "captive" coal-fired power plants to serve their aluminum operations.

In recent years there have been a large number of Chinese aluminum smelters that have integrated coal mining, power production and aluminum smelting; this is particularly true of Shandong and Henan provinces, which are rich in coal deposits.[4] These integrated coal/power/smelting operations are said to have a 50 percent cost advantage over non-integrated smelters. China's large state-owned aluminum smelters, however, almost universally are not integrated and instead rely on purchasing their power requirements from utilities; and the price that utilities charge is not market based, but rather is distorted by central government policies that sacrifice rational energy markets to continued economic growth. The lack of a strong market to determine power prices also is a significant contributing factor to chronic overcapacity and excessive energy use in the aluminum industry. The policies promoting aluminum production highlight China's growth conundrum—protecting economic growth through wasteful energy consumption increases environmental degradation and undercuts energy security, both of which threaten sustained economic growth in the long run.

ADDRESSING THE ENVIRONMENTAL AND ENERGY TOLL OF THE CHINESE ALUMINUM INDUSTRY

The severe challenges that rapid economic growth poses to the country's environment and energy security have been the drivers of the Chinese government's national policy to reducing pollution emissions and conserve energy (*jieneng jianpai*), which is putting pressure on the Chinese aluminum industry to become more energy efficient and have less impact on the environment. Specifically, Beijing has implemented a series of tax, investment, and energy pricing policies to reduce the energy and environmental impact of the Chinese aluminum industry.

These new policies complement earlier efforts to clean up this industry. For example, the massive ramp-up of smelting capacity in China beginning in the late 1990s was accompanied by a steady, concerted and successful effort to mothball the environmentally and energy unfriendly mid-20th Century Soderberg aluminum smelting technology that predominated in the People's Republic of China for most of its first 50 years.

A suite of other measures is wrestling greater efficiency out of the Chinese primary aluminum industry. The February 22, 2008 notice from the National Development and Reform Commission (NDRC), which directed the elimination of all preferential power rates, has had the effect of increasing power costs for the Chinese aluminum smelting industry, though the downturn in the economy in 2008 created slippage in this important policy. The national goal of reducing energy consumption per 10,000 Yuan of GDP by 20 percent during the 11th Five-Year Plan period (2006-2010) has set concrete objectives throughout the economy. In early June 2009 the Chinese government issued the *Notice of the State Council Concerning Adjusting the Equity Proportion of Fixed Asset Investment Projects.* The June 2009 notice further increases the equity requirements for fixed asset projects that are characterized by heavy energy consumption, including primary aluminum smelting. In 2004 the Chinese government increased the equity proportion for new aluminum smelter projects from 20 to 35 percent; the June 2009 notice raises the equity portion of new investment to 40 percent.

An important part of the drive to wrestle energy and environmental savings from the Chinese aluminum industry is reigning in the chronic over-capacity that exists in the industry, which in turn has resulted in such irrational (from a macroeconomic, energy and environmental standpoint) behavior as exports of primary aluminum. This overcapacity also showed up recently in massive increases in fabricated aluminum product exports, which has unleashed a rash of anti-dumping and anti-subsidy investigations from Canada to Australia. It is significant that after China's largest aluminum producer Chinalco undertook significant measures to reduce its energy consumption after it entered into the NDRC's "1000 Enterprises Energy Conservation Program." (See Box 1).

Box 1. PROFILE OF CHINA'S ALUMINUM GIANT CHINALCO

The Aluminum Corporation of China (Chinalco) has grown to be the world's second largest refiner of alumina and the world's third largest producer of primary aluminum. As of the end of 2007 Chinalco had assets totaling 201.4 billion Yuan (up from 30 billion Yuan in 2001) and an operating income of 131.7 billion Yuan. For the second year in a row in 2007 Chinalco's profits exceeded 20 billion Yuan. Chinalco is among the top ten Chinese enterprises in terms of the number of patents it owns.

From 2001 through the spring of 2009 Chinalco cumulatively invested nearly 10 billion Yuan in science and technology research and development, over 5 billion was spent over the last three years on energy conservation and emission reductions in the company's bauxite mining, alumina refining, primary aluminum smelting and fabricated aluminum products processing operations.

With respect to its aluminum smelting operations, more advanced controlling technologies for the company's pre-baked aluminum smelting processes, which Chinalco developed itself, have been implemented in the corporation's ten branches. This new technology alone can reduce energy consumption per metric ton (MT) of primary aluminum produced by 140 kWh. Particularly since 2006, when Chinalco joined the *1000 Enterprises Energy Conservation Objectives Undertaking* initiated by the NDRC, it has actively sought to close the gap in operations between itself and world-class aluminum enterprises and worked to conform its operations to world-class standards. As part of this effort, Chinalco entered into letters of responsibility with the corporation's nearly 100 enterprises, setting goals and distributing concrete terms of responsibilities across the the entire organization.

According to Chinalco's 11th *Five Year Plan Energy Conservation and Emissions Reductions Objectives*, by 2010 (as compared with 2005), the total amount of sulfur dioxide emissions are to be reduced by 10 percent, energy consumption per 10,000 Yuan of industrial value-added is to be 20 percent lower[4], the volume of water discharge per 10,000 Yuan of value added is to decline by 30 percent, overall utilization rates of mineral resources are to increase by 5 percent and overall utilization of industrial solid waste is to increase by 5 percent. On June 17, 2009 the National Audit Office released its audit on Chinalco as part of its random sampling of the top 1000 enterprises in China. The outcomes of Chinalco audit, while confirming that the company has made noticeable progress in its efforts to conserve energy and reduce emissions, also pointed out instances where Chinalco subsidiaries have not completed certain energy conservation and emissions reductions tasks; for example, there are 31 boilers at 13 Chinalco subsidiaries which have not completed desulphurization upgrades and that Baotou Aluminum Co., a branch of Chinalco, saw its energy consumption per unit of primary aluminum produced rise by 1.83 percent. A spokesperson for Chinalco said that in response to the audit report, Chinalco has made investigations into these situations and has formulated a follow-up plan. With respect to Baotou Aluminum's increase in per unit energy consumption, Chinalco reports that the company spent 1.66 billion Yuan in 2008 to install the most advanced 400KA aluminum smelting technology and to shut down Baotou's outdated 135KA primary aluminum and related carbide production lines, both of which consumed much greater amount of energy.

Box 1. CONTINUED

Chinalco is also operating and/or putting together a series of secondary aluminum production lines, which cumulatively save 2.8 billion Kwh of energy compared to the same output at Chinalco's primary aluminum smelting operations; the secondary lines include Phase I of Chinalco's Qingdao 200,000 tons per year secondary aluminum facility and the Guangdong, Nanhai alloy project, which produces secondary aluminum from the scrap aluminum generated by the sizable Chinese aluminum processing (particularly extrusion) industry concentrated in Nanhai.

Also on the horizon are new regulations that require investors in new fixed asset projects to submit a detailed energy efficiency blueprint; any project that does not develop an energy efficiency program for a proposed new investment will not be allowed to proceed with the investment. Besides targeting primary aluminum smelting at the initial development stage, other initiatives target primary aluminum smelters that are already operating. One significant stumbling block for Beijing to begin to achieve its goal of reducing energy consumption per unit of GDP by 20 percent by 2010 is the resistance put up by local governments who are more interested in fostering economic development in their regions, often by encouraging the establishment of more energy and resource intensive industries. As new aluminum smelting capacity grows, however, China continues to close the most energy-intensive smelters; on August 8, 2010 the Ministry of Industry and Information Technology published a list of more than 2,000 energy-intensive plants that are required to close. That list includes seventeen small aluminum smelters (ranging from 60 to 90 kiloamperes) with a combined capacity of more than 420,000 tons per year. The August 2010 Ministry of Industry and Information Technology order to close energy intensive plants may allow China to realize its 2010 goal on time, despite having just a 14.4 percent improvement in the first five years of the effort.

EFFECTIVE USE OF TAX POLICY: LIMITING INCENTIVES TO OVERPRODUCTION OF ALUMINUM

The negative effects on China's energy and environmental policies of large-scale exports of primary aluminum caused the Chinese government to reduce Value Added Tax (VAT) rebates on exports of primary aluminum from China beginning in 2004. However, even after VAT rebates on primary aluminum exports were reduced to zero the exports of primary aluminum continued, which led the Chinese government to impose export tariffs. To avoid these tariffs, Chinese aluminum producers used exports of fabricated aluminum products, which then sparked the Chinese government in July 2007 to change VAT rebates for exports of certain categories of processed aluminum products, such as aluminum profiles. When Chinese producers responded to those tariff changes by beginning to export large quantities of minimally processed aluminum products, such as tube products, as a means of avoiding tariff and VAT rebate policies respecting primary aluminum, the Chinese government was forced to further regulate those categories as well. This in turn finally resulted in a decline in exports of such minimally processed products. The large number of anti-dumping and anti-subsidy investigations and actions by

A glimpse inside some small aluminum plants in China. Photo Credit: Louis B. Schwartz and Ryan N. Hodum

nations around the world in recent years reflect in part the incompleteness of Beijing's use of tariff policy to reign in the Chinese aluminum industry. The years of cat-and-mouse games between regulators and the aluminum exporters underscores the truth of the Chinese aphorism: "you have policies, we have countermeasures" (*ni you zhengce, women you duice*).

THE ROLE OF PREFERENTIAL POWER PRICING: A LEVER TO LIMIT OUTPUT AND ENFORCE ENVIRONMENTAL CONTROLS?

In mid-July 2009, the State Electricity Regulatory Commission, NDRC and the State Energy Bureau jointly issued the *Notice on Relevant Questions Concerning Perfecting the Work of Demonstration Sites for Direct Sales to Power Users by Power Generating Companies*, marking a new stage in the reform of the electric power industry and a new effort to use power pricing to control aluminum production, among other industries. The *Notice* has the potential to become an important route to rationalizing the Chinese aluminum industry, in part by favoring larger users of electricity that have more advanced technology, and weeding out the smaller, less efficient and less environmentally friendly companies. According to the *Notice* the price of power will be separated into the price of on-grid power and the price of transporting the power and large users may directly negotiate the on-grid price with power producers. With respect to the price for the transportation of power, the *Notice* provides for a 10 percent discount for 110 kV power transportation and a 20 percent discount for 220 kV power transport.

Industry insiders say that the effect of the implementation of the *Notice* is to greatly reduce the cost of production of large power users. On the other hand, small and mid-sized companies will not be able to avail themselves of the benefits of the *Notice*, which will result in a growing discrepancy between the total cost of production of small and mid-sized enterprises and the total cost of production of the larger enterprises benefiting from the *Notice* (provided that the policymakers in Beijing are able to enforce a suspension of preferential power pricing often afforded to aluminum smelters by local governments). The goal of the planners is that this discrepancy will lead to the gradual closing of the smaller, less efficient and less environmentally friendly plants. Based on the current average price per kilowatt-hour for industrial users averaging 0.6Yuan/kwh, at a 10 to 20 percent discount, the larger enterprises will have a price benefit of between 0.06 Yuan and 0.12 Yuan. According to one analysts' calculation, where the average power use per MT of primary aluminum is 14,500 kWh, the cost of power accounts for approximately 35-40 percent of total production costs. If the power discount per kWh is 0.06 Yuan, then the cost to produce each MT of primary aluminum for these large-scale aluminum smelters will be 870 Yuan less than today; at a 20 percent discount the savings would be more than 1,700 Yuan/MT.[5]

SECONDARY ALUMINUM: A PATH TO GREATER SUSTAINABILITY IN THE CHINESE ALUMINUM INDUSTRY?

The reduced energy consumption and related lesser impact on the environment of the use of secondary aluminum are well documented. Producing a MT of secondary aluminum from scrap aluminum requires approximately 5 percent of the energy consumption required to produce a MT of primary aluminum.[6] In 2007, China produced a total of 2.849 million MT of secondary aluminum, a 17 percent increase over secondary aluminum output in 2006; this level of output of secondary aluminum resulted in a savings of 19.27 million MT of coal equivalents and 160 million MT of water. The level of production of secondary aluminum in 2006 also resulted in 141,000 MT less of sulfur dioxide emissions and 68 million MT of avoided solid waste emissions.[7]

In 2007 China's consumption of secondary aluminum accounted for 22.9 percent of total aluminum consumption (12.44 MT of primary aluminum was produced in 2007), which is lower than the world's average consumption of secondary aluminum of 50 percent. If by the year 2020, China is able to increase its consumption of secondary aluminum from 22.9 to 60 percent, the country could annually save 36.4 million MT of bauxite, 136.5 billion kWh of energy, and 91 million cubic meters of water (taking into consideration the growth in consumption and output of primary aluminum to 2020).

Wang Xihui—a representative to the National People's Congress, the General Manager of the Henan branch of Chinalco and the Chairman of the Non-Ferrous Metals Association of Henan Province—recently remarked that China needs to increase its utilization of secondary aluminum and that the greater use of secondary aluminum is a "green project" which will help reduce energy consumption and raw materials and cut down on pollution. In order to increase the amount of secondary aluminum output in China, it will be necessary for China to build a secondary aluminum recovery and utilization system, while increasing automation, the quality of equipment, environmental compliance, and further developing an effective network of scrap recovery, distribution and re-utilization. To accomplish these goals it will be necessary for the government to provide policy, financial and technological assistance to China's still nascent secondary aluminum industry.

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ENDNOTES

[1] One important goal for the Chinese primary aluminum industry is to put in place the technology that would enable Chinese aluminum smelters to reduce energy consumption per metric ton of primary aluminum from an average of 14,500 kWh to an average of 12,000 kWh. Technological upgrades such as these alone would reduce overall energy consumption in the primary aluminum industry by approximately 19.5 billion kWh/year or more than 10 percent of current energy consumption by the Chinese primary aluminum industry.

[2] The economic downturn in China caused by the worldwide financial crisis both has aggravated the environmental challenges posed by the primary aluminum industry (through the reinstitution of preferential power pricing policies directed at the primary aluminum industry) and ameliorated the problem by causing China's primary aluminum industry to idle a substantial amount of capacity, most of which is the least efficient of China's aluminum smelting capacity. The slowdown in output of primary aluminum in turn may result in a reduction in energy consumption of approximately 28 billion kWh by the Chinese primary aluminum industry in 2009, though an economic meltdown is not the most ideal way for the Chinese to reduce emissions and conserve energy.

[3] Compared with conditions overseas, the Chinese primary aluminum smelting industry relies to a much greater extent on the use of coal-fired power plants for the power required to smelt aluminum (by one estimate 70 percent of power used by the Chinese aluminum industry is coal-fired).

[4] With respect to its energy consumption, Chalco's overall energy consumption per unit of alumina refined has declined by 21.39 percent through the end of 2007, while its overall energy consumption per unit of primary aluminum produced declined by 3.57 percent. Taking all of its subsidiary companies as a whole, the company's rate of reuse of industrial water rose from 87.68 to 90.60 percent from 2006 to 2007 and 80 percent of its alumina refineries now are achieving zero discharges of industrial waste water, which results in a decline of wastewater discharge totaling 33.77 million tpy. In 2007 Chinalco increased its desulfurization by 98,000 MT/year and increased its rate of removal of smoke and dust from 85.1 to 99.1 percent.

[5] One estimate is that there is in excess of 2 million tons per year of aluminum smelting capacity that is produced in facilities that integrate coal production, power output and aluminum smelting.

[6] This takes into account the entire life cycle of primary aluminum production, including bauxite mining, alumina refining and primary aluminum smelting.

[7] In 2008 China produced a total of 2.7 million MT of secondary aluminum (down from 2.849 million MT of secondary aluminum produced in 2007) and in 2009 China's secondary aluminum output rose to ~2.97 million MT. Because China produced a total of 40 million MT of primary aluminum between 1990 and 2004 and the products produced and consumed in China since the 1980's have reached the end of their useful lives, it is expected that the rate of growth of scrap aluminum recovery will increase to 8 percent from ~6 percent beginning in 2010.

Developing Environmental Stewardship Through Art

By Sara Gavney Moore and Jim Harris

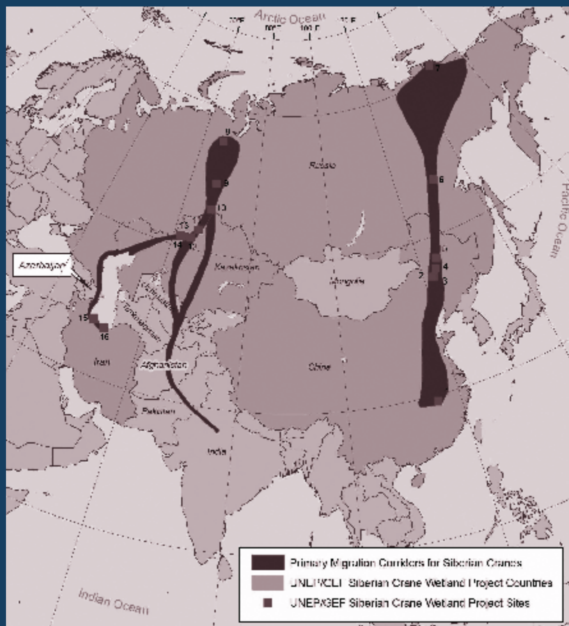
How do you paint the sky? What color are a crane's legs? Students at Xianghai Middle School in Jilin Province are asking these questions as they explore their role in educating their community about the conservation of wetlands and wildlife. With the support of two international NGOs, the International Crane Foundation (ICF) and Art in a Box, and a national NGO, Beijing Brooks Education Center (BBEC), the students and their art teacher Shi Yanqiu have designed and painted two community murals depicting the cranes, wetlands and people of Xianghai Town. The murals show the beauty of nature, the changing of the seasons, and the damages from human activities to the wetland and grassland ecosystems of western Jilin Province. Wildlife suffers, but overgrazing and groundwater depletion also threaten the livelihoods and future health of the human community. Far more than simple art projects, however, these activities are an exciting example of how students can take action to empower themselves and others through learning about their environment.

The Xianghai nature art club began working on environmental projects in 2007 after they received a donation from an elementary school in central Wisconsin. The American students had recently organized a sale of note cards depicting rare birds drawn by one of their classmates. The students donated the profits from their project to ICF which in turn gave a portion of the gift to the Xianghai Middle School art program. With $150 from the American students, the Xianghai art teacher purchased art supplies and organized field trips for the students to see wetlands and draw the cranes that migrate through or summer near the reserve, such as the endangered Red-crowned and Siberian Cranes. Inspired by the Wisconsin students, the Xianghai students designed their own set of note cards focusing on the cranes and wetlands near their home. Art in a Box, which focuses on empowering children through art, provided materials to the school for this project and developed the note cards, which are now for sale through the ICF gift shop. The funds earned support for further art and conservation activism among students at Xianghai.

The following summer, in 2008, the students once again partnered with Art in a Box and ICF to develop a mural showing the wetlands, cranes and changing seasons at Xianghai Nature Reserve. The mural was created during an annual environmental camp organized by BBEC and ICF for students and teachers living around Xianghai Nature Reserve. When asked about their art and feelings about the project, the student artists talked about working together and how they could make something as a group that none of them could do alone. This kind of attitude inspires people to work together to solve problems in their community and protect the environment.

Once the mural was complete, the students proudly marched the fully extended mural across town. A few townspeople came out to see while others ignored them. One student declared emphatically, "People don't understand art!" The students presented the mural to the Xianghai Nature Reserve and the entire student camp. They were eloquent when talking about their art and what it means to love and protect nature. The mural will be displayed in the new museum to be constructed at the nature reserve.

The students developed a new mural in the



This photo shows the countries and project activities being undertaken by the UNEP/GEF Siberian Crane Wetland Project (Described in Feature Box following this Spotlight), which includes the Xianghai Town in Jilin. The SCWP unites conservation activities at sites along the eastern and western Siberian Crane flyways, forming a network of protected wetlands that provide critical habitat for Siberian Cranes and many other waterbirds and for people who depend on these areas. Photo Credit: UNEP/GEF

fall of 2008. Painted on the side of a building on the main street of town, the mural is entitled, "Build our home, hand in hand," and shows the Xianghai Town past, present and future—with an emphasis on threats to wild resources and solutions that will allow Xianghai to be a healthy home for wildlife and future generations. In addition, ICF sponsored a video about this project entitled, "Dream on the Wall," focused on how the Xianghai students are learning about their environment and its problems, and how they are taking action through art and example to bring solutions to their community. In the video, the students and their teacher note that they are pioneers in bringing environmental awareness to their community. The students struggle with their new understanding of the impact of their village on the environment – ground water contamination from the town garbage dump or pesticide use on their crops – but the nature art club has become a tool for expressing their feelings and creating a dialogue with their community. Hundreds of people pass the mural every day.

Through personal actions and communicating with their town through art, the students have not yet solved the major the challenges in their community. Yet the problems can no longer be hidden or ignored. In fact, the example set by the children for their teachers and community leaders, and their increased ability to think critically and act according to their deepening comprehension of environmental issues may be the most significant impact of the project. They are leaders now, and will continue to contribute to the well-being of their community and environment.

ICF developed an exhibit featuring the art project, highlighting how interaction between American and Chinese students changed the way everyone involved looks at their world. The exhibit showed at ICF until October 31, 2009 before traveling to sites in Milwaukee, Wisconsin and elsewhere along the crane flyway from Wisconsin to Florida.

Support for ICF's education programs in China has been provided by the Henry Luce Foundation, the National Fish and Wildlife Foundation/ConocoPhillips SPIRIT of Conservation Migratory Bird Program and the UNEP/GEF Siberian Crane Wetland Project. More information on ICF's China Program can be found at www.savingcranes.org/chinaprogram.html or by emailing china@savingcranes.org. To learn more about the traveling exhibit or the video, please contact Joan Garland at jgarland@savingcranes.org.

James Harris is Vice President of the International Crane Foundation (ICF) where he has worked since 1984 and in China since 1986. He now lives half time in Harbin and half time in Wisconsin. Jim had the lead role from the ICF side in organizing the 1987 International Crane Workshop in Qiqihar, the earliest significant international conservation meeting

Students in Xianghai Town, Jilin Province are using art to increase environmental awareness within their community. Their mural "Build our home, hand in hand" portrays their vision of Xianghai past, present and future, and the effects of the town on the region's environment.
Photo Credit: Jim Harris

in China. Beginning in 1991, he helped to develop a project at Cao Hai Nature Reserve in Guizhou, successfully providing opportunities for local people to improve their livelihoods while actively participating in wetland and watershed protection—a project that still continues. More recently he has worked on water management issues at Poyang Lake and for wetland nature reserves in Songnen Plain of northeast China. Water allocations to sustain ecosystem functions of Zhalong Marsh have been included in national water plans, and a long-term funding mechanism established for water releases. He can be reached at: harris@savingcranes.org.

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FEATURE BOX

Linking Wetlands along the Siberian Crane Flyway in Eastern China

By Jim Harris and Sara Gavney Moore

The protection of migratory birds depends upon safeguarding key breeding areas where the birds raise their young and also the wintering grounds where the birds find food and safety. Just as important, however, is protection of sites along the species' flyways where the birds rest and refuel during their annual migrations. Ideally, conservation activities at all sites along the flyway are coordinated, to help ensure that critical habitat is protected at each stage for the journeys that millions of birds make each spring and fall. A recent project undertaken by the International Crane Foundation (ICF) with partners in China, Russia, Kazakhstan and Iran explores these concepts, focusing on the critically endangered Siberian Crane.

The UNEP/GEF Siberian Crane Wetland Project (SCWP) was initiated in 2003 to identify and protect key wetlands along the Siberian Crane flyways in Eurasia. Nearly the entire world population of Siberian Cranes winters in the Poyang Lake Basin in Jiangxi Province. Each spring the cranes migrate north through eastern China, passing through Liaoning, Jilin and Heilongjiang Provinces on their way to breeding areas in Yakutia, northeastern Russia. SCWP activities in China have focused on five wetland sites, including the Poyang Lake Basin in the southeast, Xianghai, Keerqin, Momoge and the Zhalong National Nature Reserves in northeastern China. Of critical importance to the protection of these sites is an understanding of how the cranes and other waterbirds use these wetlands and the maintenance or restoration of natural cycles of water that are vital to the ecological health and productivity of these wetlands – water resources essential for the cranes, many other wildlife species, and growing human populations.

The SCWP has supported long term research in the Poyang Lake Basin focusing on the relationship between Siberian Cranes, the wetland plants on which they feed, and water levels in the basin. Eleven years of research have found that the Siberian Cranes' winter habitat is limited primarily to areas with depths less than 30 cm, although these birds do use water as deep as 50 cm. In these areas of shallows and wet mud, the cranes can reach starchy Vallisneria tubers. This essential wetland plant feeds wintering cranes, Swan Geese, and other waterbirds that search for the tubers that develop on the plant's roots.

This research, together with related studies by others concerning hydrology, land use, and light availability for Vallisneria, is helping the Chinese Government understand what the Siberian Crane and other waterbirds need to survive during the winter months at Poyang. This knowledge is essential for evaluating the implications of developments now being considered within the lake, including a variety of water-control projects that could drastically alter the hydrology of the system. A dam proposed for the outlet to Poyang Lake, for example, would stabilize winter water levels for sake of navigation and flood control. If winter water levels were maintained significantly higher than now, most shallow waters used by Siberian Cranes and other waterbirds would be flooded too deep for the birds to feed. Extinction could easily follow for the charismatic crane. Even if water were stabilized close to current winter water levels, the lack of fluctuation within and between years could drastically change food availability for the waterbirds and indeed, transform the ecological character of the lake. The extraordinary productivity of Poyang, which benefits waterbirds and local people, likely depends on those dramatic changes in water levels.

Further north, in Heilongjiang and Jilin Provinces, the Siberian Crane finds the midpoint of its long migration where wetlands in the Songnen Plain have long provided plentiful stopover areas. Here the birds can spend one to several weeks before continuing north or south. While many wetlands have been developed and lost to wildlife, several large nature reserves have been established, most notably Zhalong, which includes over 200,000 hectares.

In recent years, however, nearly all of these protected wetlands have been drying up. A cycle of drought may be partially responsible, especially in the west, but for the Zhalong area recent rainfall has been greater than averages recorded over the past fifty years. The lack of water arises primarily from diversions for human use in a part of China where water resources are scarce compared with growing human needs. In past years, design of these projects has not emphasized efficiency of water use or minimized impacts on wild resources. For example, a system of canals carrying water from Nenjiang (river) to Daqing and elsewhere is not designed to drain the Zhalong Marsh, but the canals entirely circle the nature reserve. Fifty-meter wide canals with associated dikes and roads prevent any overland run-off from reaching the wetlands.

Through the SCWP, ICF and Chinese colleagues under the State Forestry Administration developed collaboration with the Songliao Water Resources Commission (SWRC), a part of the Ministry of Water Resources that studies water needs and develops plans for water use in these watersheds. Our project came at a good time, for SWRC had received an expanded mandate, to consider ecological needs for water equally with economic needs as it developed water plans. Our project assisted with the ecological assessments that complemented SWRC's long-term expertise in water management.

As a result, the project studied water needs for Zhalong, Xianghai, and Keerqin Nature Reserves – we later added Momoge – and developed water management plans for each reserve based on historic records for Songnen Plain. While the natural conditions – where water often flowed in sheets across large expanses of the landscape – can never be restored, the plans do show how ecological functions of the wetlands, including nurturing globally important populations of cranes and other waterbirds, can be recreated.

At Zhalong, for example, the current system of canals and water gates makes it possible to deliver the amounts of water needed at the right times of year and in diverse places along the upper parts of the wetland. This management plan has been incorporated into regional and national plans and approved by the central government. The provincial government has added an annual appropriation to the budget to pay for water supply for Zhalong.

Nevertheless, delivery of the water needs time and experience to perfect. This past spring for example, the marsh was so dry during the April-early May breeding season that fires swept vast areas, destroying nests and young birds. Water releases started in late May – too late for the breeding birds. The other challenge for Zhalong is the large number of dikes and canals that have been built even within the reserve. These structures fragment the wetland and prevent water from spreading across large parts of the marshland. As a result, some areas remain dry while other parts are deeply flooded by water releases. Water should be released before the breeding season and from multiple locations. Further coordination involving local agencies responsible for the water releases and

Each fall Siberian Cranes migrate over 3,000 miles from their breeding areas in northeast Russia to their wintering grounds in the Poyang Lake Basin, Jiangxi Province. Through the SCWP, researchers are studying the relationship between the cranes and the dynamic wetland ecosystems within the basin. Photo Credit Ji Weitao

for wetland management are needed to solve these problems. The result should be a great increase in biological function and in the ecosystem services provided by Zhalong.

In addition to these more intensive efforts, SCWP researchers are coordinating annual surveys to monitor the population and distribution of waterbirds and identify key wetlands used by Siberian Cranes and other waterbirds along the entire crane flyway in eastern China. Over 150 sites in ten provinces are involved in the monitoring, conducted annually during the fall and spring migrations by a large number of observers trained through this project. At Huanzidong Reservoir in Liaoning, for example, hundreds of Siberian Cranes pause for weeks to feed in shallows available only because the reservoir is not full. Discovery of this new site is due to amateur bird watchers and photographers, who are making growing contributions to Chinese conservation.

Within China, the project has created much greater awareness that waterbird populations and their habitats function as integral parts of long flyways—communication and collaboration must occur among many locations and agencies for conservation to be successful. Sites such as the Poyang Lake Basin and wetlands of northeast China are connected by the migrating waterbirds that share these resources. In addition, SCWP has greatly increased interaction among Chinese and Russian researchers, so that action for northern parts of the flyway link with the Chinese effort. These interactions allow researchers and others to share information, target conservation activities and better understand the different ecologies these birds encounter along their migration.

Funding for the SCWP is provided by the United Nations Environment Programme and the Global Environment Facility, with significant co-financing provided by the Chinese Government and the National Fish and Wildlife Foundation / ConocoPhillips SPIRIT of Conservation Migratory Bird Program. SCWP activities in China are led by the State Forestry Administration and coordinated through the National Bird Banding Center of the Chinese Academy of Forestry. More information may be found at www.scwp.info or by emailing scwp@savingcranes.org.

James Harris is Vice President of the International Crane Foundation where he has worked since 1984 and in China since 1986. He now lives half time in Harbin and half time in Wisconsin. Beginning in 1991, he helped to develop a project at Cao Hai Nature Reserve in Guizhou, successfully providing opportunities for local people to improve their livelihoods while actively participating in wetland and watershed protection—a project that still continues. More recently he has worked on water management issues at Poyang Lake and for wetland nature reserves in Songnen Plain of northeast China. He can be reached at: harris@savingcranes.org.

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COMMENTARY

A Vision of a Green Pearl River Delta: The NDRC's 2008-2020 Outline Plan for the PRD

By Christine Loh, Megan Pillsbury, Andrew Lawson and Mike Kilburn

CHINA'S INDUSTRIAL POWERHOUSE

Over the past 30 years, China has undergone remarkable economic modernization, in part driven by its industrial powerhouse, the Pearl River Delta (PRD) region in Guangdong Province. The PRD is one of the most vibrant economic regions globally, boasting a real GDP growth rate of 16.2 percent in 2007. Sixty percent of the world's toys and one-fifth of its mobile phones are manufactured there, and it is a major manufacturing center for everything from textiles, appliances and paper to auto parts, telecommunication equipment and petrochemicals.[1] The government has high expectations for PRD, which has been China's pioneer and laboratory for development and reform.

The other side to this story is the costs at which development has come, especially to the environment. The PRD suffers from poor air and water quality, increased toxicity in the environment, deforestation, erosion, and soil degradation, threatening public health and putting strain on the natural resources crucial to continued development. Costs to public health from air pollution alone are estimated at 1.8 billion Yuan ($260 million) each year for hospital treatments, doctor visits, lost productivity, and the premature deaths of over 10,000 people.[2] China now emits more carbon dioxide than any other country and climate change will present many ecological threats that could greatly undermine economic and human health in the country—with the low-lying Pearl River Delta being particularly vulnerable to sea-level rise and temperature change. Fortunately, the Chinese government's National Development and Reform Commission (NDRC) is paying attention to the drawbacks of unregulated industrialization in the PRD.

THE NDRC OUTLINE PLAN

In December 2008, the NDRC released *The Outline of the Plan for the Reform and Development of the Pearl River Delta 2008-2020* in which it challenges the PRD to lead the country onto a path of sustainable development through a transformation of its economy, industry and society, embracing sustainable and environmentally friendly innovations. The *Outline Plan* calls for:

- Modernization of agriculture and the existing manufacturing base as well as the development of new high-tech industries;
- Expansion and modernization of infrastructure;
- Developing and attracting innovative talent;
- Greater regional integration and coordinated development;
- Improved social services and economic opportunities; and,
- Stronger environmental protection and resource conservation.

The success of the PRD region in carrying out this plan could inform other parts of the nation about how to embark on a sustainable development path, moving away from high levels of inefficient resource consumption that have degraded the environment, weakened ecosystems and created excessive greenhouse gas emissions. Already, because of the global economic downturn, many factories in the PRD have been forced to downsize or close and the stronger performers are turning to environmental sustainability as a way to differentiate themselves. Furthermore, as China begins in earnest to deal with its greenhouse gas emissions, the region will have to find ways to reduce its carbon footprint. To transform the economy within a low-carbon sustainable development policy framework, the region's multiple authorities, including the special administrative regions of Hong Kong and Macao, will have to collaborate in articulating a compelling common vision, providing metrics and policy guidelines to assist decision-making, engaging and educating the general public and coordinating cross-jurisdictional action plans for the short-, medium- and long-term.

However, the *Outline Plan* fails to clarify the importance and difficulty of pursuing the above objectives and should offer greater guidance for achieving these goals. For example, the Outline Plan projects that per capita GDP is to climb from 38,000 Yuan today to 135,000 Yuan in 2020, which would require a sustained real growth rate of 12 percent annually, or a doubling of the economy about every six years. The demand of growth at this level on constrained energy resources and fragile ecosystems will be tremendous; major breakthroughs will be needed in technology, productivity and energy efficiency just to sustain this growth rate, let alone protect the environment.

Map of the Pearl River Delta. Photo Credit: Civic Exchange

AN INSPIRING VISION

The rate of innovation and transformation required to achieve sustainable growth will make it necessary to engage the major stakeholders of society—government, businesses and the public. Government-led direction and regulatory rewards and punishments are essential, but inspiration through a development vision is also crucial. Sustainability needs to become part of habit and culture. This is as true for China as for the rest of the world.

Civic Exchange, an independent Hong-Kong-based public policy think tank, has proposed that regional authorities adopt a vision supporting the *Outline Plan* to inspire regional stakeholders to work toward sustainable development. The aim is to generate substantial economic and employment growth and sustainable business and community development. This is to be done by demonstrating that innovation, efficiency and conservation in the use and reuse of all natural and human resources is the best way to increase jobs, incomes, productivity and competitiveness. This approach is the most cost-effective method of promoting renewable energy and clean technologies, protecting the environment and preventing harmful impacts from global warming.[3]

METRICS AND GUIDELINES FOR TRANSFORMATION

The *Outline Plan* puts strong emphasis on development through the introduction of numerous measurable objectives, from GDP and income to quantity of roads and throughput of container ports. The majority of these metrics are focused on economic outcomes, but less obvious indicators that systematically gauge achievement should also be included, particularly those related to environment, public health and quality of life. These important indicators are missing from the *Outline Plan*:

- Energy efficiency and energy intensity
- Resource productivity
- Greenhouse gas emissions and air quality
- Water efficiency and water intensity
- Human health and safety
- Land use
- Job expansion and types of jobs

The development, use and mandatory public reporting of these types of indicators, in addition to economic outcomes, are important tools for guiding public administrators to achieve the goals of the *Outline Plan*. The inclusion of energy, air and water indicators could be relatively straightforward as the Chinese government has existing standards or targets that regulate these areas.

PEARL RIVER BAY AREA CONCEPT

Implementation of some components of the plan is in development. In September 2009 the Pearl River Bay Area Concept (PRBAC) was introduced at a briefing session in Hong Kong on the *Outline Plan*. Drawing on the examples of the San Francisco Bay Area and the Northwest Ports Clean Air Strategy (NWPCAS) which covers emissions in Seattle, Tacoma and Vancouver, the concept requires Hong Kong, Macao Shenzhen, Zhuhai, Dongguan, Guangzhou and Zhongshan to collaborate in the development of a "green and quality living environment."

