

## ESSAYS

# The Sudden Rise of Carbon Taxes, 2010–2030

10/20/14 (<http://www.cgdev.org/publication/sudden-rise-carbon-taxes>)

Lawrence MacDonald and Jing Cao

It's 2030 and instead of racing toward the brink of climate catastrophe the world has begun to back away. Annual global emissions of heat-trapping gasses have fallen two-thirds—faster than anybody had dared to hope as recently as a dozen years ago—with continued steep reductions ahead.

Although carbon dioxide (CO<sub>2</sub>) concentrations in the atmosphere breached 450 parts per million (ppm) last year—the level believed to offer a 50 percent chance of holding global warming below 2 degrees Centigrade this century—the rate of increase has slowed dramatically. Atmospheric CO<sub>2</sub> was increasing by 3 ppm per year as recently as 2020; today the annual increase has fallen to just 1 ppm, and attention and investment are shifting from the need for steep emissions reductions—a global goal that has largely been attained—to large-scale, low-cost biological methods for extracting carbon from the atmosphere.

Strikingly, all of this has coincided with improved economic performance and continued reductions in global poverty—despite the absence of a binding international treaty. Although the emissions fees imposed in the United States, China, Europe, and elsewhere raised energy prices, they also sparked a technology and job-creation boom. Revenue from carbon pricing has made possible dramatic rollbacks in other taxes—especially taxes on employment and investment—giving economies a further boost. As a result, growth rates have remained robust in the big emerging market economies, making possible rapid reductions in extreme poverty and the emergence of a global middle class. In the United States and Europe, growth has accelerated from the sluggish rates that prevailed until 2018, when revenue-neutral national emissions fees were put in place as part of a grand bargain that included cuts in middle-class income tax rates.

A fantasy? Of course. But perhaps more plausible than the slim hope that UN negotiations will lead to an ambitious, binding international agreement. Read on to discover an alternative path to averting climate catastrophe. (Everything in this future history up to the publication date is real.)

Little could we have anticipated when we first met at the Center for Global Development's Washington, DC, headquarters in 2013 that a series of events would soon begin to unfold that would bring the world to a situation in 2030 where instead of racing toward the brink of climate catastrophe we have begun to back away. Annual global emissions of heat-trapping gasses have fallen two-thirds—faster than anybody had dared to hope as recently as a dozen years ago—with continued steep reductions ahead. Although carbon dioxide (CO<sub>2</sub>) concentrations in the atmosphere breached 450 parts per million (ppm) last year—the level believed to offer a 50 percent chance of holding global warming below 2 degrees Centigrade this century, and thus perhaps averting runaway climate change [1]—the rate of increase has slowed dramatically. Atmospheric CO<sub>2</sub> was increasing by 3 ppm per year as recently as 2020; today the annual increase has fallen to just 1 ppm, and attention and investment are shifting from the need for steep emissions reductions—a global goal that has largely been attained—to large-scale, low-cost biological methods for extracting carbon from the atmosphere.

Strikingly, all of this has coincided with improved economic performance and continued reductions in global poverty—and despite the absence of a binding international treaty. Although the emissions fees imposed in the United States, China, Europe, and elsewhere raised energy prices, they also sparked a technology and job-creation boom. Revenue from carbon pricing has made possible dramatic rollbacks in other taxes—especially taxes on employment and investment—giving economies a further boost. As a result, growth rates have remained robust in the big emerging market economies, making possible rapid reductions in extreme poverty and the emergence of a global middle class. In the United States and Europe, growth has accelerated from the sluggish rates that prevailed until 2018, when revenue-neutral national emissions fees were put in place as part of a grand bargain that included cuts in middle-class income tax rates.

This unexpected achievement of falling carbon emissions and dramatically improved well-being holds true even when economic performance is calculated using the now largely discarded gross domestic product (GDP) methods developed in the mid-20th century. Improvements in human welfare are even greater when calculated using the now standard green national accounts method, which takes into account such things as health, education, natural resources, environmental quality, and the value of leisure time that were absent from GDP.

Today global CO<sub>2</sub> ppm and national per capita emissions are tracked with the same concern once reserved for those misleading old GDP reports, except of course that the goal is lower rather than higher numbers and nations compete for bragging rights that come with large drops in per capita emissions. Last year the United Nations General Assembly called for a sustained global effort to eventually reduce atmospheric carbon concentrations to below 350 ppm, the level championed by the pioneers of the climate action movement at the start of this century.

Whether humans can eventually stabilize the climate and restore the acid-alkaline balance of the oceans remains uncertain. Because the planet has yet to feel the full effects of the huge pollution load already in the atmosphere, the high temperatures, extreme weather events, sea level rise, and ocean acidification of recent decades may be just the prelude. Pretty much everybody understands that humanity will struggle with the destructive legacy of the 20th and early 21st centuries for generations to come and that the situation is likely to get a lot worse before it eventually begins to get better. Still, there is wide satisfaction that economic activity has been unshackled from carbon emissions, and hope that the problems ahead of us can be resolved.

An emerging school of academic climate historians argues that all this might have come about sooner had it not been for the global climate negotiations. Older readers will remember this well, but for younger

readers it may come as a surprise that countries once attempted to solve the climate problem using the same tools and mind-set that had been effective in cutting trade tariffs in the late 20th century: global multilateral negotiations leading to a binding agreement in which countries would mutually commit to taking actions that were politically difficult but ultimately in their own best interest. Although that approach sounded reasonable in theory—indeed it was the dominant model for addressing global problems—already in 2009 the failure of the UN Copenhagen Climate Summit made it obvious that the United States and China, then the world’s biggest emitters, would not make binding commitments to cut emissions soon enough to avert catastrophe. The international negotiation model was fatally flawed, yet the annual UN climate summits continued to absorb time and energy that might have been better used exploring alternative solutions. [2]

The climate summits didn’t just fail to produce an agreement. Worse, they created the perception that policy changes to address climate change were “concessions” to be given or extracted in adversarial negotiations. For many years that mind-set distracted policymakers and citizens from the fact that taxing “bads”—things society wants less of, like pollution—makes more sense and is less distorting for economies than taxing things that are desirable, like employment and investment. This is now conventional wisdom, of course. But concern about higher energy prices, coupled with resistance from the fossil fuel industries, long obscured this simple but important idea. As recently as 2014, the International Monetary Fund (IMF) found it necessary to issue a major report making the case that “getting energy prices right means that taxes on fossil fuels should be set at such a level that energy prices reflect their associated environmental side effects” The report noted that the potential for co-benefits from carbon pricing suggested that “countries need not wait on internationally coordinated efforts if some carbon mitigation is in their own national interests—that is, the domestic environmental benefits exceed the CO2 mitigation costs, leaving aside climate benefits.” [3]

Governments need revenue. Taxing the bad stuff that society wants to discourage—like conventional and climate pollution—makes a lot more sense than taxing good stuff that society would like to encourage, such as jobs, savings, investment, and profits. Well, duh!, as the kids used to say. Still, at the time, the political obstacles to this self-evident policy approach appeared massive. The idea that carbon emissions were a “public bad” and that therefore it was rational for nations to “free ride” and wait for others to act first was so deeply ingrained as to seem self-evident and immovable.

Fortunately, once some jurisdictions began to put a price on carbon pollution, initially at low levels, it soon became evident that such so-called [Pigovian taxes](#) [4] were politically quite popular. Making the switch, and then raising the price of emissions to a level necessary to address the climate crisis, turned out to be less difficult politically than most of us had imagined. Looking back, the remarkable thing is how unlikely this course of events seemed in 2013 and how quickly the change has come to pass. We are reminded of a famous saying of Nelson Mandela, the great 20th-century South African anti-apartheid leader: “It always seems impossible until it’s done.”