In March 2010 the developers of the PRBAC received agreement from the Guangdong Provincial Government to further expand the concept. Even though the study is not due to be completed until early 2011 the fruit of this new concept began to emerge in the Framework Agreement on Hong Kong Guangdong Co-operation which was announced in April 2010. The framework agreement translates the strategies set out in the Outline Plan into concrete policies and measures, laying a foundation for incorporating these measures into China's 12th national Five-Year Plan. Chapter six specifically identifies reductions in vehicular and marine emissions, enhancing cleaner production, promotion of electric vehicles and the circular economy, the development of ecological and green corridors and marine parks, and protecting marine water quality.[5]

While these issues build on the foundations of established collaboration between Hong Kong and Guangdong, the PRBAC draws them together under a unified policy vision for the first time. China's track record in swift policy execution suggests that outcomes may come faster than expected. Indeed another cross border joint study, the three-year *Planning Study on the Coordinated Development of the Greater Pearl River Delta Townships*[6], incorporated both the Outline Plan and the PBRAC into its findings even though its final report was published in October 2009, just a month after the PRBAC was formally announced.

The impact of climate change in the PRD region could substantially affect ecology, human health, transportation infrastructure, fresh water and energy supplies, and industry.

PLANNING OPPORTUNITIES

The *Outline Plan* goes into some detail about economic transformation through the relocation of industrial centers and upgrading of manufacturing. It specifies transformation in terms of applying advanced technology to produce high-value products. This approach would yield opportunities to improve environmental performance as well. For instance, textile and garment production is an important manufacturing sector in the PRD. While per-piece value may be low, production is the core function of the fashion industry, which in advanced economies is a lively, sophisticated and innovative business. Increasingly, consumers are paying attention to sustainability—ecological and social—in terms of how garments are produced. One organization called the Sustainable Fashion Business Consortium, comprised of more than a dozen leading Hong Kong textile and apparel businesses mostly based in the PRD, aims to encourage improvements and share best practices in key social and environmental areas of the business. The results are higher quality products, less waste, a fairer workplace and most importantly, more competitive businesses in the global marketplace.[7]

Another challenge that poses opportunities in planning is climate change. The impact of climate change in the PRD region could substantially affect ecology, human health, transportation infrastructure, fresh water and energy supplies, and industry. The *Outline Plan* could incorporate requirements to address adaptation, which offers opportunities for selecting the right development choices in land use and urban planning, water resource management, flood management systems, coastal and river defense and long-term land use planning.[8]

REGIONAL COORDINATION

The PRD region is administratively complex because it encompasses provincial and municipal authorities, special economic zones and special administrative regions. While each has a certain level of autonomy in decision-making, and each has its own perceived interests to protect, the *Outline Plan* is useful to drive all regions to look longer term and buy into a compelling new prosperity plan based on industrial transformation. This will require dialogue and exchanges not only among the authorities but also with business and civil society. To start, the region as a whole should conduct research on its ecological carrying capacities, identify its many assets and create a roadmap involving all stakeholders, so that a regional prosperity agenda can be articulated and discussion about delivering tangible results can begin.

Consider the shipping industry. The PRD ports handle some 12 percent of global container throughput, but there is no regulation of the highly toxic emissions from the huge vessels delivering the containers. Neighboring shipping ports compete for business, but that does not preclude them from collaborating on environmental issues. The PRBAC provides a fine opportunity for environmental or port authorities to introduce strict environmental regulations across multi-port regions to address air and water pollution near densely-populated cities. Overseas models include the NWPCAS, through which the ports of Seattle, Tacoma and Vancouver co-operate on the reduction of diesel and greenhouse gas emissions. In California, the ports of Los Angeles and Long Beach aim to reduce shipping-related pollution in the San Pedro Bay and have set impressive "green port" policies.

Civic Exchange has been engaging the key stakeholders responsible for marine emissions in the PRD since 2007.[9] These include shipping lines, port operators, officials and PRD-based manufacturers. Recent discussions have revealed that neither Hong Kong's Marine Department nor their PRD counterparts have any objection to a low emissions zone for the PRD, while Hong Kong's Environmental Protection Department is exploring the possibility of mandating a switch to cleaner fuels for ships at berth.

In summary, the *Outline Plan* set out by the NDRC is ambitious in its aim. The plan's designers recognize the fact that future development must take a more sustainable path, and the Outline Plan is beginning to shape that path. There are many challenges ahead but also opportunities for cross-jurisdictional collaboration, proactive planning, using metrics and guidelines, and most importantly tapping into the minds and hearts of people in the PRD to set an example for China and the rest of the world.

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[1] HKTDC. (2008). PRD Economic Profile. [Online]. Available: http://www.hktdc.com/info/mi/a/mp/en/1X003JXI/1/Market-Profiles/PRD-Economic-Profile.htm.

[2] Civic Exchange. (2008). A Price Too High: The Health Impacts of Air Pollution in Southern China. [Online]. Available: http://www.civic-exchange.org/eng/upload/files/200806_pricetoohigh.pdf.

Civic Exchange proposes a vision statement for the PRD based on "Climate Prosperity" as set out by Global Urban Development. For more information, see Loh, C.; Pillsbury, M.; Lawson, A. (2009). A New Vision of Industrial Transformation. [Online]. Available: http://www.civic-exchange.org/eng/upload/files/NDRCresponse.pdf.

[3] There is also ambiguity in the Outline Plan about the relative importance given to development and environment. In section I, part 3, the Plan states, "the region will… take as its top priority to sustain the stable and comparatively fast economic growth," while in section VIII, part 2, it states the guideline is, "emphasizing both development and conservation but prioritizing conservation."

[4] http://gia.info.gov.hk/general/201004/07/P201004070113_0113_63622.pdf

[5] For more information, see Planning Study on the Co-ordinated Development of the Greater Pearl River Delta Townships (2009) Construction Department, Guangdong Province, Development Bureau, Hong Kong Special Administrative Region, Secretariat for Transport and Public Works, Macao Special Administrative Region.[Online] Available: http://www.pland.gov.hk/pland_en/misc/great_prd/gprd_e.htm

[6] More information on the Sustainable Fashion Business Consortium can be found at http://www.sfbc.org.hk.

[7] This approach is consistent with other research and planning initiatives at the Central Government level, such as the May 2009 White Paper, Actions for Disaster Prevention and Reduction, which calls for a strategic approach to managing the impacts and costs of natural disasters in China, including climate change related disasters.

[8] For more information, see Galbraith, V.; Curry, L; Loh, C. (2008). Green Harbours: Hong Kong & Shenzhen – Reducing Marine and Port-related Emissions. Civic Exchange. [Online]. Available: http://www.civic-exchange.org/eng/upload/files/200806_Gports.pdf.

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COMMENTARY

Shifting Power in Central-Local Environmental Governance in China: The Regional Supervision Centers

By Scott Moore

In 2009, water supplies to 200,000 people in the city of Yancheng in southern China were disrupted following a large release of carbolic acid into a nearby waterway. Investigations revealed that the company responsible for the leak, Baoxin Chemical, had been investigated and fined several times by the local environmental protection bureau, but that authorities had failed to stem illegal dumping into the waterway. "Compliance is expensive," lamented a local official, "and evasion is cheap" (Wang, 2009).

Such incidents indicate the challenges China faces in developing effective institutional capacity for environmental protection and enforcement. The six Regional Supervision Centers (RSCs, or *quyu ducha zhongxin*) established by the Chinese Ministry of Environmental Protection (MEP) in 2006 represent one of the most important recent reforms to China's environmental protection infrastructure. Apart from their potential to enhance environmental protection in China, the RSCs represent an important case study in China's environmental policy, the relationship between central and local environmental protection bureaus (EPBs), and the role of international cooperation in strengthening environmental protection in China. This commentary explores the still evolving RSC system and analyzes its significance for China's continuing efforts to strengthen environmental protection as the country continues its rapid economic development. It draws primarily upon the author's personal experience of participating in technical assistance workshops for the RSCs sponsored by the Asian Development Bank (ADB), as well as interviews with several individuals involved with the RSC system.

THE LOCAL CHALLENGE

It is no secret that China's environmental protection efforts often founder at the local level. The previous failures of China's environmental protection efforts are well documented (Economy, 2004), as are the structural difficulties facing such efforts within China's overall policy framework. As a major OECD report concluded in 2006, China's "general policy framework favoring development over the environment compromises the work of enforcement bodies at the sub-national level and results in widespread non-compliance with environmental requirements" (OECD, 2006). In response to this precarious situation, China's leadership has promoted the development of a robust system of environmental protection laws and regulations, many of which aimed at circumventing powerful local governments. Central government prioritization of environmental protection is also stressed in the five-year plans and in comments by high-level officials. For example, in a 2007 speech, President Hu Jintao emphasized the importance of building an "energy-efficient and environmentally-friendly society" (Ministry of Foreign Affairs, 2007). The former Vice-Minister of the State Environmental Protection

Administration (SEPA) has similarly urged the development of an "ecological civilization" (*shengtai wenming*) (Pan, 2009).

The growing political profile of environmental protection in China was further reflected by the promotion of SEPA into the Ministry of Environmental Protection in 2007. In the context of China's shift to strengthen and develop more comprehensive environmental protection policies, the RSC system was established in 2006. At the opening of the North China RSC in late 2006, MEP Vice Minister Zhang Lijun explained that "The six [Regional Supervision] Centers will…take on the task of supervision of local government and local departments of environmental protection, to prevent administrative inaction, corruption or dereliction of duty in the process of environmental management" (Ma, 2008). The RSCs are guided by a technical assistance program funded by the ADB, which sees the development of these centers as key in building "institutional mechanisms to link environmental plans with regional and local economic development policies" (ADB, 2005). Fundamentally, however, the RSC system is intended to strengthen the hand of the central government in local environmental protection efforts.

STRENGTHENING THE HAND OF THE CENTER

The fundamental legal basis for the RSCs is provided by the *Decision of the State Council on Implementing a Scientific Outlook on Development and Strengthening Environmental Protection*, which stipulates that "regional environmental supervision branches will be improved to coordinate trans-provincial actions on environmental protection and push for inspection of looming environmental issues." The Decision also defines a policy context for the operation of such branches, by declaring that "the State authority inspects, local departments supervise and individual enterprises are held responsible. The State will give more guidance to and support of local efforts in environmental protection and intensify the supervision on their performance" (State Council, 2005). The Decision thus establishes that RSCs are intended to strengthen the state's role, while remaining distinct from local environmental protection bureau (EPB) authorities, without local EPB authority to control the activities of enterprises.

Leading up to the State Council Decision, MEP began issuing a number of notices in 2002 that began to spell out how the RSCs would function in practice. An initial Notice established two centers on a trial basis, while a later, 2006 version formally established the remaining four regional branches. These Notices directed that the six centers be located in Nanjing (East); Guangzhou (South); Xi'an (Northwest); Chengdu (Southwest); Shenyang (Northeast); and Beijing (North). In addition, the Notices defined the standing of the RSCs as equivalent to a MEP-level bureau or department, and stipulated that each RSC would consist of 3 to 4 internal departments, whose functions would be defined by each center with the approval of MEP (Wang et al., 2009).

This statutory basis makes clear that the RSCs are intended to operate as "dispatched organs" (*paichu jigou*) of MEP, which act as the local representatives of the central government authority (Cai, 2007). In this capacity, they are intended to guide the implementation of the "national will" (*guojia yizhi*) on environmental protection at the local level (Xia, Shen, & Song, 2008). Central government priorities are to be exercised through eight specific functions of the Regional Centers (SEPA, 2007):

- supervise the implementation of national environmental policies, laws, regulations, and standards of the region within its jurisdiction;
- investigate cases of major environmental pollution and ecological damage;

- coordinate and settle major environmental disputes in trans-provincial areas and river basins;
- supervise emergency responses to and handling of major sudden environmental accidents;
- inspect environmental law enforcement;
- supervise the implementation of the *three simultaneities*[1] system of major pollutant sources and construction projects approved by the state;
- oversee environmental law enforcement of national-level nature reserves (scenic locations and forest parks) and key national eco-function protection areas in the region; and,
- receive, coordinate, and settle visits and complaints related to environmental pollution accidents and cases of ecological damages in trans-boundary areas and river basins within its regional jurisdiction.

A legal analysis conducted as part of the ADB consultation process sheds further light on the central government's attempt to tighten control over the RSCs. Somewhat confusingly, while RSCs are responsible for carrying out the mainly information-gathering activities that are assigned by MEP, they are explicitly not created to provide guidance to local environmental protection authorities (Wang, et al., 2009). Moreover, while lower-level RSC personnel are assigned by MEP, mid-level officials come from local EPBs or other local agencies. The net effect of this structure is to make the RSCs little more than listening outposts of MEP, in order to avoid duplication (or supervision) of efforts with EPBs.

In sum, the status of the RSCs as dispatched organs of MEP entails an extension of central government authority to the local level, but without significantly expanded powers or capacities. The functions of the RSCs are limited to supervision and information gathering for MEP, which can alert central officials to step in to deal with cases where local EPBs are jurisdictionally incapable of effective action, such as trans-jurisdictional pollution disputes. The 2005 Songhua chemical spill along China's northern border, for example, had international ramifications and was a major embarrassment to Beijing's environmental protection officials (UNEP, 2005). While intended to redress the systemic failures of local environmental enforcement, the RSCs lack capacity to act. This shortcoming is particularly vexing given they were originally created to address the wide gap between central and local environmental protection efforts.

AN INCOMPLETE FOUNDATION

Environmental protection at the local level in China is characterized by various forms of "local protectionism" (*difang baohu zhuyi*) (Cai, 2007). Perhaps the most serious form of such protectionism is the information asymmetry that exists between local and central environmental protection authorities. Local officials are notorious for sealing off or concealing pollution information (Wang et al., 2009) and the scale of the contamination often is not revealed until it becomes extreme, such as the numerous lead poisoning scandals at smelters in

Yunnan and Gansu provinces in 2009 in which hundreds of children were found to have extremely high levels of lead in their blood. While citizen protests over pollution grow (Ma, 2009), there are likely thousands of Chinese communities where health and livelihood problems stemming from pollution do not make national news. Without better supervision, one Chinese legal expert summarized that "it is hard for the state to obtain information that reflects the actual condition of environmental protection work and the [local] environmental situation" (Xia, 2006).

With respect to the RSC system, this asymmetry is exacerbated by significant shortages in resources and capacity. Each of the six centers is expected to employ between 30 to 40 people (Xia, 2006), which is a fraction of the number in each of the U.S. EPA's 10 regional offices—each of which employs 800 to 1,200 persons. Chinese experts have observed that the personnel strength in each center is "far too low" (Cai, 2007) and an independent ADB analysis indicated that each RSC should have approximately 1,700 staff to adequately supervise the enterprises within its jurisdiction (Gunaratnam, 2008). While the proposed total budget for the RSCs is 1.3 billion Yuan (ADB, 2009), the ADB suggests that the budget for the RSCs must be at least 75 billion Yuan (Gunaratnam, 2008). Another complication in financing is the fact RSCs are predominantly funded by the local governments, which could complicate some of the supervision work by the centers. Limited capacity is characteristic of China's environmental protection institutions; MEP itself has only some 300 core staff. As the country's total environmental protection budget approaches 3 trillion Yuan during the 12th Five-Year Plan, the amount devoted to the RSCs is notably very limited (Alibaba, 2009).

Finally, the RSC institutional structure suffers from weaknesses in its political and legal foundation. Wang et al. (2009) conclude, for instance, that the centers are of "low legal status," since they were established as an administrative measure by the weak SEPA. The lack of a strong legislative basis puts the centers in a weak legal position as they attempt to carry out their work (Wang et al., 2009). Moreover, though the RSCs possess supervisory functions over local environmental authorities and enterprises, they have no power of legal or administrative sanctions. Given the historic weakness of MEP relative to other government agencies, and the prevalence of informal *guanxi* (personal connections) networks at the local level, this weak political-legal foundation places the RSC system at further disadvantage.

MOVING FORWARD TO STRENGTHEN ENVIRONMENTAL GOVERNANCE IN CHINA

The RSC system is a milestone in China's efforts to improve environmental protection, establishing the basis of a firm local presence for central authorities to aid in environmental monitoring and enforcement. Indeed, as China's environmental policy grows more complex and sophisticated, embracing efforts to reduce greenhouse gas emissions and to promote sustainable rural-urban development, such local presence will be crucial to successful implementation. Nonetheless, it is clear that the RSC system possesses significant defects which reduce its efficacy in accomplishing basic environmental monitoring and enforcement objectives, let alone more difficult emergency management, dispute resolution, and other tasks. Redressing these defects, most experts concur, would entail a redesign of the RSC system towards one that emphasizes regional management.

Most crucially, such a system would move away from the current dispatched organ model to grant the RSCs power to directly and effectively supervise the work of local government and environmental bureaus. Specifically, the centers need to move beyond the current focus of only supervising how local EPBs enforce law and be endowed with the right to supervise the local governments. Such a shift in power implies that the RSCs gradually be granted the power to sanction EPBs for under-performance (Wang et al., 2009). Similarly, other Chinese researchers advocate the gradual provision of a "supervision and management function" to the RSCs on behalf of MEP (Xia et al., 2008).

In addition to this structural reform, experts have suggested several specific modifications that can build the capacity of the RSC system. One recommendation is to provide financial independence for RSCs to free them from local authorities. Others advocate the allocation of special funds to encourage and sustain "innovative work" by the RSCs (Wang et al., 2009). RSCs should be empowered to form partnerships with nongovernmental organizations (NGOs), the press, and community groups to enhance their information-gathering and capacity to promote multi-stakeholder involvement in environmental enforcement. These modifications would thus imbue the RSCs with capacities not possessed by the MEP, despite its role as the central government's primary environmental watchdog.

THE EVOLUTION OF CHINA'S ENVIRONMENTAL GOVERNANCE

The RSC system is worthy of description and analysis for several reasons. First, it represents one of the most important reforms to China's environmental protection apparatus in recent years. Second, the system itself reveals a great deal about relationships between central and local environmental protection authorities. Third, the RSC case illustrates the growing role of international cooperation in China's domestic environmental protection efforts. Far less about the RSC system would be known, for example, were it not for the series of ADB workshops and related publications, from which this commentary is informed. The U.S. EPA has similarly committed to assist MEP in the development of its enforcement capabilities, in part by sharing knowledge and experience with the RSCs (U.S. EPA, 2008), though little substantive engagement has occurred to date. Ultimately, however, the RSC system is worthy of outside attention because it presents an opportunity to implement vital reforms that are needed if China is to develop strong environmental governance institutions.

The RSC system needs to be recalibrated to better oversee the activities of local governments and their EPBs, while also forming partnerships with citizen groups, NGOs, and media to offset the information asymmetry problem. International cooperation activities, such as the Vermont Law School Environmental program, the American Bar Association, the Natural Resources Defense Council, and other groups that focus on strengthening environmental law and governance in China, can (if given central government approval) help RSCs to develop stakeholder partnerships and develop new tools to improve their supervisory work. In the long run, regional structures can serve to initiate policy experimentation at the local level, adapting and strengthening national regulations and policies to local contexts. Besides continuing exchanges and learning with the U.S. EPA regional offices, a number of international cooperation initiatives, such as the EcoCities Partnership recently announced by the United States and China, can serve as conduits to build regional capacity for such experimentation.

If, as China's leaders have indicated, the nation is to develop a sustainable development model, better structures and capacities for environmental protection will be necessary. International experience has shown that as countries improve their environmental protection abilities, they almost invariably develop greater regional management capacities. The present RSC system marks an important step forward in China's environmental protection efforts, but it falls short of the broad-based reform that will be necessary to meet the myriad, complex environmental challenges China faces in the twenty-first century.

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[1] This policy directs that infrastructure designed to protect the environment for a given project (especially in construction) be in place at the same time the project itself is being conducted. For more information, see the Sino-Italian Cooperation Program for Environmental Protection, http://www.sinoitaenvironment.org/ReadNewsex.asp?NewsID=248.

[2] The author gratefully acknowledges the contribution of Jianbo Ma, consultant on environmental issues in China, on this specific point.

[3] The author gratefully acknowledges the contribution of Charles McElwee, environmental lawyer, on this specific point.

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FEATURE BOX

Preparing for Humanitarian Disasters at the Third Pole

By Linden Ellis

In May 2010, chinadialogue, the Humanitarian Futures Programme at King's College London, and the Hazard Research Centre at University College London launched The Waters of the Third Pole: Sources of Threat; Sources of Survival, a joint report on the growing water crisis in the Hindu-Kush Himalaya.

More than one in five people in the world depend to some degree on the rivers originating in this region, often referred to as the Third Pole because of its large reservoirs of frozen water. But climate change is threatening to undermine the stability of the area. Groundwater contamination, natural disasters—such as drought and flooding—and intra-regional conflicts are very real dangers that pose major challenges for humanitarian intervention.

This report considers the role of water as a potential crisis driver in the region and urges policymakers to prepare for a range of humanitarian emergencies, including mass migration, famine and cataclysmic floods. The authors warn that natural hazards, particularly those relating to water quantity and quality, will continue to hamper socioeconomic development and poverty reduction and could lead to inter-state conflict. chinadialogue's editor, Isabel Hilton, said:

This report is intended to focus attention on the long, complex, evolving crisis in the Third Pole region—a crisis generated by poor water management, intra-regional tensions and climate change—that has the potential to threaten the lives and livelihoods of millions of people. It brings together the concerns of science, human security and humanitarian perspectives and calls on all sectors to give the issue the attention it demands.

Key recommendations in the report include:

- Pushing the Third Pole region up the agenda of global policymakers;
- Creating humanitarian professionalization programs for sharing best practices and other tools for improving non-intrusive humanitarian intervention capabilities;
- Improving dialogue between the region's countries, including better sharing of scientific data; and,
- Establishing a regional mapping exercise to monitor factors that create humanitarian crises.

The full text for The Waters of the Third Pole: Sources of Threat; Sources of Survival report can be found at: http://www.chinadialogue.net/UserFiles/File/third_pole_full_report.pdf.

chinadialogue.net is an independent, nonprofit organization based in London, Beijing and San Francisco. The bilingual website publishes articles by experts, policymakers, activists and concerned citizens in English and Chinese on global environmental issues, with a special focus on China. Linden Ellis is the director the U.S. office of chinadialogue in San Francisco. She can be reached at: linden.ellis@chinadialogue.net.

FEATURE BOX

Relieving Stress on China's Agriculture:
Long-Term UK-China Collaboration to Help China Adapt to Climate Change Impacts

By John Warburton

The UK and China have been working together since 2001 to better understand how China is going to be impacted by climate change, particularly in the agriculture sector. But understanding must also lead to action, with adaptation needing to be integrated into the development process at both national and local levels. This work, which is ongoing, will increasingly provide a model for how to approach adaptation in other countries.

In my opinion, this work has also contributed to the realization among top-level Chinese officials that it is important to take global action on climate change as part of the international negotiation process; until very recently, most of the international engagement with China has focused on mitigation, with the result that the very real and urgent challenges that China faces in regards to its own adaptation needs have been sidelined.

CLIMATE CHANGE—YET ONE MORE STRESSER FOR CHINESE AGRICULTURE

China's Polices and Actions for Addressing Climate Change, issued in October 2008, state:

The impacts of future climate change on agriculture and livestock industry will be mainly adverse. It is likely there will be a drop in the yield of three major crops—wheat, rice and corn; …enlarged scope of crop diseases and insect outbreaks; [and] increased desertification.

Even though assessing the likely impacts of climate change on crop yields is a complicated process, with some evidence showing that in some areas crops may benefit if agricultural technology can keep pace, the overall picture is grim for China.

Potential climate impacts are very worrying for a country which already faces so many other challenges within the agricultural sector, among them the facts that it has to feed nearly one-quarter of the world's population (1.3 billion people) with only 7 percent of the world's arable land; that it has only one-quarter of the world's average per capita water distribution (one-tenth in large parts of northern China, which are heavily dependent upon agriculture); and that the agricultural land base is fast diminishing due to urbanization, industrialization, and the conversion of arable land to grasslands and forest.

UK-CHINA ADAPTATION COLLABORATION

Much of the evidence that supports the understanding of the likely adverse impacts on Chinese agriculture from climate change stems from collaborative work between the UK and China which started in 2001. A joint project, Impacts of Climate Change on Chinese Agriculture (ICCCA), has combined cutting-edge scientific research with practical development policy advice. Although national in scope, the project included pilot work to develop a stakeholder based approach to adaptation in the Ningxia region of north-central China. ICCCA was successfully completed in December 2008. The UK-China collaboration is now continuing with a major new project which is going beyond agriculture and looking at additional socioeconomic sectors and geographic areas.

ICCCA was funded by the United Kingdom's Department for International Development (DFID), and the Department for Environment, Food and Rural Affairs , although the latter's involvement has now transferred to the Department for Energy and Climate Change. The project was conducted in partnership with China's Ministry of Science and Technology. The research was led by the Chinese Academy of Agricultural Sciences, in collaboration with leading Chinese and UK climate change researchers.

The following summary of ICCA project findings is distilled from the information provided in 6 "leaflets for policy makers" produced in 2008 and available on the project website (www.china-climate-adapt.org) together with the full accompanying reports.

ANALYSIS OF CLIMATE IMPACTS AT NATIONAL LEVEL

Developing Scenarios of Future Climate Change for China

ICCCA's first task was to understand how China's climate may change in the future. This was done by running the regional climate model, PRECIS (Providing Regional Climates for Impacts Studies), to give detailed maps of climate change during the 2020s, 2050s, and 2080s, based upon two standard greenhouse gas emissions scenarios from the IPCC (Intergovernmental Panel on Climate Change), a medium high (A2) scenario, and a medium low (B2) scenario.

The PRECIS modeling work indicates that the climate in all parts of China will continue to warm, possibly by as much as 4.5°C by the 2080s, together with an increase in the numbers of days where the maximum temperature exceeds 25°C. There may also be a consistent and progressive shift to wetter conditions in the south of China (although the PRECIS model is known to over-estimate rainfall patterns compared to other climate models), but with some northern regions becoming moderately drier. There is also strong evidence that heat waves, temperature extremes and precipitation intensities will increase. Unfortunately, increased precipitation intensity is likely to result in more flooding and storm damage, rather than being beneficially and evenly-distributed across crop growing seasons.

Although there is considerable uncertainty about the detail of future climate change, especially in how the frequency and magnitude of extreme events will evolve, these rates of change are unprecedented in China's history and, together with other shifts in China's climate, will lead to significant physical and socio-economic impacts across the country.

Impacts of Climate Change on Cereal Production in China

ICCCA then used the CERES (Crop Environment Resource Synthesis) models to predict impacts on rice, maize and wheat yields across China, based upon the climate change predictions from PRECIS. The project also assessed changes in yield with and without the potential fertilizing effect of extra carbon dioxide (CO_2) in the atmosphere. This effect is highly uncertain - not least because it is unclear whether, even if extra atmospheric CO_2 leads to enhanced plant growth, this growth translates into higher grain yields, as opposed to extra growth in the non-edible parts of the crop plant such as the stalks.

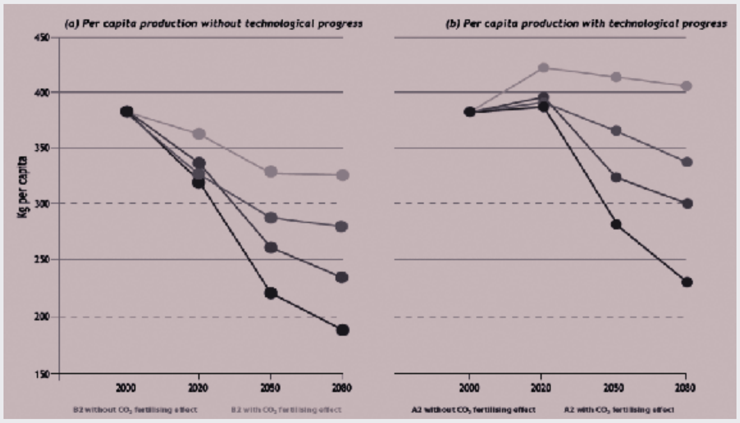
The results are mixed: Irrigated rice and rainfed maize tend to show reductions in yield, while yields of rainfed wheat tend to increase, when averaged across China. However, all crop yields decrease without the potential fertilization

Water is likely to become an increasingly scarce resource in north-central China, where many farmers already have to collect irrigation water by hand.
Photo Credit: John Warburton

effects of CO_2. The changes get bigger further into the future. Importantly, without improvements in agricultural technology, per capita production declines dramatically relative to today's production. This is summarized in the figure below:

The results show the need to improve understanding of the effects of CO_2 on plant growth, and to obtain better projections of future improvements in agricultural technology. It is also important to note that these projections are likely to be optimistic because, as stated above, PRECIS has simulated a much wetter condition for China than do other climate models. Also, the effects of extreme events (floods, droughts, major storms) on crop growth and water availability have probably been underestimated.

HOW CHINA COULD SUFFER FROM THE IMPACTS OF CLIMATE CHANGE: A LONG-TERM UK-CHINA COLLABORATION IS HELPING CHINA TO UNDERSTAND AND ADAPT TO THESE IMPACTS



Changes in per capita cereal production simulated to 2080 under two emissions scenarios (Source: ICCCA)

Modeling the Interactions of Climate Change, Water Availability and Socioeconomic Scenarios on Cereal Production

Climate change is not the only challenge facing Chinese agriculture. ICCCA combined crop and water simulation models with climate and socio-economic scenarios to explore how changes in cereal production and water availability due to climate change will interact with other socio-economic pressures in China. Four key variables were included: population growth, GDP growth, changes in water demand between agriculture, industry, and municipal areas, and changes in agriculture land use.

This modeling work suggests that in future, water availability will play a significant limiting role on potential cereal production, due to the combined effects of higher crop water requirements and increasing demand for non-agricultural use of water. The interactive effects of all drivers together led to significant decreases in total production by the 2040s.

Overall, the work of ICCCA strongly indicates that climate change is a massive additional stress on China's future agricultural production. Over the next couple of decades the most significant impacts are likely to arise from the interplay between rising temperatures and the need for more water (or rather, the need to use existing and probably declining water resources more efficiently), and better management of the effects of extreme weather events, especially droughts, floods and storm damage. Successful adaptation policies based on sustained improvements in agricultural technology will be essential to produce enough cereal to keep pace with population growth and the effects of other drivers such as land use change.

WHAT DOES THIS MEAN AT THE LOCAL LEVEL?

Rural Livelihoods and Vulnerability to Climate Hazards in Ningxia

The work described to date took place at a national level, but how does it all relate to the experience of farmers on the ground, and how does it translate into local development policy? To address these questions, ICCCA focused on one area of north-central China, Ningxia Autonomous Region. By working with rural communities and local institutions, the aim was to understand better their vulnerability to climate hazards and their capacity to cope with and adapt to future climate change.

Ningxia is divided into three agricultural zones, a southern, mountainous, rain-fed area, a central plain with a mix of irrigation, rainfed cultivation, and livestock grazing, and a northern area irrigated by the Yellow River. On the whole, conditions are extremely dry and farming communities face many physical and economic challenges. Farmers in the three agricultural areas have different levels of vulnerability to climate change. Not surprisingly, susceptibility is highest in the middle arid and southern rainfed mountainous areas, because farmers are more exposed to climatic hazards and a greater proportion of income comes from farming activities. However, the entire region suffered from a major drought from 2004-06, and is seeing year-on-year increases in damage from extreme weather events such as hailstorms and periods of hot dry winds.

The farmers in Ningxia use an impressive array of measures—rainwater collection, increasingly efficient irrigation, greenhouse cultivation and switching to new crops—to retain soil moisture and maintain agricultural production in the harsh environment. But a range of factors influence their ability to respond to environmental conditions. When asked about the constraints they faced in adapting to the effects of climate change, respondents most often cited lack of money, available water resources, and inadequate infrastructure.

Developing an Adaptation Framework and Strategy for Ningxia

Some level of adaptation to climate change is now inevitable, and indeed is already happening, as can be seen by the year-on-year northward spread of winter wheat cultivation. Society and individuals must adapt to the changes which will occur—either to avoid negative impacts or to take advantage of new opportunities. Drawing on the findings of the survey on the impacts of climate change on rural livelihoods, ICCCA produced an adaptation framework and strategy for agriculture in Ningxia. The framework has six main stages, illustrated in Figure 2.

Development of the adaptation framework in an iterative, participatory manner leads to the identification and prioritization of a range of adaptation options, which can be incorporated into development processes, and whose subsequent implementation can be monitored, evaluated, and modified as appropriate. Experience in Ningxia is showing that local level changes are further enhanced when underpinned by a systemic shift in the region-wide planning process. Thus, Ningxia has established a regional cross-departmental group on climate change adaptation, is undertaking a general drive to raise awareness of climate change trends and impacts, and is committed to making adaptation an important element of all relevant development and poverty-alleviation plans.

ADAPTATION WORK CONTINUES WITH A MAJOR NEW COLLABORATION

Following the success of ICCCA, China and the UK, together with the Swiss government, have now initiated a new and much larger project, Adapting to Climate Change in China, or ACCC.

ACCC aims to improve Chinese and international knowledge on the assessment of climate impacts and risks, and to develop practical approaches to climate change adaptation. It will do this by helping China to integrate climate adaptation into the development process to reduce its vulnerability to climate change, and by sharing this experience with other countries. There will be five main outputs:

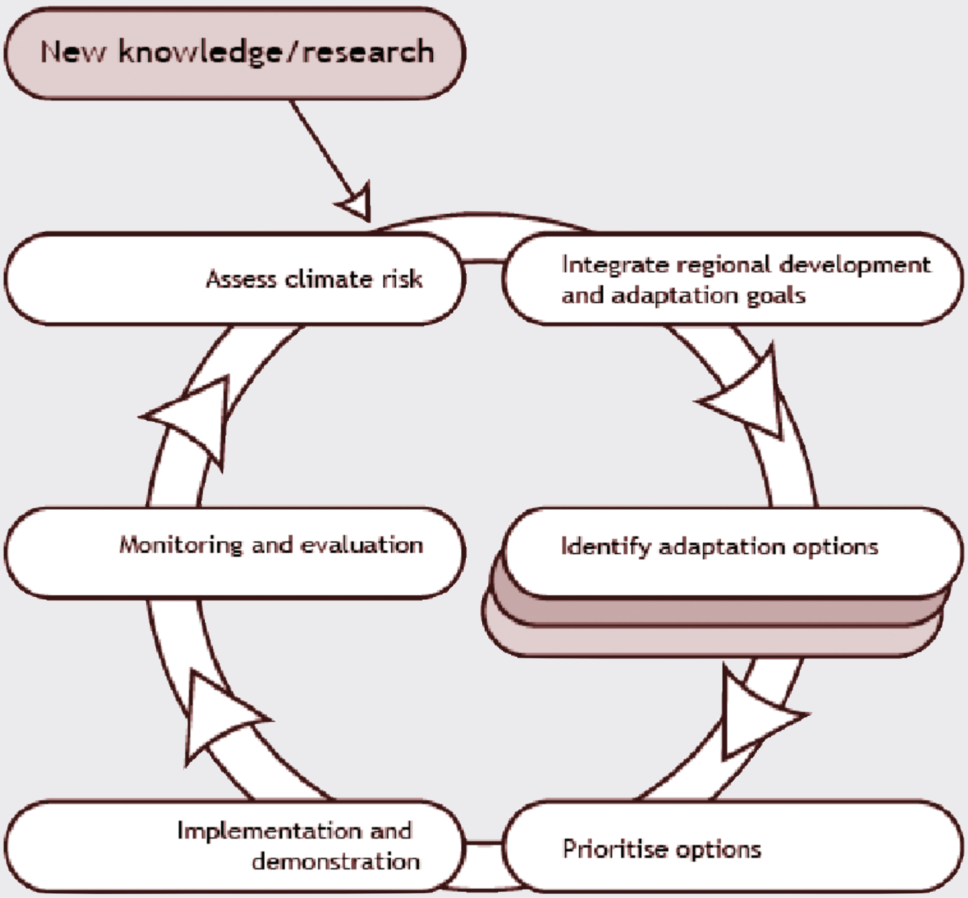
- Improved development of, and access to, climate change science in China;
- Comprehensive risk assessments in selected socioeconomic sectors, based upon an analysis of vulnerability and impacts, produced at national and provincial level;
- Climate risks integrated into planning and management within the three project provinces, and informing national level processes;
- Increased awareness and capacity among Chinese policymakers and other key stakeholders to address climate change adaptation within China's development process;
- Knowledge sharing between China, UK, and other countries in Asia and Africa, to further develop climate change adaptation approaches.