The key, of course, was the growing recognition that the policy solution to climate change—high and rising carbon prices (or carbon pollution fees, as they came to be called in the United States)—was not at odds with fixing economic problems; rather it was a means to their solution. Countries have moved to impose carbon taxes or to create emissions trading systems (ETSs) because they are sound domestic policies, are good for the economy, and are good for the environment, and because doing so gives such countries a competitive edge in global technology markets and higher standing in the international community.

This is so obvious and widely accepted today that one can hardly remember that as recently as 15 years ago putting a price on carbon emissions and fostering economic growth were often portrayed as being at odds, despite mounting evidence to the contrary. In January 2014, for example, a *New York Times* reporter

wrote, “The energy and climate debate, which is playing out across Europe, reflects similar trade-offs being made around the world on mending economic problems today or addressing the environmental problems of tomorrow.” [\[5\]](#)

Policymakers and the public now understand that the so-called “co-benefits” of charging for carbon pollution are so large that doing so would be sound economic policy even if the problems of runaway climate change and ocean acidification did not exist. The path to charging for carbon emissions has varied greatly from country to country, but the benefits have been similar. Some countries have adopted carbon taxes while some have chosen emissions trading. [\[6\]](#) Either way, the benefits of carbon pricing fall into three classes:

- **Fiscal advantages.** Revenue from pricing carbon, whether generated from a tax or from the auction of tradable permits, has made it possible to roll back and even eliminate other, more distorting taxes. The tax burden has shifted from things people desire (income, jobs) to things people want less of (pollution). Rather than the economic slowdown that some had feared, this has led to a win-win solution, with more rapid economic growth and less carbon emissions. Moreover, because fees on fossil fuel carbon emissions are relatively easy to collect and hard to avoid, in many countries the tax base has broadened, generating large welfare gains. These gains have exceeded the drag on the economy from higher energy prices—like getting paid to eat a free lunch.
- **A wealth-creating [green industrial revolution](#).** [\[7\]](#) Countries that moved early to price emissions experienced a surge of investment into climate-friendly technologies: hyper energy efficiency, cheap clean renewables, energy-saving nanotechnologies, and green biotech. Businesses across all industrial sectors are working hard to find ways of using energy and resources with increasing efficiency, spawning a new generation of billionaire success stories including tech entrepreneurs, green service providers, renewable energy project developers, and project financiers. Economic historians liken the growth surge to the Internet tech boom of the late 20th and early 21st centuries.
- **Better health, reduced pollution.** Reductions in noncarbon local and regional pollution, especially from coal (ultrafine particle pollution known as PM2.5, sulfur dioxide, carbon monoxide, mercury, lead, zinc, cadmium, and soot) but also from oil and natural gas, have cut cancers and cardiovascular and respiratory diseases around the world; fragile environments that would have otherwise been subject to fossil fuel extraction (coastal waters, tropical forests, the Arctic, and the arboreal forests of the Northern Hemisphere) are less in need of special protections because exploiting them has ceased to be profitable.

As we shall see, the United States and China came to recognize these advantages through very different paths, reflecting the large differences in our political systems and stage of development. In each case, however, the primary driver for imposing carbon pollution fees was not international negotiations, as climate activists early in the century had hoped. Rather there were powerful domestic policy drivers—not least growing recognition that moving quickly to charge for carbon would be a major source of national advantage.

This dynamic is familiar to those of us old enough to remember the 20th-century Cold War with its arms and space races. Today we have a carbon emissions fee race—a race to the top—in which the United States, China, and other major emitters recognize that national competitiveness requires being at the forefront of the clean tech revolution and that this can best be accelerated by imposing high and rising carbon taxes or pollution fees.

Border tax adjustments—excise taxes on the so-called embedded carbon in imports from countries that have lower effective carbon prices or none at all—have been important in deterring free riders and leakages but have played a smaller role than many policy analysts imagined. As the United States and China moved independently to charge for the negative spillover effects (“externalities”) of carbon pollution, carbon-intensive industries such as steel, cement, chemicals, and steel-intensive manufactured goods naturally feared competition from jurisdictions that did not price carbon and lobbied heavily for these offsetting border tax adjustments.

Provisions for such charges were included in both US and Chinese carbon-pricing legislation, and in similar laws passed in many other countries. At the World Trade Organization (WTO) in Geneva, negotiators spent years debating when such fees were permissible and when they were merely a veiled form of protectionism. In the end, however, it was the threat of border tax adjustments rather than the reality that mattered, providing an incentive for the two biggest emitters to raise carbon prices more or less in tandem. Europe soon followed suit, as did Brazil, India, Indonesia, South Africa, and Russia, as well as smaller countries in Southeast Asia, Latin America, and Africa, partly to reap the benefits of carbon pricing increasingly on display in the pioneering jurisdictions, and partly for fear of facing border tax adjustments if they did not. Today all 15 of the major economies that accounted for three-quarters of global emissions in 2010 have adopted some form of carbon pricing, and many smaller countries have done so as well.

Here again a Cold War analogy is useful in understanding how events unfolded. Just as the threat of mutually assured destruction restrained war in the nuclear age, preventing any nuclear power from using its arsenal, so the much smaller threat of border tax adjustments provided welcome impetus for China and the United States to price carbon at similar levels, and for their major trading partners to do the same.

Low-income countries with tiny per capita emissions have argued with varying degrees of success for exemptions, on the sound moral basis that they did not create the problem and that they should be permitted to exercise their “right” to a share of the atmosphere. In practice, however, most of their labor-intensive, job-generating exports (apparel, light electronics, produce, and agricultural commodities) had little carbon content and were largely exempt from border taxes. More important, low-income countries, with weak tax collection systems and chronically short of revenue, were quick to see the domestic advantages of collecting their own carbon-pricing revenues. In the end, border tax adjustments for embedded carbon have been highly contentious but relatively rare, similar to the once contentious antidumping tariffs of the early 21st century.

One area in which carbon taxes in the major emitter countries have had a substantial effect is on the energy exports from high-cost producers, including several developing countries with potentially large but hard-to-exploit reserves. Early in the 20th century the discovery of new hydrocarbon reserves in poor developing countries—notably oil and gas off the African coast—led many governments and investors to anticipate a natural resource boom. Along with that, however, were fears of what was widely known as the [resource curse](#), [8] the phenomenon, epitomized in Nigeria, of oil wealth fueling massive corruption, overvalued exchange rates, slow economic growth, internal conflict, rising inequality, and environmental problems.

With the imposition of carbon taxes in major emitter markets, low-cost producers such as Saudi Arabia and Kuwait were able initially to adjust by levying compensatory excise taxes on their exports, capturing revenue that would have been captured by importers while nonetheless remaining price competitive. For marginal, higher-cost producers, however, imposing such taxes would have made their exports uncompetitive. As a result, some marginal producers, like Alberta, Canada (where oil was extracted from bitumen deposits by expensive and environmentally harmful techniques) and Uganda (located far from

the major markets and lacking in oil extraction infrastructure), were crowded out of the market, their oil and gas deposits remaining in the ground. [\[9\]](#)

Whether this was bad news for developing countries that eagerly anticipated becoming energy exporters is a matter of fierce debate. One view holds that this was an unfair imposition on poor countries that should have been free to tap their hydrocarbon wealth just as the rich nations before them. An alternative view argues that carbon taxes had a salutary effect, even on the countries whose oil and gas exports became noncompetitive, by slowing and sometimes averting the resource boom—and thus the resource curse. Untangling cause and effect is impossible in the absence of a counterfactual. Still, it is striking that several African countries that had anticipated oil booms and did not get them are today stable democracies with rapid, poverty-reducing growth. Because of weak global demand, much of the natural gas produced on the continent is being used for a massive electrification program rather than exported.