ACCC started in June 2009 and will continue to work nationally and in three specific provinces—Ningxia and Inner Mongolia Autonomous Regions, and Guangdong. ACCC will also focus on specific sectoral areas that are likely to be heavily impacted by climate change.—agriculture, water resources, disaster risk reduction, and health. ACCC will then develop detailed risk and vulnerability assessments, and use case studies to identify specific adaptation options which are relevant to local communities and decision-makers. It will use the Adaptation Framework approach described above to develop adaptation strategies.

ACCC will also share its results, lessons and experiences as widely as possible. This will include involvement in international adaptation networks, and direct contact with adaptation program in other countries in Asia and Africa. ACCC will bring together the best international and Chinese expertise to tackle this shared challenge.

John Warburton is a DFID Senior Environment Adviser, and is currently based in Beijing. For more information on ICCCA, contact him at j-warburton@dfid.gov.uk. For more information on ACCC, contact the UK Project Coordinator and adaptation adviser, Ellen Kelly, at ellen-kelly@dfid.gov.uk

AN ADAPTATION FRAMEWORK – EACH STEP OF WHICH MAY REQUIRE CAPACITY BUILDING



Source: ICCCA, 2008

金 木 水 火 土

COMMENTARY

Incineration: A Dangerous Policy Option for China's Municipal Solid Waste

By Zhao Ang and Mao Da

AN INHARMONIOUS ODOR

The evening of August 24, 2008, while the closing ceremony of the Beijing Olympic Games held, was not enjoyable for Zhao Lei, a resident in the eastern suburb of Beijing because the intolerable odour swept away his morale in such a "harmonious night" for the country.

The odour was not unfamiliar, but especially annoying when it came in on such a special evening. The smell was from Gao An Tun, a "sanitary landfill", about 2 miles away at the northeast direction. For the past two years, local people had been complaining about the notorious management of the landfill. Their petition reached the district government and even the municipal government, but the problem was getting worse even during the Olympic. The landfill ate the most garbage from the Olympic sites. Its daily input suddenly increased to its operation limit and even beyond.

The odour night was just a microcosm of the chronic garbage crisis in Beijing, and in many other huge cities in China. Before the Olympic, Zhao Lei and his neighbours had already been suffering from the rapid growing waste. Their complaints did raise the attention of the government. The authority promised to build up a modern incinerator next to the landfill. The residents thought the odour would go away when the incinerator takes over the job.

However, the situation did not improve much when the incinerator started to work right before the commencement of Beijing Olympic Games. When local residents accumulated more information about incineration, they realized they were fighting against the two "devils". The newcomer seems to be more difficult to deal with than the first one. In the near future, a large number of Chinese people will face similar problems that Zhao Lei and his neighbours are facing.

THE TRASH DILEMMA FACING CHINA'S CITIES

Over the past three decades as Chinese cities have exploded in size and number, municipal solid waste (MSW) (which includes organic waste, paper, plastic, glass, metal, and other waste, but not toxic and medical waste) has become a major social and environmental challenge (World Bank, 2005; Diaz & Warith, 2006). At the end of 2007, China's urban areas produced about 135 million tons of MSW, compared to the 254 million tons in the United States (China Statistical Yearbook, 2008). The economic history of many developed countries has shown that the decoupling of MSW growth from GDP growth is possible with continuously improved MSW management (The Economist, 2009). The annual growth rate of MSW is predicted to decline from 7 percent for 2009 to 2019 to 4 percent for the period from 2020 to 2030 when China's GDP per capita reaches nearly $5,000. Nevertheless, by 2030, China is estimated to generate 480 million tons of MSW annually (World Bank, 2005).

For decades, the dominant MSW management method across China has been landfills (Lacoste & Chalmin, 2006). Landfills demand less financial investment but can cause serious and irreversible groundwater and soil contamination if poorly done. Well-lined and properly managed landfills that meet international standards and effectively alleviate contamination have increased in number in China over the past few years; most of them are located in highly developed cities on the east coast. However, the average quality of landfills throughout the country is troubling. A survey across China indicated that no landfill satisfies all national environmental standards. For example, 231 of Beijing's 490 landfills pose a high risk of contaminating groundwater and soil (Jiang & Wu, 2008). This poor performance of Beijing landfills is being improved, for landfills in the capital face stricter regulations than other cities. In most Chinese cities the separation, recovery, recycling and composting, which are major components of MSW management that are neglected by government policy. Source reduction, which is the highest priority of modern Integrated Waste Management used in many developed countries, is scarcely applied in China.

Incinerator Rush

China's first incineration plant began to operate in Shenzhen in 1998. Since 2000, incineration has become a highly prioritized approach for many local governments to resolve the problem of MSW. In 2008, the China Statistical Yearbook reported that 14.35 millions tons of waste, 11 percent of the country's MSW, was processed through incineration plants in 2007. After peaking in the 1980s and 1990s, incineration in industrialized countries has declined in use due to disastrous environmental pollution, high economic costs, and a shift to other forms of waste treatment and reduction.

According to China's 11th Five Year Plan (2006-2010), more than $6 billion was targeted for building and renewing 82 incineration plants (Jiang & Wu, 2008). China plans to process 30 percent of the country's MSW, about 126 million tons, by 2030 using the waste-to-energy approach (ADB, 2009). This approach encompasses incinerators and methane collection in landfills. In Beijing, the municipal authorities plan to invest $1.5 billion to build dozens of incinerators with the capacity to consume 3 million tons of MSW until 2015 (Beijing Science and Technology Report, 2009). According to AMEC Earth & Environmental, 127 Chinese cities could each be generating over 1 million tons of MSW annually by 2030 (World Bank, 2005). It is estimated that hundreds of incinerators will be built and operated nationally during the next two decades. All kinds of policy incentives have been issued to support this governmental objective, including value-added tax refunds, prioritized commercial bank loans, state subsidies (2 percent) for loan interest, and guaranteed subsidized prices for electricity from waste (Word Bank, 2005).

Foreign investors are moving quickly to take advantage of newly mandated waste development technology and over 100 domestic companies and research institutes across China have also joined the "Incinerator Rush" (Cheng et al., 2007). At the China Solid Waste Management Summit 2009 (24-25 September) there was enthusiastic discussion by national policymakers, investors and developers about the potential of incinerators in China. However, green groups and local communities worry about the environmental and health impact brought by the boom of incinerators. Without comprehensive environmental impact assessments and effective public participation mechanisms, the great leap into incinerator development in China may put ecosystems and public health in considerable danger. The emitted pollutants—including dioxins, mercury and others—of incinerators are highly toxic. No national statistics demonstrate how many incinerators in China satisfy international environmental standards and the communities near incinerators have no access to information about emissions.

THINKING LIFECYCLE INSTEAD OF BURNING

Even though quite a few advanced management models, policy tools and new technologies have been developed to assist decision-makers to tackle MSW issues over the last decade, the major solutions still focus on recycling, composting, burning, and landfill. The latest approaches based on life cycle assessment and cost-benefit analysis of environmental and social impact have demonstrated that in order to minimize the negative effects of MSW, the top-tier management priorities should be source reduction, efficient separation during collection, and increased recovery and recycling. The second-tier priorities should be composting and building well-lined landfills with biogas collection. Incineration with the latest technology to minimize pollution is generally seen as the lowest priority (De Feo & Malvano, 2009; Hanandeh & El-Zein, 2009; Diaz & Warith, 2006).

Because environmental regulations, technology, financial capacity, natural resource profiles and historical situations are diverse, prioritization of MSW methods varies among countries. For example, the incineration rate is high in Japan and many western European countries due to land constraints. But in the United States, where land is relatively abundant, landfill is the dominant method. The higher incineration rate of MSW in developed countries is attributed to limited land resources and an initial lack of understanding of the negative impact of incinerators. Today, stricter environmental regulations that were driven by pressure from environmental groups and the general public inhibit the use of incinerators. The argument by some incineration developers that waste burning provides renewable energy has not swayed new investment by governments in most industrialized countries. In the European Union (EU) most countries strongly favor recycling over incineration in terms of energy saving and the EU Commission maintains that incineration as an energy recovery method is secondary to reduction and recycling.

In addition to its environmental downsides, incineration is also much more expensive than landfill. The international average cost to incineration is about $150 per ton, compared to $30 per ton to landfill (Word Bank, 2005). Incinerators also discourage resource recovery and recycling of the waste flow. China's MSW has lower caloric value per unit than that of OECD countries, as organic materials account for about 50 percent of China's total MSW. This trend will not change greatly from now to 2030 (World Bank 2005, OECD, 2009). This heavy organic proportion means that China's incinerators have much lower burning efficiency rates than those of developed countries. To help improve combustion, Chinese incinerators are allowed by China's Regulation on EIA in Biomass Generation to add up to 20 percent of coal content in waste incineration projects (ADB, 2009). Of 72 incinerators in operation in June 2007, nearly one-third added 20-40 percent coal to support the combustion efficiency, which creates significant problems in controlling ash and toxic emissions (Chen et. al, 2009; ADB, 2009). More significantly, low environmental emission standards and weak environmental enforcement in China make the public increasingly worried about the capability of the government in holding the pollutants of stack emissions, bottom-ash, and fly-ash at safe levels in existing and future incinerators (Chen et al., 2009; Word Bank, 2005). Facilities to remove ash and toxic materials are very expensive, particularly for dioxins, which are also the most harmful. Some conflicts between local communities and developers of incinerators have indicated that there is not an effective legal framework for stakeholders to participate in the decision-making process for incineration projects. Without public involvement and transparency it is highly questionable that Chinese authorities can regulate MSW incineration as a type of renewable energy generation, let alone gain public support to build a large numbers of incinerators (National Renewable Energy Development Plan, 2007).

PONDERING THE CARBON FACTOR IN MSW MANAGEMENT

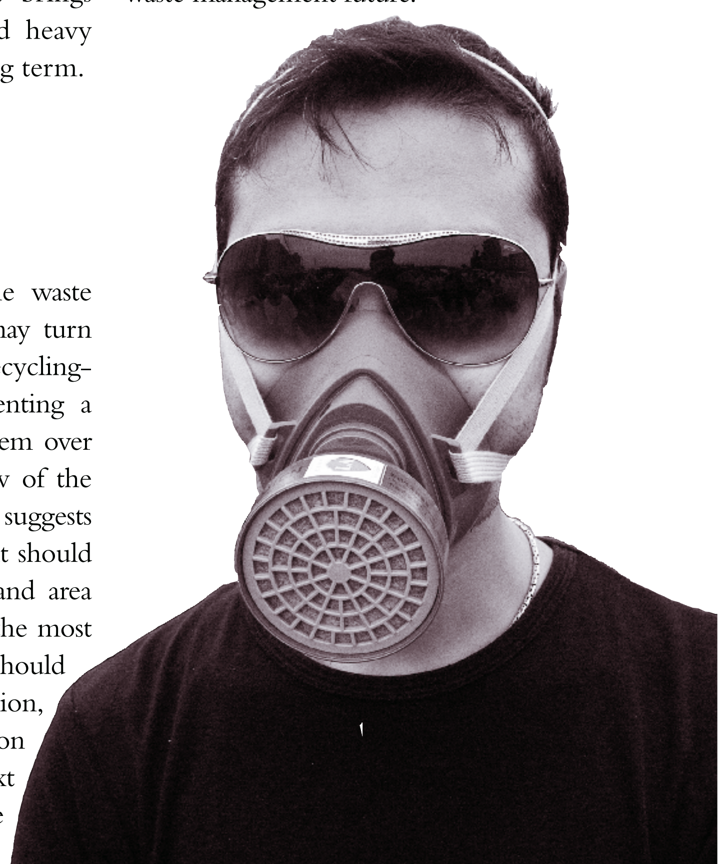
International climate change policy schemes such as the Clean Development Mechanism (CDM) allow developing countries to obtain financial support from developed countries by applying renewable energy technology,including small hydropower, wind power and solar energy. Chinese MSW incineration projects have started to apply for carbon credits through CDM. The National Development and Reform Commission approved an incinerator in Wuhan to be eligible for CDM in 2008. The CDM fund appears to have become another stimulus for the growth of MSW incinerators in China. However, developing a CDM methodology for MSW incineration projects will significantly increase the cost of building incinerators thanks to strict regulations on environmental emission standards under the CDM. Until now, no incineration project has been awarded carbon credit under CDM (CD4CDM, 2009). As green groups raise their voice against the marriage of CDM with MSW incineration, the green washing efforts of MSW incinerator developers will be difficult. Meanwhile, methane collection and power generation from landfills is a comparatively efficient and cheap way to fight greenhouse gas emissions from waste. One such landfill project in Guangdong Province has successfully obtained CDM funding (Nan Fang Daily, 2009).

Even without CDM support, Chinese developers and policymakers emphasize the carbon reduction effect of MSW incineration, particularly for the future when China will

A glimpse at some incinerator and landfills in Beijing area.Photo Credit: Mao Da have to meet international climate policy obligations to cut greenhouse gases. However, studies indicate that even if the possible emission reduction effect of incinerators is considered, incineration still compares unfavorably against other waste management strategies. In analyzing carbon emissions from 11 different types of MSW systems, Hanandeh and El-Zein (2009) found that burning all waste without efficient separation and collection is the worst choice as it is the most polluting and least economically efficient. Unfortunately, most cities in China have not established a productive system to separate, collect and recycle MSW (Jiang & Wu, 2008; World Bank, 2005). A number of research efforts, which take into account the carbon emission reduction effect of incineration, demonstrate that incineration is still the worst option for MSW management as it brings unbearable environmental impacts and heavy economic and social burdens in the long term.

HOW TO BEGIN THINKING DIFFERENTLY ABOUT WASTE MANAGEMENT

With the boom of incinerators in the waste industry, China's MSW management may turn away from a source reduction and recycling-based approach, and look to implementing a landfill and incineration-dominated system over the next twenty years. This brief review of the latest thinking on MSW management suggests that truly sustainable MSW management should not follow this path. China's massive land area makes landfill an easier option; but for the most benefit in the long run, Chinese cities should first prioritize source reduction, separation, recovery, and recycling. Anaerobic digestion and composting should be the next priority and current landfills must be better managed with increased methane collection and power generation. Finally, incineration should be an option only if an efficient separation and recycling system is established and emission of incinerators is effectively regulated. Even in the context of tackling global warming, these priority rankings will not change. In order to prioritize more preventative waste management approaches, Chinese cities will have to divert financial resources and policy incentive away from the end-of-pipe measures, namely landfill and incineration. In addition, a legal framework should be provided to address conflicts of interest among different stakeholders, with a priority on protecting and empowering communities. While challenging, it is crucial that legal institutions are created to prevent business groups from overly influencing local authorities in MSW decisions. A good start would be to require that incineration plants make their emission data public. Only real political will and action and not just lip service can reverse the current trend towards an unsustainable waste management future.



In the run up to the Olympics, residents in the affluent Changying district in east Beijing who live near the Gaoantun landfill and waste incineration facility took to the streets in an escalating campaign against the city's biggest dump site. Residents claimed that this facility was polluting the air with a foul stench and dangerous dioxins.
Photo Credit: Jonathan Watts, author of new book *When a Billion Chinese Jump: How China Will Save Mankind—Or Destroy It*

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The Gun Shoots The Bird That Sticks Out

By Xiu Min Li

In Green Eyes' Wildlife Rescue Center in Cangnan, Guangdong Province there is a small eagle that was rescued many months ago. He is skinny with dark black feathers and can no longer fly. This once great bird is relegated to walking in a cage that he shares with two peacocks and a duck. Although mostly healthy, the bird nonetheless appears anxious and neurotic. He walks back and forth in the same spot and his head twitches every step of the way. Volunteers believe he ate something poisonous and is suffering from some form of neurological disorder.

The twitchy bird oddly returned to my mind as I chatted with Fang Minghe, Green Eyes' founder and director, about the state of grassroots nongovernmental organizations (NGOs) in China. The sector is both thriving and anxious. On one hand, people working in green NGOs are excited by the Chinese government's increasing prioritization to protect the environment and the international community's attention and funding of grassroots groups that are addressing China's immense environmental problems. On the other hand, there is a fear that too much success of a Chinese NGO might illicit the attention of political entities or individuals in China that perceive the sector as a threat.

While Western NGOs normally highlight media coverage of their accomplishments to boost their reputation, some environmental activists try their best to stay under the radar. When Green Eyes won a landmark victory in March 2009 and rescued a gray nurse shark, Fang was wary and unwilling to answer a few eager questions from an international paper. When I asked Fang to explain his reaction, he stated simply, "the gun shoots the bird that sticks out." This popular Chinese saying refers to the risks of being too conspicuous in one's public conduct.

BREAKING OUT OF THE CAGE

Sometimes Chinese NGOs must tread cautiously and anxiously like the caged bird and activists feel compelled to carefully avoid any missteps and hush themselves when they think they may be making too much noise. However, there are signs of more openness among Chinese green groups. For example, in early 2009, the Gansu NGO Green Camel Bell tried to utilize the new Environmental Information Disclosure Regulation to request a list of polluting enterprises from a local Environmental Protection Bureau (EPB). The Green Camel Bell staff received a phone call and an invitation for an in-person meeting, at which EPB officials told them that the information could not be released at the moment due to its potential impacts on companies that were already crippled by the economic downturn.

The EPB's open reception marks progress from the organization's early days when Green Camel Bell engaged in a campaign to prevent the city from shutting down one of Lanzhou's popular electric bus lines. Aside from refusing the organization's request for information regarding the government's reasoning behind the decision, official strongly "advised" Green Camel Bell to stop engaging in its "disruptive advocacy."

In early 2009 some of my other Pacific Environment colleagues and I visited another NGO's project site in a southern city, where local efforts recently shut down three polluting factories after a two-year campaign. However, our presence generated official paranoia that evidently lasted for months. The local NGO's campaign leader was summoned to meetings with high-ranking officials and cautioned not to get involved with foreign organizations. The officials further claimed to be aware of some articles that were published in foreign papers about our visit, but refused to cite their sources. The leader became anxious that we had written something that had put him in political danger. Clearly, the goal of the officials was to create mistrust between locals and outsiders and to discourage cooperation.

Small NGO leaders regularly lament to us that groups like theirs do not have the protection many Beijing NGOs enjoy. They can not advocate against polluting enterprises or local government violation of environmental regulations with the same fanfare and aggressiveness as bigger Beijing groups like the Institute for Public and Environmental Affairs and the Center for Legal Assistance to Pollution Victims. This view is widely shared among young environmental activists operating outside of major cities like Beijing, Shanghai or Guangzhou.

However, two recent incidents of government harassment of well-known NGOs in Beijing demonstrate that no one is immune from sanction when the political wind changes direction. In June 2009, authorities practically shut down two NGOs—Yirenping (a group fighting discrimination against HIV-AIDS infected individuals) and Open Constitution Initiative (a group focused on rule-of-law issues)—based on allegations of tax and registration irregularity. In the same month the government disbarred 50 lawyers known for being active in politically sensitive advocacy work. Intense and arbitrary scrutiny such as this critically affects the growth and effectiveness of grassroots civil societies in China.

ACTIVISM WITH CHINESE CHARACTERISTICS

Local NGOs are already careful at cultivating their role as a constructive force within the environment they operate. The successful ones build strong connections, or guanxi, with the government, media and academic institutions. It is what one Chinese observer described as "activism with Chinese characteristics." Once guanxi is established, the NGOs can be effective in their own ways.

Green Eyes is perhaps one of the more successful groups engaging in such activism. In the mere decade since its founding, Green Eyes has built a remarkable reputation among key stakeholders in its home province of Zhejiang. Fang and some of his staff are environmental lecturers officially designated by the Wenzhou EPB's Propaganda Department to regularly speak to schools and universities about environmental protection.

In our brief three-day visit in March 2009, I witnessed how Fang Minghe was able to tap on his good reputation in helping local officials and educators in environmental education to help his group obtain critical resources for his organization. The Cangnan Education Bureau Chief donated a vacant school to Green Eyes, enabling them to expand their Wildlife Rescue Station and help supplement the work of the bureau. The Wenzhou City University also provided them with a free office on campus to enable them to expand their environmental education work with youth. The new office unveiling ceremony was marked with fanfare and captured with a photo story published in the Wenzhou Metro Post.

After building a strong reputation in Zhejiang, Fang expanded into Guangdong and formed the South China Nature Society

David Gordon, director of Pacific Institute, meeting with students who work at the Green Eyes Wildlife Rescue Station in Wenzhou City, Zhejiang Province.
Photo Credit Xiu Min Li

(SCNS). Utilizing their experience working with local governments in Zhejiang, Fang and his team regularly visits the Guangdong EPB to report on their work and he proactively seeks consultation on their projects. These efforts helped build a strong cooperative foundation with the EPB, which designated a liaison to receive SCNS and provide information and guidance for this NGO's work.

Within two months of opening its door, the Guangdong office garnered attention in March 2009 and literally caused a sensational stir among the "eat-anything" Cantonese for saving a gray nurse shark from being served as shark fin soup. SCNS volunteers appealed for public support with a parade through the streets of Guangzhou and received monetary donations from citizens and positive reception from the media. The restaurant owner went from being stridently dismissive of their efforts to ceremoniously announcing their decision to give up and donate the shark to the Guangdong Aquarium. However, this success did not go unnoticed and Fang's staff has since been directed to tone down their work by government representatives.

As China develops its economy, the society must recognize the inevitable growth of NGOs and the value of their presence. Globally and within China NGOs have proved to be effective agents for incremental changes that benefit both society and government. The list of accomplishments by Chinese NGOs is long and growing. For example, domestic organizations like IPE have created successful tracking systems to monitor polluting enterprises and local implementations of environmental laws; others have built organic water treatment system that successfully cleaned up polluted farmlands and fish ponds; and some are engaging in large-scale projects to adopt alternative energy that are fundamentally changing how rural economies operate.

All things considered, China's local governments can and will benefit from supporting local NGO efforts. Furthermore, the national government can and should do more to enable and protect these grassroots environmental efforts, specifically by reforming the current registration regulations that inhibit the growth of the NGO sector and encouraging local governments to collaborate more with NGOs rather than to simply monitor them. These changes would help promote the independence and self-governance of NGOs and undoubtedly be more constructive than "shooting the bird that sticks out."

Xiu Min Li is Pacific Environment's China Program Co-Director. Li was born and raised in Southern China. Her love for the environment comes from hiking in the beautiful redwood forests while attending UC Santa Cruz, where she obtained her BA in Sociology. Prior to joining Pacific Environment, Xiu worked for 5 years as a labor union organizer in San Francisco and gained valuable skills in community organizing. Xiu traveled extensively in China while living and studying in Beijing, where she worked on research projects relating to the social impacts of urban development. She can be reached at: XmLi@pacificenvironment.org.

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COMMENTARY

Greenlaw and the First Year of China's Open Environmental Information Regulations

By Hu Yuanqiong (Translated by Michael Zhang and Jacob Fromer)

On October 5, 2008 the Beijing office of the Natural Resources Defense Council (NRDC) re-launched a newly revamped Greenlaw (www.greenlaw.org.cn) website, which aims to disseminate current information on environmental law and citizen participation in environmental policy developments in China. The Greenlaw website previously sent out two to three updates a week, however the older website was unable to keep up with explosion of news stories and policy developments after the Chinese Ministry of Environmental Protection (MEP) issued its Open Environmental Information Regulation (for Trial Implementation) on May, 1 2008. Today the Greenlaw site posts daily updates with hundreds of news pieces about open information and nearly a quarter of all the environmental law-related blog posts are about open environmental information.

The State Council's Regulations on Open Government Information that was issued on May 1, 2008 sets legal obligations on the Chinese government for open government information. MEP's Open Environmental Information Regulation appeared as the first implementation measures issued by a government bureau and notably linked the required disclosure responsibilities for enterprises to the cleaner production promotion laws. The open environmental information measures promise to be the proverbial hammer that will smash the wall between polluting enterprises and the public, turning China from a country that singled-mindedly emphasizes economic growth to one that focuses on sustainable development. While these measures represent a significant potential for improving China's environmental governance institutions, there are still challenges to be confronted. Looking back at the past year reveals a developing legal regime where the circumstances remain quite complicated.

THE GOVERNMENT AND THE PEOPLE GROW UP TOGETHER

If one views the Yuanmingyuan Park leak proof project debate four years ago to be a positive start in generating meaningful legal dialogue between the public and the State Environmental Protection Agency, then the Xiamen PX episode two years later marked an even greater high point in the advancement towards effective dialogue. In 2008, following the official implementation of the Open Environmental Information Regulations, various environmental protection NGOs had issued local citizen guides on open environmental information and public participation, in addition to conducting round-table conferences and training activities.

Moreover, these environmental NGOs also began to test the law in practice. In October 2008, when the All-China Environment Federation hosted its annual meeting on sustainable development for environmental NGOs, many of the attending organizations, lawyers, and legal experts shared their experiences with the new open environmental information laws. For example, Greenpeace (2008) discovered in its "Investigation on Enterprise Pollutant Information Disclosure" that the BASF

Corporation was not as transparent with its environmental record in China as it was in other countries. Greenpeace then submitted an application to the Shanghai EPB seeking disclosure of BASF's emissions figures. Their attempt at accessing this information failed, though it raised a series of questions for the Chinese public and legal experts that still require answers: First, is the current system for publicizing an enterprise's environmental record enough to satisfy the public's right to that information? Second, how to define business secrets that can be omitted from emission information of enterprises?

There also was some positive results in the first year of implementation. In August 2008, Friends of Nature joined together domestic environmental NGOs to investigate the Gold East Paper Company—a highly polluting enterprise seeking an Initial Public Offering (IPO)—about its environmental protection record (Hu, 2008). In March 2009, the Ministry of Environmental Protection fulfilled its obligation to disclose such data when it informed the public about its own investigation of the Gold East Paper's attempts to join the market and gave clear and open answers to the questions raised by the environmental NGOs. Although the emissions of Gold East Paper still remain a concern, this move by the MEP is worthy of praise.

On June 3, 2009, the Beijing-based Institute of Public and Environment together with NRDC launched China's first civil society evaluation index on government's environmental information disclosure performance—Pollution Information Transparency Index (PITI)—and its ranking results for 113 cities in China. (Wang, 2009) By evaluating what the city EPBs have disclosed according to the laws, PITI gives quantitative articulation identifying the progress and gaps in the implementation of open information in environmental sectors. PITI thus shows an innovative way of using open the information law for better environmental governance in China.

The actions of legal professionals have aided the advancement of environmental information disclosure. On May 5, 2008, mere days after the enactment of the open information regulations, Shanghai lawyer Yan Yiming filed an environmental information disclosure request, thus initiated the legal world's push for more transparency in environmental information.

In the first year, what mattered most was getting the public focused on gaining greater transparency with environmental information. For NGOs, there is no longer the excuse of not having legal support; the question now lies more on how to make the law effective. For legislators, the dialogue process between the government and NGOs provides additional assistance towards implementing legislative goals effectively and quickly, including fixing legal loopholes and clarifying ambiguities vulnerable to exploitation. For the government, there is no longer time to slowly nudge the notion of change, because the new openness has become a legal obligation.

THE SLOW DEVELOPMENT OF THE COURTS

After May 1, 2008, five citizens of Rucheng, Hunan Province initiated China's first open information suit (Chen, 2008). But one month later, the the Chenzhou court still had not taken up the case (Zhao, 2008). The public worried that if the justice system stayed silent, then these new open information laws would serve nothing more than a decorative function. But perhaps this was only a reflection of transition difficulties, because on October 10, 2008, the China Youth Daily and Beijing Daily successively released reports of citizen victories in seeking information disclosure from the Hubei and Zhejiang provincial governments(Hu, 2008). Before the deadline, Hebei's Baoding City also ruled in favor of some of its citizens seeking open information from the government.

Although we cannot view the actual environmental information case reports, these aforementioned cases will undoubtedly provide an opening for those who have been seeking to shine light on open environmental information. The open information judicial decisions to date have only addressed a small fraction of the problems that hinder effective implementation of the law faces, but it is worth waiting for the courts to become an even more powerful force in pushing for the legal development of open environmental information.

A CAUTIOUS RESPONSE FROM ENTERPRISES

In 2008, 250,000 people in Guangzhou submitted applications to the government for open information (Wu, 2009). This case demonstrated a progressive government image in dealing with increasing public demands. Comparatively, a few of the major enterprises who fall under the new transparency rules are simply turning a cold shoulder towards information disclosure requirements.

During Greenpeace's campaign, BASF was arrogantly silent the whole time and has still not yet taken the initiative to voluntarily disclose its environmental information. From last June, IPE led more than ten environmental NGOs in publishing the "Enterprise Environmental Information Disclosure Alert Letter ," directed at over 30 manufacturers in China who were determined by the government to conduct mandatory clean production audit. According to the open environmental information regulations, these enterprises are obligated to publicize detailed pollutant emissions information. Otherwise, the penalties include fines and forced disclosure by EPB. But only a few enterprises actually followed the regulations, with most choosing to simply stay silent, and the conduct was not punished.

Within these grey areas, the attitude of enterprises towards open environmental information remains vague and conservative. Luckily we still saw some, though limited, shining points. On June 5, 16 companies from Tianjin economic development zone released their information voluntarily, marked a hopeful start for future development (Li & Wang, 2009).

THE MEDIA HARD AT WORK

On March 31, 2009, for the first time since the official enactment of the "Regulations on Open Government Information" and "Measures on Open Environmental Information (for Trial Implementation)," government bureaus began releasing their legally-mandated annual open information work reports. In the beginning of April, Caijing (Lan & Qin, 2009), the Investigative Daily (Zhi, 2009), and some other media outlets published commentaries on the annual reports. Reports revealed that many ministries and bureaus under the State Council had not fulfilled their obligations to release their annual reports on time. In the same month, using the information from the work reports, the media (Song, Deng & Wu, 2009) exposed the challenges open government information continues to face. For example, while 250,000 applications for open information were submitted in Guangzhou in 2008, one nearby city received only one application in all of 2008 (Wu, 2009).

There were many factors that made 2008 an extraordinary year, and the media played an irreplaceable role in following the implementation of government transparency. The prompt follow-up reports to some legal cases, as well as commentaries on the cases by experts and newspapers, were key in spreading awareness and usage of the new regulations. Discussions of the range and validity of open information (Zheng, 2008), analyses of the practical legal problems (Huang, 2008) related to open information, and dialogues on how to improve the existing system (Sohu, 2008) all shed light on the main issues in the first year of the open information regulations. But even still, most newspaper reports seemed half-hearted and shallow. This does not meet the enormous public demand for open information. As the law continues to develop, the media must get involved even more deeply.

FUTURE IMPLICATION ON ENVIRONMENTAL HEALTH ISSUES

2008 also marked a year of reports on environmental health cases. While nontransparent information has caused public furies on severe pollution incidents in the past, several reported incidents about children blood lead poisoning caused by industrial pollution again turned public attention to information of environmental health. Lawyers and experts have started looking at it from the information transparency perspective, reasoning that lacking of information may cause low awareness of public and weak supervision on the polluters (Du, 2009).

With reviewing the one year law implementation, we believe that information transparency can do more than it has been doing in China in promoting a greener development and safeguarding people' well-being.

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FEATURE BOX

Sino-Italian Energy and Environmental Cooperation

By Natalie Matthews

In October 2007 a stunning ten-story C-shaped green building was unveiled on the Tsinghua University campus—the Sino-Italian Ecological and Energy Efficient Building (SIEEB). The highly resource efficient building, which is the product of four years of collaboration between Italian and Chinese energy experts and architects, utilizes natural ventilation and lighting, renewable energy, and reclaimed water. Key in the building's low-carbon design is the over 1,000 square meters of photovoltaic panels.[2] SIEEB houses not only Tsinghua University's Department of Environment and Technology, but also the Sino-Italian Cooperation Program for Environmental Protection (SICP). The building is designed to be the center for teaching, experiments, research and Sino-Italian environmental technology exchanges as well as a model for future Chinese eco-building construction.

In September 2010, SICP hosted a series of international workshops at the Shanghai World Expo's Italian Pavilion that highlighted eco-friendly technologies, climate change and sustainable development, as well as progress in the Sino-Italian environmental and energy cooperation over the past decade.[2]

FOUNDATION OF THE BILATERAL GREEN PARTNERSHIP

The SIEEB green building project is just one of the many environmental cooperation initiatives between Italy and China since the SICP was launched in 2000 by the Italian Ministry for the Environment, Land and Sea (IMELS) and China's State Environmental Protection Administration (now Ministry of Environmental Protection/MEP). Since 2000, cooperation has expanded to many other government departments, universities, research institutes and enterprises. The focus of SICP is primarily high-level technical cooperation to create on-the-ground initiatives with Chinese national institutions and municipal authorities. To facilitate projects, a Joint Program Management Office was established in Beijing coordinated by the Italian Trade Commission.

Bilateral work on energy and environment tends to be more technology focused and takes a three-pronged approach: pilot projects; cooperative research programs; and capacity building exercises. Over the past decade, more than 200 projects have been carried out by the two partners and their affiliates in a wide variety of areas. The total value of on-going and past projects is $438 million, nearly half of which was co-financed by IMELS and multilateral funds.[3] Early cooperation projects included plans to green the Beijing Olympic Village through a solar energy system, constructing a solar village in Inner Mongolia, and testing emissions-reducing technology for vehicles in Beijing. Beginning in 2003, cooperation between IMELS and SEPA helped Haier Electric Appliance Company eliminate CFCs in the refrigerator manufacturing process. IMELS and Tianjin's Haihe Economy Development

Office cooperated in a master plan for restoring a wide industrial area near the center of Tianjin for business and community use. The master plan was presented to local authorities in April 2008 and it notably includes plans for an Italian park to serve as a model of environmentally sustainable public space.

SICP's most recent agreement with China's Ministry of Environmental Protection is to develop pilot projects in selected areas affected by pollution from energy production and utilization as well as other environmental issues addressed in international protocols and conventions. On the joint research project front there is an agreement with the Chinese Academy of Social Sciences to undertake a strategic assessment of the future of energy and the environment in China in 2020. The project will start from an evaluation of the structure of energy consumption in the last ten years.

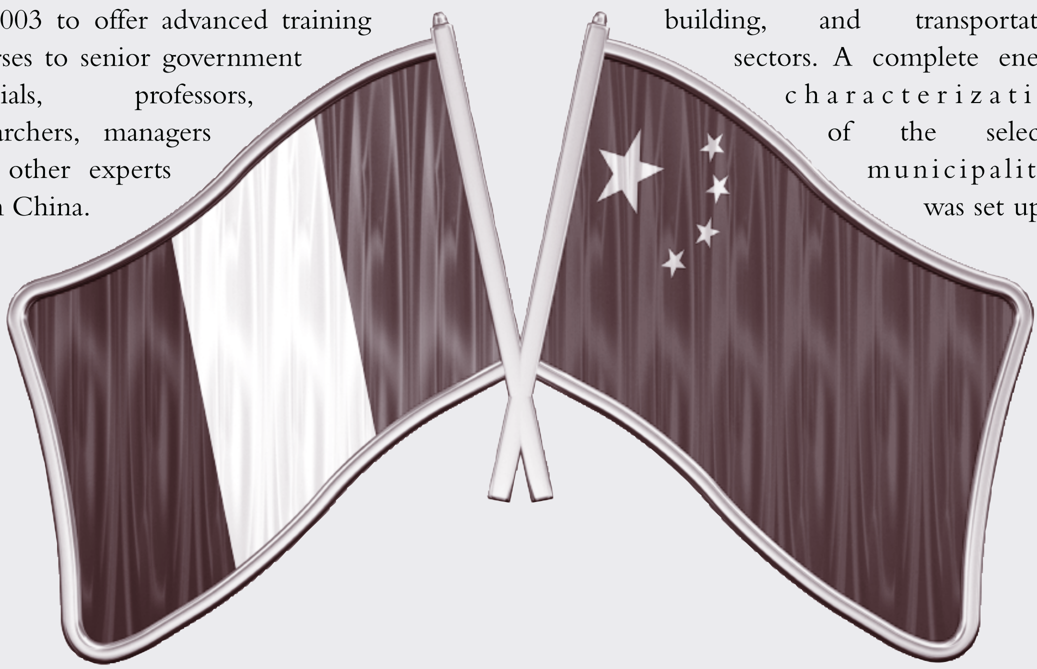
Current areas of SICP cooperation with the Ministry of Science and Technology focuses on joint ventures for producing polycrystalline silicon wafers for solar energy (the Solar Village Project); coastal zone management; and capacity building for using the Clean Development Mechanism.

In the area of personnel and policy capacity building, Venice International University began a Sustainable Development and Environmental Management Advanced Training Program in 2003 to offer advanced training courses to senior government officials, professors, researchers, managers and other experts from China.

SUSTAINABLE RECONSTRUCTION AND URBAN ENERGY PLANNING

Italy is also responsible for the first international cooperation project for earthquake reconstruction in Gansu Province. The only landfill in Wudu district of Longnan city was damaged in the May 12, 2008 earthquake. The earthquake damage to waste disposal and treatment facilities was threatening the local environment, particularly groundwater. Italian researchers have partnered with counterparts at Lanzhou Jiaotong University and local institutions to carry out a program to evaluate the environmental damage, set up a groundwater monitoring system, and help guide local officials in the reconstruction of the landfill. The partners in this project also have been planning a sustainable waste management system that will be integrated into the overall urban reconstruction plan.

The recent Urban Energy Planning for Sustainable Development (ENP) initiative was charged with identifying and evaluating optimal solutions for Chinese municipalities to reduce CO_2 emissions and to improve integrated environmental quality in the long run. The project began by selecting three second and third-tier municipalities: Jinan, Suzhou, and Taiyuan, which represent a cross-section of energy efficiency challenges in industry, building, and transportation sectors. A complete energy characterization of the selected municipalities was set up to



gather the fundamental information of the main energy consumption sectors and possible energy efficiency improvements.

The methodologies and outcomes for energy efficiency in these municipalities are being disseminated through an English-language publication and the recently unveiled online "energy portal" that guides users through energy assessment steps. The website (www.e2-china.com) is designed as a platform to promote information sharing on energy efficiency development in China's industrial sector. Chinese industry practitioners who are registered on the site find and exchange technical information with international experts. The ENP initiative's success has sparked ideas for future projects, such as selecting new pilot municipalities, a demonstration project for boiler energy efficiency improvement, and assessing the potential for CDM project implementation in each of the industrial sectors the initial project investigated.

For more information on the Sino-Italian Cooperation Program for Environmental Protection See: www.sinoitaenvironment.org.

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COMMENTARY

Eco-Farming: A Long-Term Strategy for Dealing with Climate Change

by Pan Wenjing (Translated by Ada Wu)

HOPE IN DISASTER

In 2006, huge waves of rice planthoppers attacked blocks and blocks of rice paddies in Yixing, a town famous for its clay teapots in Jiangsu Province. Farmers in Fenghuang Village had to spray the rice paddies with pesticide doses several times stronger than usual. Some villagers even turned to highly toxic pesticides for help. However, pesticides could not conquer the bug infestation. Desperate farmers had to burn down rice paddies that had been destroyed beyond recognition. Among all the farmers in the village, only Wang Falin's crops were spared, not due to any effective use of pesticides, but rather because of his "duck corps." Using a typical ecological farming method—raising ducks in his rice paddies—Wen Falin took good care of both ducks and the rice paddies. Rice planthoppers survived the pesticide sprays, but could not escape the hungry ducks. Weng Falin's duck corps successfully defeated the hoppers, rekindling his hope for a good harvest.

The Spring Festival of 2008 left many Chinese with profound memories. A snow and ice disaster froze almost half of China. In the countryside of Guizhou Province which was hit by the disaster, people sat in ice-cold darkness waiting for the government to restore electricity. On farmland just steps away from their homes, crops lay frozen and dead. The livelihoods of villagers would inevitably be affected by the snow disaster. But in a village called Wayao, a flame of hope was burning warmly in the hearts of villagers who has been practicing eco-farming methods. Under the guidance of agronomists, villagers had built a methane system, used organic fertilizers from the system and other sources, and employed straw coverage technology to protect their crops. The snow and ice disaster made the superiority of eco-farming evident: when many other villages were covered by darkness, the methane system in Wayao was providing clean energy for villagers. When the surrounding villages had no crops to harvest, leeks and Romaine lettuce carefully protected by the coverage technology survived and grew abundantly, offering the villagers of Wayao hope.

In the beginning of 2009, An Jinlei, a farmer from Hebei Province was doing what he usually does that time of year—looking after his wheat seedlings, which would soon turn green. A drought that was occurring in the area seemed to have no influence on his farmland. Local people who had not seen a drought like this in decades watched helplessly as their wheat seedling dried out and died. But that was not the case for An Jinlei, who started practicing organic agriculture more than ten years ago. After so many years, his farmland had developed into an ecosystem full of vitality. The soil structure was healthy and nutrient-rich with good air permeability and had a strong capacity to retain water, which in turn helped the crops resist drought. Unlike Jinlei, other farmers in his village stuck to conventional chemical farming that relies heavily on the use of chemical fertilizers and pesticides. When the drought came, their farmland became extremely dry, but in Jinlei's field, after digging 30 centimeters down to the earth with a hoe, the soil was still moist (Qiu , 2009).

THE REAL THREAT OF CLIMATE CHANGE TO AGRICULTURE

Climate change effects like high temperatures, extreme weather, and plant disease are affecting agriculture and livelihoods all over the world. China is the world's largest producer of agricultural products and climate change poses a great threat to the country's food safety. In recent years, news stories about the adverse effects various disasters have had on agricultural production frequently appear in the Chinese news media with the link to climate change highlighted as a growing problem. As this article was being written in 2009, almost all the areas of food production in China were facing the second major drought that year.

According to a Climate Change and China's Food Safety report issued by Greenpeace and China's Agricultural Academy on October 16, 2008, the World Food Day, "temperature increment, agricultural water reduction and the diminishing cultivated area will cause China's total grain output to drop 14 to 23 percent compared with the 2000 level (Zhu Hui et al. 2008)." With these stark figures, the report underscores how climate change is endangering China's food safety.

VICIOUS CYCLE

Chemical farming methods that rely heavily on chemical fertilizer and pesticide still dominate China's agriculture, though chemical agriculture can further intensify the effects of climate change. Long-term, intensive use of chemical fertilizers and pesticides has already placed a heavy burden on China's environment: water pollution, greenhouse gas emissions, soil pollution and hardening, and endangered biodiversity. Unwittingly, China's agriculture has fallen into a vicious cycle.

Perennial use of pesticides has made many agricultural pests resistant to chemicals. A large number of natural predators (such as insects, amphibians and birds) that prey on pest species are also killed. In order to get rid of harmful pests which are increasingly difficult to destroy, farmers spray pesticides in greater amounts and with more toxicity. The seemingly easy solution causes harmful pests and germs to develop stronger resistance to chemicals, leaving farmers with little recourse. Climate change alters the distribution range and occurrence patterns of agricultural pests and makes both more unpredictable (FAO, 2008). The majority of farmers still turn to pesticides when facing these problems. But like Wen Falin's fellow villagers, they are still unable to deal with unpredictable pests and plant diseases.

Compared with the vicious cycle of using pesticides (e.g., heavier pesticide use contributes to increased resistance in insects and diseases, which then leads farmers to apply more pesticides), the cycle involving synthetic fertilizers is even more complicated. In China, chemical fertilizer is considered a resource indispensable to food production. In recent years, the chemical fertilizer industry has received government subsidies in the form of lower prices for raw materials (such as coal and natural gas), electricity, and railway transportation. Government subsidies to chemical fertilizer manufacturers not only stimulate the expansion of production but also enable farmers to purchase chemical fertilizers at a lower price, which encourages increased use. According to the 2008 Greenpeace report cited above, China's chemical fertilizer consumption rate remains high and an upward trend is apparent (Greenpeace, 2008).

The large amount of chemical fertilizers used in China cannot be completely absorbed by crops. Studies show that the chemical fertilizer efficiency rate is only 15 to 30 percent in China. Unabsorbed fertilizers can enter the water causing pollution, remain in the soil giving rise to the imbalance of nutrients, or transform into greenhouse gases (mainly nitrogen monoxide) entering the atmosphere. A large amount of chemical fertilizers will not only transform to greenhouse gases thus intensifying climate change; these agents also cause soil to harden and reduce its air permeability, making agricultural systems too fragile to survive natural disasters like drought and flooding.

When farmers face food production reduction directly or indirectly caused by climate change, they often choose to use more chemical fertilizers. This is how the vicious cycle came into being: massive use of chemical fertilizers intensifies climate change, which in turn reduces grain output thereby leading farmers to apply more chemical fertilizers. Exacerbating the situation are government subsidies to the fertilizer industry that ultimately fuels the vicious cycle. The situation in China parallels what one Greenpeace report discussed regarding government subsidies in India which is a major reason for overuse of pesticides, soil nutrient imbalance, and declining soil productivity (Roy & Reyes, 2009). Furthermore, these subsidies indirectly contribute to greenhouse gas emissions, intensifying climate change. In both India and China well-intended chemical fertilizer subsidies to help poor farmers are imposing high environmental costs.

The soil in An Jinlei's farm is healthy and fertile.
Photo Credit: Greenpeace

A NEW CHOICE

Climate change is endangering agricultural activities in an unprecedented way. As these threats become increasingly clear, seeking an agricultural plan that guarantees long-term food safety has become a topic that is attracting the attention of governments around the world.

With 1.3 billion people to sustain, China is in dire need of an escape from the vicious cycle of chemical agriculture to a better path for agricultural development. The eco-farming that has given hope to Wen Falin, An Jinlei and villagers from Wayao is an option that should be pursued. However, given the deep roots of chemical agricultural practices, support for ecological farming is far from sufficient. The sooner the Chinese government can change its mindset and support eco-farming with as much as enthusiasm and intensity as it gives to chemical agriculture, the sooner we will see positive change.

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COMMENTARY

Too Much of a Good Thing?
Phosphorus Flows and Water Eutrophication in China

By Marcy Nicks Moody

For readers of the *China Environment Series*, the following story is pretty old: At some point in the summer of 2007, we woke up, drank our coffee or tea, opened the newspaper, and probably saw images of an alien-looking lake in eastern China. Previously a source of water for as many as 30 million people, well known for its productive fishing industry, and traditionally considered one of the most lovely natural settings in China, over one-third of Lake Tai's 2,250 square kilometers had turned a sickly, fluorescent green. Locals complained about an unrelenting stench, and the cyanobacteria, which had overrun the lake, killed off many of the other things living in it. Water supplies from the lake had to be suspended, and at least two million people were left without their primary source of water for cooking, much less drinking. The price of bottled water in surrounding areas increased six-fold, price controls were undertaken, and eventually water was rationed. Less than a year later, in April 2008, it happened again. Despite the evidently anthropogenic nature of the chain of events, a natural disaster was declared, and official promises were made to clean up the lake by 2012.

Though the story is old, the problem is far from solved. As of this writing, Lake Tai still suffers from ongoing eutrophication, the same imbalance of nutrients that led to the algae outbreaks of 2007 and 2008 (Li, 2009). A study of the precise origins of the Lake Tai disaster, as well as strategies for avoiding or mitigating future such disasters, thus merits further attention. After a short overview of the industrial and agricultural activities that lead to water becoming eutrophic, this paper discusses the environmental and geopolitical challenges posed by such activities in order to explore opportunities for alleviating them.

Water eutrophication is one of China's most severe environmental challenges, and is particularly worrisome given the country's limited water supplies, with per capita resources reaching only one quarter of the world average (Xie et al., 2009). It is caused by an excess of nutrients, chiefly nitrogen and phosphorus, which promotes growth of 'choking' vegetation. This growth, known as an algal bloom, clouds the water, deprives it of oxygen, and can interfere with drinking water treatment. Organisms living in the water that need light and oxygen to survive subsequently die, and the quality of the water decreases sharply. It has been argued that phosphorus is the key limiting nutrient in water eutrophication and thus determines the rate of algae growth (Liu, 2005). Therefore, remedial actions must focus on phosphorus flows, and strategies for shifting them.

Buildup of excess phosphorus in water bodies can be caused by a variety of sources, two of the most important of which are agricultural runoff and discharge of untreated waste by municipal sewage systems. In the Lake Tai disaster, chemical fertilizers and disposal of untreated industrial waste were found to be the key culprits. In considering strategies for addressing water eutrophication in China, agriculture and waste management are thus two important places to start brainstorming.

PHOSPHORUS CONUNDRUM ON THE FARM

With regard to agriculture, it should be noted that phosphorus is not all bad. On the contrary, it is essential to all life and a key component of fertilizer. Phosphorus does not occur as a free element in nature. It is bound up in phosphate rock, which must be extracted (usually via strip-mining). Not surprisingly, the most important commercial use of phosphate rock is for the production of chemical fertilizer. There are no known substitutes for phosphorus in agriculture, and phosphate rock is not a renewable resource. That is, the world could run out of it.

With global population on track to reach 9 billion by 2040, however, demand for chemical fertilizers is unlikely to decrease any time soon. Indeed, beginning in late 2007 and continuing into 2008, the price of phosphate rock rose dramatically due to increased agricultural demand and tight supplies. U.S. prices for phosphate rock doubled between 2007 and 2008, and the 2008 average spot prices from some exporting regions were more than five times their 2007 average (World Bank, 2009; USGS, 2009). Though other factors were involved in this price increase and the price of phosphate rock has fallen substantially from its 2008 highs, increasing demand and dwindling supply suggest that prices will rise again.

Complicating this picture is the fact that phosphate's geographic distribution is highly skewed. India and Europe are net importers. Though the United States still has commercially viable reserves, they are estimated to be exhausted in 30 years, according to the Stockholm Environment Institute. The largest reserve base of phosphate rock is located in Morocco and the adjacent territory of Western Sahara. The world's leading producer of phosphate rock and country with the second largest reserve base is China. Given these circumstances, a likely scenario in the coming decades could include a complex array of geopolitical movements to control production and prices, not unlike the current political economy of petroleum. For China, then, the picture is ironic. In the ground, it has an enormous quantity of a highly valuable and very limited commodity and, for better or worse China stands to play an important role in the political economy of phosphate.

After phosphate rock is extracted and processed to create fertilizer, it is applied to agricultural fields to encourage plant growth. China has the world's highest rate of fertilizer use per unit of arable land (McKinsey & Company, 2005), but more fertilizer does not necessarily mean more productive land. Much of the phosphorus applied to agricultural fields as fertilizer becomes bound to the upper soil layer, making it unavailable for plant growth, and the only way to release it is through 'slash and burn,' which can lead to severe local pollution. Of course, runoff from fields containing excess fertilizer that has not been absorbed contributes to water eutrophication. One way to limit phosphorus flows in China, then, is to curb overuse of fertilizer. Economic realities—that is, rising prices of fertilizer—should eventually lessen problems of overuse, but environmental realities dictate that the issue be addressed now.

China has already taken two important steps in this regard. First, in 2005, the Ministry of Agriculture began promoting technologies to calibrate fertilizer usage according to the land's soil type and characteristics. This project has been estimated to save five percent of the fertilizer used nationally (McKinsey & Company, 2005), and should be continued. Second, in early 2009, the National Development and Reform Commission announced that it would remove price controls on domestically-produced fertilizers, which had been set artificially low. Though this may have happened because prices of phosphate rock have now dropped from their 2008 highs, the elimination of price caps should not be ignored. More aggressive training and dissemination of information on overuse of fertilizer should be undertaken by the Chinese government. There are notably very few international or Chinese NGOs working on this issue.

While China has large reserves of phosphate rock and substantial capacity to produce chemical fertilizers, supplies are not infinite. Worldwide phosphate reserves are estimated to be exhausted in the next 50 to 125 years, according to the Stockholm Environment Institute. Though the world could run out of commercially viable phosphate rock, phosphorus can be recycled from elsewhere in the ecosystem. Indeed, we have not always had synthetic fertilizers. Traditionally, food was consumed close to the land on which it was produced, and the human and animal wastes that are high in nutrients including phosphorus, were returned to that land in the form of manure. One way to ease the demand for phosphate rock is, frankly, to use this ancient form of recycling.

OVERCOMING THE "ICK" FACTOR

While major cities surrounding Lake Tai have wastewater treatment plants that are more efficiently run since 2007, considerable household sewage is generated from the thousands of smaller villages and towns in the basin. Untreated sewage is thus another major area in which phosphorus flows need to be addressed. However, this waste represents both problem and solution to water eutrophication in Lake Tai and other water bodies in China. Specifically, while poorly managed waste disposal contributes to water eutrophication, sustainable forms of waste management could both decrease instances of eutrophication and ease the demand for phosphate rock. To be sure, there is an "ick" factor involved. Few people like talking about their bathroom habits, and "any innovation in the toilet that increases owner responsibility," caring for its contents and turning it into compost to spread on one's garden "is probably seen as downwardly mobile," observes Carol Steinfeld, an importer of composting toilets (George, 2010). But sustainable waste disposal is particularly important in the developing world, where 80 to 90 percent of sewage is discharged untreated into nearby waters, according to the U.N. Environment Program. At some point, whether because of expensive fertilizers, severe degradation or crippling limitation of water resources, people will need to overcome disdain for composting toilets, which can be used to produce fertilizer or with biogas facilities also generate electricity.

In China, there have been forays into sustainable waste management, with some success. In Dongsheng, Inner Mongolia Province, for example, where water resources have already been highly stressed, the local government partnered with a private construction company and several other organizations to install dry composting toilets and an associated decentralized system of wastewater treatment, which would decrease household water usage, prevent water contamination, and provide an alternative to chemical fertilizers. The project was

undertaken in several residential buildings, and became fully operational in 2007. However, that aforementioned ick factor—what might be termed social or cultural barriers—was too high. Dongsheng now plans to replace their dry toilets with the traditional variety, though the local government will continue to use the less energy intensive decentralized wastewater treatment facilities. In Guangxi Province, however, where water and financial resources are also highly stressed, UNICEF, the Red Cross, and the Swedish International Development Agency have supported the installation of over 650,000 dry composting toilets, with fewer signs of rejection and plans for more. A similar project completed in 2009 in Shaanxi Province seems to be more in line with the experience in Guangxi. (Editor's Note: See Commentary by Yan et al., on biogas projects in Chengdu). There are notably not yet many such projects to address household waste in Lake Tai.

Water eutrophication poses a serious challenge to water security in China, and scarcity of phosphate rock will likely pose a serious challenge to food production for both China and the world. Curbing overuse of synthetic fertilizer to conserve scarce resources and managing waste to mitigate further demand for those resources can help address the water crisis in China. It will take more efforts of farmers, NGOs, countless government agencies at all levels to begun to address these challenges, but there is much work still to be done, particularly in Lake Tai.

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Local Understanding of a Melting Glacier:
Conversing with Lamas and Circumambulators in Shangri-La

By Zhou Lei

The news of glacier melt is finally being given more attention in the media, but for most people in the world glaciers are still something far away and abstract. While the speed of glacier melt due to global climate change is debatable, for those living near these impressive ice giants their disappearance is a very real and frightening trend. I am in a way fortunate to have become acquainted with a community of people who live and worship in the shadow of one of the fastest melting glaciers in the world. Located in northwestern Yunnan Province, the Mingyong Glacier on the Kawadgarbo Peak of the Meili Snow Mountain is one of Tibetan Buddhism's eight sacred mountains. The area is considered by some the real Shangri-La and every year thousands of Tibetan pilgrims come to circumambulate this holy mountain.

The Mingyong is in Deqing County where local officials regard the glacier as a quintessential tourist destination that woos both Chinese and international travelers. However, this tourism cash cow is rapidly disappearing due not only to global climate change but also to tourism activities and inappropriate infrastructure building. Located a mere 2,700 meters above sea level, the Mingyong Glacier is at the lowest elevation and latitude among all of China's glaciers. One researcher from a local meteorological research center voiced concern that the Mingyong Glacier has shrunk by at least forty meters over the past thirteen years and the Meili Snow Mountain will likely be deprived of all the snow cover within 80 years if global warming trends continue. The annual average temperature in Shangri-La County has risen from 4.8 degrees Celsius since 1990 to 5.2 degrees in 2006. Barry Baker, a climate change modeler for The Nature Conservancy concurs with these claims, noting that "northwest Yunnan—which has one of the most diverse temperate ecosystems on Earth—is threatened by rising temperatures, the magnitude of which doubles the average global trend" (Fetzer Sheehan, 2010).

While local government and businesses see the melting as a threat to their income, many Tibetan villagers and pilgrims I have spoken with see the tourism development and the melting as an affront to the deities of the sacred mountain that will lead to punishment on humans who have caused it.

TOURISTS AND DEITIES

During one of my many visits there, one tourism bureau representative told me that the number of domestic tourists in Deqing County had increased from 517,500 in 1997 to 2.86 million in 2006 with an additional 308,000 foreign tourists. However, a local meteorologist told me that while many people tend to think that the melting of the glacier is due to tourist influx, there is no clear proof that it is the main cause. Many experts I spoke with list global climate change combined with mining and industrial activities in Deqing as the biggest drivers to the melting glaciers.

Very few Tibetan villagers in Deqing benefit from the lucrative business of tourism, especially tourism from circumambulation even though the local government promotes economic growth around the pilgrimage traffic through building transportation infrastructure, hotels, and restaurants located along many of the major circumambulation routes and holy sites. The majority of local Tibetan people in the holy mountain area sustain themselves through mushroom picking, farming and animal husbandry; occasionally, they can make some extra money (100-200 Yuan/day) by working as tourist guides during peak tourism seasons or major pilgrimage years—such as the Year of Sheep in 2003. That particular year drew nearly 100,000 pilgrims, for Tibetan people believed that all the major sacred deities would gather in Kawadgarbo at the time, making all the merits and virtues the pilgrims accrued even greater.

Lamas have been unwillingly transformed as workers in the tourism industry, performing "authentic" religious activities for curious tourists. Lamas on Snow Mountain must be prepared to answer the bombardment of questions from outsiders in this omnipresent tourist Panopticon.[1] Many Lama informants have told me in many occasions their understanding of the melting glacier, "These are our sacred mountains, where deities live. Now all have been changed into tourist resorts. In Mingyong Glacier, they built wooden and steel stairs all the way to the heights of the sacred mountains, there was one time, people doing karaoke business in the heart of a sacred mountain, tourists chanting and waving barbequed chicken wings to deities. This place can not avoid to be ruined with such behavior."

Religion still observably holds sway in the everyday lives of local villagers, where people are extremely conscious of respecting and honoring deities. The local Tibetan people live in awe of the omnipresent spiritual world. Deities are part of everyday conversation, folk literature, dreams and the natural environment—rivers, mountains, flora and fauna are all spiritual entities. The circumambulation is seen by Tibetans as an important life journey that not only pays tribute to an otherworldly sacred domain, but is also a physically challenging and solitary ritual that aims to bring a more blissful life to the individual pilgrim and his/her surrounding world. Unfortunately, the Tibetan pilgrims at Meili Snow Mountain and elsewhere have involuntarily become part of the marketing for tourism development, for their journey is seen as exotic. Tourists come to this region not just to view the landscape, but also to experience and in some ways "consume" the image they have of Tibetan-ness.

Left: Meili Snow Mountain and Right: Zhou Lei conversing with Lamas in Lamasery. Photo Credit Zhou Lei

INDIGENOUS UNDERSTANDING OF MELTING GLACIERS

In the course of my research I have discovered starkly different views on development and environmental protection. Specifically, I have been struck that while the development in western China is claimed as being sensitive to environmental concerns—such as "construction of ecological civilization" (*shengtai wenming jianshe*)—ultimately the top priority of the government is to promote economic growth and reduce poverty in a region that lags far behind eastern China in per capita income and standard of living. Most of the indigenous communities I met with see the world through a strong religious lens that prioritizes the protection of nature for reasons that differ from the government planners, domestic business investors, and even environmental groups.

Specifically, while Chinese officials, environmentalists, and scientists are advocating that the area be designated an environmental protection zone (*baohuqu*) or a national park, I heard from many local Tibetans that they would prefer the concept of Circumambulation Protection Zone. Such a designation acknowledges would prioritize the needs of religious pilgrims to use the area.

In the eyes of some Tibetans, the propaganda and policies promoting environmental protection, science, and eco-friendly education are seen as sinister rather than beneficial to the protection of their local environment, which they value not as economic or biodiversity resource, but as something sacred. Conversely, calls by the Tibetan or other minority communities that their mountains or lakes are sacred and should not be developed are usually viewed with suspicion by the government and industry in China. This is a major area of not just miscommunication but no communication.

One Tibetan informant told me that he made a documentary about Tibetan attitudes of life during one circumambulation. He filmed how the circumambulators saved the life of one frog in a puddle, anticipated their afterlife on a mountain top, strewing clothes, bowls, tsamba, and jewelry in honor of ancestors and deities. "I want to stress that Tibetan people's concern about the environment and life is different from you Han people and foreigners," noted one Tibetan informant. Repeatedly, they expressed their anger at the encroachment of consumerism and money-rules-all mentality from lowland Han societies. Strikingly, when my lama informants and pilgrim friends complain about the environmental degradation of sacred mountains and glaciers, they do not turn their discontent into political action. Ultimately it seems that it is, in essence, pure nostalgia of the spiritual place and time that will never com back.

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ENDNOTES

[1] This is a prison designed in a way that allows a guard to observe all of the prisoners without the incarcerated knowing they are being watched.

Zero-Waste Comes to China: The Green Anhui-GAIA Partnership

By Skye Gilbert

One hot, mid-June day in 2009, I enter the office of Green Anhui's Wuhu Ecology Center and smell Zhang Huiying's incredible red bean soup. She has left the rice cooker on to keep it warm for me, but has already abandoned breakfast to begin our day's work. I pour myself a bowl, and walk out onto our office balcony before I join Huiying. The smell of smoke fills my nostrils; Anhui farmers are harvesting rapeseed right now and the sky is a dark gray from all the stock burning. Ironic, since we are currently on a scavenger hunt for incinerators. We want to know how many of them exist in Anhui Province and in China. Back at my desk, I eat my red bean soup and browse the Internet for incineration stories. In addition to incineration, articles about illegal dumping, China's inadequate waste infrastructure and growing consumption flood my search results. Overwhelmed by the magnitude and variety of waste disposal problems in China, I reread the website of Green Anhui's newest international partner, the Global Anti-Incinerator Alliance (GAIA). Fortunately, since its founding, GAIA has expanded its knowledge base and expertise to include all aspects of sustainable waste management systems and obstacles towards implementing them. I begin writing a report on China's waste situation, hoping GAIA's experience and Green Anhui's local knowledge can improve a terrifying situation.

CHINA'S CHALLENGES: A CLOSER LOOK

Disposable chopsticks, double- and triple-wrapped packaged goods, streets lined with potato chip bags, disposable razors, and pill bottles—even the most insulated tourists cannot fail to recognize the enormous volume of waste in China. In 2008, industrial, municipal and agricultural waste in China totaled 8 billion tons. The country's problems are multifaceted and, as with everything else, unique to China. While the per capita waste generation is low relative to other countries, the infrastructure for waste collection and management is inadequate, in some regions resulting in over 40 percent of waste being illegally or improperly disposed. The negative impact of China's waste has global consequences, from mercury poisoning in North America's rivers to the spread of viruses. Leaking landfill sites, inefficient coal-burning plants, factories that ignore municipal pollution laws, illegally imported toxic waste, and piles of abandoned garbage are the main culprits. What about incineration? Fortunately, burning garbage has been slower to take hold in China, where so much municipal waste is wet and organic that burning is often impractical and expensive. Unfortunately, waste incineration has received large investments in recent years and now comprises over 5 percent of municipal solid waste disposal, compared to 1.7 percent in 2000, leading to increasing health concerns locally and media attention internationally.

GAIA'S ACTIVITIES IN ASIA

GAIA has a strong presence in the Asia-Pacific region, with over 200 partnerships with nonprofits in 20 countries. These partnership organizations have already been met with some success. In the Philippines, the nonprofit

WISHCRAFT has successfully implemented a Cash-for-Trash scholarship program, where students collect recyclable waste for money that they use to purchase school supplies or pay tuition fees. South Korea has recently implemented a volume-based waste collection fee system, where citizens must pay based on how much waste they produce (recycling is free). A Malaysian partner successfully canceled plans to build an incinerator in Selangor. In each of these countries, GAIA relies on nonprofit partnerships to localize their extensive knowledge base and apply it to specialized regional issues.

THE GREEN ANHUI-GAIA PARTNERSHIP

GAIA had wanted to work in mainland China for many years, but it was constrained by the language barrier and limited financial resources. In 2009, Pacific Environment's Wen Bo came to the rescue by helping GAIA understand the political, social and economic role of nonprofits in China. After studying Chinese environmental NGOs and the environment in which they operate, GAIA determined that Anhui Province's lone environmental organization, Green Anhui, would be an excellent partner. As Manny Calonzo of GAIA explained to me in an interview:

Green Anhui has a considerable number of experts and volunteers and has been implementing various programs since it was established in 2003. More importantly, Green Anhui is working on issues that are directly of interest and concern to GAIA and its members, such as chemical pollution and environmental health.

With the right focus, a strong staff, active programs and smaller budget requirements than Beijing- or Shanghai-based nonprofits, Green Anhui was a natural choice for China's nexus of zero-waste advocacy. When asked how Green Anhui differs from some of GAIA's other Asian partners, Manny stressed the youth of the organization and its members, but confirmed that like most of GAIA's partners, Green Anhui has a clear mission and a passionate devotion to its activities.

In China, Green Anhui's initial focus is on building awareness through local education programs and the China National Waste Information Network, a website that went online in late 2009 that will provide a national forum for academics, professionals and activists interested in sharing information on China's waste issues. Fortunately, Green Anhui will not have to "start from scratch" as many communities in China have implemented recycling and waste advocacy initiatives. Rather, Green Anhui's programs will formalize and expand on what has already begun organically. In addition to these two primary projects, Wuhu Ecology Center has set up a team of local volunteers to translate GAIA's documents into Mandarin, supporting translation efforts initiated in Taiwan and Hong Kong. In 2009, Zhang Huiying, Green Anhui's GAIA contact, completed a month of training in the Philippines, the location of GAIA's Secretariat and one of the more progressive countries in terms of waste management. She published an article in the fall of 2009 in China Development Brief about community waste management and how successes in the Philippines could be adapted to Chinese communities. Huiying is very aware of how challenging waste management activism will be in China. She is particularly focused on how to make the initial education initiative result in a functional waste classification system. She notes that:

There is a lot of construction in China, so area for composting is not easy to find. We'll have to do some environmental education [for] people don't know where to put their waste. It will take a long time to find cooperative groups. I know of three [grassroots] groups that are already working on similar projects, doing simple waste classification. But even they mixed up some waste.

In addition to initiating activities, Huiying has spent significant time in the past month reaching out to Chinese nonprofits doing similar work and writing grant proposals to support future projects. On the fundraising side, Huiying is applying for a grant from Frontline to begin an education program and waste classification system in a 1000-household community in Hefei City. GAIA's Gigi Cruz recently met with the Social Science Research Council's Beijing office to discuss possible funding for future projects. Both recently participated in the CAN Regional Training on Climate Change in China, along with Green Anhui Director Zhou Xiang. Huiying and Gigi Cruz did presentations and discussed zero-waste strategies with 30 participants in a special, daylong mini-workshop called Zero-Waste Zero-Warming. Two Chinese NGOs—Xiamen Green Cross and Shanghai's Green Oasis—presented their already-initiated efforts at waste classification. This was GAIA's China-focused conference.

In the few months since I left Green Anhui, the Green Anhui-GAIA partnership has made enormous progress. Huiying's days are no longer filled with scouring the Internet for information over red bean soup. Instead, she is actively educating others about successful campaigns implemented in other Asian countries, China's waste issues, and zero-waste strategies. When she is not giving talks, she is coordinating the activities of a committed and growing volunteer base, or seeking out local communities that may face severe waste pollution issues and would welcome an advocate. With its quick progress and well-informed strategy, the Green Anhui-GAIA partnership will be an interesting one to watch in the coming year. But do not hold your breath for radical change. As Manny Calonzo says:

The change in attitude, value and practice that we seek will certainly not happen overnight. But through painstaking effort to share information and foster meaningful relationships with the Chinese people, we surely will get there.

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FEATURE BOX

Anatomy of a Partnership:
Benefits of U.S.-China Private Sector Cooperation in the Power Sector

By Claire Casey and John Juech

Overview of a Garten Rothkopf study commissioned by Duke Energy that was presented at a China Environment Forum meeting on October 6, 2010

Accounting for 42 percent of global energy demand, together the United States and China can lead the world in addressing energy and the deployment of new power generation technologies. Both countries face a similar set of challenges including the need for trillions of dollars in power infrastructure investment over the next two decades while reducing their CO2 emissions and diminishing their dependence on coal-based power generation.

Collaboration in the power sector, unlike other sectors, offers potential for mutual economic benefit and job creation through the development of clean energy technologies. Power generation, after all, is a domestically developed good. However, little work has been done to date to quantify this potential. In order to better understand how this relationship would impact the United States and China and the range of potential benefits, Garten Rothkopf conducted a study, Anatomy of a Partnership: Benefits of U.S.-China Private Sector Cooperation in the Power Sector. In this groundbreaking report, Garten Rothkopf mapped the supply chain of four model clean energy projects, using employment projections based on actual budgeted estimates and supply chain dynamics based on current perspectives and purchasing decisions.

However, and it is vital to note this, all of these potential benefits depend on a level playing field between the two countries, a fair and balanced currency and trade regime, and a set of rules that are clear and that do not inappropriately disadvantage any actors on either side. Also, this particular study does not focus on or draw conclusions about the broad U.S.-China relationship overall, but rather focuses very narrowly on specific prospects for cooperation in the power sector.

The report focused on four power technologies identified as having potential for advancement through U.S.-China technical cooperation: (1) IGCC and carbon capture, (2) solar PV manufacturing and installation, (3) supercritical coal, and (4) smart grid development. Across all four, Garten Rothkopf found potential for shared benefits. From R&D, to manufacturing, construction and installation and operations and maintenance, there is the potential for tens of thousands of direct and in-direct jobs, with 66-95 percent created in the project's home market, even in those cases where the capital equipment was imported.

SHARED CHALLENGES

Though China recently passed the United States in total CO_2 emissions, the United States still leads the world in per capita emissions, with the average individual responsible for 19 tons of CO_2 each year—a full 7 tons more than the next largest emitter, Russia. The two countries face enormous power infrastructure investment challenges as well. In order to account for growing demand, China is projected to spend $3.1 trillion cumulatively on electricity to 2030. The United States, faced with the need to update its aging infrastructure, is expected to spend $2.1 trillion. Further, the United States and China still largely rely on coal as a cheap and reliable source of energy. It is estimated that coal will account for 48 percent of U.S. power generation by 2030. In China, coal use is expected to grow an average of 3.5 percent per year for the next twenty years, making the country 82 percent dependent on the fossil fuel for power generation in 2030.

Pressure from both national and state governments is also creating a similar investment environment within the two economies. In China, the national government has committed to producing 15 percent of its electricity from renewable sources by 2020. It also announced the goal of reducing its carbon intensity by 45 percent from 2005 levels in that same period, and is expected to embrace further renewable energy developments in its next five-year plan. U.S. states have taken the lead in crafting renewable energy mandates and tax incentives to attract renewable investments. The U.S. House of Representatives has passed a renewable energy standard and it remains possible, though not likely, that the U.S. Senate will take it up before the end of the year.

Shared Opportunities

In the midst of these challenges, the two countries share unrealized economic potential. Across the four key prospective areas of collaboration (IGCC and carbon capture, solar PV manufacturing and installation, clean coal technologies, and smart grid development) the report found opportunities for both countries to increase access to growing markets, accelerate development of these clean energy technologies, and create tens of thousands of new jobs. The report also found that some U.S. and Chinese energy firms are already taking advantage of opportunities in solar PV, wind, and battery production. These companies are benefiting from U.S. and Chinese incentives to expand their operations, create new jobs, and establish global supply chains to reduce costs, illustrating the tangible benefits of collaboration.