Not unexpectedly, carbon taxation led to major trade disputes. Sharp reductions of previously astronomic levels of fossil fuel consumption in the United States made available an immense supply for export. Should these export-bound fossil fuels be subject to carbon pollution fees domestically, at the point of production? Or should they be exempt, to enable them to be competitive in those markets that did not yet tax emissions? Other fossil fuel exporters faced a similar dilemma. Should countries that had put in place carbon taxes grant exemptions to countries that had already taxed such fuels at the time of export?

Inevitably these disputes landed in the WTO, which launched a major round of carbon pollution fee trade talks following the WTO summit in Caracas in 2018. As with the prior Doha Round, however, the talks achieved little. Rather, a patchwork system of bilateral and plurilateral agreements has grown up over time, shored up by case law established in a series of WTO rulings. The result is the messy situation we have today, where some low-cost exporters reap a windfall by imposing carbon pollution fees at the point of production, while higher-cost producers forego such revenue in a desperate effort to keep their fossil fuel exports competitive in a dwindling international market.

There were of course many other important transition challenges. Notably, all the major emitter countries were home to interests whose wealth and power depended on the fossil fuel status quo, an issue we discuss at the end of this essay.

The surprising thing, however, is how quickly the energy system has transformed; starting with the early, relatively low carbon prices. As price signals changed, the market shifted, and firms that had huge investments in fossil reserves and the extraction, refining, and transportation of hydrocarbon fuels scrambled to diversify. The surge of private-sector investment into renewables, energy efficiency, and conservation has accelerated technological change, rapidly bringing down costs. Already some higher-priced fossil fuels—those with high extraction, processing, and transportation costs—would be economically uncompetitive even in the very unlikely event that carbon prices eventually come down.

Inevitably some fossil fuel firms have been more successful in negotiating the transition than others. In general, the small-to-medium-size firms proved more agile than the behemoths that had once been among the biggest and most profitable companies in the world. Few observers are surprised that the giant state-owned firms, such as Saudi Aramco, Gazprom, and the National Iranian Oil Company, are awakening too late to the fact that their vast reserves are plummeting in value. Some firms rushed to extract and sell their reserves as fast as possible, to get ahead of the coming carbon prices, in what came to be known as a “green paradox.” Fortunately, this effect was transitory and had a smaller climate impact than some had feared. Indeed, in some countries awareness of this phenomena helped bolster efforts to begin pricing carbon sooner rather than later.



More surprising is that some big private firms also largely missed the boat. It seems hard to believe that just two decades ago Exxon Mobil was the most profitable company on the planet. Today, of course, global demand for its products—and its political clout—has fallen sharply. The company also suffered a major blow in the early 2020s when it lost a multi-trillion-dollar class action suit brought by an alliance of US state attorneys general, displaced residents of submerged island states, and environmental groups seeking damages in connection with the firm's support for climate denial junk science. BP and Royal Dutch Shell have fared somewhat better, dumping some of their fossil fuel assets relatively early and diversifying into clean renewables, but their wealth and power have been greatly reduced, as their core business continues to be providing hydrocarbon fuels to a shrinking global market.

Economic historians tell us that the sudden decline of once-dominant industries has happened many times before. Whaling, a dominant US industry in the 1830s, was brought to an end with the arrival of kerosene, which was cheaper and burned brighter than whale oil. The sleek clipper ships of the 17th and early 18th centuries gave way to steamships, which were in turn overcome by diesel-fueled cargo carriers and later container ships. On land, the railroads in the United States killed the canal business and became vastly powerful in the 19th century only to be eclipsed by the automobile, trucking, and the interstate highway system in the 20th. More recently, within the lifetime of our older readers, computers and digital communications arose so quickly that many households found themselves with boxes of outmoded recordings (first 33 rpm records, then jumbles of cassette audiotapes, videotapes, CDs, and DVDs) even as the devices on which to play them vanished. In our own time, we are witnessing a similarly rapid transformation in the production, distribution, and consumption of energy.

How did this happen so quickly? Why did so few informed observers anticipate these changes even as they were beginning to unfold? The remainder of this essay will seek to answer those questions, with a particular focus on the politics and policy process in the United States and China, the world's two biggest emitters at the start of the period. To be sure, trying to untangle cause and effect in such a complex, multifaceted process is a fool's errand. Future historians, with better training, better access to records, and a longer-term perspective than we have will surely find much to fault in our effort. We make no claims to this being an authoritative account. Rather we offer this brief sketch of the past 20 years as we have watched them unfold in hopes of providing useful notes for future historians seeking to understand one of the major developments of the first part of our century.

## Quiet US–China Talks Open the Way for Convergence on Carbon Prices

Following the failure of parties at the 2009 climate summit in Copenhagen to reach a binding agreement, the annual United Nations Framework Convention on Climate Change (UNFCCC) negotiations continued with little outward progress. Gradually hopes came to focus on the 21st Conference of the Parties (“COP21” in the UN jargon of the time) to be held in Paris late in 2015.

Despite dire warnings from scientists that the window for action was rapidly closing, and heroic efforts by the French to push for a new accord, Paris ended inconclusively, leaving the advocates of climate action in despair. But during the process the dialogue between the United States and China laid the foundation for the two countries to begin to move broadly in parallel to put in place roughly similar hybrid systems that included carbon taxes, ETs, border adjustment taxes, and increased expenditures on clean energy research, development, and deployment.

During the run-up to COP21, the United States and China, then the world's two largest emitters, found that they had much in common. Even though China had been a strong supporter of the failed 1992 Kyoto Protocol, in ensuing years its economic juggernaut and the attendant surge in its own emissions had led it to share the US view that a binding international treaty was infeasible and an inappropriate interference in internal affairs. Rather both countries favored "nationally determined commitments" that are reinforced only by "norms and expectations," not by treaty or sanctions.

In focusing on the Paris 2015 COP the media and climate advocacy community largely overlooked quiet-but-promising US-China bilateral discussions on climate change. A joint statement released in February 2014 said in part:

In light of the overwhelming scientific consensus on climate change and its worsening impacts, and the related issue of air pollution from burning fossil fuels, the United States and China recognize the urgent need for action to meet these twin challenges. Both sides reaffirm their commitment to contribute significantly to successful 2015 global efforts to meet this challenge. Accordingly, China and the United States will work together, within the vehicle of the U.S.-China Climate Change Working Group (CCWG) launched last year, to collaborate through enhanced policy dialogue, including the sharing of information regarding their respective post-2020 plans to limit greenhouse gas emissions. [\[10\]](#)

Although the joint statement did not mention it, the two huge but vastly different nations were also increasingly in agreement on their opposition to a binding international treaty with top-down assignment of emissions reductions targets. Todd Stern, the US special envoy for climate change, set forth US views on this question in an October 2013 speech at Chatham House in London: "Rather than negotiated targets and timetables, we support a structure of nationally determined mitigation commitments, which allow countries to 'self-differentiate' by determining the right kind and level of commitment, consistent with their own circumstances and capabilities." He added, "We need to focus much more on the real power of creating norms and expectations as distinguished from rigid rules." [\[11\]](#)

The US view was comparable to the position China and other developing countries had taken for some years in the UNFCCC negotiations, namely that developing countries should commit only to "nationally appropriate mitigation actions" (NAMAs, in climate talk jargon). Taken together with the agreement at the 2011 climate talks in Durban, South Africa, that the goal of the climate talks should be "a legally binding deal comprising all countries" [\[12\]](#) the two largest emitters were gradually moving onto a path where they would hold back from a binding international agreement on emissions reductions but instead move in parallel—and in consultation with one another through bilateral talks—to take aggressive actions to address the problem.

Of course, action in the United States was impossible before the 2016 elections, due to a highly polarized Congress and fierce opposition to climate action from conservative activists within the Republican Party. As we know now, the groundwork was quietly being laid for that to change.



## In the United States, Revenue Neutrality Was Key

The most important change—and arguably the least expected—was the rapid rise in the United States of a broad coalition in favor of revenue-neutral carbon pollution fees. Strange to recall, it was not so long ago that the very findings of climate science were a hotly disputed, highly partisan issue in the United States, with the two main parties at the time, Democrats and Republicans, differing not in their preferred policy response but in the degree to which they accepted the now universally recognized facts that the earth is getting hotter and that human-caused climate change is real.

In 2009, three out of four Democrats said that there was solid evidence of rising temperatures on Earth, while just one of three Republicans acknowledged knowing this fact. By 2013, 80 percent of Democrats and half of Republicans said that they knew that the earth was getting hotter. Of course, that meant that the other half of Republicans either did not know or were unwilling to acknowledge that they knew this important piece of information. And among the so-called Tea Party Republicans, a highly conservative faction then challenging the traditional GOP party leadership, only one in four said that the earth was warming.

This partisan divide had three sources. First, Al Gore, a former US vice president who lost a hotly disputed 2000 election to George W. Bush and went on to champion climate action, made some conservatives eager to dismiss climate science as a “hoax” by the left to expand the power of the state. That Gore then won an Academy Award for his climate film *An Inconvenient Truth* and later shared the Nobel Peace Prize with the UN’s Intergovernmental Panel on Climate Change further inflamed these resentments.

Second, many conservatives worried that regulatory responses to climate change—from tighter fuel economy standards for automobiles, to regulations requiring more efficient light bulbs, to tighter pollution controls on coal-fired power plants—were part of a larger program to trample individual freedoms and choke private enterprise. Finally, these embers of resentment and worry were fanned by a steady infusion of money from fossil fuel companies who supported so-called “climate-skeptic” candidates and ran public disinformation campaigns, such as pro-energy advertising that confused public opinion on the issue.

## Generational and Attitudinal Shifts

Against this background, a sea change in public opinion was quietly under way, driven in part by younger voters. A 2013 survey by the Pew Research Center found that younger Americans were much more likely than their older counterparts to understand that the earth is getting warmer and that human activity is the primary cause. [\[13\]](#) Among Americans 18 to 29, 70 percent said that the earth is getting warmer, compared with just 61 percent among Americans 65 and older. More than half (52 percent) of the younger poll respondents said that human activity was mostly to blame, compared with a mere one out of three (36 percent) among older group. In the years that followed, the younger cohort retained its comparatively greater understanding of climate change science as it aged, and, in addition, awareness of the problem increased across all age groups.

In this dynamic, public opinion on climate change followed a path that was already discernable in the early part of the century on two formerly controversial issues: gay marriage and decriminalization of marijuana. In both of these examples, localities and states had responded to changing public opinion more quickly than the national government. And in both cases, court battles ensued in a dizzying array of jurisdictions,

with cases brought by supporters of the status quo and those out to change it. In a now familiar pattern, proponents of change, with demographics on their side, made fitful progress, two steps forward, one step back, that over the period of just a few years added up to a change that would have once been thought impossible. States served as laboratories for policies that would eventually be tried at the national level. Seemingly overnight, views once regarded as outside the mainstream became so commonplace that politicians seeking elective office had little choice but to embrace them.

Something very similar occurred with attitudes toward climate change. Climate change denial continued to appeal to a vocal minority of highly conservative voters who could be counted on to turn out in the primaries. But candidates who catered to such views increasingly failed to win office in the general elections. Conservative donors, including business interests who recognized the need for climate action, began withholding funds from such candidates, instead backing politicians who could articulate a way forward on climate that was in line with conservative values yet would appeal to younger voters, many of whom were concerned about climate change but also drawn to Libertarianism on issues such as gay marriage, decriminalization of marijuana, and avoidance of foreign military entanglements.

One early sign of this shift: former congressman Bob Inglis, long a lonely Republican advocate for climate action, garnered surprising support from younger voters when he entered the 2016 GOP primaries advocating revenue-neutral carbon taxes. His remark in a 2012 discussion of the issue proved prescient: “I think that the impossible may be moving to the inevitable without ever passing through the probable,” he said. [\[14\]](#)

How did this happen? Identifying the many forces at work and who did what when is beyond the scope of this paper. Many organizations and individuals played important roles. Our list is far from comprehensive. Rather it is an attempt to highlight some of the types of organizations that played a role in advancing the idea of carbon taxes much faster than people had previously believed possible.

## **R Street Institute: A Libertarian Voice for Carbon Pollution Fees**

Overcoming conservative antipathy toward climate action required a new approach that recognized climate science and addressed it with a simple, market-friendly tool—emissions taxes. Such a proposal, long favored by economists, also had potential appeal to elements of the environmental left but was seen as a political nonstarter due to opposition on the anti-tax right. In hindsight there is a seeming inevitability that the seeds of the solution sprouted in the free-market R Street Institute. The key to winning acceptance on the right was revenue neutrality, a carbon tax (or pollution fee) with 100 percent of the proceeds returned to the citizens through a combination of rebates and cuts in other taxes.

Today, of course, the R Street Institute is widely known around the country, having eclipsed once-better-known conservative think tanks that clung too long to climate skepticism, squandering their credibility. But 15 years ago R Street was new and little known. Its founding president, Eli Lehrer, had previously been a vice president of the Heartland Institute, a fossil fuel-funded climate-skeptic organization; he left because Heartland’s top leadership refused to acknowledge climate science and respond to it with sensible policy proposals. R Street’s mission statement described it as “a free market think tank supporting limited, effective government and responsible environmental stewardship.” [\[15\]](#)

Unlike some other conservative groups that saw climate science as a liberal ruse for unbridled government expansion, R Street accepted the conclusions of climate science as a starting point and then applied conservative principles to devise a response. The conclusion: eliminate fossil fuel subsidies and make polluters pay. Already in 2013, R Street’s website stated, “Government subsidies that encourage

environmental destruction should be removed. At the same time, governments do have a role to play by assigning a cost to carbon and other pollutants, and then stepping out of the way to allow price signals and market forces (rather than command-and-control regulation) to determine the most efficient allocation of resources.”

Where Lehrer differed from most environmental activists was in his insistence that all proceeds from carbon pollution fees be used to reduce or eliminate other taxes, that is, that carbon pollution fees be revenue neutral. This approach proved crucial to winning support from the right, which staunchly opposed regulation-based climate policy for fear that it would impinge on citizen freedom and increase the size and complexity of government. [\[16\]](#)

Rebating the proceeds of the tax also provided a means for addressing a concern among some economists and many people on the left: that carbon taxes would exacerbate rising inequality, since they lead to higher energy prices and poor and working families pay a larger share of their income for energy than higher-income households. Various proposals were floated and vigorously debated for how to structure the rebates. States that pioneered carbon pollution fees tried a variety of approaches. In the end, the US national legislation adopted a hybrid approach, not unlike that of British Columbia described below, that included tax cuts and transfers for low- and moderate-income households that otherwise would be most disadvantaged by rising energy prices. [\[17\]](#)

In hindsight we can see an early version of this approach in a 2013 speech at the Center for Global Development (CGD), where Lehrer proposed a pollution fee of \$15 to \$20 per ton, calibrated to raise sufficient revenue to eliminate the employee portion of the Medicare tax. [\[18\]](#) He suggested that the pollution fee should increase steadily at a dollar or two per year, until the tax was about double the initial level. Since revenue from pollution fees at any given price per ton would fall over time, as emitters shifted to cleaner technologies, the fee per ton would need to continue to rise to provide sufficient revenue to fund Medicare. Additional revenues, he suggested, could be applied to reduce and eventually eliminate the corporate income tax. [\[19\]](#)

The idea of a revenue-neutral carbon pollution fee might have remained largely speculative had it not been for the work of a variety of advocacy groups. The groups had different strategies and sometimes different policy goals, but all were dedicated to raising the price of fossil fuel carbon emissions with the dual goals of reducing emissions and channeling investment into energy efficiency and clean energy alternatives.