PROJECT MODELS

To understand the benefits of collaboration across four different power generating sources, Garten Rothkopf conducted over 30 interviews with leading power and technology industry executives and academics, with a view to acquiring employment projections based on actual budgeted estimates and an understanding of the supply chain based on existing projects and purchasing decisions. Though each technology offers unique opportunities, there are broad trends that run throughout each study model. The advantages include acceleration of energy technologies, expanded access to new markets, and rapid growth of emerging industries. However, the most common feature is that regardless of project location, these collaborations create jobs in both markets, with the majority created in the country where the power generation is taking place. Further, across all the projects, if we think of job creation in terms of wage creation, the United States economy greatly benefits from a positive "balance of wages," with quality jobs created that cannot be exported. Below is a summary of findings in each of the technology areas.

IGCC with Carbon Capture. Collaboration in this area would produce 3.25 GW of additional capacity through an agreement to construct five 650 MW IGCC plants with carbon capture in China. The project would lead to $5 billion in total investment between participants and government incentives. China would acquire critical technology transfer and know-how, while the United States would gain the opportunity to smooth the learning curve and later apply this knowledge to the U.S. market. This serves a major need in the United States, as there is the potential for 56 new IGCC plants in the country by 2030, driven by large increases in power generation capacity and a need for cleaner and more efficient generation.

Direct Jobs Created: *US*: 19,715 jobs at $23 - $40/hour / *China:* 35, 053 jobs at $2.70 - $3.05/hr.
Total Jobs Created: *US:* 40, 950 jobs at $23 - $40/hour / *China:* 136,636 jobs at $2.70 - $3.05/hr.

Utility-Scale Solar PV. U.S.-China cooperation with solar PV technology has the potential to lead to 400 MWs of additional capacity through an agreement to construct utility-scale solar power plants in the United States. A total of $1 billion in investment would be required between participants and government incentives. Under our projections, annual U.S. solar PV installations are to increase to 1515MW by 2013, creating a large market for solar PV cells (assumed to be from China for the purposes of this study) and installation and maintenance services in the United States.

Direct Jobs Created: *US:* 9,880 jobs at $15 – $41/hour / *China:* 4,820 jobs at $1.50 – $ 3.00/hr.
Total Jobs Created: *US:* 18,772 jobs at $15 – $41/hr / *China:* 18,798 jobs at $1.50 – $ 3.00/hr.

Clean Coal Technologies. Collaboration between the two countries on clean coal technologies would lead to $5 billion in total investment between participants and government incentives, and six 1,000 MW ultra supercritical plants (potentially with carbon capture). China would benefit by gaining heat resistant materials technology, while U.S.-based firms expand exports and flatten the learning curve, reducing costs of constructing new plants. There is a huge market potential for clean coal technology given additional electrical capacity; as many as 377 clean coal plants in China and 36 in the United States by 2030 may be needed.

Direct Jobs Created: *US:* 23,430 jobs at $23 – 51/ hour / *China:* 78,810 jobs $1.50 - $3.05/hr.
Total Jobs Created: *US:* 44,517 jobs at $23 – 51/hour / *China:* 307,360 jobs at $1.50 - $3.05/hr.

Speakers at the October 6, 2010 CEF meeting *A Roadmap for Economic Growth: U.S.-China Private Sector Cooperation in Power Sector* included (L to R): Duke Energy's CEO Jim Rogers and Vice President and Chief Technology Officer David Mohler; Commerce Secretary Gary Locke; and President of ENN Group North America Sun Yunquan.
Photo Credit: David Hawxhurst.

Smart Grid. Between the United States and China there would be two million meters of smart grid deployed, leading to $1.4 billion total investment between participants and government incentives. Under such collaboration, the United States provides technology and expertise, while China provides meter manufacturing and gains access to a burgeoning U.S. market; as much as $63 billion is needed to implement smart meters nationally in the U.S. over the next 15 years.

Direct Jobs Created: *US:* 3,374 jobs at $20 - $45/hour / *China:* 172 jobs at $1.52 - $2.70 /hr.
Total Jobs Created: *US:* 6,410 jobs at $20 - $45/hour / *China:* 671 jobs at $1.52 - $2.70 /hr.

CONCLUSION

Through access to expanding markets and technology transfers, U.S.-China partnerships in the power sector speed technology development, promote economic growth, and drive local job creation. The generation options and private partnerships profiled in this study indicate that there can be mutual benefits gained from collaborative efforts in power generation and distribution. While economic competition and employment remain very active concerns in the U.S.-China relationship, this study demonstrates that collaboration in clean energy technologies has the potential to not only directly generate jobs for both countries, but provides a foundation for sustained economic growth and further investment opportunities.

Please visit the China Environment Forum Event Summary page to watch the webcast of the meeting where this report was presented. Speakers included Secretary of Commerce Gary Locke, Jim Rogers (CEO of Duke Energy); Sun Yunquan (President of ENN North America); and David Mohler (CTO of Duke Energy).

The full study is available on the Duke Energy website at: http://news.duke-energy.com/2010/10/06/u-s-china-energy-partnership/

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FEATURE BOX

The China Carbon Forum: Enhancing China's Response to Climate Change through Network-building and Stakeholder Dialogue

By Leo Horn-Phathanothai

As the world's largest emitter of greenhouse gases and one of its fastest growing economies, China will be at the crux of global efforts to tackle climate change. It is no surprise, therefore, to find that Beijing is brimming with diplomats, lobbyists, consultants, lawyers, investors, and technologists – including the very best minds in their fields—all sharing a commitment to working with China as it offered a pledge to cut its GHG emission growth at a level unmatched by any other developing economy as it became a signatory of the Copenhagen Accord. The China Carbon Forum's aim is to help organize this potentially tremendous collective resource, and to help the Chinese government make productive and beneficial use of it.

The China Carbon Forum is a not-for-profit organization set up in 2007 to enable constructive dialogue between major stakeholders in the Chinese carbon sector. It aims to enhance the contribution of the international business and non-governmental community to low carbon development in China by: (i) facilitating the sharing of knowledge and expertise between key participants in China's power sector, and; (ii) providing an independent and neutral platform for businesses and NGOs to engage in structured, strategic level dialogues with senior Chinese government decision-makers.

The China Carbon Forum now counts over 350 individuals and 200 firms in its network of low carbon solution providers. It has been particularly active over the past year in conducting structured consultations between business executives, international experts and the top Chinese government climate decision-makers on the topic of clean technology development and diffusion.

BUILDING A PROFESSIONAL NETWORK OF SOLUTION PROVIDERS IN CHINA

China's carbon sector is highly fragmented and made up of a broad array of local, foreign, private, and public players. As an example there are more than 70 local and foreign wind turbine manufacturers (more than the rest of the world put together) competing to supply turbines for China's wind market. With cutthroat competition and a general lack of transparency as to market norms there has been little incentive for information sharing between companies.

Initially, the China Carbon Forum's primary aim was to improve the sharing of information, knowledge and best practices between the various participants in China's carbon sector through the establishment of a professional network of low carbon solution providers within China, and by developing an information and knowledge resource powered by a WIKI-engine that members would contribute to, called the 'WiKiCarbon'.

The China Carbon Forum organizes regular networking and speaking events to build professional communities around key themes, to share authoritative analysis and views on important issues and developments, and to communicate new knowledge. To date, 16 distinguished policy makers and market shapers have spoken at these networking events, including: Jonathan Pershing, former Director of the Climate Program at the World Resources Institute, and currently Head of the U.S. delegation to UN climate negotiations; Zou Ji, a then) member of the Chinese delegation to UN climate negotiations and adviser to Minister Xie Zhenhua; and Andrew Aldridge, Vice President of Climate Change Capital. The events are usually held in a 300-year-old Manchu Courtyard, providing for a congenial and relaxed atmosphere for discussion and networking.

ENHANCING BUSINESS-TO-GOVERNMENT DIALOGUE ON KEY PUBLIC-PRIVATE THEMES: THE PARTNERSHIP WITH RENMIN UNIVERSITY

As the network evolved it became clear that there was a mismatch between the aims and objectives of Chinese regulators and realities facing foreign and local companies in the market. At the same time there was a clear desire on the part of Chinese regulators to reach out to foreign and local companies in the sector to understand the policy obstacles and better understand what they needed to do to facilitate market development and, in particular, the development of foreign technologies amongst Chinese companies.

The China Carbon Forum has been able to step in to fill this role, rapidly becoming a key conduit for businesses to engage with senior Chinese government decision-makers on climate-related reform. Its identity as a neutral and independent platform with wide representation from across industry and non-governmental organizations gives the China Carbon Forum credibility in the eyes of the Chinese authorities. Furthermore, drawing on

The China Carbon Forum
碳排放市场论坛

Photo Credits: The China Carbon Forum

Chinese government policy is grounded in an understanding of the interests of these key stakeholders.

For more info about the China Carbon Forum see: www.chinacarbon.info, or contact the General Manager, Xusheng 'Simon' Wan, at: simon@chinacarbon.info.

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Sector-based Approaches to Measuring and Managing Greenhouse Gas Emissions: China's Cement Industry

By Angel Hsu, Neelam Singh, and Ranping Song

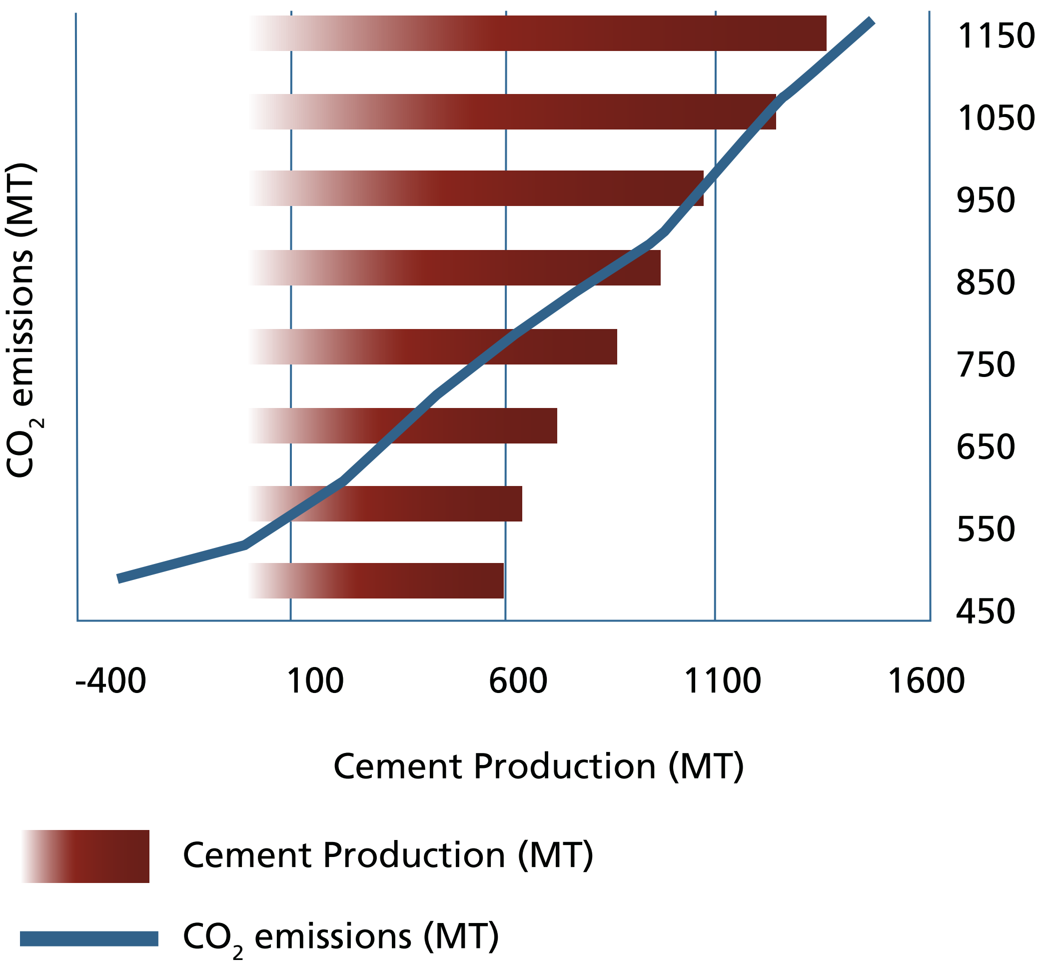
As China's cement industry is responsible for half of global cement production and five percent of total worldwide carbon dioxide emissions (Cho & Giannini-Spohn, 2007), greening Chinese cement companies would have a major impact on addressing domestic energy concerns and global climate change. However, this is easier said than done. Actors—both Chinese and international—have formed multilateral partnerships involving nongovernmental, governmental, and industrial stakeholders to transfer knowledge and expertise to build the capacity of Chinese cement industry. The goal of these efforts is to provide companies with customized tools to measure emissions and plan for key reduction measures following international standards, such as the World Resources Institute (WRI) – World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol. This commentary examines the process by which Chinese cement companies are adopting internationally recognized best practices to take critical, practical steps toward reducing energy consumption and greenhouse gas emissions.

Sui Tongbo of the China Building Materials Academy giving instruction on how to use the Cement Sustainability Initiative Protocol at the Third Workshop on Energy Efficiency and Clean Energy Development in the Chinese Cement Industry, which was held on July 8-10, 2009 in Beijing. Photo Credit: World Resources Institute

CHINA'S CEMENT SECTOR

Increased production of cement has been a result of China's rapid economic expansion necessitating growing infrastructure needs. Over the last two decades, China's cement production has steadily grown over 10 percent per year (NBS, 2009). (See Figure 1). Globally, China has been the leader in cement production since 1986: 1.6 billion tons of cement were produced in 2009, and output is expected to grow to 1.8 billion tons for 2010 (CBMA, 2010). Already, China's cement output from January to May of 2010 was up 19.1 percent from last year during the same period (Cement China, 2010). Domestically, the cement sector is responsible for nearly 10 percent of total industrial energy consumption and more than half of industrial energy use in building materials (IEA, 2007).

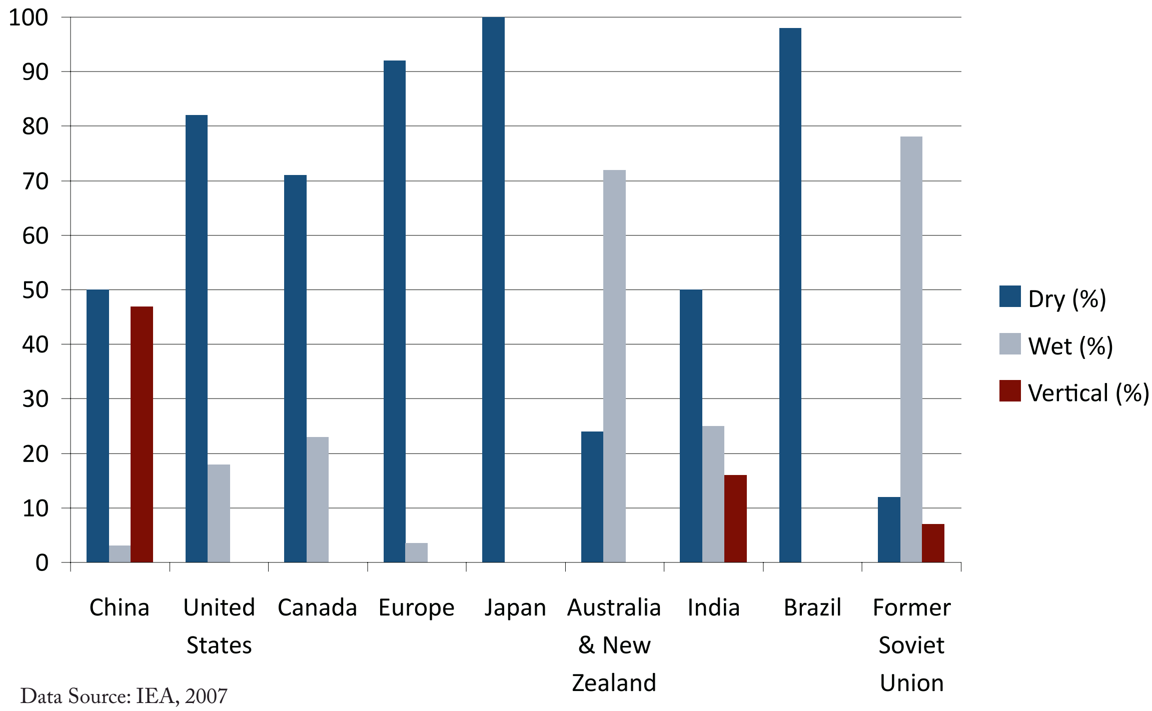
FIGURE 1. CEMENT PRODUCTION AND ASSOCIATED CARBON DIOXIDE EMISSIONS GROWTH (2000-2008)



Data Source: Tsinghua, 2008

Exacerbating these numbers is the overall size and structure of the Chinese cement sector. China's cement manufacturers are predominantly medium- (production totaling 2,000 tons/day) and small-sized firms—those with production less than 2,000 tons/day but still meeting a 5,000 Yuan sales threshold to qualify as a firm. In 2007 small-sized cement firms numbered around 4,670 (92.8 percent), while large firms only totaled 60 (1.19 percent) and medium-sized firms 146 (2.9 percent) (Lei, 2009). Compared to international standards for efficiency, the Chinese cement sector is more energy and resource intensive (Tsinghua, 2008). Almost 40 percent of cement production capacity is based on outdated or inefficient technologies (China Energy Group, 2009). Such outmoded technologies include the persistence of wet cement processes and vertical shaft kilns (see Figure 2), which are known for high energy consumption and severe air and water pollution.

FIGURE 2. CEMENT TECHNOLOGIES AS A PERCENTAGE OF TOTAL USED BY REGION



Data Source: IEA, 2007

Realizing the energy and environmental impacts of the industrial sector, the Chinese government in the Eleventh Five-Year Plan established an ambitious target to reduce energy intensity—energy consumption per unit of gross domestic product—by 20 percent, and environmental pollutants by 10 percent from 2005 to 2010. For the building materials industry, the government set an even greater target of 25 percent reduction in energy intensity; however, most Chinese cement companies lack the capacity to reach such targets, which require baseline energy assessments and continuous environmental monitoring (Price, et al., 2008).

One approach being used to reach these targets is the consolidation and modernization of the cement sector. In 2006 the Chinese government established a set of policies to shut down many of the smaller, less-efficient enterprises while updating the capacity of larger plants by 2010. Key milestones have included: [1]

- the number of cement producing enterprises dropped from 5,000 to 2,000;
- the average scale of corporate production of cement increased to 400,000 tons per company, up from 200,000 tons in 2005; and,
- the top ten cement companies now comprise 20 percent of industrial production, up from 15 percent in 2005.

In 2007, China's National Development and Reform Commission (NDRC)—the main policy implementing body responsible for energy and climate change regulations in China—ordered the shutdown of 1,066 cement plants, with Beijing moving out 13 of its 30 cement plants by 2010 (NDRC, 2007; CCTV, 2009). The central government also set targets for increasing the proportion of dry-process cement manufacturing to 70 percent, up from 40 percent in 2005, and for eliminating implementation of any new vertical shaft kilns (Alves, 2009; IEA, 2007). In the 12th Five-Year Plan, the government plans to continue increasing industrial concentration of cement production; eliminating 389 million tons of backward cement capacity; and focusing on energy savings and emission reductions (APP, 2010).

The challenges facing policymakers in improving the cement sector led to the creation of a collaborative partnership between international and Chinese actors—described below—to develop the capacity of Chinese cement companies to meet the government's ambitious energy efficiency targets.

A STEPWISE APPROACH TO CAPACITY BUILDING

To address the gap between the government's goals and the low capacity of cement enterprises to meet these goals, a collaborative partnership involving international and Chinese actors emerged in 2007. Under the framework of the Asia-Pacific Partnership for Clean Development-Cement Task Force (APP-CTF), experts from Australia, the European Union, India, Japan, South Korea, and the United States cooperated to build the capacity of Chinese cement companies on greenhouse gas accounting and measurement. This paved the way for a comprehensive program integrating energy use and greenhouse gas emissions.

In the 12th Five-Year Plan, the government plans to continue increasing industrial concentration of cement production; eliminating 389 million tons of backward cement capacity; and focusing on energy savings and emission reductions.

In 2008, the World Resources Institute (WRI), Lawrence Berkeley National Laboratory (LBNL), China Building Materials Academy (CBMA), E3M Inc., China Cement Association (CCA), and Cement Industry Energy Efficiency and Environmental Protection Evaluation and Test Center, created a comprehensive program in the Chinese cement sector to enhance energy efficiency, increase the use of alternative fuels and raw materials, and reduce greenhouse gas emissions. NDRC, the U.S. Environmental Protection Agency and the U.S. Department of State provided strong support for the program's implementation.

The program's strategy employs a five-step approach focusing first on large cement companies whose output comprises a substantial portion of overall industrial production, and then widely disseminating the results to encourage smaller plants to adopt similar tools and measures, therefore encompassing the entire sector. The first step includes workshops for 42 of China's largest cement plants to provide training in the use of tools to measure and benchmark energy consumption and greenhouse gas emissions. The second phase involves a joint U.S.-China effort to conduct on-site energy and greenhouse gas assessments, and database development for 12 cement plants. Subsequently, the remaining 30 facilities will be added for a total of 42 cement plants that represent over 30 percent of total Chinese cement production. After the development of facility benchmarks, the fourth step is to develop decision-making tools and guidelines for alternative fuels and raw materials and to demonstrate co-processing in six plants. Finally, the tools, activities, and results will be documented and disseminated to enhance capacity building of the entire Chinese cement industry.

To achieve these reductions, three complementary tools are coalesced based on internationally most credible practices from the partnering organizations and multinational companies. When combined, these tools can help identify and implement energy-efficient technologies and measures, illustrate the benefits of using alternative fuels and raw materials, and allow companies to measure and track greenhouse gas emissions and other pollutant emissions. These tools are:

(1) Companies can establish a baseline and track carbon dioxide emissions from calcinations process by using the *Cement Sustainability Initiative* (CSI) CO_2 Quantification Protocol—a cement-sector specific tool based on the WRI-WBCSD GHG Protocol that has been implemented in over 700 cement kilns worldwide (WBCSD, 2007).

(2) *The Benchmarking and Energy Saving Tool for Cement* (BEST-Cement)—developed by LBNL in collaboration with the Energy Research Institute, CCA, CBMA, and Shandong University—is used to benchmark cement plants to both Chinese and international best practices in terms of energy consumption and to provide up to 50 energy-efficiency options to be employed in any particular facility.

(3) *The Process Heating Assessment and Survey Tool-Cement* (PHAST-*Cement*) is an energy audit tool customized by E3M, Inc. for the Chinese cement industry from the widely used PHAST tool developed for the U.S. Department of Energy. PHAST provides a detailed process and equipment-level assessment of the cement plant combustion efficiency and is used to analyze effects of energy-saving opportunities.

Since the partnership began in January 2008 with a CSI training workshop in Beijing, NDRC has adopted the comprehensive program as a critical part of its energy and climate change mitigation strategy for the industrial sector. Furthermore, NDRC announced the implementation of the CSI Protocol based on the GHG Protocol as the industry standard for carbon dioxide emissions accounting for Chinese cement companies. Two other training sessions have been held since: November 2008 in Zhuhai, where 16 cement companies received training on the CSI tool, and on July 2009 in Beijing under the new comprehensive program, where 42 cement companies participated in a training workshop on energy and carbon dioxide emissions measurement and benchmarking using the three tools (CSI, BEST and PHAST).

LOOKING FORWARD

These efforts by the government and cement companies in China have led to tangible results and demonstrated "measurable, reportable, and verifiable"[2] actions toward addressing climate change. The program described above

A team of international and Chinese cement experts visits a cement plant in Shandong Province to conduct on-site training with plant representatives and to assist plant technicians in conducting GHG and energy assessments.
Photo Credit: World Resources Institute

represents a sector-based approach in which cement companies both in China and abroad have begun to collaborate to measure, manage, and reduce overall energy consumption and greenhouse gas emissions. Such an approach affords several advantages, not only locally in China but globally as well:

Faster technology transfer and adoption: The direct relationships forged between industrial, governmental, and nongovernmental partners allow for increased technology transfer between industrialized and developing countries. In the case of Chinese cement companies, which still rely heavily on wet-process manufacturing and vertical shaft kilns, technology improvements could make a substantial impact on energy savings and environmental pollution reduction.

Improved data availability and quality: The adoption of internationally recognized, consistent accounting, measurement, and assessment tools and standards in the cement sector will bolster domestic and international confidence in energy and emissions measurement, monitoring, and targets. The systematic calculation and monitoring of energy use and greenhouse gas emissions will enhance overall data quality in the Chinese cement sector, which can then better guide future national discussion regarding sectoral targets and national commitments, strategies, and policies.

Model for other industrial sectors: Based on the early successes and lessons learned from this program, other heavy-industrial sectors within China could adopt this capacity-building model. WRI and WBCSD have worked with many government and industry associations to develop sector-specific tools and protocols for energy and greenhouse gas measurement and management, including iron and steel, power generation, and oil and gas, among others. Similar capacity-building programs and voluntary greenhouse gas accounting and reporting registries have been implemented in other developing countries, including Mexico, Brazil, the Philippines, South Korea, and India through partnerships WRI and WBCSD have forged with local government and NGO partners.

Co-benefits: Limited resources and the absence of official commitments to reduce greenhouse gases under the Kyoto Protocol often prevent developing countries from investing in climate change programs and management strategies. However, this program adopts an integrated approach to reduce energy intensity, greenhouse gas emissions, and criteria air pollutants in cement manufacturing, which is more compelling and appealing for developing countries, where it is often imperative to invest in initiatives with co-benefits. Moreover, the program's focus on going beyond measurement and providing solutions through demonstration of alternative fuels and raw materials and through energy- and cost-saving technology options has help it gain wide acceptance.

Moving forward, the Chinese government could seriously consider adopting the model of the cement sector discussed in this paper for other heavy industrial sectors. In doing so, the country would reap significant benefits from applying internationally-adopted best practices, measurement standards, technology, and tools to its entire industrial sector, which comprised 76 percent of China's total energy consumption in 2006 and is expected to remain above 70 percent through 2030 (IEA, 2009). Such benefits include consolidated sector-based registries and programs that could measure and track progress toward energy intensity and greenhouse gas emission reductions over time and that could provide the basis for cap and trade programs.

While implementing similar approaches in other sectors could be potentially challenging, the early success of the cement initiative is encouraging. The steps that both the government and cement companies in China are taking to reduce their overall energy and greenhouse gas impacts are truly noteworthy and demonstrate a strong commitment to improving the global environment.

The authors would like to thank Pankaj Bhatia of the World Resources Institute for providing valuable comments on this article.

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ENDNOTES

1 These objectives are found in "Notice of Several Suggestions for Accelerating Structural Adjustment of the China Cement Industry," the "Special Planning for Cement Industry Development" and the "Policies for Cement Industry Development" of the Chinese government.

2 The Bali Action Plan, as adopted by the Thirteenth Conference of Parties (COP-13) of the UNFCCC, stipulates future negotiations for a long-term climate agreement should include considerations of "measur-able, reportable, and verifiable" nationally-appropriate mitigation commitments or actions.

International Fund for Animal Welfare: Promoting Animal Welfare in China

By Grace Ge Gabriel

An elephant mother and a calf are walking into the sunset on the vast African savannah. The calf excitedly declares,

"Mom, I got teeth."

The mother does not respond. The calf repeats:

"Mom, I got teeth."

"Aren't you happy I've got teeth?"

The message further explains:

Babies having teeth should bring joy to a mother.

But what does it mean for elephant families?

Because of people's unnecessary want of ivory, hundreds and thousands of elephants are killed for the ivory trade.

If we don't buy, they don't die.

Say "No" to elephant ivory.

These messages are part of an educational campaign by the International Fund for Animal Welfare (IFAW) to reduce consumer demand for products derived from wildlife, in this case, elephant ivory. In spring 2009, travelers in Beijing's Capital International Airport and those riding subways in Beijing, Tianjin, Guangzhou, and Nanjing began seeing huge posters that featured this message.

In Chinese, elephant ivory is called "*xiang ya*" (meaning: elephant teeth). This nomenclature unfortunately gave people the impression that elephant ivory, like a baby's tooth, can fall out naturally and is, thus, a painlessly obtained, renewable product.

In a 2007 poll, IFAW found that more than 60 percent of the people did not know that the elaborately carved tusks displayed in store windows and the bracelets, signature seals and chopsticks sold on retail markets come from elephants which either died from natural causes or were killed by poachers. Encouraged by the finding that a majority (80 percent) of Chinese would not purchase ivory if they knew its source was a dead elephant, IFAW created the "Mom, I got teeth" poster, hoping that enlightened consumers would make animal-friendly choices. The elephant poster is the first of a series designed to reduce demand for wildlife and wildlife products by highlighting the kinship between animals and people.

Founded on a campaign to stop the brutal commercial hunt of white-coat harp seals in Canada forty years ago, IFAW (www.ifaw.org) has been working in China since the mid-1990s to provide direct care to individual animals, improve government conservation and animal management policies, and encourage wide adoption of the concept of animal welfare. Over the years, we have seen a significant shift in policies and attitudes due, in large part, to IFAW's numerous projects and campaigns in China.

IFAW promotes the adoption of the precautionary principal in conservation policies, international treaties and national laws. We work to enhance the effectiveness of wildlife law enforcement by building capacity through practical training and the provision of information and equipment. We also conduct educational campaigns to motivate the public to reject wildlife products and thus, reduce demand.

Photo Credit: IFAW

Over the years, IFAW has helped to protect species threatened by consumer demand in China such as bears, tigers, elephants and seals as well as the Tibetan antelope, a species endemic to China that is threatened by a demand from luxury markets in the West for "shahtoosh shawls," which are woven from their fur.

The growth of the Internet poses new threats to wildlife. The escalation in global Internet use increases the ease with which traders can fill burgeoning consumer appetites. The rules, regulations and laws governing the trade in endangered species are often complex, diverse and differ from country to country, yet the online trade has no boundaries. IFAW conducts investigations of online markets around the world and provides recommendations to site owners and governments that can enhance regulation and enforcement.

These investigations of online marketplaces in China are critically important because, by the end of 2008, China surpassed the United States as the country with the largest number of internet users (298 million) in the world. Based on the data gathered during online wildlife trade investigations, IFAW developed a routine information-sharing mechanism with law enforcement agencies and private companies involved in Internet commerce. IFAW has alerted enforcement agencies about illegal trade activities (both online and offline), identified emerging trends and helped provide evidence for prosecutions. As a result, online shopping sites promptly eliminated postings of illegally traded wildlife products. In partnership with these sites, we constantly update the list of "key words" to improve the product screening processes Internet companies use to block out illegally traded wildlife products.

IFAW has successfully persuaded major auction and shopping sites to ban the online trade in endangered species. Following their prohibition on offerings of live animals and endangered species, eBay banned the trade in all elephant ivory.

Taobao.com (Chinese for "*Treasure Hunt*"), the largest online shopping site in China, collaborated with IFAW in a public awareness campaign to combat online wildlife crime and set up an online IFAW store to enable users to report illegal wildlife trade activities. In addition to banning the trade of all endangered and protected animals, Taobao also led the industry in China in ending the online trade in shark fin products.

To save China's last Asian elephants, IFAW initiated the Asian Elephant Project in Yunnan in 1999. In the past ten years, the project has helped map out elephant habitat needs, enhance law enforcement to curtail elephant poaching and educate both locals and tourists about the importance of wild elephant conservation.

As an animal welfare organization, IFAW's mandate of care and protection includes

Photo Credit: IFAW

wildlife populations as well as individual animals. Several large seizures of Saker falcons by Chinese enforcement agencies, and a series of failed attempts to release these victims of the raptor trade in the mid-1990s, prompted IFAW to establish the first dedicated raptor rescue and rehabilitation facility in China.

Since opening in 2001, the Beijing Raptor Rescue Center (www.brrc.org), situated on the campus of Beijing Normal University, has received more than 4,000 birds of prey, of which 2,500 were successfully released back to the wild. Adhering to the latest scientific methods in the rescue, rehabilitation and release of birds of prey, and demonstrating the highest animal welfare standards in the care of wildlife, BRRC not only saves individual raptors, but also educates people about threats to wildlife and promotes policies and actions that advance the conservation and welfare of animals.

After the massive earthquake that devastated the lives of millions of people in Sichuan in 2008, IFAW provided a mix of humanitarian and animal aid, operating in five different areas. Field teams distributed food and supplies and provided veterinary advice, primary health care and rabies vaccinations to 18 villages in Zun Dao township, delivering aid to some 1,500 dogs and 8,000 pigs.

Driven by fears of rabies outbreaks, many townships in the disaster area executed an order to kill all dogs. The methods of killing—shooting or beating with a bat—are inhumane, unpopular with local people, and ineffective at achieving the objectives of preventing dog bites and the spread of rabies. In Zun Dao, IFAW worked with local veterinary officials to vaccinate dogs and provide animal care education and training in humane animal control methods.

To enhance the welfare for companion animals, IFAW assists municipal governments in promulgating humane dog regulations that mandate vaccination, encourage spay/neuter to control population and promote responsible pet ownership. In addition to supporting local animal rescue groups that provide care to animals in distress, IFAW established the Animal Resource Center website (www.ifaw-arc.org.cn) where Chinese animal lovers can discuss issues of mutual interest, from individual animal care and adoptions to the need for China to pass anti-cruelty legislation that covers all animals.

While China has a Wildlife Protection Law (1989) that protects endangered wild animals with utilitarian value, there is no law to prevent cruelty to animals. IFAW is supporting draft legislation which would govern the way wild and domestic animals are treated in all situations. A recent online poll of 63,000 people found that 89 percent support an animal welfare law for China.

It is encouraging to see public rising

support for animal welfare in China. Over a decade ago, when IFAW first started working in the country, we intentionally translated the organization's name as "*guo ji ai hu dong wu ji jin hui*," which means "international fund for love and protection of animals." The intention was to emphasize human responsibility toward animals and to address the concern that "animal welfare" might not have been readily acceptable in China.

However, public attitudes toward animals are changing in China. One indication of this change is the number of young people across the country who participate in IFAW's annual animal welfare education campaign—Animal Action Week.

Stepping into its 11th year in China, this campaign is carried out every year in colleges, middle and elementary schools. Animal Action Week fosters compassion, empathy and kindness toward animals. Hundreds of thousands of students embrace animal welfare and take action to benefit animals, from participating in beach clean-ups and organizing petition drives, to putting on school plays and entering art competitions. In sixth-grader Gai Yue's winning entry to his school's composition contest, he questions the quality of life for the turtle his mother bought from the market. He writes, "The turtle's new 'home' is no comparison to the immense ocean environment it was used to." He vows to return the turtle back to the wild, "That's where he really belongs."

For more information about IFAW activities in China, please visit www.ifaw.org or for Chinese www.ifaw.org.cn

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NRDC: Leading the Way Towards Climate Solutions for China

By Li Yang

LAST STOP BEFORE CANCUN—TIME FOR ACTION

Action speaks louder than words. This was truer than ever in the lead-up to the United Nations Framework Convention on Climate Change (UNFCCC) conference in Tianjin, China in October, 2010.

After the December 2009 United Nations climate change conference held in Copenhagen failed to live up to the world's high expectations and after many rounds of international negotiations produced limited substantial progress, it has become very hard to see a clear picture of how the global climate agreement will move forward. Without some renewed momentum, optimism is not high about the December 2010 climate conference in Cancun, Mexico.

This Copenhagen pessimism has made the Tianjin conference—the last "stop" before Cancun—so crucial. Despite, or perhaps because of, the perceived lack of progress on a global climate agreement, there actually has been considerable momentum on country-level actions. Under the Copenhagen Accord, the countries accounting for over 80 percent of the world's emissions have committed to specific actions to be undertaken at home to reduce their carbon emissions. This is a crucial next step in international response and these stories and actions will be a major topic of focus at the intercessional climate meeting in China.

It is notable that the Tianjin meeting was the first time that China is hosting a UNFCCC conference. However, unlike other similar global climate forums, there was not much international or Chinese press coverage about the event. This was a missed opportunity by the Chinese news media, for such stories could have expressed pride in China for hosting a significant international conference and for taking the lead on an issue of global importance. However, keeping such a low profile might have been due to expectation management—the Tianjin conference was supposed to be a pragmatic, problem-solving meeting and not a flashy event.