## Citizens' Climate Lobby

One of the more influential of these was the Citizens' Climate Lobby (CCL), a nonpartisan group founded in 2007 by Marshall Saunders, a former Colorado real estate broker and developer who had been active in the international microcredit movement. Drawing on his experience as a successful development advocate, Saunders built a nationwide, nonpartisan network of volunteers who pushed for a revenue-neutral carbon fee, starting at \$10 to \$15 per ton and increasing by a similar amount each year. The fee was to be assessed at the point of production (the wellhead or mine) or point of entry into the United States, with all revenue distributed to households in the form of a rebate.

Led by Saunders, CCL adopted a low-key, nonconfrontational approach, organizing local groups by congressional district that worked to develop helpful, friendly relationships with elected representatives and members of the press by providing timely, reliable information. To ensure consistency, volunteers were asked to listen in on monthly conference calls and to pass a test of their knowledge about the carbon

fee proposal. The group posted two-page draft legislation on its website and a Frequently Asked Questions list that gave volunteers ready answers to possibly difficult questions. “How would a carbon fee affect energy prices?” Answer: “The best example would be gasoline. A \$1 per ton increase in the carbon fee would equal about 1 penny on the price of gas. So if the carbon fee started at \$15/ton, gasoline would go up by 15 cents per gallon the first year and 10–15 cents each year afterward [as the tax per ton increases].”

CCL pushed consistently for the rebate of 100 percent of the revenue yielded by a carbon fee and rapid increases in the charge per ton of pollution. The group asserted that returning all revenue to the American people “will improve the prospects of attracting Republican support AND provide the best protection for households against rising energy costs.” Increasing the fee by \$10 to \$15 per year was necessary, CCL pointed out, in order to “reduce CO<sub>2</sub> emissions 30 percent below 2005 levels over the next 10 years . . . more in line with the reductions needed to avert future catastrophe.” [\[20\]](#)

In early 2014 CCL released a now famous study that suggested even very high carbon emission fees were not only compatible with sustained economic growth but could actually drive job creation, provided that the bulk of the revenue is recycled in some form. [\[21\]](#) The study, commissioned from Regional Economic Models Inc., a private consulting firm, simulated the economic impact of carbon taxes within California at \$50, \$100, and \$200 per metric ton of CO<sub>2</sub> emissions associated with the use of energy. In the study, the first \$4 billion per year in revenue was assumed to go into a fund for investments in renewable energy. The remainder was to be refunded to tax payers either in an “across-the-board” (ATB) tax cut to income, sales, and corporation taxes or a “fee-and-dividend” paid out to households modeled on the [Alaska Permanent Fund](#). [\[22\]](#)

The study found that while the resulting higher energy prices could have a negative effect on growth and jobs, the tax relief made possible by rebating the proceeds would help to restore competitiveness of firms in California, and increased income for Californians would encourage spending on local businesses. There were modest differences in the economic outcome between the two approaches—ATB or fee-and-dividend—but both had large positive impacts on economic growth and jobs. The ATB approach, which came to be known as the “tax swap” was projected to mean 300,000 more jobs in the state by 2035, an extra \$18 billion in state GDP, an additional \$16 billion in annual income, and carbon emissions less than 75 percent of 1990 levels.

The study sparked a surge of interest in carbon taxes and was soon replicated for other US states, with support from CCL and a growing number of think tanks and other nongovernmental groups. A wide range of environmental groups, many of which had long favored putting a price on carbon but had not put it at the top of their policy agenda because they considered it a political nonstarter, began to coalesce around the proposal, bringing to bear their substantial fundraising prowess and grassroots networks. Groups as diverse as Environmental Defense Fund, Rainforest Action Network, the Sierra Club, Conservation International, the Audubon Society, Greenpeace, and 350.org joined in the push.

By 2016, CCL’s annual June lobby day in Washington, which had begun with just a few hundred people, had ballooned into a three-day festival with dozens of co-sponsoring organizations that drew tens of thousands of people to Washington for marches, speeches on the National Mall, and meetings with their elected representatives. More important, CCL members and affiliated volunteers showed up at every campaign event throughout the long and messy Republican primary to ask candidates their views on climate and a revenue-neutral carbon tax, as well as at the rallies organized for the Democratic frontrunner Hillary Clinton and her challengers. By the time of the general election, candidates from both of the major parties, the third-party Libertarian candidate, and the candidate from the new National

Green Party, who managed to get on the ballot in a handful of states, all favored carbon taxes in one form or another. The debate was not about whether to have such taxes, but how quickly to raise them and whether they should be entirely or only partly revenue neutral.

## British Columbia Shows the Way

US interest in carbon pollution taxes was also boosted by slowly growing awareness of the success of a carbon tax implemented in the western Canadian province of British Columbia starting in 2008. A 2013 assessment of the tax by the Ottawa-based think tank Sustainable Prosperity found that the province's consumption of fossil fuels covered by the tax fell 19 percent per capita compared with the rest of the country, while the province's economy outperformed most of Canada. [\[23\]](#) As a result, British Columbia's greenhouse gas emissions fell 10 percent between 2008 and 2011, versus a 1.1 percent decline for the rest of the country. Investments in clean energy were twice that in the rest of Canada, with a 48 percent increase between 2008 and 2010. By 2011 clean energy industries in the province had \$2.5 billion in sales and employed more than 8,400 people.

British Columbia's success was initially largely overlooked, not only in the United States but even within Canada itself, which was in the midst of a last-gasp oil boom. Starting in 2011, when the Conservative Party won a majority in the national parliament, Canada had become what Andrew Nikiforuk, a Canadian environmental activist writing in *Foreign Policy*, called "a rogue, reckless petrostate." With oil and gas accounting for about a quarter of Canada's export earnings, the federal government led by prime minister Stephen Harper had "muzzled climate change scientists, killed funding for environmental science of every stripe, and . . . systematically dismantled the country's most significant long-cherished environmental laws," Nikiforuk wrote. [\[24\]](#)

Canada's transformation from model global citizen to petro bully was most evident in the United States in Ottawa's no-holds-barred push for President Obama to approve the Keystone XL pipeline, which would have brought tar sands crude from Alberta, Harper's political base, to Texas refineries on the Gulf Coast, where it could be processed into diesel and exported to Europe and Latin America. [\[25\]](#) In December 2011, Canadian environment minister Peter Kent had announced that Canada was withdrawing from the Kyoto Protocol, the global climate treaty, arguing that "the Kyoto protocol does not cover the world's largest two emitters, the United States and China, and therefore cannot work." While he was right—the Kyoto Protocol was already seen as largely irrelevant—the move nonetheless should have been a wake-up call to the international climate community, which was at that time still pinning its hopes on a new global accord. [\[26\]](#)

Despite the adverse national political environment in Canada, polls in British Columbia showed that public support for the provincial carbon tax increased during the first four years of implementation, to 64 percent. In research that would help show the way to a revenue-neutral carbon pollution fee in the United States, investigators found that the carbon tax was popular in part because it made possible a reduction in other provincial taxes, giving British Columbia the lowest income taxes in Canada. Other Canadians began to notice: a 2013 poll found that 59 percent of Canadians would support a carbon tax similar to British Columbia's in their own province.