CHINA'S LOW-CARBON EFFORTS

By the time this publication comes out, NRDC (Natural Resources Defense Council) will have held a side event at the Tianjin conference. As a highly effective environmental advocacy group in the United States and the first international environmental organization to establish clean energy and green building programs in China, NRDC has been actively fostering China-U.S. cooperation on clean energy, energy efficiency and other efforts to fight climate change. At the side event, NRDC's climate experts and Chinese partners offered a detailed look into specific actions that China and other key countries have taken to reduce carbon emissions. In addition to discussing recent progress on efficiency and renewables in China, India, and Mexico, NRDC experts will be releasing reports analyzing China's carbon intensity target and the country's efforts to strengthen its renewable energy legal framework, as well as the carbon emission reductions possible through smart grid development in the United States and China.

China's rapid development has created urgent environmental and energy challenges, but it also presents a unique opportunity to help shape a low-carbon, sustainable development pathway for China that would have significant benefits for both China and the world.

Since the passage of the Renewable Energy Law in 2005, China's wind, solar, biomass, micro- hydro and other renewable energy sectors have been growing at an incredible speed. China's installed wind power generating capacity has been doubling every year for the past 5 years. The rapidly expanding production of solar photovoltaic products now accounts for 40 percent of the global total. According to the European Photovoltaic Industry Association, 4 of the top 10 global solar battery corporations are Chinese companies. The Chinese government has made great progress on meeting the self-imposed targets to reduce energy intensity (energy used for generating per unit of GDP) by 20 percent by 2010 compared with the 2005 level. In the last few months of 2010 there will be some final aggressive actions to meet the energy intensity goals.

URGENT NEED TO DEVELOP LOW CARBON CITIES

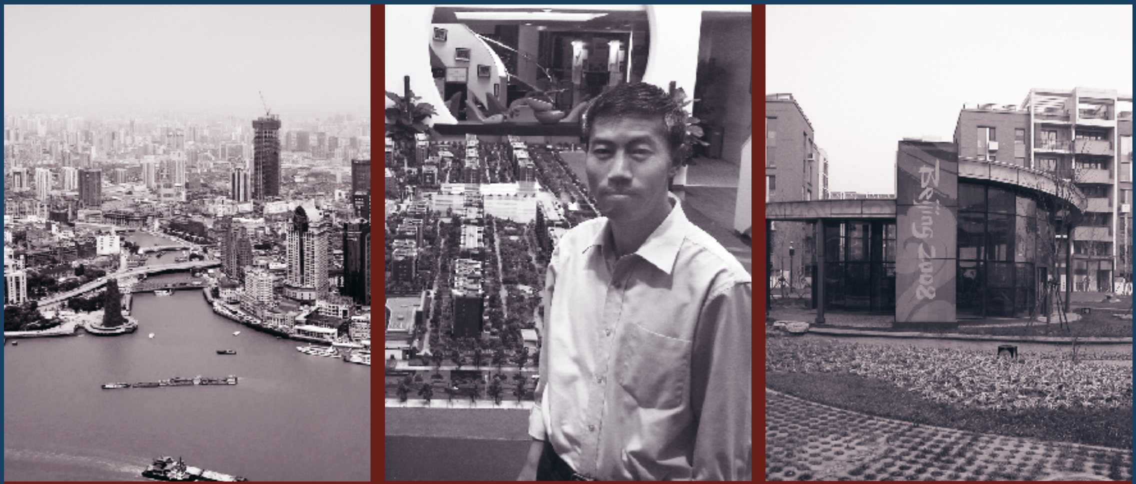
In the wake of the Copenhagen commitments to lower CO_2 intensity as a percentage of GDP by 40-45 percent, dozens of Chinese cities have announced low carbon development plans. Fifteen years ago when NRDC first began doing energy work in China the country had an energy surplus and there was no political agenda to lower CO_2 emissions or progressive energy efficiency policies. In the early 1990s no city planners talked about low carbon growth or even had heard of the concept of a "green building." Given that half the world's 4 billion square meters of new buildings built every year are located in China, the country holds enormous potential to harnessing the power of sustainable construction and helping curb greenhouse gas emissions. If China's urbanization boom creates inefficient buildings, the lock-in effect will cause huge energy waste in the coming decades.

NRDC has spearheaded the promotion of green buildings in China, helping the central government craft national energy codes for commercial and residential buildings and develop green building standards. NRDC's green building experts also have provided technical assistance on several flagship green building projects in China, including the Agenda 21 building in Beijing, which is the first in China to earn a LEED (Leadership in Energy and Environmental Design) certification. Built with just 5 percent additional cost, this building uses 74 percent less energy and 64 percent less water compared to conventional office buildings in China.

In 2008, NRDC worked with Olympic officials to green the Beijing Olympic Village, a 160-acre complex with 42 buildings housing athletes during the Olympics that has since been converted into residential apartments. Through more than 20 advanced green technologies, including heating and air-conditioning from solar and geothermal heat pumps and electricity from rooftop wind turbines, the buildings are at least 50 percent more energy efficient than average Beijing residential buildings, and reduce carbon dioxide emissions by 67,000 tons per year. The Olympic Village was awarded with a LEED-Neighborhood Development Gold certification. From individual green buildings to green neighborhoods, NRDC is now bringing these successes onto a larger scale of sustainable city planning and low carbon city development.

EFFICIENCY POWER PLANTS

With some 350 million more people moving from China's rural areas to its cities in the next two decades, the country is facing an unprecedented challenge in meeting its roaring energy demand. Efficiency is actually



1-The city of Shanghai and Huangpu River, Credit: (c) istock; 2-Professor Jin Ruidong, Director of Green Buildings Project of NRDC-China, is one of the most senior green buildings experts in China. Credit: (c) NRDC China; 3-Buildings in the Olympic Village are over50 percent more energy efficient than the average Beijing residential buildings, and reduce carbon dioxide emissions by 67,000 tons per year. Photo Credit: (c) NRDC China/ Jin Ruidong.

the cheapest, fastest, cleanest and most reliable energy resource. NRDC is adapting lessons learned through 25 years of experience as the top Demand Side Management (DSM) policy advocate in the United States to help China's cities and provinces develop large-scale DSM programs to fund investments in energy efficiency. The goal of these initiatives is to help provinces enact policies that will provide incentives for businesses to improve their efficiency. Together with improvements in end-use energy efficiency, these virtual "efficiency power plants" can satisfy energy demand rather than building conventional power plants. In 2005, NRDC partnered with the government of Jiangsu Province and the State of California to establish China's first large-scale provincial DSM program. As a result of this partnership, the Jiangsu DSM program currently provides 100 million Yuan (approximately $ 15 million) in annual government incentives for industrial enterprises to improve their energy efficiency. These investments in energy efficiency have already helped to reduce the province's peak load by 580 megawatts, which saves 2 terawatt hours of electricity and reduces carbon dioxide emissions by 1.8 million tons each year.

All these on-the-ground projects and demonstrations that NRDC has been carrying out with Chinese partners are aimed at exploring and showcasing the concrete solutions for combating climate change in China and in other developing countries. How to further enhance these concrete actions, among other things, is the main substantial issue that world leaders should look at during the upcoming Tianjin conference. These action and not words will be among the key steps towards a more fruitful conference in Mexico.

NRDC's Switchboard Staff Blog contains many articles on the global climate dialogues and China's energy/climate policies: www.switchboard.nrdc.org/blogs. Jake Schmidt, the international climate policy director of NRDC will be blogging on the key steps on global warming that will need to be agreed to in Cancun at: http://switchboard.nrdc.org/blogs/jschmidt/key_steps_on_global_warming_in_mexico.html.

For more information on NRDC's energy and climate in China and beyond see: www.nrdc.org and www.greenlaw.org.cn.

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Averting Another Toxics Disaster in China

By Arlene Blum

Rarely does a week go by in China without a report of a serious chemical pollution problem—melamine in baby formula, workers with lead poisoning, or fish die-offs from industrial effluents. Chinese authorities closed several metal smelters in 2009 over community outrage when thousands of children were diagnosed with excessive lead levels in their blood. The Chinese government is increasingly concerned how to mitigate the environmental and health costs of toxic chemicals and the growing citizen unrest linked to toxic pollution. However, lowering toxic chemical pollution is a major challenge for China, which has become the factory of the world.

TUG-OF-WAR OVER HALOGENATED FLAME RETARDANTS

Nearly one thousand scientists from around the globe gathered in Beijing from 23-28 August 2009 at the Dioxin 2009 meeting on persistent organic pollutants (POPs) to present their research findings and discuss toxics problems in China and worldwide. POPs are chemicals that are persistent (they do not break down into safer chemicals in the environment for many years); bioaccumulative (they accumulate in plants and animals, becoming more concentrated as they move up the food chain); and toxic. All of the 21 chemicals currently designated as POPs by the Stockholm Convention belong to the family of halogenated chemicals, where carbon is bonded to a halogen such as fluorine, chlorine, bromine or iodine. The Dioxin 2009 meeting included numerous research reports about halogenated flame retardants, a class of chemicals that are being found at increasing levels in humans and animals throughout the world. When certain toxic flame retardants are banned, companies often switch to using other chemicals of similar structure and toxicity, the health impacts of which have not yet been identified.

Dioxin 2009 affirmed China's commitment to reducing such toxics and working towards a POPs-free world. During an opening ceremony worthy of the Olympics, a dozen welcoming speeches were heralded with trumpets and drum-rolls. Talented young singers and dancers clothed in vibrant red and gold silk performed environmental songs and skits. A dynamic rock group, singing about protecting the environment, was flanked by two large screens with images of environmental devastation, flaming oil wells, and deforestation.

Yet only a month later in Shanghai, at a much larger event, a scenario for further worsening toxics problems from flame retardants began to unfold. A multitude of flame retardant chemical producers and buyers thronged the Shanghai Expo Centre for the Fourth International New Flame-Retarding Technology and Flame-Retarding Material Industry Exhibition from 23-25 September 2009. The expos are one of many strategies to promote the use of flame retardant chemicals in China. (See http://www.flameexpo.com/en/). When it comes to the production and use of flame retardants, China is in a tug-of-war with the protection of the citizen health and environment pulling in one direction and profit-seeking foreign companies pulling in the other.

GLOBAL HEALTH AND ECOLOGICAL THREATS

The increasing production and use of halogenated flame retardants in China poses a threat to the health of China and the world. These compounds are ubiquitous and have been detected in human tissues, marine mammals, house dust, soil, air, water, and most biological or environmental media collected from all over the planet. In lab animals, they can cause neurological and reproductive impairments; cancer; attention-deficit/hyperactivity disorder; infertility; reduced sperm count and endocrine disruption; cryptorchidism (undescended testicles); and hypospadias (a penile deformity), among other health disorders. In humans they have been associated with reduced IQ; increased time to pregnancy; changes in thyroid hormones; undescended testicles in infants (a condition associated with a higher cancer risk later in life); decreases in sperm quality; and function and alterations in the levels of male hormones.

The increasing production and use of halogenated flame retardants in China poses a threat to the health of China and the world.

In addition to being hazardous during production and use, halogenated flame retardant chemicals often return to China and pose a threat at the end of their life as e-waste. For example, plastic cases of electronics and other consumer products laced with flame retardants are sent to China from around the world for disposal. When burned, they convert to highly toxic dioxins and furans, which can remain in the human body and the atmosphere for decades. It has been estimated that the primitive recycling of thousands of tons of pentaBDEs contained in e-waste releases tons of brominated and brominated-chlorinated dioxin/furans into the environment. In open burning e-waste areas in China, the measured levels of dioxins in soil exceeded allowable soil standards. Worldwide, pentaBDE flame retardants have been shown to be the major precursor chemicals for this severe environmental contamination from dioxins.

In China's e-waste disposal regions, the air, soil, and water as well humans and animals contain some of the highest levels of halogenated flame retardants and their combustion products in the world. Researchers have reported that flame retardants blood levels in workers in the electronics dismantling center of Guiyu—China's biggest e-waste city in Guangdong Province—are, on average, nearly 600 parts per billion, some of the highest amounts reported in humans. Remarkably, in the flame retardant production area of Laizhou Bay, residents have recently been found to have levels comparable to those found in Guiyu. The Guiyu and Laizhou Bay levels are 10 times higher than average levels in the United States and more than 100 times higher than levels in Europe and parts of China not impacted by the chemical or e-waste industries directly.

Not only are halogenated flame retardants associated with health risks to production and recycling workers, and consumers, the overall benefit of flame retardants in increasing fire safety has not been proven for use in furniture and other consumer products. While halogenated flame retardants may somewhat reduce the time for a material to ignite and the heat released, at the same time they considerably increase the carbon monoxide, toxic gases, and soot emitted once the fire has begun. Most fire deaths and fire injuries result from inhalation of these gases and soot. More effective and less dangerous ways to increase fire safety include reducing smoking; using smoke detectors and/or sprinkler systems; and better enforcement of fire safety standards.

Since smoldering cigarettes are the major cause of fire deaths, the United States and the European Union now require "fire-safe" cigarettes. Bands of thick paper in these self extinguishing cigarettes reduce the flow of oxygen. If left unattended or if the smoker falls asleep, the cigarette will extinguish itself when it burns to one of these "speed bumps," rather than smoldering long enough to start a fire. China, with the largest number of smokers in the world, could reduce fire hazard by requiring fire-safe cigarettes rather than by adding chemicals to all the potentially flammable items in homes and public places.

… plastic cases of electronics and other consumer products laced with flame retardants are sent to China from around the world for disposal.

SHIFTING MARKET FOR HALOGENATED FLAME RETARDANTS

Given the health and environmental hazards and lack of proven fire safety benefit, many scientists, environmentalists and even the International Association of Fire Fighters oppose the use of chemical flame retardants unless there is a proven need and alternative methods are not effective. Nonetheless, their use is being actively promoted in China by the three major flame retardant producers: Albemarle, Chemtura, and Israel Chemicals Ltd. As the European Union and the United States are reducing their use of halogenated flame retardant chemicals—the most toxic variety—these three companies are turning to China for both manufacturing and sales The market share for halogenated flame retardants is estimated to be 20 percent and declining in the European Union and the United States, while it is 55 percent and growing in China. The production capacity of flame retardants in China has gone from 50 kilotons in 1993 to 350 in 2006 and continues to grow rapidly.

The production of brominated flame retardants—the most toxic and persistent of the halogens—has a 30-year history in China. About 70 different varieties of brominated flame retardants are produced, primarily in Shandong and Jiangsu provinces. In 2010, the demand for brominated flame retardants in China should reach approximately 200,000 tons. In addition, in China the manufacturing of chlorinated paraffins as flame retardants and for other uses is growing exponentially. About 60,000 tons of chlorinated paraffins, currently under review to be listed as a POP under the Stockholm Convention, were produced in China in 2007. The growth in production of brominated and chlorinated flame retardants is expected to further accelerate as the major producers of these chemicals work to expand their manufacturing and markets in China.

Chemtura recently moved its Asia-Pacific headquarters from Singapore to Shanghai and has opened a new Application Development Center in Nanjing. Albemarle entered into a joint venture in December of 2008 with Sinobrom, extracting bromine directly from the Shandong brine fields. One motivation for this investment is the high profitability of these chemicals. Albermarle's profits rose 377 percent in 2009 compared to 2008, powered by an increase in the sales of brominated flame retardants. These three bromine producing companies have a history of proposing and supporting flammability requirements that would increase their sales, independent of whether a fire safety benfit has been established

When a regulation for a flammability standard for public places in China was promulgated by the Ministry of Public Security in July 2008, prior to the Olympics, the advertising literature for the Annual Flame Retarding Expo in Shanghai proclaimed, "The enforcement of such a requirement will definitely bring a bright prospect to China's flame-retarding industry." Not surprisingly, the potential adverse health and environmental impacts are not discussed in the promotional literature.

Seeking Less-Toxic Alternatives

One potentially positive trend is that China could take the lead in the production of safer alternative non-halogenated flame retardants based on phosphorus. China has the largest supply of the basic phosphorus raw material in the world, located in Yunnan and Sichuan provinces. Chinese scientists are working to develop new phosphate flame retardants as safer alternatives to those currently on the market. It would be beneficial for the Chinese ministries of environment and commerce to discuss opportunities to work together to speed the development and use of phosphate flame retardants, while discouraging the production and use of the more hazardous halogenated flame retardants. This shift to safer flame retardants would benefit China and the world.

A TOXICS DÉJÀ VOUS

Decision-makers in China need to be informed about the history of adverse impacts of such chemicals to prevent a repeat and amplification of problems in the past. This unfortunate history began with poisoning in the state of Michigan, where in 1973, one ton of a brominated flame retardant called polybrominated biphenylether (PBB) was inadvertently mixed with animal food being produced in the state. The toxic chemical moved from farm animals to milk, eggs and meat, ending up in humans. Millions of farm animals that had consumed the toxic mixture had to be killed and humans with high levels of exposure had increased risks for some cancers. This situation evokes parallels to the recent food safety scandal in China caused when melamine, a flame retardant, was added to dog food and infant formula.

The addition of the fire retardant pentabromodiphenyl ether (pentaBDE) to polyurethane foam in furniture and baby products in the United States is another example of a case where the potential harm far exceeded the fire safety benefit. After pentaBDE was found to be highly toxic and persistent, the United States ceased production in 2004. Production in China continued until May 2009, when pentaBDE was listed as a POP under the Stockholm Convention. The primary replacements are from similar chemical families that share similar properties and likely adverse impacts.

Although the flame retardants are only required for California furniture, all Chinese furniture being exported to North America contains flame retardant chemicals. In addition, leftover foam treated with chemicals is exported to North America for use in bonded carpet cushion insulation. To meet the demand, thousands of small foam and furniture factories throughout southern China produce flame retardant foam and furniture for export to North America. Workers wearing little protective gear add chemicals to the foam before cutting and producing the furniture. The chemicals are also a threat to the health of villagers who live adjacent to these small factories and to farmers who grow rice and vegetables nearby.

Clearly driving the use of these chemicals in products made in China is the lack of regulation of them by importers, like the United States. For example, why have toxic pentaBDEs been replaced with other toxic flame retardants (such as chlorinated tris and Firemaster 550) without government oversight? One problem is that the U. S. Environmental Protection Agency does not currently have the authority to regulate such potentially toxic chemicals. The Safe Chemicals Act of 2010, recently introduced into the U.S. Congress, proposes to solve this problem by amending the Toxic Substances Control Act of 1976 (TSCA), to require industry to test industrial chemicals before they are used in consumer products. If passed, this new legislation should help protect American consumers well as Chinese workers and citizens who live in the manufacturing and waste disposal regions of China from toxic and untested chemical flame retardants.

Primarily used in North America, pentaBDE and its replacement flame retardants are now found in high levels throughout the world in creatures at the top of the food chain such as marine mammals, birds of prey and humans. These chemicals can persist for a very long time. Retardants, such as PBBs, banned more than three decades ago, are still present and problematic in sediments and wildlife.

The Beijing Dioxin 2009 meeting included research showing brominated flame retardants in both giant and red pandas, in fish on the Tibetan Plateau, in dolphins and porpoises in the Pearl River Delta of South China, as well as in frogs, birds of prey, and human breast milk throughout China.

CHOICE FOR POPS-FREE WORLD

Given the potential dangers an important question is whether the production and use of toxic halogenated flame retardants should continue to increase in China. As the flame retardant industry works to expand its scope, government decision-makers are pulled in

On the bridge at the Western Academy of Beijing, a pre-K-12 international school in Beijing China where the Green Science Policy Institute Fire Retardant Dilemma meeting was held in August 2009.

From L-R: Mike Bilan (IB Biology instructor), Erika Helms (Executive Director, Jane Goodall Institute, China), Michael Crook (Founder, Western Academy of Beijing), Arlene Blum (Executive Director, Green Science Policy Institute), Seungmin Cho (Student), SooJin Yim (Student), Trish Smith (Director of Development, Western Academy of Beijing)
Photo Credit: Arlene Blum

conflicting directions. Will they listen to their scientists' research as presented at the Dioxin 2009 meeting in Beijing and strive for a POPs-free world or will they listen to the chemical industry as at the Flame-Retarding Industry Exhibition in Shanghai and build more plants to produce halogenated flame retardants with the potential to pollute China's land and people? Their decision could have a major impact on the health of China and the world.

To share information about health and environmental impacts of halogenated flame retardant chemicals, the Green Science Policy Institute hosted a workshop on 22 August 2009 at the Western Academy of Beijing. Distinguished U.S. and Chinese scientists presented information about the dangers of increasing production and use of halogenated flame retardants in China. Their lectures, some of which informed this article, are posted in both Chinese and English at: http://greensciencepolicy.org/flame-retardant-dilemma-beijing-22-august-2009

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COMMENTARY

Will China Emerge Greener from the Global Economic Downturn?

By Leo Horn-Phathanothai

Dreadful as their consequences are, economic downturns are not always all bad news. For one, they tend to be good for the environment, as economic bustle is strongly correlated with energy consumption and environmental pollution (whether in one's own backyard or that of someone else). And economic recessions give pause for thought, and cause for healthy self-questioning. They offer that most precious of gifts for policymakers: the chance for a fundamental change of tack. As Rahm Emmanuel put it: "you never want a serious crisis to go to waste."

The current global economic downturn presents China with an historic opportunity to reorient its economy onto a more stable and sustainable path. It has exposed the structural imbalances that are at the root of China's current economic vulnerabilities and its profound social and environmental malaise. At the same time the crisis calls for a counter-cyclical boost that could potentially unleash massive resources for a transformative green push to the economy. In other words China's stimulus package could serve as a crucial lever in nudging the economy on to a greener trajectory.

GREEN STIMULUS GOALS

There are grounds for optimism. The Chinese government won much praise for its bold and speedy response to the unfolding global crisis, announcing its largest ever stimulus program as early as November 2008, well ahead of other major economies. A March 2010 Pew report noted that in 2009 the green investment from the stimulus along with other programs led China to become the global leader in clean technology investment, at a rate nearly twice as much as the United States invested. And the Chinese government has made laudable progress towards reaching the ambitious environmental targets it has set itself. In April 2009, China joined other G20 leaders in pledging to "make the best possible use of investment funded by fiscal stimulus programs towards the goal of building a resilient, sustainable, and green recovery."

The stimulus package is impressive in its sheer scale: 4 trillion Yuan ($586 million)—equivalent to 16 percent of China's gross domestic product—has been committed as part of the package. This has been accompanied by an unprecedented expansion of credit: in the first quarter of 2009 Chinese bank lending increased to more than 5 trillion Yuan, which is almost triple the credit level reported during the same period in 2008.

The signs are that China's economic rescue package is working. The World Bank and the International Monetary Fund revised their 2009 growth forecast for China upwards by 0.7 and 1 percent, respectively from the 6.5 percent predicted at the beginning of that year. Macroeconomic analyses indicate that China's economy had returned to a stable track by the end of the second quarter. China's economy seems to have bottomed out.

What is more difficult to assess at this point, is how sustainable these early 'successes' are, and at what cost they may have come.

HOW GREEN?

Whether or not China will emerge greener from the current economic downturn will depend on the following, in increasing order of importance: (1) the proportion of the stimulus package earmarked for environmental purposes; (2) how the different components of the stimulus package stack up in environmental terms (i.e., the overall environmental implications of the stimulus package); and (3) the extent to which the stimulus is being used to support a broader shift towards to a more environmentally sustainable growth path. The emerging evidence is discouraging on all three counts.

Of greater concern there are signs that, in its 'all-but-the-kitchen-sink' approach to stimulating the economy, the government has systematically placed environmental concerns as the lowest priority.

There are some notable green features to the economic stimulus package, but these have been modest in size. Initially, 9 percent of the investment package—amounting to 350 billion Yuan ($51 billion)—was set aside for "biological conservation and environmental protection." When the details of stimulus package were approved by the People's Congress and announced in March 2009 however, this amount was cut down to 210 billion Yuan ($ 31 billion) or just over 5 percent of the total package. In contrast to the speedy disbursement of funds for infrastructure projects, as of June 2009, only 10 percent of that amount had been disbursed.

There are broader environmental opportunities within the package however. The environmental benefits that would result from directing the much larger spending for infrastructure and technology toward clean and energy-efficient solutions would far outweigh those that can be achieved through the 5 percent allocation alone. For example, the 280 billion Yuan ($41 million) allocated for housing projects could be a major boost for improving energy and water efficiency in buildings. Likewise, the 1.8 trillion Yuan proposed for the transportation sector and the power grid could deliver strong environmental benefits if focused on public transit systems and linking renewable energy sources to transmission lines. A recent report by HSBC estimates that 37.8 percent of China's stimulus package may be considered 'green' if such opportunities were realized.

To date, however, the bulk of the stimulus spending is being funneled into energy-intensive sectors and large infrastructure projects, many of which have been on the books for years but slowed or halted by negative environmental assessments that are now being overridden in the interests of salvaging the economy. A similar story can be told of the massive injections of credit: because of the way the Chinese financial system is hard-wired, much of this new lending is channeled into the highly polluting construction, manufacturing and infrastructure sectors, the latter two of which are already plagued by overcapacity.

So far the main beneficiaries of the stimulus seem to have been cement, iron and steel producers. This is hardly surprising for an economy that invests over 40 percent of its GDP in infrastructure. Crude steel output in China rose to a record 266.6 million tons in the first half of 2009, as the stimulus spurred demand from the construction and automobile sectors.

Of greater concern there are signs that, in its 'all-but-the-kitchen-sink' approach to stimulating the economy, the government has systematically placed environmental concerns as the lowest priority. The roll back of Environmental Impact Assessments—through the establishment of a fast-track system, ironically called the green passage—is a surface sign of deeper power shifts within the Chinese government.

BATTLEGROUND LINES

Just as the Songhua River chemical spill in northeast China brought to the boil simmering tensions between 'pro-environment' and 'pro-growth' lobbies four years ago—culminating in the forced resignation of the then environment minister—so is the stimulus proving to be a battleground for diametrically opposed visions and policy programs.

The fault lines are broadly the same this time round.

On one side are those who recognize that the current mode of growth is socially and environmentally unsustainable and economically unsound and advocate for a response to the crisis that would address fundamental imbalances in the economy. I would call this the 'rebalancing' camp. The Ministry of Environmental Protection (MEP), the National Bureau of Statistics, the People's Bank of China and many prominent academicians, policy advisors and think tanks seem to fall in this camp. They have all voiced concerns that the current stimulus package may be exacerbating Chinese imbalances.

On the other side are those who maintain that the overriding priority is to safeguard jobs and that the only proven way to do so is to expand infrastructure, and prop up manufacturing and exports by throwing money at those same polluting and energy-hungry industries that have been the powerhouse of China's economy over the past two decades. Call this the '8 percent' camp, as that is widely taken to be the minimum rate of growth needed to prevent spiraling unemployment and ensuing social unrest. Eight percent is also, unsurprisingly, the target rate of growth that Prime Minister Wen Jiabao has vowed to reach. Municipal leaders, the Ministry of Commerce, the Ministry of Finance and the State Council at large seem to fall squarely in this camp.

This crisis should have strengthened the hand of the 'rebalancing' camp. It threw in to sharp relief the structural weaknesses and vulnerabilities that the 'rebalancing' camp had been cautioning against long before the crisis occurred. The need for a robust counter-cyclical boost to the economy offered the opportunity of marshalling resources on an unprecedented scale towards stimulating new, 'greener' sources of economic dynamism and growth. Spurring green innovation would not only create green-collar jobs but also strengthen economic competitiveness. The crisis provided an occasion for cash-rich China to purchase state-of-the-art environmental hardware at rock-bottom prices from developed economies in disarray, to speed up its industrial upgrading, build its technological capabilities and strengthen its competitive edge.

However, all the signs are that the '8 percent' lobby is getting the upper hand. MEP appears to have been sidelined once again: in June 2009 China's Environment Minister Zhou Shengxian, publicly voiced concern about the escalating environmental risks and impacts of the economic stimulus plan. Environment Vice-Minister Pan Yue—once the government's most outspoken environmental champion—has been stripped of his responsibilities as environmental enforcer and has been conspicuous by his absence from the political scene since the beginning of the crisis. The new vice-minister in charge of environmental assessments, Zhang Lijun, has announced that most stimulus projects will be eligible for fast-track environmental approvals.[1]

Meanwhile, Finance Minister Xie Xuren has reiterated Beijing's commitment to continue with the current policy response. Michael Pettis, a finance professor at the Beijing university lamented in a recent blog that: "policy is still being managed largely by policymakers who are far more worried about rising unemployment in the short term than about asset bubbles and an exacerbation of the unbalanced development model."

China is certainly to be commended for its bold and swift response to the unfolding global financial crisis. Yet, as Gandhi once famously said: "speed is irrelevant if you are going in the wrong direction." Unfortunately, China's response so far seems to be reinforcing the structural imbalances that are at the root of its economic vulnerabilities and environmental ills.

Leo Horn-Phathanothai is an environment and development professional currently working with the United Nations Development Programme (UNDP) as the technical focal for Africa on climate change. In 2007, Leo co-founded the China Carbon Forum, and led the organization for two years. He remains a director-at-large with the China Carbon Forum. Leo holds degrees from Oxford, Cambridge and Sussex universities. He can be contacted at: leo@horn.net.

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ENDNOTES

[1] According to MEP only infrastructure and public welfare projects would be able to obtain fast-tracked environmental reviews. But infrastructure account for about half of the spend, while many other items—such as rural development, health care and post-earthquake reconstruction—are also subject to exemptions as they are classified as 'improving public welfare.'

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COMMENTARY

Facing Five-Year Delay in New Water for Beijing: A Catalyst for Officials to Limit Growth?

By Wang Jian and Jonathan Aloisi

Beijing has long been a thirsty city. The rapid growth of this booming metropolis has sparked four water crises dating back to the 1960s. So far, the city has managed to cope, but only by first marginalizing its surface resources, then by overexploiting subsurface supplies, and finally by using political clout to control water from similarly dry neighboring provinces. The environmental, economic and social costs of these strategies are enormous. The latest plan to boost water supply and subsidize Beijing's further growth, the South-North Water Transfer Project (*nanshui beidiao gongcheng*), was supposed to bring significant new water to this dry city from the Yangtze River by 2010. Recently, however, officials have announced that no new water will reach Beijing via that channel before 2014. This ensures that Beijing's current water crisis will extend into the new decade, even if the ten-year drought ends in 2010.

City leaders have responded to the delay of water transfer from the Yangtze by promising further reductions in industrial and agricultural water use and expanded treatment and reuse of wastewater. These efforts will help, but will barely compensate for the now postponed transfer of 10 billion liters of Yangtze River water annually. Technical difficulties and the general lack of water in North China will limit the capital's ability to expand purchases from neighbors to fill the gap. This leaves Beijing facing tough choices. Continued over-exploitation of subsurface water is inevitable, at least for the next five years, even if the city grows little. The shock of this reality could help Beijing's leaders to take steps limiting Beijing's further population growth. If they do, it will be the first time over 50 years that they match such rhetoric, a staple in planning documents for decades, to resource constraints.

BEIJING'S DILEMMA

Decades of population growth and water-intensive economic development choices have left hundreds of millions with insufficient access to water across North China. The impact of overuse of limited water resources on the environment is obvious and well documented. Over the past 20 years, reservoir levels have fallen and rivers have dried up across the North. In 2007, estimated per capita water resources for Beijing residents stood at about 200 cubic meters per year, only one-tenth of China's national average (which itself is only one-fourth of the global average). Worldwide, Beijing is dead last in estimates of per capita water resources among the world's approximately 120 national capitals ("World and Chinese water crises," 2009). [1]

Chinese authorities are aware of the consequences of unsustainable growth, and formal plans for future development since the 1950s have included resolute statements on the need to limit future population growth in Beijing. [2] In practice, however, authorities have never once adhered to these guidelines and population growth has always exceeded stated limits. Beijing's official population figure has risen from 4.14 million in 1949 to over 17 million in 2007 in a fairly constant expansion. The city's built-up urban area has correspondingly increased from 346 square kilometers (km^2) in 1949 to 1,254 km2 in 2006.[3] Beijing planning documents have estimated the city's urban area will extend to 1,650 km2 by 2020, despite projecting only modest population growth.

In addition, Beijing residents' per capita water usage increased steadily over the past 50 years. In 1949, the figure stood at an estimated 14 liters per person per day. By 2000, that figure had increased 18 times to 259.6 liters per person per day ("Geology," 2000). What has driven Beijing's increases in water consumption? One critical factor has been the creation and expansion of the city's industrial sector. In 1949, Beijing was an administrative and commercial center. By 1963, driven by explicit policies to make the city a showcase of heavy industry, Beijing had become one of China's largest centers of metal refining, power generation, chemical production, machinery, textile and papermaking industries. Beijing's agricultural development also contributed to city's first two water crises. In 1949, agriculture in Beijing involved minimal non-rainfall water use. By 1958, the area of irrigated farmland increased almost seven times to 95,000 hectares. By 1965, irrigated land area reached 229,000 hectares. [4]

THE WATER CRISES BEGIN

During the drought year of 1960, demand far exceeded supply, sparking Beijing's first water crisis. The Guanting reservoir system, built in the 1950s primarily to prevent local flooding, became an important resource for addressing Beijing's short-term problems. As demand for water continued to increase, Guanting, and later Miyun reservoir, became important regular sources of supply. Over time, increases in demand greatly exceeded the capacity of Beijing's two reservoirs to maintain water levels, eventually leading to their marginalization as a source of additional water ("Geology," 2000). [5]

When rainfall again dropped in 1972, Beijing met demand by initiating a massive well drilling campaign enabling total water consumption to continue rising. Beijing's water usage peaked during 1980 at approximately 4.78 billion cubic meters per year.[6] When rainfall fell below average again from 1980-1984, Beijing faced its third water crisis. Municipal leaders greatly intensified pumping of subsurface water. In order to ensure household supplies, they also severely limited water use by agriculture, and supplies to many industrial enterprises were restricted to four days per week for a period. During this time, Beijing permanently ceased providing water to Hebei and Tianjin, which it had consistently helped supply in the past. The 1980s crisis finally resulted in serious moves to increase the efficiency of water use. While Beijing achieved significant increases in efficiency of water use in agriculture and industry, and total consumption dropped from their 1980s peaks, the continued rapid expansion of the city's economic base and population ensured that total water use stayed well above sustainable levels.[7]

Matters came to a head again as Beijing's current drought, which began in 1999, extended into the current decade. The year 2008 was Beijing's ninth straight of below-average rainfall. Beijing leaders formally announced that the city was in an "emergency situation" with regard to water supplies and the municipality has sanctioned emergency pumping of subsurface water resources. In addition to further exploitation of underground water resources, Beijing successfully lobbied for permission to purchase water from the neighboring, equally water-short provinces of Shanxi and Hebei. Controlling these new resources helped Beijing survive in the years before the 2008 Olympic Games, but technical problems, including the loss of up to one-third of water released upstream as it flows toward Beijing, limit the amount of help Beijing can expect from such purchases. In late 2008, a channel specially built from reservoirs near Hebei's provincial capital Shijiazhuang began supplying some additional water to Beijing, but far from enough to allow for decreases in usage of subsurface water

(Chinese Government Website, 2009).