The British Columbia carbon tax gave those who changed their habits (by driving less or buying a more fuel-efficient vehicle, for example) an opportunity to save money, because the revenue raised through the tax was being shared with them in the form of tax breaks. By 2014 the tax had brought in some \$5 billion in revenue; [more than \\$3 billion](#) had been returned in the form of business tax cuts, [\[27\]](#) more than \$1 billion in personal tax breaks, and nearly \$1 billion in [low-income tax credits](#), [\[28\]](#) to protect those for

whom rising fuel costs could mean the greatest economic hardship. That year the British Columbia ministry of finance reported that for individuals earning up to \$122,000, income tax rates in the province were Canada's lowest. [\[29\]](#)

## Washington and Oregon Follow British Columbia's Lead

Before long, British Columbia's success attracted attention south of the border, in the US states of Washington and Oregon, where the large share of voters in favor of climate action had ringside seats to watch the British Columbia experiment with carbon taxes to their north and California's experiment with cap-and-trade to the south.

In October 2013 the premier of British Columbia, Christy Clark, and the governors of California (Edmund "Gerry" Brown Jr.), Oregon (John Kitzhaber), and Washington (Jay Inslee) signed a [Pacific Coast Action Plan on Climate and Energy](#) [\[30\]](#) that declared their intent to "lead on national and international policy on climate change" by, among other actions, "accounting for the costs of carbon pollution in each jurisdiction." The document pledged that the four jurisdictions would seek to "harmonize 2050 targets for greenhouse gas reductions and develop mid-term targets needed to support long-term reduction goals."

In the years that followed, a lively debate ensued in Washington and Oregon about which path to follow. California's cap-and-trade system seemed to be off to a good start, and the idea that reductions in emissions could be obtained at lower cost and without politically difficult "tax" increases appealed to significant numbers of voters and politicians. In Washington state Governor Inslee, a former US congressman who had been an outspoken advocate for national cap-and-trade legislation, issued an executive order [\[31\]](#) in July 2014 establishing a Carbon Emissions Reduction Taskforce to provide recommendations on the design and implementation of a state-level ETS. Oregon, meanwhile, appeared to be leaning toward a carbon tax. [\[32\]](#)

It wasn't long, however, before California's cap-and-trade system began to lose its luster. As in the European Union (EU) ETS, it soon emerged that the cap had been set too high as the result of lobbying efforts from covered industries, so the price of emissions permits fell too low to incentivize emissions reductions. In California's case, initial overallocation of permits was compounded when otherwise welcome technological breakthroughs in smart grids and utility-scale concentrating solar power reduced the demand for permits, knocking the bottom out of the permit market.

Worse for advocates of cap-and-trade, by 2016, as the US presidential election approached and voters in Washington and Oregon prepared to go to the polls to elect state officials, repeated scandals over false reporting and even corruption in monitoring, reporting, and verifying the actual emissions in California's "covered entities" further tarnished the system's reputation. Popular distrust of the cap-and-trade approach heightened a year later when *SiliconTribune.com* and *ProPublica* revealed in a joint investigative reporting project that ambitious efforts to link California's cap-and-trade program to the emerging program in China had opened the way for California firms to buy unverifiable Chinese emission reductions certificates. [\[33\]](#)

For these and other reasons, both Washington and Oregon followed British Columbia's lead and adopted revenue-neutral carbon taxes, while nonetheless leaving the door open for the future development of US and international certified emissions reduction credits (CERCs), which businesses could purchase as a means of offsetting their tax liability. [\[34\]](#) As in British Columbia, revenue was rebated through a combination of cuts in business taxes, personal tax breaks, and low-income tax credits. And, as in Canada,



other subnational jurisdictions took notice when the US Pacific Northwest managed to combine increased economic growth and falling emissions with tax reductions.

The experiment was watched especially closely by the nine northeastern and mid-Atlantic states participating in the Regional Greenhouse Gas Initiative (RGGI), the first US market-based cap-and-trade program. RGGI had reduced the number of permits in 2013 in an effort to shore up the price after a sudden surge in natural gas supplies due to hydrologic fracturing (“fracking”) led to a steep drop in demand. At the spring 2014 auction, some 23.5 million permits sold for a clearing price of \$4.00 per ton. [35] While the reduction in the number of permits was successful in maintaining a positive price, as with the EU ETS, few citizens understood the opaque and confusing system and there was little popular pressure to cut the number of permits further and thus push for a higher carbon price. At \$4 per ton, the RGGI permit price was better than nothing but below even the initial price for the British Columbia, Washington, and Oregon revenue-neutral carbon tax schemes.

## State-Level Experiments and National Legislation

In 2014 President Obama’s decision to use his powers under the Clean Air Act to move forward on climate despite congressional opposition accelerated state-level experiments with carbon taxes. In June that year the US Environmental Protection Agency (EPA) released long-awaited proposed rules to reduce CO<sub>2</sub> emissions from existing fossil power plants. The EPA’s Clean Power Plan proposed requiring significant reductions in CO<sub>2</sub> emissions from the power sector, while also providing each state the flexibility to determine its preferred way to comply. [36]

Drawing on powers to regulate carbon and other greenhouse gases that [the US Supreme Court had confirmed in a landmark 2007 case](#), [37] the EPA set state-specific goals and invited each state to develop policy approaches to meet the target. This state-by-state approach was familiar—it had been used repeatedly to successfully cut pollution under the Clean Air Act. [38] Significantly, the EPA approach left the door open to more comprehensive efforts, provided that they met the goals for reductions from existing power plants. The EPA also left room for groups of states to join together in common efforts. This unleashed a range of experiments with fee-and-rebate approaches, several of which were getting under way before the 2016 election. In 2018, RGGI shifted to a revenue-neutral carbon tax approach, joining the upper midwestern trio of Michigan, Wisconsin, and Minnesota and a southwestern regional grouping that included Arizona, Colorado, and New Mexico.

Meanwhile, a series of Deliberative Polls on climate change and carbon pricing had provided a further impetus to a nationwide, revenue-neutral carbon tax. Based on an ancient Athenian approach that combined random samples of citizens with opportunities for learning and small-group discussions, a modernized form of Deliberative Polling developed by political scientist James Fishkin at the [Center for Deliberative Democracy](#) [39] at Stanford University had proven successful in helping to drive policy change on complex, contentious issues. For example, a series of Deliberative Polls in Texas—a famously oil-and-gas-friendly state—had led to the implementation of renewable energy portfolio standards that resulted in a rapid expansion of wind power, bringing Texas from last to first among the 50 states in the amount of power from wind. [40]

Starting in 2015 [the World Resources Institute](#), [41] working with partners including [MacNeil/Lehrer Productions](#), [42] producer of the *PBS NewsHour* and other award-winning public affairs programs, organized a series of Deliberative Polls on policy responses to climate change, with a particular focus on revenue-neutral carbon taxes. One early poll, in the low-lying Tidewater region of southeastern Virginia, included information on the anticipated impacts of sea-level rise, a phenomenon that (unlike storms,

heatwaves, and droughts) is indisputably caused by global warming. As participants in the two-day deliberation—a random sample of Tidewater residents that reflected the area’s diverse political mix—learned more about the issue and possible policy responses, opinions shifted strongly in favor of state and national policies to cut emissions by pricing carbon. Similar polls in other parts of the country, culminating in a national deliberative poll on climate change and emissions pricing in Washington, DC, early in 2016, produced similar results.

Climate advocates, including organizations such as the Citizens’ Climate Lobby, 350.org, the Sierra Club, and Greenpeace, used these poll results—particularly answers to questions about what factors led participants to change their opinions—to improve their messaging. Perhaps more important, political advisers to candidates for local, state, and national office also took notice, crafting policy positions that took into account the new evidence on what US citizens would think about climate change and carbon pricing when they were given an opportunity to learn about the issue and discuss it with others.

Information from the Deliberative Polls proved especially helpful to Republican politicians who were increasingly eager to escape from an anti-science, climate denial box. During the 2012 Republican primaries, only [Jon Huntsman](#), [\[43\]](#) a former governor of Utah and one-time White House aide to President Ronald Reagan, dared to address the issue, tweeting, “To be clear. I believe in evolution and trust scientists on global warming. Call me crazy.” [\[44\]](#) The tweet put him in direct conflict with vocal elements in the conservative base and a newly minted presidential candidate, Texas governor Rick Perry, who days before had said that climate scientists “have manipulated data so that they will have dollars rolling into their projects.” [\[45\]](#) Huntsman failed to gain traction in the primaries, and the eventual nominee, Mitt Romney, sought to avoid the question while pouring cold water on proposals for action. [\[46\]](#)

By 2016 things had changed. The question was no longer whether candidates believed that human-caused climate change was real but rather what to do about it. The shift came about not only among moderate Republicans but more surprisingly among elements of the activist Republican base, notably evangelicals and libertarians, who frequently were at odds with the party’s pro-big-business moderates. All three groups included a growing number of people who were uncomfortable with the anti-science stance of climate skeptics and deniers, but who were strongly opposed to big-government regulatory solutions. Revenue-neutral carbon taxes gave them a way to accept climate science while arguing for a solution that was in line with their values and ideology.

Thus the 2016 national election became the first in which what to do about climate change was a significant issue addressed by all major candidates. Many proposals were floated, with Democrats predictably favoring a mix that included carbon pricing, strengthened regulations, government investment in renewables, and direct transfers to households while Republicans pushed for carbon pricing with various combinations of offsetting tax cuts. By 2018, just two years after the election, national legislation for a revenue-neutral carbon tax was well on the way to passage in both houses of Congress. [\[47\]](#) Much of the debate and attention shifted to complex questions involving the harmonization—and revenue sharing—of existing state programs and the national program slated for implementation in 2020.

The national legislation also left open the possibility, here following the lead of the Pacific Northwest, of a future CERCs program of up to 20 percent of the carbon tax liability. The provision was pushed by a coalition of antipoverty and environmental groups drawing on a legislative blueprint set out in a working group report from CGD. As we shall see, that provision proved to be a key element in providing finance for emissions reductions in the developing world, including so-called “cash-on-delivery” or “pay-for-performance” approaches to protecting the last remaining stands of tropical forests.

# In China, Pollution and Revenue Needs Drive Action

As in the United States and everywhere else, in China politics was inevitably at the heart of decisions about how to respond to climate change. Compared with most other countries, however, in China even more of the politics took place behind closed doors. Less is therefore known about the process, though it seems clear that at least one of the key elements was a bureaucratic tug-of-war between competing ministries, with the powerful National Development and Reform Commission (NDRC) favoring cap-and-trade while the Ministry of Finance preferred carbon taxes. In addition, as in the United States, there was fierce resistance from wealthy, well-connected firms and individuals who had profited immensely from the coal-intensive status quo.

Several factors came together to accelerate China's development of a hybrid system that combined carbon taxes and cap-and-trade. As in the United States, the primary drivers were domestic—in China's case rising concern about the health and economic effects of extreme air pollution the need for a more sustainable source of government revenue top the list. An additional complexity in China, and a powerful driver for change, was the revenue needs of sub-national governmental units—provinces, major cities, and even sub-provincial jurisdictions. But China's leadership also had an eye toward the country's global reputation and a desire to gain leverage that would cause other major emitters, especially the United States, to accelerate their own efforts, because Chinese leaders recognized that the country's huge population made it highly vulnerable to extreme weather events and rising sea levels driven by climate change.

China's early efforts to reduce carbon emissions and the associated conventional pollution through traditional command-and-control techniques proved less than satisfactory at addressing the tension between the growth imperative and sustainability. For example, although the 10th Five-Year Plan (2001–2005) stressed the need for energy efficiency and set ambitious pollution reduction targets, few were achieved. In the 11th Five-Year Plan, targets to reduce energy intensity of the economy by 20 percent and to reduce sulfur emissions and other air pollution were made mandatory and attainment was linked to the promotion prospects of local officials. These tougher enforcement mechanisms achieved an economy-wide energy intensity reduction of more than 19 percent.

But in some places the targets were achieved at high costs. As the end of the plan period approached in 2010, local governments resorted to deliberate power outages to meet their targets for reduced energy intensity. Not only did that approach have substantial economic costs, it also ran counter to the intended purpose of the targets, as firms shifted to diesel to generate their own power. This in turn led to a diesel shortage and long lines of cars waiting at the gas stations with “sold out” signs in many cities.

In response to these experiences, Chinese officials began to assemble the policy building blocks for a more market-oriented approach. In November 2013 the central government released the much-anticipated communiqué of the Third Plenum of the 18th Central Committee of the Communist Party, the first policy blueprint unveiled by the new leadership under President Xi Jinping and Premier Li Keqiang. [\[48\]](#) Extending the market-oriented reform process begun by Deng Xiaoping in 1978, the communiqué changed the description of the role of market economy from “basic” to “decisive.” The communiqué also specifically addressed ecological concerns with a four-point agenda for an “ecological society”:

- establish a systematic and integral ecological societal system;
- improve the natural resource property rights system and usage management system;

- implement the compensated use of natural resources system; and
- reform the ecological and environmental protection and management system.

Although such commitments were compatible with any system for pricing carbon, the references to market pricing were clearly more in line with a cap-and-trade approach, already then being piloted in China, than with carbon taxes. Nonetheless, the policy framework was in place for some form of carbon pricing. This would prove important to the subsequent rise of carbon taxes in China and the eventual emergence of a hybrid system that included both carbon taxes and emissions trading.

Among Chinese technocrats debating the relative merits of the two approaches, the success of the British Columbia experiment and similar programs in Washington and Oregon and the problems with low permit prices encountered in the EU ETS, RGGI, and later in California likely played an important role. Europe had long been a leader in climate action policies and the EU ETS was the first and largest ETS in the world. But the initial distribution of emissions rights—given free to the largest polluters—resulted in an extensive oversupply of permits and a subsequent tumbling of permit prices. Efforts to reduce the number of permits, thereby raising the price and incentivizing investments in renewable energy, proved to be bureaucratically and politically cumbersome.

Before these lessons had become apparent, China had invested heavily in an ETS modeled largely on the EU ETS. In 2009, the State Council announced that China would reduce the intensity of CO<sub>2</sub> emissions per unit of GDP in 2020 by 40 to 45 percent compared with the level of 2005. In August 2010, the NDRC launched a low-carbon pilot, opening the way for the inclusion of an ETS in the national development strategy. In November 2010, the Chinese government announced its 12th Five-Year Plan, which highlighted the carbon intensity reduction target and encouraged the development of an ETS. At the UN Climate Summit in 2014, Vice Premier Zhang Gaoli told the world that China had implemented a national climate change program to ensure that the country would meet its target of cutting carbon intensity by 40 to 45 percent by 2020 from the 2005 levels. [\[49\]](#)

In 2011 the NDRC General Office had designated seven cities and provinces (Beijing, Chongqing, Shanghai, Tianjin, Guangdong, Hubei, and Shenzhen) for ETS pilots. By December that year the State Council had published the “12<sup>th</sup> Five-Year Plan Work Program to Control GHG Emissions,” following which the seven pilot governments issued their own plans and each proceeded to put in place an ETS. By 2014 pilots were underway in all seven jurisdictions.