The stark fact is that Beijing has consistently overexploited its subsurface water resources over the past 30 years. Water tables have had no opportunity to recover, even in times of above average rainfall. This has several obvious, negative effects. Official measurements indicate that subsurface water resources under Beijing in 2009 were 10.6 billion cubic liters less than in 1960. As a result Beijing's many natural springs have either dried up or seen their water output drop considerably. Sinkholes and the settling of land affect some areas, creating costs in repairing infrastructure and loss of use of affected land. Around concentrations of wells, underground funnel shaped depressions have formed, affecting 2,600 square kilometers. Building foundations and roads in this area risk damage from settling. Of course, wells are drying up as the water table drops.[8]

THE NEXT-LEVEL STRATEGY

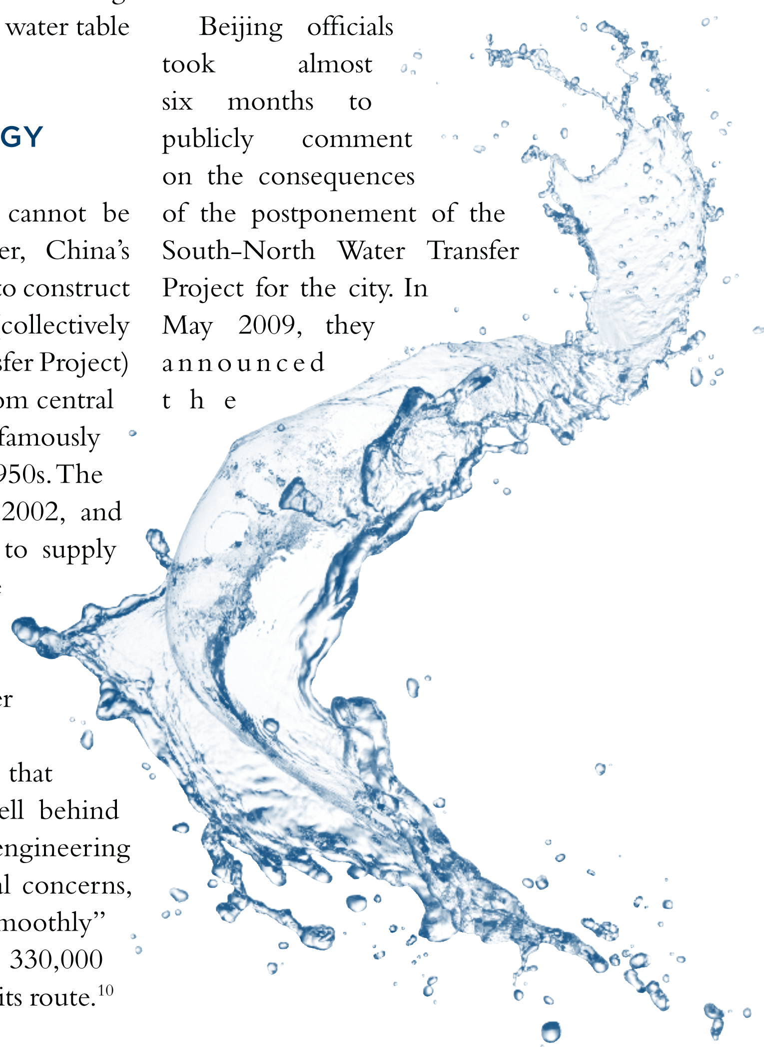
Understanding that North China cannot be sustained without additional water, China's government began serious planning to construct major infrastructure projects (collectively termed the North-South Water Transfer Project) to divert huge quantities of water from central China to the dry north, an idea famously suggested by Mao Zedong in the 1950s. The State Council approved plans in 2002, and construction on the central route to supply Beijing began in late 2003, with the goal of beginning the initial supply of 10 billion cubic liters of new water annually to Beijing and other areas along that route in 2010.[9]

In late 2008, officials announced that work on the central route was well behind schedule due to complications in the engineering design of the project, environmental concerns, and the need for more time to "smoothly" arrange the relocation of well over 330,000 people affected by the project along its route.[10] The costs of the project increased an estimated 150 percent, both due to price increases for materials and a major increase in the calculation of the size of payments to dislocated families, a measure designed to ensure social stability in the areas affected (Mu & Ryder, 2008).

BEIJING'S REACTION

While the Beijing will probably continue to be able to purchase some water from neighboring, equally water-poor jurisdictions, technical issues and these neighbors' own shortages will limit Beijing's ability to increase this source as a short-term fix. Municipal authorities will need to address the shortfall largely within the current capability of Beijing to supply its own additional water needs.

Beijing officials took almost six months to publicly comment on the consequences of the postponement of the South-North Water Transfer Project for the city. In May 2009, they announced the



1-No Fishing or Swimming sign on the "bank" of Daning reservoir.; 2-Building in the outskirts of Beijing destroyed due to settling caused by falling water table.; 3-Guanting Reservoir now holds only a fraction of its capacity. Photo credit: Wang Jian.

establishment of a "rigorous water resource management system," which will "strictly implement total volume control and quota management so that the water consumption needed to produce every 10,000 Yuan of GDP will decrease by five percent." The city will urge forty enterprises with high water and energy consumption and causing heavy pollution to close or move out and will also "promote the use of non-conventional water sources," for example capturing rainwater. In addition, Beijing will expand the utilization of reclaimed water for areas such as golf courses, suburban parks, large-scale green land and agricultural irrigation. Furthermore, the area of green land that is irrigated by reclaimed water will be increased by 2 million square meters, and the amount of annually utilized reclaimed water is targeted to reach 650 million cubic meters.[11].Some modest gains will be easy. An article published in the hot summer of 2009 indicated that local authorities were actually operating only 180 of 5,000 rural water treatment plants, probably to save the cost of electricity *Beijing Youth News*. (2009). While initial 2010 reports indicate some success in utilizing unconventional sources of water, building new infrastructure to capture rainfall and to treat and distribute waste water, will be very costly and cannot serve as a fundamental solution of Beijing's problems.

SHIFTING THE DEVELOPMENT MODEL?

Beijing officials did not list increased pumping of groundwater as a stop-gap solution to the current situation, reflecting perhaps a growing awareness of the serious damage done to the environment by pumping over past decades. Continued "emergency" pumping will be impossible to avoid, however, unless municipal authorities take bold steps to take seriously the rhetoric in planning documents and actually limit growth. This will mean moving away from the exclusive "engineering solution" approach to increase both water supplies and water use efficiency.

Beijing's response to today's water crisis may prove to be more constructive than in the past due to the realization by officials that they cannot count on receiving Yangtze basin water until 2014. Further delays are possible as the nation grapples with the huge engineering, pollution, social and environmental issues of the South-North Water Transfer Project. Neither can municipal officials count on a return to "average" rainfall levels. Also the social and environmental costs of over exploiting subsurface resources are more visible and better understood today, both by increasingly sophisticated municipal experts and leaders and the general population. In addition, while still limited in their ability to influence policy and public opinion, increased access to data on resource use has allowed outside experts and activists to constructively highlight the problems created by continued rapid growth and the need to cease over exploitation of heavily depleted water resources. For all these reasons, Beijing authorities are now more likely to adopt more science-based and comprehensive approaches toward managing the relationship between growth and the sustainable use of the area's water resources.

Much can be done. While much of Beijing's growth reflects welcomed enhancements in residents' standards of living, many developments are poorly planned and some are irrationally placed in areas designated as protected. Many projects lack water treatment facilities and hookups mandated by regulation. Cracking down on corruption and rigorous, transparent implementation of existing regulations could go a long way toward reducing the impact of expansion.[12] Beijing leaders could also do even more to speed the city's transformation away from its previous, and very costly, focus on industry and water-intensive agriculture.

Most importantly, Beijing's leaders could in all their actions take seriously the reality that constraints on growth cannot be ignored or resolved exclusively through "engineering solutions." New thinking is needed, even after the eventual arrival of Yangtze Basin water. Now, when public understanding of the challenge facing Beijing is at a peak, would seem to be a good time for decisive action. We hope Beijing's leaders agree.

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ENDNOTES

[1] Statistics are from Chinese official sources and from calculations based on these by author Wang Jian.

[2] Beijing's 2004-2020 formal development planning document *Beijing Municipal Comprehensive Plan* contains good examples of the priority of containing population growth in the face of resource constraints. The 2004-2020 plan anticipates minimal population growth before 2020, yet posits a huge increase in the urban footprint of the city. In no previous case have such statements translated in actual limits on population growth. For the Chinese text of the 2004-2020 plan, see the Beijing Municipal Government Website: www.bjpc.gov.cn/fzgh/csztgh/ght/200508/t249.htm. For a Chinese official's prediction that Beijing's 2020 population will reach 21 million (not 18 million as posited in the plan cited above), see *Chinanet*. (2008, December 5).

[3] The 2006 figure appears in the 2007 version of the *China Urban Statistics Yearbook*.

[4] Current statistics, compiled by author Wang Jian, indicate crop patterns have changed and the efficiency of irrigation with regard to water use has significantly increased as wasteful practices are abandoned. Changes in cultivation patterns are in large part explicitly driven by officials to reduce water use in agriculture and move farmers into other pursuits. A good assessment of water use for agriculture over past decades can be found in Wolf, J., et al. (2003).

[5] By 2007, Guanting reservoir water amounts had fallen to only 1/40th of its capacity. Miyun's useable water resources stood at only 25 percent of its capacity.

[6] Author Wang Jian's calculation based on official statistics.

[7] Numerous official statements and statistics document Beijing's overuse of groundwater. For one recent example of such a report see *China Net*. (2009, May 9).

[8] The drop in water tables is well documented in Chinese press and academic writing. For example see: "Beijing's predicament" (2004). For an English-language review of the consequences of Beijing's water shortage, and some statistics that parallel, but do not match precisely with, those calculated by author Wang Jian for this article, please see Welford (2010). For an official statement on China's over reliance on subsurface water resources, see *Chinanet* (2004).

[9] The statements of leading officials of the South-North Water Transfer Project give the official justification and basic information on the scheme. For English see: http://www.mwr.gov.cn/english1/20040827/39304.asp. Wiki entry on the project contains links to a large number of related English-language sites with project details. See: http://www.ritchiewiki.com/wiki/index.php/South-North_Water_Transfer_Project. The official Project website is: http://www.nsbd.gov.cn/.

[10] Statistics from Chinese sources on the number of people forced to move to make way for the project vary. 330,000 is often cited, but some sites, such as official Chinanet (2005, April 6), which cites "nearly 400,000" will need to be moved.

[11] For Chinese language text see: *Xinhuanet*. (2009, May 11).

[12] A Chinese official is quoted in December 2008 saying: "In the first six month of this year, about 5.05 sq km of the 8.8 sq km of newly acquired land was illegally developed in 14 districts and counties of Beijing, taking up 57 percent of the newly acquired land area." and "The major reasons for this was illegal occupation of land by county governments and property developers." See *Chinanet*. (2008, December 5).

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COMMENTARY

Persistent Pollution in China: It's Not the Economy, Stupid

By Elizabeth Balkan with assistance by Michelle Lau

ECONOMIC SLOWDOWN = POLLUTION SLOWDOWN?

When a country experiences economic slowdown, industry slackens in response to waning demand. In countries where industrial activity is energy-intensive, energy use typically decreases as well. But, in these conditions, it may not necessarily follow that air quality improves, particularly in countries such as China where heavy and light industry contribute significantly to air pollution. It is an important question to understand the relationship that exists between economic activity and pollution in Chinese cities during an economic slowdown. For if a downturn does not yield better air quality as logic might lead one to expect it will be important to understand why not.

The recent global financial crisis slowed China's economic growth to its lowest annual rate in almost a decade.[1] In the fourth quarter of 2008, real GDP growth slowed to 6.8 percent. It dropped further to 6.1 percent in the first quarter of 2009. Though still impressive compared to stagnant growth rates elsewhere, it was China's lowest rate of growth since 1992, when quarterly data recording began (Reuters, 2009). By the second and third quarters of 2009, growth increased to 7.9 percent and 8.9 percent, respectively. In the fourth quarter of 2009 and first quarter of 2010 China's recovery was robust with real GDP growth of 10.9% and 11.9% respectively (Kitchen, 2010).

Though China's slowdown now seems like a flash in the pan, individuals and industry alike fully felt its impact. Reports of factory shutdowns following sluggish foreign demand studded newspapers for most of 2009, and left an estimated 20 million migrant workers jobless, according to government figures (gov.cn, 2009).

Environmentally, there are conflicting reports on whether the deceleration had a positive or a negative impact. On one hand, the mainstream media ran numerous variations of this article, "Slowdown's Gift to Beijing: Cleaner Air," suggesting that slowed economic growth has led to improved air quality in Chinese cities. On the other hand, some headlines have claimed that the economic slump has tilted priorities of industry to neglect pollution control efforts.

GRIM AIR POLLUTION TRENDS

For about a decade, particulate emissions have been gradually declining in China, despite increasing coal consumption. In contrast, SO_2 emissions have been increasing at roughly the same rate as coal consumption (Ni, 2009). In China, industry accounts for the lion's share of SO_2 and soot emissions.[2] Thermal power production, classified under industry, constitutes the largest single source of industrial emissions, and roughly half of China's total SO2 emissions (Sinton, 2004). The dominant fuel source used in primary energy production is coal, used in approximately three-fourths of the country's primary energy production (*China Energy*

Databook, 2008). Because of the makeup of China's energy landscape, trends in power production carry considerable potential to impact air quality.

A year-long study conducted by MIT researchers explored the environmental performance of power plants throughout China. They visited and collected data from 85 power plants (with a total of 299 generating units) across 14 provinces in China, carrying out a survey of plant managers and specialized personnel. The survey results indicated that several plants were emitting SO_2 at levels exceeding the legal limit. A correlating and somewhat surprising finding, however, was that many of the non-compliant plants were newer and equipped with state-of-the-art stack cleaning equipment (Steinfeld, 2008).

The pervasiveness of expensive and advanced environment equipment within the sample merits mention. Almost 80 percent of the plants studied had installed "clean coal" SOx scrubbers on at least one of their power generating units. The non-compliant emissions levels were due, the study concluded, to two primary factors, neither of which was outdated equipment.

First, though flue-gas desulfurization (FGD) systems were being installed, they were not being consistently or properly operated. The large expense of operating the environmental equipment, energy penalty, and inadequately trained personnel were believed to explain its misuse and disuse. Lax monitoring allows this practice to occur. Second, the authors believed many plants were substituting sub-standard coal in the generating units. Doing so places stress on the system as a whole and degrades FGD capacity, contributing to larger emissions.

Financial reasons explain much of why lower quality coal is being used. In recent years, China has experienced rising fuel costs, government-set feed-in pricing, and then economic slowdown. These factors combined have strained power producers considerably, prompting them to seek cost-cutting measures. Since fuel constitutes the largest operational expense in power generation, it is an obvious place to cut costs.

Emissions "depend almost entirely on the quality of the coal they use," according the report's lead author, rising when low quality, high-sulfur coal is burned (Steinfeld, 2008). The substitution of sub-standard coal offers a way to contain rising operating costs. Based on this argument, it follows that an economic downturn and the financial concerns it introduces, might actually result in increased emissions if this trend occurs at the aggregate level.

The dearth of quantitative data supporting this argument served as the basis for this statistical inquiry. In order to determine the presence and degree of correlation between economic activity and pollution in China as well as whether it was positive or negative, I conducted statistical analysis of economic and pollution data in China during the recent slowdown, as well as the period proceeding it.

OVERVIEW OF THE METHODS

An environmental indicator derived from the Ministry of Environmental Protection's (MEP) daily Air Pollution Index (API) data (available via http://datacenter.mep.gov.cn/) served as the dependent variable. For the economic indicator, and independent variable, I used the monthly industrial value-added (VAI) figure taken from official municipal reports. I obtained the monthly incremental change in VAI by working backwards from the cumulative data. In order to compare the two indicators, the air quality figure was aggregated to a mean monthly figure (measured in 100,000 Yuan).

China's API is derived from measurements of five pollutants (sulfur dioxide, nitrogen dioxide, coarse particulates, carbon monoxide and ozone) taken at various monitoring stations throughout the day. Particulates smaller than 10 micrograms (PM_{10}), and particularly particulates smaller than 2.5 micrograms ($PM_{2.5}$), are most commonly associated with the negative health effects of air pollution on humans and animals (Andrews, 2008; 2008/2009). China's MEP does not include measurements of particulate matter smaller than 10 micrograms in the API.

The recorded daily API figure is calculated, based on a set pollutant-specific formula, using only the concentration level of the day's major pollutant. As such, API data aggregated on a monthly, seasonal or yearly basis would yield statistically less indicative data, given the mix of pollutants that make up the API over time. To overcome this obstacle, I sorted the data according to the dominant daily pollutant, as reported by MEP. Because PM_{10} was the dominant pollutant for over 97 percent of recorded figures, quantitative analysis examined only how PM_{10} trended. I used the government-reported formula[4] to calculate PM_{10} concentrations from reported API (measured in micrograms per cubic meter).

One unavoidable and admittedly limiting factor of using PM10 in this analysis was that PM_{10} can be any suspended solid or liquid larger than 10 micrograms that are emitted directly or formed in the atmosphere as other pollutants react (Particulate Matter, 2009). Both organic (sand, dust) and inorganic materials may be classified as particulates, and organic particulate matter may be either volatile or nonvolatile. Analysis of only PM_{10} disallows the formulation of conclusions about sources of pollution specific to industry, like sulfur dioxide and nitrogen dioxide. Thus, the correlation between PM_{10} levels and economic activity does not tell the entire story of how industry slowdowns affect air quality.

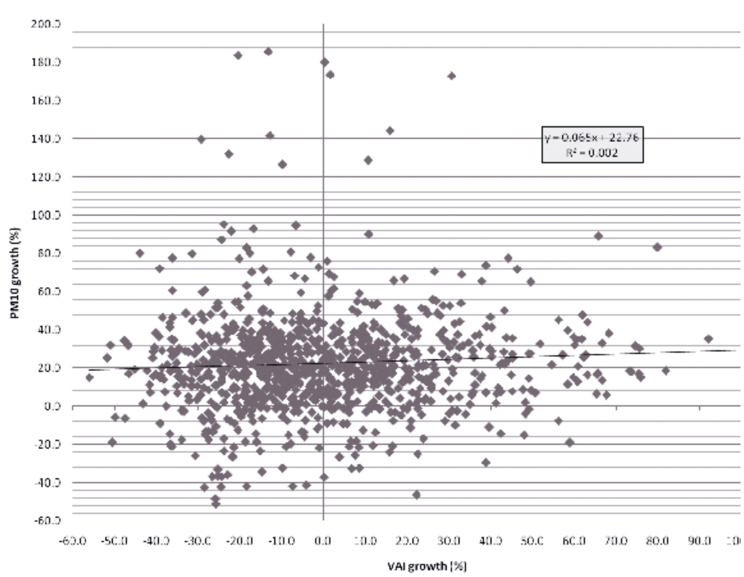
The sample set comprised 36 of China's major cities, both industrial and nonindustrial, and spanned over the 40-month period from March 2006 to June 2009. I generated year-on-year growth rates for each of the variables, in order to avoid skewed results, thus returning 28 data points per variable, per city. This yielded a total of 1,008 observations. Among the factors the year-on-year growth rates corrected for was seasonal trends: in all regions of China, pollution levels are lower in the summer and fall, while economic activity tends to be most robust in the summer months.

POST-CRUNCHING RESULTS

I conducted a simple linear regression on the dataset, testing the assumptions that the variables are normally distributed; a linear relationship exists between the independent and dependent variables; the variance of the errors are the same at all levels; and that the sample size is random, normal, and representative. My hypothesis was that the relationship between economic and pollution variables is negative.

All assumptions held true, and the P- value was less than one percent, yielding statistically significant relationship between the pollution and economic growth at a 99 percent confidence interval. The line of best fit generated from the regression was:

$$y = 0.065x + 22.76$$



This means that, for every unit increase in pollution growth, economic growth increases by .065. The relationship was positive, but not a very dramatic one. Moreover, the r-squared statistic was only 0.002, meaning that economic activity explains only two percent of pollution trending. Because of the weak predictive value and small coefficient of the independent variable (x), the results were not very robust and the hypothesis was incorrect.

CONCLUSIONS

Though the results indicated only a minor positive relationship between pollution and economic activity, they clearly demonstrate that, when it comes to the factors affecting air quality, a lot more than the economy is at play. Among these relevant factors are the role of policy and strength of the regulatory environment, as well as the level of environmental transparency and monitoring.

From a regulatory standpoint, expectations of local officials to deliver growth (in order to raise provincial revenues) directly undermines central mandates on environmental compliance. During an economic slowdown, the primacy of growth over environmental protection is heightened. Thus, as the MIT study demonstrated, despite centrally mandated technological upgrades, a lack of enforcement permits local, financially constrained industrial users to bypass advanced, but expensive modes of fuel consumption. Improvements in standards and progressive policies will not deliver results unless coupled with on-the-ground capacity building and use of incentives.

Also, improvements in environmental performance depend on not just the development and implementation of policy, but on achieving compliance through transparency. In the United States, an environmental organization's 1985 op-ed in the *The New York Times* catalyzed the development of the Environmental Protection Agency's Toxics Release Inventory (TRI) Program, active since 1988. Today, the TRI contains a publicly available database with information on toxic chemical releases and waste management activities of certain industries and federal facilities. While the data is self-reported, many credit the public disclosure requirement as having done a great deal to promote industrial entities to mitigate pollution. On the EPA website, both the Sierra Club and Monsanto, entities with very disparate interests, are quoted praising its effectiveness. This kind of environmental transparency does not exist yet in China. However, the potential and momentum for its development do. In mid-2009, the U.S.-based Natural Resources Defense Council and China-based Institute of Public & Environmental Affairs released the first ever Pollution Information Transparency Index (PITI; available in Chinese via http://www.greenlaw.org.cn/blog/?p=1191). PITI evaluation includes disclosure of polluters environmental rule violations, any remediation action taken, and assessment results of enterprises' environmental impact, and is available online. Built on the belief that "environmental transparency is a critical tool in the fight against pollution," this index gives hope for significant improvements in air quality, as well as the systemic underpinnings affecting it (Wang, 2009).

No sooner did China's economy rebound than articles about increasing pollution resurged. But as the numbers indicate, persistent pollution in China has a lot more to do with institutional shortcomings. In other words, it's not the economy, stupid.

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ENDNOTES

[1] According to World Bank Development Indicators: GDP growth (annual %)

[2] Around 80 percent of SO2 and soot emissions came from industry in 2000 (World Bank 2007)

[3] Environmental equipment accounts for upwards of one-third of total plant expenses (Steinfeld 2008)

[5] For API 0-51: PM10 concentration = API/1000, For API 51-200: PM10 concentration = (API – 25)/500 For API 201-300: PM10 concentration = (API + 300)/1429, For API 301-400: PM10 concentration = (API + 225)/1250, For API 401-500: PM10 concentration = (API + 100)/1000

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COMMENTARY

Pulling the Plug on Water Wastage in Beijing's Bathhouse Industry

By Hu Kanping (Translated by Zhu Sha)

Chinese cities are big and thirsty—and growing bigger and thirstier. With the built area equivalent of one New York City popping up each year, China's urban growth rate will move 350 million more people to cities between 2010 and 2030—a migration unrivaled in human history. The water and energy required to fuel this growth and satisfy an increasingly wealthy population are mind-bogglingly huge. While agriculture currently uses 50 percent of China's water, cities will be demanding more of this share to address current and growing water shortages. No city in China feels the pinch of water shortage more acutely than Beijing, China's capital in the dry north.

For many years Beijing has relied on emergency water transfers to quench its thirst; recently this practice has become increasingly expensive and contentious *(Editor's Note: For more insights on these problems see Wang and Aloisi Commentary in this volume)*. In 2006, Beijing's *Water Resource Protection and Utilization Plan* for the 11th Five-Year Plan period indicated that the city would begin prioritizing conservation and demand-side management goals to be met by 2010, such as: raising public awareness of water saving, broadly implementing water saving technology and standards, and optimizing the allocation of water resources. The plan intended to begin modernizing Beijing's water management by enhancing the legal framework and improving water administration. The overall goal of the plan is balance resource protection and development in order to establish a water-saving society.

The plan identified several specific industries—including skiing, golf, public baths, and car washes—as targets for stricter water regulation. By issuing water withdrawal permits, the municipal government aims to immediately control water usage and eventually implement a comprehensive industry-specific water pricing scheme.

Progress on meeting water-saving goals set out in the 11th Five-Year Plan was initially slow, which is why 2009 was a crucial year. Government data indicated that in 2009 Beijing witnessed a constant decline in per capita household water consumption, due to significant cuts in agricultural water use and a noticeable upward trend in the use of reclaimed water by industry. However, a deeper examination of specific water saving scores for each special industry reveals that there is much more progress to be made, particularly in Beijing's bathhouse industry.

BATHING IN A MOUTHFUL OF WATER

Beijing has one of the lowest levels of per capita water availability among the world's major cities. The international definition for water scarcity of per capita water share is 1,000 m3 per person; Beijing (based on the 2005 population level) only has 248 m3, which ranks the city less than one-eighth of China's national average and one-thirtieth of the global average. To visualize the point:, if the global water average per person is a pitcher, the average Chinese has a glass and Beijingers only get a mouthful.

Successive years of drought in northern China have intensified the water shortage situation. In the past decade, Beijing's annual precipitation average was only 450mm, which is only about 77 percent of the historical level of 585mm and was lower than other major Chinese cities. Strikingly, in the midst of this prolonged drought several highly water-dependent industries boomed in the heart of Beijing; at the forefront of which stands the bathing industry.

The water used during one individual's public bath can supply one household in Beijing for 3 days

Beijing's city planning bureau has labeled the bathing industry as one of the few special industries that are critical to citizens' quality of life. Bath centers have a long history in Beijing, but it is been only recently that the city has witnessed a boom of several thousand new spas, public bath centers, and hot spring clubs—some of which are huge, encompassing over a hundred thousand square meters. Bath centers are equalitarian in their distribution, spreading into every district and the suburbs that have expanded with each subsequent ring road.

In 2009, the Beijing SpaView hot spring hotel claimed the title of world's largest indoor spa in the Guinness World Records, a recognition that was lauded by Beijing media as "another world-renowned Chinese achievement." Located in a townhouse complex in the northeastern corner of the fourth ring road inside Chaoyang District, SpaView contains 96 hot spring pools and can host 5,000 clients. The area covers 130,000 square meters and the pools are supplied by a spring that is 3,500 meters below ground and discharges 4,000 cubic meters of water everyday. SpaView dwarfed former leaders of the city's bathhouse market. However, a source close to the industry revealed that SpaView will not enjoy the title of largest bathhouse for long, as an even larger successor is likely to take over both its market share and the Guinness record in 2010.

Along with the advent of bath giants, small players are also actively crowding the scene. According to the city government, at the end of 1989, there were only 39 bath centers in Beijing, but by 2009 the number jumped to over 3,000. Yet, given the city government's inclination to underestimate market capacity and overlook the role of bath centers when calculating the city's water use, the 3,000+ number could be a massive underestimate. Responding to a journalist's request a few years ago to estimate the industrial water usage, the Beijing Bureau of Industry and Commerce answered that no accurate number of those centers was ever available due to the fast proliferation of new facilities, compounded by the fact that numerous hotels and restaurants had begun bath services as well.

WHY ARE BATH CENTERS SO POPULAR?

In the mid-1980s, ordinary Chinese paid less than 1 Yuan to shower at either a public bath or a bathhouse located in their work place. When electric water heaters became an affordable home appliance, people could enjoy the convenience of showering at home. There was a resurgence of popularity in public bathhouses in the 1990s as the bath industry began attracting customers by offering other leisure services, which not only included sauna rooms and hot spring pools, but also stage shows, restaurants, hair salons, gyms, and game rooms.

Special packages for group events have attracted business people who use bathhouses as a form of entertainment for their clients. Every evening, people pack the rooms at the Jinsha Hot Spa Club, which is located in western Beijing; this is only a snapshot of what is happening every evening at the large number of high-end bath centers around Beijing.

Exuberant popularity and rising customer demand make this industry highly profitable. Most flagship companies express confidence in continued growth of their business with a steadily expanding clientele pool (pun intended!). Undoubtedly, the bath industry is experiencing a bubble supported by domestic and international investors who wish to tap into a novel consumer market. The average cost of establishing a luxurious bath center in Beijing can reach hundreds of millions of Yuan, yet these high startup costs have not slowed the growth of spas and water therapy centers within the city and on its outskirts. Some spas even upgrade to operate in chains. For example, Gwongeumseong International Holding Group has opened more than 20 chain bathhouses in Beijing alone.

Taking into account the economic impact and government revenue bathhouses provide, it is easy to understand why municipal governments enthusiastically support the industry. In 2009, the district government of Changping in northwestern Beijing gave out over 100,000 free spa tickets worth a total of 15 million Yuan to residents of Beijing and neighboring provinces in order to promote business for its 17 local bath enterprises. As a result, daily client visits at some sites exceeded 10,000, a stunning number that should have sounded alarm bells about the likely huge water consumption. Unfortunately, the government, enterprises, and the news media were silent on the issue of water consumption during the promotion. A second large round of ticket distribution, this time at a major discount, hit the market in May 2010 and was greeted with fanfare in the news media but again there was silence on the issue of city water-saving needs.

INVISIBLE COST

The first China Hot Spring Economic Forum was held in 2008 at which delegates voiced warnings about the excessive exploitation of hot spring resources in China and cited an urgent need to establish water use rules for the industry. There was also a consensus that an industrial association needed to be created to enhance standards and sustainability associated with the growth of spas and bathhouses. A marked lack of a nationwide legal framework to guide the use of hot springs has led to massive over extraction of water resources, particularly in Beijing where the instant commercial benefits are driving development of new hot spring tourism sites.

Spas in Beijing are developed with little attention to ecological or geological impacts, which can be severe. For example, in Beijing a good number of spa centers that market themselves as hot springs actually drill for regular groundwater and then heat it for pools and baths, rather than tapping into true hot springs that push up to the surface through long cracks in the rock stratum.

According to a joint announcement made by Beijing Municipal Bureau of Land and Resources and Beijing Bureau of Geology and Minerals Exploration and Development, each year Beijing exploits 100 million square meters more groundwater than is environmentally sustainable. This massive extraction of groundwater has resulted in serious ground subsidence that is particularly severe in many areas of the city. In March of 2005, ground subsidence caused an underground water pipe to burst and turned the San Yuan East Bridge road into a water reservoir within 10 minutes.

BLIND SPOT ON THE ROAD TO A WATER-SAVING SOCIETY

Because water is not always well metered in Chinese cities and such data is rarely easily accessible, it is difficult to know how much water any specific industry is consuming in Beijing. The per capita water consumption in Beijing is approximately 110 liters per day. According to some estimates, each individual bath center visit equals 3 to 5 times of that amount and the use in hot springs is even greater. To help understand the scale, the water used during one individual's public bath can supply one household in Beijing for 3 days. If the 17 million people of Beijing visit a bath center once a month and each uses 400 liters per visit, then it will cost Beijing an extra 8.16 million tons of water every year. Simply put, this lifestyle entails a water price that is too expensive for this thirsty capital to pay.

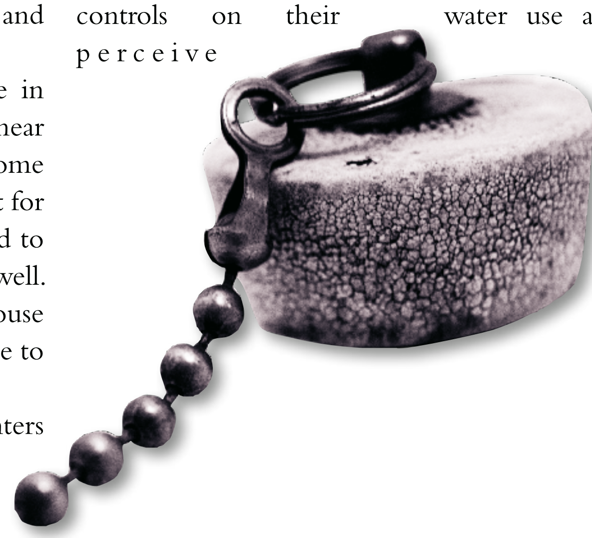
Since the Chinese version of this article expressing my concern with the Beijing bath industry was published in the March 2010 issue of *China's Environment Green Paper (zhongguo huanjing lü pishu)*, my estimate of 8.16 million tons of water annually was widely quoted in many media outlets, with some of them describing it as the equivalent of "41 Kunming Lakes" (of the Summer Palace) in their reports. On April 8 2010, the Beijing Municipal Water Saving Office hosted a press conference in an effort to clarify misunderstandings and to replace the so-called "non-factual" number that I proposed with its own calculation of 5 million tons. This new number does not hold up to scrutiny. In interviews with numerous bathhouse managers in Beijing, the consensus is that on average a male customer uses 300 liter water whereas a female bather averages about 500 liters. Thus, we can estimate that each Beijinger uses 400 liters on average with each visit. Dividing the estimate by Beijing water officials of 5 million tons by 3,000 bath centers would mean that each establishment will get 4.56 tons water per day, which could only suffice 10 individual visits each day. Regardless of the size of the center, such a daily consumer volume would not keep these businesses profitable and growing in number.

Without many policy tools to leverage in slowing the expansion of bathhouses in the near term, it will be crucial for water saving to become a key corporate social responsibility concept for this industry. Moreover, customers will need to voluntarily reduce their consumption as well. Without such awareness among bathhouse managers and customers, water will continue to be wasted at a stunning rate.

Random interviews at bath centers across Beijing resulted in candid admissions that customers had limited awareness of the amounts of water used per shower. Some even argued that they have already paid the price to use more water, which gives them the right to ignore posted signs that request individuals to shut off water while applying shampoo. One interviewee commented bluntly: "why would I pay for the service here and then try to save water?"

Managers have their side of story to tell when challenged about water saving efforts. One manager responded that "clients come to the bath center for relaxation and unrestrained leisure. It would appear that saving water is to our own interest, but if we try to tell clients to save water, they may simply take offense and stop visiting our center." Another facility owner told the author that their 168 Yuan price rate is set to target mid- to high-end consumers and it includes swimming, spa, performance tickets, and three buffet meals. Therefore, the majority of patrons try to get the most out of the money spent by showering longer and eating more, neither of which favors water conservation. Needless to say, Beijing's water saving campaign has a long way to go in this water-squandering industry.

For the time being, one immediate and practical solution is to install water-saving equipment such as low-flow shower nozzles. Surprisingly, such equipment is rare in Beijing; one explanation being that customers dislike controls on their water use and perceive



companies using the equipment as skimping on service

REFORMING WATER PRICE: A LIMIT ON HIGH-WATER CONSUMPTION INDUSTRIES?

To cope with the astonishing reality of water shortage, Beijing implemented new pricing mechanisms for non-household water consumption on December 20, 2009. The readjusted water price for the bath industry increased from 61.50 Yuan per cubic meter (Y/m^3) to 81.68 Y/m3. On the following day, Beijing also announced a price increase for residential water, from 3.70 Y/m^3 to 4.00 Y/m^3.

People who are concerned with water conservation welcomed these two moves. But for the bath industry and its effects on water supplies, the real impact of these policies remains to be seen. The change in water price will not substantially drive up operational costs for high-end bath centers, since their services are more diverse and not necessarily water intensive, including fitness centers, entertainment, and business clubs. To the contrary, the rising water resource price could trigger more wasteful behavior. As one customer pointed out, as people become more sensitive to household water consumption they may spend more time in bath centers.

Beijing could take more aggressive action in regulating this high-water-use industry, which will be important for controlling water consumption in the city. Three possible agendas for the city include:

1) Learning from Changchun's example by adopting water-saving regulation for this industry as early as possible. In July 2001 the city of Changchun approved and implemented a "Provincial Measure for Bath Industry Administration." The People's Congress of Beijing had expressed similar intention for such regulation in 2005, but a draft is yet to be seen.

2) Urging bath centers to follow the example of universities in Beijing, Tianjin, and Nanjing that successfully upgraded public shower space with water-saving technologies and modern shower equipment to be a "pay as you use" system. The results of which have been encouraging.

3) Recommending the citizens of Beijing as well as residents of other water-scarce cities to learn from the example of Australian tennis players. In making "water saving" a theme for 2009 Australian Tennis Open, the organizer called upon the athletes to shower for less than one minute after training and competition. All participants viewed it as "a simple yet significant move." To make the goal more realistic for ordinary citizens, we could start by showering for one less minute each time. This very small change could benefit Beijing's water thirst in the long run.

There are likely many more strategies, but real action will not start until the silence on water wastage in Beijing's bath industry ends.

This article was adapted from one the author published in Chinese in The China Environment Yearbook in March 2010. Hu Kanping is an editor of the Environmental Protection magazine. He also participated in the China Environment Forum's first U.S. study tour in 2000 that included Chinese environmental NGOs and green journalists. He can be reached at: hukanping@gmail.com.

Green Earth Volunteers

By Jon Aloisi

Green Earth Volunteers (GEV) is one of China's oldest indigenous environmental NGOs. Founded in 1996, GEV serves as a vehicle for grassroots participation, both by organizing educational trips to raise consciousness on environmental issues and by helping to generate press coverage about pollution, energy and climate change policy. Today, GEV's monthly journalist salons in Beijing routinely bring key environmental journalists and specialists together to discuss breaking issues. Many benefit from the Internet transcripts of lectures and discussion among participants at each session.

In a related project, GEV supports contributors in Beijing and 18 other cities who forward local stories on environmental issues for inclusion in its daily news digest. On average, each digest includes 15-20 items and is sent to over 700 recipients. These stories document matters related to pollution and health, enforcement and justice, and climate change. Through its salons and this digest, GEV has helped to create a nationwide network of concerned journalists, which now constitutes a potent force in China's indigenous environmental movement.

The effectiveness of GEV's work is demonstrated by its continuing impact on policy, especially in recent years. GEV's multi-year focus on the Nu River dam "development" controversy, for example, has helped keep the issue fresh in the minds of Chinese policymakers and the public. More broadly, seeing articles on pollution problems in print reassures individuals that they have the "space" to raise their specific concerns, which in turn helps increase public willingness to engage on local environmental issues.

GEV's founder, Ms. Wang Yongchen, is a prolific writer and award-winning journalist. Wang's media credentials and reputation as a crusading reporter, and her ability to take on special interests and the government when necessary, help explain GEV's effectiveness to date. But GEV's road is not an easy one. All indigenous NGOs operate within strict constraints on advocacy, organizing and fundraising, and GEV's key volunteers admit that they face daunting challenges in transforming the organization from a small, project-driven group into something more substantial. GEV formally registered with a local branch of the Ministry of Civil Affairs as a citizen-run nonprofit organization in December 2007 as the "Green Earth Environmental Scientific Research Centre." Friends are now working with GEV to create a stable and professional management staff as a foundation on which to consolidate and expand the NGO's activities. With a modest injection of management talent, they believe GEV can capitalize on its success in attracting committed volunteers and become a more substantial channel to disseminate environmental information and constructively influence policy.

Specifically, GEV looks forward to further expanding its outreach and training for interested journalists in provincial capitals around China. GEV also wishes to increase its educational activities to encourage thousands more influential Chinese to actively participate in the indigenous environmental movement. In addition, GEV is working on ways to translate into English and disseminate key articles included in GEV's Chinese-language digest. Given the

Participants celebrate during their 2005 Green Earth Volunteers study trip.
Photo Credit: Green Earth Volunteers.

pool of talented volunteers already associated with GEV, and its significant track record to date, prospects are good that the organization can continue to play an important role in China's nascent environmental movement.

To date, GEV has subsisted largely on volunteers' contributions, but has also received funding from overseas groups, including small grants from the Blue Moon Fund, Canon, and the Natural Resources Defense Council. Interested readers can visit the group's website at www.greensos.cn.

Jon Aloisi is a retired U.S. Senior Foreign Service Officer who has been studying and living in China off and on since 1979. Based in Chengdu, he is currently teaching, writing and lecturing throughout China. He can be reached at: aloisijm@gmail.com.

COMMENTARY

Grassroots Groups Catalyze Sustainable Community Agricultural Efforts in Chengdu

By Jiong Yan, Hongyan Lu, Lei He, Jun Tian, and Yu Luo

China is a country with a long tradition of organic farming. Despite thousands of years producing crops, careful cultivation has helped much of China's land maintain fairly good productivity to feed the 1.3 billion population. However, soil quality has been dropping precipitously over the past twenty years, due to pollution, erosion, and a rapid increase in chemical fertilizers, trends that threaten to undermine China's food security.

As China's economy has boomed the demand for food for domestic consumption and export has increased considerably. To meet this demand, Chinese farmers have rapidly expanded the use of chemical fertilizers, which has helped them produce more out of the country's limited arable land and to farm very marginal lands. In 1978, China's total chemical fertilizer consumption was 8.8 million tons and by 2007 the use increased six-fold to reach 51 million tons.[1] Approximately one-third of the world's nitrogen fertilizer was used in China in 2006,[2] the highest use of any country. Although the use of chemical fertilizers has helped ensure food security for China, these chemicals cause severe non-point pollution exacerbating the country's already severely degraded waterways. Chemical fertilizers also contribute to China's greenhouse gas emissions. While China's CO_2 emissions are the largest in the world, it also leads in greenhouse gas emissions from chemical fertilizers—such as nitrous oxide (N_2O), nitric oxide (NO) and ammonia (NH_3).

In recent years, a handful of grassroots environmental groups in China have promoted organic farming and community-supported sustainable agriculture. Such projects were initiated to deal with the harmful health and ecological impacts caused by heavy chemical fertilizer use, as well as work to improve the livelihood of farmers, whose poverty rates are increasing. Chengdu, the capital city of Sichuan Province—one of China's breadbaskets—is attracting a number of organic farming projects supported by Chinese nongovernmental organizations (NGOs). Such projects are a striking new trend, for few Chinese environmental groups focus on rural issues. This article provides a quick overview—like a dragonfly touching the water (*qingting dianshui*)—of three organic food projects, two of which were initiated by local NGOs—Chengdu Urban Rivers Association and Weeds Culture—and one by a private business—the Guoyuanxiangzhu Farm. Strikingly, while each project differed in origin and goals, all three came to prioritize similar strategies of directly involving and building trust with farmers and local consumers. All three projects stimulated a renewed interest in China's organic farming tradition and therefore represent important models for other regions in China.

ANLONG VILLAGE MODEL: A COMPREHENSIVE SYSTEM FOR SUSTAINABLE DEVELOPMENT

Located in the northwest outskirts of Chengdu's city center, Anlong is a typical Sichuanese rural village with a rich agricultural tradition. Anlong is situated along the Zouma River, a tributary feeding into the Funan River that flows through the center of Chengdu. The non-point chemical fertilizer, livestock, and household waste pollution (e.g., cesspits and public toilets) runoff from Anlong and other neighboring villages are major pollutants degrading the Zouma River. China's water pollution laws regulate pollution emissions from industries and wastewater treatment plants, but there are no standards regulating agricultural runoff. Moreover, challenges in enforcing existing water pollution regulations in China's vast rural areas are beyond the capacity of many environmental bureaus. In an effort to protect the rivers in this area, since 2005 the Chengdu Urban Rivers Association (CURA) has been carrying out a demonstration project to help promote more sustainable agriculture and better livelihoods for farmers in Anlong Village.

CURA was founded in the summer of 2003 and was officially registered as an environmental NGO by the Chengdu Bureau of Civil of Affairs. CURA's aim is to protect rivers and environment, and promote sustainable development in urban and rural areas. With a strikingly large staff of 19, this Chinese NGO has been able to take on long-term projects to promote sustainable agricultural production. CURA's projects engage villagers in pollution control work through integrating organic farming with resource recycling and sanitation improvements. For example, in Anlong CURA assisted the farmers in building household biogas plants, urine-diverting toilets, and ecological wastewater treatment plants. CURA also has been training Anlong farmers in organic farming, an activity that links all the recycling and sanitation work into a closed-cycle eco-farming system. The key components of CURA's integrated agricultural initiatives are outlined below.

Household Biogas Plant

Biogas plants were the first project that CURA started in Anlong, which exposed the farmers to the idea of changing Anlong into an eco-village. The success of this project became the foundation for more ambitious sustainable development initiatives. In the past, villagers used straw, wood and grass for cooking, which generated greenhouse gases—particularly black carbon—and had very low energy efficiency. In 2005, CURA organized experts and working teams to assist farmers in constructing the first household biogas plant, which then provided one family with clean energy and high-quality organic fertilizer. The biogas plant uses manure and urine from livestock and organic residues and straw from agriculture activities as the input materials. After the anaerobic fermentation, the generated biogas can replace straw and wood as energy and the digested residues are used as organic fertilizers. This first plant helped CURA to demonstrate the basic concept of a recycling economy village and encourage other households to build their own and accept other practices and technologies that protect the watershed.

The Eco-Toilet Project

Starting in 2006, CURA began a second project that helped 108 households construct urine-diverting toilets. Previously, farmers used cesspits or very simple toilets that were connected to pigsties—both very unsanitary practices that spread disease and contaminate local water sources. This project employed urine-diverting toilet technologies from Sweden that collects urine and flushed water separately so they can be applied to crops directly. Excrement is not flushed by water, rather covered by plant ash. After 6 to 8 months of naturally decomposing, the waste turns into organic fertilizers that are free from viruses and can be used for agriculture. This toilet combined with biogas ultimately promotes much better sanitation and living conditions in the village.

Ecological Wastewater Treatment Facilities

Helping the farmers create an ecological wastewater treatment facility was CURA's important third project because the 420 Anlong village households had long discharged untreated wastewater directly into the Zouma River. CURA helped many of the households build a small wetland area made up of local vegetation that filtered domestic wastes through a three-step purification process. The final treated water can be used for growing fish. The wetland wastewater facility also became a beautiful landscaped area for each of the households.

Organic Farming

The organic farming initiative has become the key that links all of CURA's projects in Anlong together. Following the expansion of the household biogas plant and urine-diverting toilet, CURA encouraged Anlong farmers to stop using pesticides, herbicides, and fertilizers and begin shifting toward organic farming. Previously, Anlong farmers used around 600 kilograms per hectare (kg/ha) of chemical fertilizers. Since 2006, nine families joined the organic farming project. Today, these farmers use traditional farming methods, such as composting, duck-rice farming, and organic fertilizers from urine-diverting toilet and biodigested residues. During the transition all families experienced a significant decrease in vegetable and grain production. After two years the situation improved considerably for the farmers who not only increased their income through selling organic vegetables and but also saved money because they do not have to buy chemical fertilizers. The price of organic vegetables in Anlong village averages approximately 8 Yuan/kg (~$1.17/kg) including delivery service charges (7 Yuan/kg without delivery); the price is around 30 to 100 percent higher than the non-organic vegetables. To help these farmers expand their market, CURA helps advertise and build direct supply-consumption chains between the farmers and urbanites in Chengdu.

Farmer Gao's family takes part in organic farming after CURA training in Anlong Village.
Photo credit: Chengdu Urban Rivers Association

Farmers As Implementers

Central to CURA's success in Anlong was its emphasis on empowering the farmers as implementers and as proud stewards of their land. For example, in the process of constructing the facilities, CURA did not hire any workers. Instead, CURA staff worked with the first farmer family to set up the demonstration models and opened them up to the other farmers for inspection, which encouraged other farmers join the project. CURA provided materials that farmers could not buy locally and trained farmers how to construct these facilities. Farmers worked on the construction with their own money and labor. They could also change and improve the design based on their needs and expertise. The building process became a learning and competitive process among the farmers. For the urine-diverting toilet project, CURA assessed and awarded each household 800 to 3,000 Yuan (~$117-$440) based on the investments and quality of the toilets.

The participatory process helped the farmers to understand the design and technologies of these facilities, which was key for them to use the facilities appropriately. Moreover, farmers learned how to solve any problems that arose themselves and maintain the facilities without relying on outside experts. With low costs and successful implementation the participating farmers also acquired a strong sense of ownership of the projects.

With the improved sanitation and biogas facilities, Anlong farmers now have safe and environmentally friendly energy and fertilizers that are generated from animal and human waste. But even more important has been how the projects have helped the farmers look at their work, life and land with a new perspective and pride.

WEEDS CULTURE: ECO CITY AND COUNTRY 1+1

Eco City and Country 1+1 is a community-supported agricultural project led by Weeds Culture, an NGO founded in Chengdu in 2004 and formally registered in 2007. The 10 fulltime staff working at this NGO undertakes projects to promote public participation in environmental protection and integrate environmental protection into citizens' daily lives.

Eco City and Country 1+1 began as a urine-diverting toilet project that Weeds Culture undertook in areas affected by the 12 May 2008 earthquake in Wenchuan, Sichuan Province. This eco-toilet project was launched to address the severe pollution being caused by sanitation facilities damaged after the earthquake. Even before the earthquake, primitive toilets that were combined with pigsties were a sanitation hazard, as well as a major source of soil and water pollution. In the first year of work that began in July 2008, local farmers helped Weeds Culture construct 500 urine-diverting toilets in 15 regions of Wenchuan.

A New Option To Combat Crushing Poverty

During the implementation of the eco-toilet project, Weeds Culture staff realized that local farmers were extremely concerned with securing a stable livelihood—many of them survived on 2,000 Yuan/person each year (~$294), which was less than one-third of what most rural farmers in China earn each year. In order to understand how they could help, the Weeds Culture staff surveyed farmers to identify development strengths and obstacles in each village. In the process, Weeds Culture staff discovered that many local farmers still used the traditional farming methods, forgoing fertilizers because of the expense. However, due to the difficult transportation out of these remote rural areas, these agricultural products were mainly consumed by the farmers instead of sold in the cities. In one case, villagers in Mao County who grew apples without chemical fertilizers ended up feeding them to pigs because they lacked market networks to sell them in cities. When vendors do make it to the more remote villages, local farmers can only sell some livestock, such as chickens, ducks or pigs at very low prices.

Organic products have a high potential to bring in significantly more income for local farmers, in great part because Chinese urbanites are increasingly concerned about food safety. There are, however, two major challenges for organic food sales in China: high cost and doubts regarding the credibility of certified organic food or "Green Food." Weeds Culture designed the Eco City and Country 1+1 project to get more organic food to markets through building new farmer-consumer networks.

Organizing Farmer and Consumer Associations

In the first step to build farmer-consumer networks, Weeds Culture did surveys in three nature reserves in the earthquake region and three urban communities in Chengdu. Working together with local farmers, over 100 agricultural products were selected as "local specialty foods" to be grown organically and marketed to urban areas. Key in facilitating the urban-rural links were efforts by Weeds Culture to organize farmer associations in three villages located in or near the Wanglang, Heshuihe, and Wolong nature reserves and to establish three consumer associations in three middle-class urban communities (Zhongyanghuayuan, Shuduhuayuan, and Zhixinhuayuan) in Chengdu. As the first big advertising push, Weeds Culture marketed the organic food products to women, stressing the benefits of these products for children and pregnant mothers. The farmer and consumer associations greatly improved information dissemination for these new organic markets and greatly increased the sales.

Cultivating Trust and Mutual Benefits

In China farmers and consumers often are isolated at both ends of the food production and consumption chains. Urban consumers are skeptical of the food quality and farmers are unhappy with the low prices they receive from vendors. One of the first activities Weeds Culture organized were trips for urbanites to the farms, for during surveys, the NGO's staff discovered that many retired urbanites wanted to visit the countryside more often and many urban women wanted to buy food directly from farmers they knew personally. Urbanites visited farms and learned how the products were grown and then were able to put in orders for regular purchases. Many consumers have their own cars, which helped the consumer associations organize visits to the 100 organic farms participating in the network. The prices that consumers paid to farmers are no more than 30 percent higher than the market prices for conventional vegetables in Chengdu and the direct link to consumers also means farmers do not lose money to middlemen vendors. The direct trade also brings the information that urban consumers prefer products without using fertilizers and pesticide to the farmers, encouraging them to continue the traditional farming methods. Weeds Culture plans to organize 6 visits each year to the villages, which could generate an extra 2,000 Yuan (~$294) per year for each of the participating 100 farmer households in three villages. This added income nearly doubles the household's yearly income.

GUOYUANXIANGZHU FARM: CATALYZING NGO-BUSINESS COOPERATION

In contrast to CURA and Weeds Culture, Guoyuanxiangzhu Farm (hereafter the Farm) is not an NGO, but a privately run organic farm. Mr. Yu Luo, a former bond dealer, was motivated to establish the farm in 2001 due to his strong personal interest in organic farming and Chinese traditional farming methods. He began by contracting around 3 hectares of land in Shuangliu County near Chengdu to start experiments in organic agriculture. After 8 years practice the farm is planning to expand to 12 hectares and Mr. Luo has become the leading organic farming practitioner in Chengdu. The impact of the Farm was enhanced by partnerships with many farmers, companies and NGOs, who have been key in the Farm's three core areas of work to promote organic food markets in the Chengdu area, namely: (1) trainings for farmers, (2) creating initiatives to protect local biodiversity, and (3) demonstrating how organic standards can be met.

Linking Farms to Markets

Over the years, the Farm has developed multiple strategies to publicize organic farming and products in order to raise the awareness of both farmers and consumers on how their food choices impact the environment and their own health. Since 2006, the Farm has provided organic farming training to over 500 farmers, as well as staff at NGOs and companies. Mr. Luo also works as the chief agro-technician for an earthquake recovery project that the Chinese NGO Global Village of Beijing is carrying out in Daping Village in Sichuan. He also acts as the chief agro-technician for WWF Chengdu office and organic farming trainer for CURA's Anlong village project. Although the prices for the Farm's organic products are 2.5 times more expensive than conventionally farmed products, there are 120 households in Chengdu ordering products each week from the Farm. To further expand the market for the Farm's products, in October 2009, Mr. Luo and some of his long-term customers invested to open the first organic restaurant in Chengdu. The restaurant closed after one year, but helped him gain insights in how to open another in the future.

Another important information dissemination activity began in 2006, when the Farm joined with local NGOs, companies, and farmers in Chengdu active in organic food production to organize a platform called the Chengdu Organic Food Market (COFM). COFM promotes information sharing and education on organic food through public lectures, product exhibits and sales and cooperation and resource sharing among the area's practitioners. Mr. Luo is the secretary of COFM.

Protecting Local Agricultural Biodiversity

Over the years the Farm has identified traditional crops, vegetables, and livestock species that need to be protected. Many animals have been eliminated from production due to the rise in intensive factory farms or CAFOs (confined animal feeding operations). While few farms in Chengdu raise traditional species of hens, pigs, and ducks, the Farm still has them, as well as 6 different types of radishes and 4 types of sweet potatoes.

1-Mr. Luo trains farmers and NGO staff how to make an insect-catching bottle Photo Credit: Su Su
2-The Chengdu Organic Food Market. Photo Credit: Yayuan Yang

Notably, the Farm also selects species that become part of they cycle of organic farming. For example, the pigs raised on the Farm are one of its most well-known and marketable livestock. The pig species was selected from an ethnic minority area in Sichuan that has cultivated it for nearly 20 years. These pigs only grow to about 50 kg and take twice as long to reach maturity than pigs typically used in factory farms. These pigs do not do well being raised in confined spaces, but are a very hardy breed that thrives being raised outdoors. Pigs and chickens are fenced in an area for ten months so their waste can fertilize the soil, which later is planted with crops.

The Farm has developed a well-working and balanced agriculture ecosystem over the past eight years and has become an important model for local farmers to learn and be inspired how to strictly follow organic farming requirements, forgoing chemical fertilizers, pesticides, and herbicides.

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Yu LUO is the founder and general manager of Guoyuanxiangzhu Farm. He can be reached at: jtstgyxz@163.com.

ENDNOTES

[1] National Bureau of Statistics China. (2008). China Statistic Year Book 2008.

[2] Food and Agriculture Organization of the United Nations. (2008). FAOSTAT 2008.

Native pigs in the Farm. Photo credit: Hongyan Lu

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COMMENTARY

Corporate Environmentalism in China:
An NGO – Corporate Partnership to Improve Energy Efficiency in Chinese SMEs

By Gwen Davidow

The World Environment Center (WEC) is an independent, nonprofit, non-advocacy organization whose mission is to advance sustainable development through the business strategies and operations of its member companies. In this capacity, WEC is in a unique position to work with corporate partners, governments, and other nonprofits to further both sustainable environmental and economic goals—a combination of mission and incentive that is exemplified in WEC's Greening the Supply Chain strategic initiative.

This Greening the Supply Chain initiative is one of WEC's keystone programs and is proving the significance of collaborating with industry and governments to achieve improved performance across global supply chains. This approach combines the purchasing power of large multinationals (incentivized by their own stakeholders to address their global footprint) with the market drivers of their supplier base, which continues to grow in developing nations, particularly China. Chinese businesses have been feeling the pinch as the Chinese government pushes energy efficiency and pollution control in its national and municipal environmental regulations and corporate customers increasingly use their purchasing power to demand better environmental performance. While the Chinese government has struggled to enforce its many clean energy and pollution control laws, pressure from global markets to demand more energy efficiency and less pollutions from suppliers has begun to "green" the production of some of the larger Chinese exporting industries. This market-driven approach to green suppliers can trigger a domino effect of better environmental stewardship farther upstream in the production chain and influence the harder-to-reach small enterprises. With the potential of influencing the vast number of small Chinese suppliers, even small energy or pollution control improvements in operations and facilities can have a significant impact on protecting human health and energy security in China.

BUILDING A KEY PARTNERSHIP WITH SHANGHAI GENERAL MOTORS

Over the past five years, WEC has been fairly successful in building a large green supply chain (GSC) collaboration in China in partnership with Shanghai General Motors (Shanghai GM) and 127 of its suppliers. WEC and General Motors launched the GSC pilot project in 2005 with General Motors-China; Shanghai GM (a joint venture between GM and Shanghai Automotive Industry Corporation); the Society of Automotive Engineers- China; and a number of first-tier suppliers to GM-China. The success of the pilot project resulted in continued GSC projects carried out by WEC and Shanghai GM, working with a hand-picked group of 40 suppliers in 2008 and a total of 127 suppliers in 2009.

The project has since been incorporated in Shanghai GM's Drive to Green initiative, which promotes sustainable development throughout the company's national supply chain by working with suppliers to improve their manufacturing processes by lowering consumption of raw materials and energy sources.

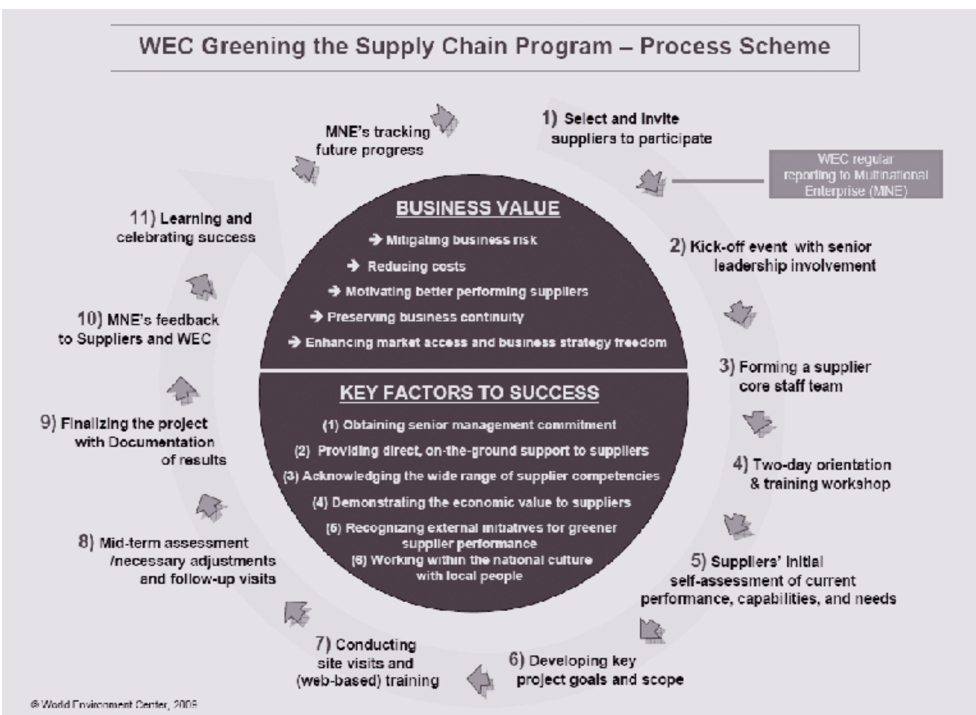
GSC Project Goals

The GSC project in with Shanghai GM aims to enhance performance in small and medium enterprises (SMEs) in the areas of clean production and energy efficiency, while simultaneously creating economic results that will further motivate continued "green" improvement. Specifically, the processes and facilities for each SME are assessed to see where improvements can be made in health/ safety practices, efficient use of energy and natural resources, reduction of emissions, and the impact of the company on its community. In achieving these goals, the suppliers are often able to maximize efficiencies, cut costs and increase savings—results that will incentivize the suppliers to not only continue the cycle of assessing and improving energy and environmental performance after the project is over, but also passing the lessons learned to their own suppliers.

Global corporations devote increasing amount of attention to clean production in their supply chains, particularly in developing nations, because (1) the focus of concerns among stakeholders of corporate responsibility has changed to include the full value chain; (2) the countries where many companies operate continue to develop stronger policies to regulate industrial energy and environmental issues; and (3) these efforts with suppliers can serve to strengthen performance and benefit the corporation from more efficient suppliers.

Project Approach

The GSC project is a tool to address environmental and economic performance in SMEs through incentives and best practices. The incentives are spurred by the multinational corporation, usually a WEC member company, reaching out to a select group of suppliers to participate in a drive to improve manufacturing processes in their facilities by adopting cleaner production and energy efficient practices. These activities are funded either by a government entity or the corporation itself. The current GSC project in China is funded by Shanghai GM,



Source: World Environment Center

who works with WEC to approve the overall direction and provide access to the suppliers. It is Shanghai GM's initial responsibility to bring in the selected suppliers, choosing to work with those that are both willing and capable to commit to the full project term.

Once Shanghai GM selects a set of appropriate suppliers, WEC works with them to create timelines and deliverables, establish baselines, train staff in the supplier's company in the methodology, and draft action plans for cleaner production and energy efficiency goals. Shanghai GM's relationship with these suppliers and their visible support for this work is—and has been—pivotal to the project's success. Throughout this process, WEC consistently monitors supplier progress and communicates with Shanghai GM, among the suppliers, and with the local team. (See Figure 1).

As the project expands to new participating suppliers, the previous green suppliers carry on by applying the continuous improvement principles to a wider range of their practices and operations, thereby ensuring the greatest reach of the project among Shanghai GM suppliers.

ENVIRONMENTAL AND ECONOMIC RESULTS

In 2008, Shanghai GM announced that the progress made by the 40 suppliers involved in the second phase of the GSC project provided a total savings of 22 million Yuan ($3.2 million) in one year in energy costs; over 18 million Yuan ($2.6 million) in one year in raw material savings; reductions of over 6 million tons of solid waste and 4.3 million tons of waste gas, among other noteworthy achievements. At the completion of the third phase of the project in early 2010, the 79 newest participating suppliers undertook 187 projects that focus on cleaner production, material savings and production efficiency, as well as 175 energy efficiency initiatives. The results of these projects provided a strong environmental and economic rationale for continuation of the GSC initiatives:

- Total annual cost savings of 69,910,000 Yuan ($10.2 million) was realized with a total investment of about 48,758,000 Yuan ($7.1 million);

One of the greatest project results has been the institutionalization of consistent energy and environmental monitoring efforts throughout Shanghai GM's supply chain.

- The average payback period for 78 percent of the cleaner production projects implemented was less than one year; and,
- Reductions of more than 36,700 tons per year of greenhouse gases;
- Annual reductions of 370,600 tons water usage; 7,600 tons of solid waste; and,
- Decrease in annual wastewater by 136,600 kiloliters.

One of the greatest project results has been the institutionalization of consistent energy and environmental monitoring efforts throughout Shanghai GM's supply chain. The next phase of the project was inaugurated in Shanghai in the summer of 2010 for 80 new suppliers, as the graduates from the program in past phases now focus on maintaining results through continuous improvement efforts.

KEY FACTORS TO SUCCESS

As summarized above, WEC's work with Shanghai GM has led to the participating SMEs to mitigate waste, improve air and water quality, and practice stronger public health and safety practices, all while increasing productivity and efficiency. There remains much more work to do, but the successes thus far are attributed to four key factors:

Senior Leadership Commitment. Commitment is necessary from the senior levels of the multinational corporations, as is the communication of that commitment to their suppliers. The role of developing, customizing, implementing, measuring and managing the project is a joint effort between the WEC global team and the multinationals, but the primary role of the latter is to provide visible and consistent support of the activities throughout the project term. Equally important is the commitment from the executives of the participating suppliers. Their visible support is essential to encourage the in-house teams to devote the resources necessary for a successful project.

WEC's Local Team. WEC's local experts and partners are able to navigate cultural, language, and business issues that might otherwise present barriers. The local team, in conjunction with WEC global and Shanghai GM leadership, worked with the selected suppliers from initiation to understand each company's unique capacities and opportunities. Although WEC's activities and operations are global in scope, this project and providing direct, on-site support to suppliers.

Actionable and Measurable Results. The action plans are customized to each supplier, using self-audits as a baseline, incorporating WEC technical guidance for process improvements, and measuring the improvements in terms of savings in energy, natural resources, waste and money. WEC trains the participants in this full process, from assessment to final results, providing tactical and strategic direction throughout the project term.

Communication. A consistent level of communication is imperative among the suppliers, WEC team, and SGM throughout the project. The suppliers provide baseline assessments, annual plans, and monthly reports to the WEC team, who then are able to collate the information into monthly progress reports for Shanghai GM.

SGM Senior Executives, WEC Team members, and Suppliers on stage at a 2008 Green Supply Chain Recognition Ceremony in Shanghai
Photo Credit: World Environment Center

INCENTIVES AND CHALLENGES FOR PARTICIPATING STAKEHOLDERS

The Chinese government has been very active in encouraging businesses to focus on reducing their environmental and energy footprints. While there are incentives for large and small enterprises to meet and even go beyond the government's goals, capacity and clear guidance on how to operate sustainably are often lacking in China, particularly within SMEs. Shanghai GM has been instrumental in guiding its suppliers through its "Drive to Green" initiative (under which the GSC project is managed), which establishes clear targets and capacity building to promote greener growth.

Even if SMEs do not take government goals into account, becoming part of a greener supply chain provides a focus on processes that create more efficient production systems, greater savings, and a reduction of resource usage and waste. So while the incentives might initially be regulatory, companies will take more action when green business practices help promote economic savings.

Challenges for Participants

In addition to China, over the past eight years, the World Environment Center has implemented "Green Supply Chain" projects in Australia, Brazil, El Salvador, Guatemala, Mexico, and Romania through a combination of government and corporate funding. In the course of this work, WEC has discovered many challenges that suppliers face in participating in GSC projects. The challenges summarized below highlight the kinds of challenges suppliers face in trying to green supply chains.

Competing Priorities. It can be challenging to integrate the GSC project into the business operations of SMEs when there already are competing priorities for the financial and human resources of the company. WEC addressed this in China by emphasizing the support and expectations of Shanghai GM's senior management; clarifying the role of WEC and the on-the-ground team (not to scrutinize, but rather to evaluate and assist); and enlisting the buy-in of the senior levels of the suppliers.

Credibility. There might be an initial concern that GSC is a way for the corporate customer—or possibly the government—to impose greater scrutiny on a supplier's operations. As a nonprofit, mission-based organization, WEC's management of the project provides an unbiased margin between supplier and customer.

Project Expansion. As the project continues to succeed, WEC has focused on the challenge of the costs associated with managing the growing number of participants. One of the solutions has been relying on web-enabled communication: a member-only site for participating suppliers to centrally post their reports, plans, and results so that the local experts and administrators can review and collate en masse. The web solution continues to evolve as the project does, and is expected to be one of the strongest cost equalizers WEC will employ.

FINAL THOUGHTS

In the three-plus years that WEC has worked on the Greening Supply Chain project in China with local partners and Shanghai GM, the team has found ample opportunity to discern the factors that strengthen the project, and to underscore key lessons learned. The key success factors—local, on-the-ground implementation; senior-level buy-in from both the suppliers and the corporate customer; measurable goals; and consistent communication—apply to this project across the globe. As do the lessons learned, such as:

- Results are maximized when the stakeholders with vested interest can assume a level of economic incentives, whether it be the continued loyalty of their customer base (Shanghai GM, in this case); the potential for greater returns and savings garnered from better practices; or the creation of efficiencies in the process;
- These activities can be applied successfully in parallel with government mandates, and indeed be strengthened by them; and,
- Management by a mission-driven NGO is necessary to assure participants that, although the results do tend to provide economic benefits, the underlying purpose is always a drive toward cleaner production and energy efficiencies.

The strength of this project relies on WEC's team taking these lessons and threading them through the next iterations, in China and elsewhere.

In her current capacity as Global Director of Corporate Programs for WEC, Ms. Davidow manages several membership-based projects, such as the Greening the Supply Chain initiatives in Shanghai and Australia, and government-funded projects in Central America. She can be contacted at gdavidow@wec.org.

The Keystone of Nanjing's Environmental Movement

By Samantha L. Jones

In the university-filled city of Nanjing in southern Jiangsu Province, it is perhaps no surprise that students and recent graduates are spearheading the environmental NGO movement. Jiangsu is a major economic powerhouse in central China that is plagued by many water pollution challenges—most notably the serious toxic algae blooms in Lake Tai, but many rivers in the province contain undrinkable water—polluted by agricultural runoff, municipal waste and untreated industrial emissions. Water has thus been one issue that inspired a particularly notable green group to emerge amid the famous tree-lined streets of Nanjing—Green Stone Environmental Action Network.

The organization, which was established in 2000, acts as an information exchange platform for the university students of Nanjing and surrounding cities. In this role, Green Stone routinely conducts environmental training sessions throughout Nanjing's many universities to foster the next generation of environmental leaders, both to join the organization and to improve management in other environmental organizations. In addition, Green Stone volunteers conduct environmental educational seminars at local primary schools and online. As one of China's first youth volunteer organizations, Green Stone serves as a structural model for younger environmental organizations across the nation.

While Nanjing is normally considered one of China's "greener" cities, Green Stone does not lack environmental issues about which to raise public awareness. Through a variety of small-scale projects, Green Stone acts as a community advocate for improving the public sense of environmental responsibility. These small projects include efforts against Siberian Musk Deer poaching and the establishment of a Tiger-butterfly protection program around Purple Mountain, the city's primary scenic area.

One of the biggest issues that Green Stone has brought to the public eye is the pollution of the Qinhuai River, often referred to as the "mother river" of Nanjing, which is a tributary of the "mother river" of China—the Yangtze River. The Qinhuai River has always played a pivotal role in Nanjing's identity as a city—making the city's fengshui ideal for locating the Ming Tombs and running straight through the classic Nanjing cityscape of traditional architecture around Confucius Temple.

Beginning in the 1980s, industrial pollutants released into the river caused, among other things, reports of a "green mud" along the river banks. The "recipe" for making this mud begins with a variety of agricultural pollutants entering the river in its path from the suburb of Lishui to downtown Nanjing. Once inside Nanjing proper, chemical, textile, paper, and pharmaceutical industries released further pollutants into the river.

In 2002, environmentally-minded university students petitioned the Nanjing government to take action. Throughout the remediation efforts, Green Stone continually documented the problem and created an informational pamphlet that led this NGO to win the "Ford Motor Environmental Award" in 2005. The Nanjing government responded to public outcries about the pollution by expanding and raising river banks, constructing a flood wall, and increasing waste management systems with pipelines to keep all effluents directed at new treatment plants away from the river. UN-HABITAT's Water for Asian Cities Program worked with the city to improve its water and sanitation systems with a U.S. $100 million Asian Development Bank loan. In 2008, immediately prior to hosting the 4th United Nations World Urban Forum, the Nanjing Municipal Government won the UN Habitat Scroll of Honour Special Citation for its revitalization effort along the Qinhuai River, in no small part due to the work of Green Stone.

Throughout the rehabilitation process, raising awareness about the Qinhuai River remained an important part of Green Stone's work. The organization executed a community water savings program with the goal of minimizing water usage through small, everyday measures and focused its 2008 annual environmental mapping project for Green Map Systems (a New York-based organization that has similar projects in Beijing, Dalian, Ningbo, Hangzhou, Taiwan, and Hong Kong) along the banks of the Qinhuai that charts for communities the vital aspects of Nanjing's ecological, social and cultural resources, for example the location of vital habitats. In its role as an environmental advocate for Nanjing's mother river, Green Stone is at the forefront of China's environmental movement, in which the urgency of water pollution issues is becoming increasingly evident.

Samantha graduated from Wellesley College in 2008 with double majors in Environmental Studies and East Asian Studies. She was a CEF research intern twice in 2008, conducted the Wellesley-Yenching Fellowship in Nanjing from 2008-2009, studied at the Johns Hopkins Nanjing Center for Chinese and American Studies in the 2009-2010 academic year, and is now working in Shanghai. She can be reached at samanthalaurenjones@gmail.com.

A view of Nanjing along the banks of the Qinhuai River, a river that Green Stone is working to protect.
Photo Credit: Samantha L. Jones

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