But the markets were not linked, and a careful assessment of their progress published in early 2014 that compared each with the EU ETS showed broad diversity in how they were being implemented. [\[50\]](#) Nonetheless, in August that year a senior climate official with the NDRC told a conference in Beijing that a proposal to launch a national cap-and-trade system in 2016 would be sent to the State Council for approval by the end of the year. [\[51\]](#) Speaking at a press conference in September 2014 following the release of a national plan on climate change, Xie Zhenhua, Vice chairman of NDRC, said China was considering extending the trading regime for the whole nation after the pilot stage [\[52\]](#)

In the years that followed, China’s ETS pilots and the fledgling national scheme encountered many of the same problems seen in Europe, the US Northeast, and California: excessive initial allocations, difficulty in sticking to auction plans in the face of industry pressure for free allocations, and cumbersome procedures for reducing the number of permits sufficiently quickly to keep prices high enough to incentivize innovation. In particular, with more government regulation and intervention than in the West, markets were even thinner, limiting the emissions reductions that could be achieved. Perhaps most important, as in other jurisdictions, China’s ETS failed to generate popular demand for higher carbon prices, leaving

well-intentioned government officials vastly outgunned when faced with the lobbying of powerful firms and industrial federations. Perhaps inevitably, corruption came into play in the initial allocation of permits.

Against this background, the Ministry of Finance's plea for carbon taxes to shore up China's fiscal position and to provide meaningful incentives for reductions in carbon and health-harming conventional pollutants became increasingly persuasive—especially when combined with the examples of success in British Columbia and the US Pacific Northwest.

## Air Pollution Cleanup

Though the extreme air pollution that marred China's early industrialization is now something that Chinese children learn about from their grandparents and in school, not so long ago it was a major social and even political problem. Growing public concern about the health effects and economic costs of air pollution was a major driver in the push to tax carbon pollution. Though carbon itself has no direct ill effects on health, most of the carbon emissions in China were the result of burning coal to generate power and heat, so pricing carbon proved to be a highly effective means of reducing so-called conventional pollution, mono-nitrogen oxides, sulfur dioxide, and particulate matter (PM), especially the superfine particle pollution PM2.5 that was a major threat to human health and was suppressing the productivity of Chinese agriculture.

As recently as 2007, the Chinese government had been unwilling to acknowledge the health costs of the heavy pollution burden. That year Chinese censors removed from a joint World Bank–Chinese report the fact that pollution caused an estimated 350,000 to 400,000 premature deaths per year. By 2014 things had changed, and it was possible for the country's recently retired health minister to publish an article in *The Lancet* with co-authors from the Ministry of Environmental Protection putting the annual estimated death toll from air pollution at between 350,000 and half a million. [\[53\]](#)

Senior Chinese officials presumably knew already that even that heavy toll was likely an underestimate: the “Global Burden of Disease Study 2010,” also published in *The Lancet* had estimated that airborne particles smaller than 2.5 microns in diameter (PM2.5)—small enough to lodge deep in the lungs and enter the bloodstream, causing respiratory infections, asthma, lung cancer, and cerebrovascular disease—caused 1.2 million premature deaths in China in 2010 alone. [\[54\]](#) Another [study](#) published in the US journal *Proceedings of the National Academy of Sciences* found that 500 million people in northern China lost a staggering 5.5 years of life compared with people in southern China due to air pollution from coal. [\[55\]](#)

Public awareness of the problem was also on the rise, with feelings of resigned helplessness shifting to fear, anger, and societywide pressure to change the status quo. One study found that mentions of the term PM2.5 on China's microblog site *Sina Weibo* surged from just 200 in January 2011 to more than 3 million per month in January 2013. [\[56\]](#) That year smog enveloped hundreds of millions of people with pollution levels up to 40 times higher than the World Health Organization deemed safe. Public anger was widely reported in the state-controlled media, and by mid-2015 there were 100 million mentions of PM2.5 per month on *Sina Weibo*.

Concern was also rising about the impact of pollution on food safety and even agricultural productivity. A 2013 study by China's Ministry of Environmental Protection estimated that one-sixth of China's arable land, nearly 50 million acres, was affected by soil pollution, primarily contamination by heavy metals, much of which was associated with coal mining and the disposal of coal ash. A 2013 study, *Clearer Skies Over China*, estimated that air pollution, primarily ozone generated through coal burning, had reduced the output of rice and wheat. [\[57\]](#)

## Revenue Needs Clinch the Deal

Pollution concerns alone might not have been sufficient to overcome resistance to carbon pricing and, in particular, to high and rising taxes per ton of emissions. An additional and more urgent factor was China's fiscal situation and the unmet needs of the central government and provincial and local governments for additional revenue. Taxing carbon emissions offered a major new revenue source that was easy to collect and had minimal impact on economic growth.

As in the United States, Chinese economists and planners had worried that taxing carbon emissions—and thus raising energy prices—would slow economic growth and hinder job creation. Two studies, one conducted by the Ministry of Finance and one by the Harvard China Project and Tsinghua University, found little basis for these concerns. Both studies reached similar conclusions, recommending that China begin with a modest carbon tax to increase substantially over time. These findings were to prove highly influential in the policy debate.

"Clearer Skies over China", for example, ran seven scenarios at different tax levels, ranging from 10 yuan per ton to 100 yuan per ton. It concluded that while the higher energy prices had a small growth-suppressing impact, this could be alleviated by cutting other, more distortionary taxes. [\[58\]](#) After taking into account co-benefits, such as improvements in health and agricultural productivity, the negative impacts on growth were negligible at the national level. Distributional effects, which varied across regions and sectors, could be addressed through transfers if they would otherwise be regressive, the study suggested. Of the various scenarios it considered, the study recommended a middle path, starting with CO<sub>2</sub> taxes of 10 yuan (about \$2) per ton in 2013 and rising to 50 yuan per ton by 2020 (all in 2013 values). Under this scenario, the study projected GDP would be just 0.14 percent lower in 2020. But coal use was projected to decline by a whopping 23 percent and overall fossil fuel use by 17.7 percent. Consumption and investment both showed small positive effects, while exports were projected to drop by 1.12 percent. CO<sub>2</sub> emissions were slated to fall by almost 19 percent.

Unlike in the United States, with its highly vocal small-government, anti-tax movement, the Chinese government faced fewer constraints on how it could use the resulting revenue. And fiscal needs were large: China's total government revenues were only about a quarter of GDP, compared with 40 percent in Germany and 30 percent even in the tax-phobic United States. Moreover, while individual income taxes accounted for about 34 percent of revenue in the United States, in China, despite growing affluence in the cities, individuals accounted for a bare 4 percent of revenue. China instead relied heavily on indirect tax revenues, such as value-added tax and business taxes, as well as revenue from land leases, a bubble-prone and unsustainable source.

The unusual reliance on land leases for revenue had been possible because in China all land is government owned; as villages and farms were converted to urban use, the government reaped windfall profits on the land leases. With rapid urbanization in the late 20th and early 21st centuries, millions of traditional villages were obliterated, their residents sometimes relocated into high-rise apartments or given cash compensation, as local and provincial governments cleared land to offer long-term leases to state and private entities. One study estimated that 1.1 million villages had been destroyed in the first decade of the 21st century, about 300 villages a day in the rapid onslaught of urbanization. [\[59\]](#)

But these land conversion activities were not sustainable. Even with China's breakneck urbanization the amount of rural land that could be converted to urban use and offered for lease was finite and would eventually be exhausted, meaning that a major new revenue source would soon be needed. Meanwhile, China's rapidly aging population—a result first of the one-child policy and then of young urban dwellers'



preferences to have few or no children—meant that the government would urgently need new resources to support a burgeoning population of old people who lacked adult children to care for them. [\[60\]](#)

## China Taxes Carbon Emissions

In 2015 China imposed a 10 yuan per ton tax on carbon emissions, with the proceeds split evenly between the central government and the provinces. Collections were made upstream, at the extraction points for coal and oil (mine mouths and wellheads) and at the port of entry for imports of coal, oil, and natural gas. This ease of collection from a relatively small number of locations and enterprises proved to be a valuable feature of the carbon tax. In China, as in many other developing countries, tax collections were hindered by a large informal sector and the fact that rich people could easily avoid taxes. With the carbon tax indirectly imposed on almost all commodities, the tax base expanded substantially. [\[61\]](#)

Though some Chinese enterprises, in particular the coal industry and a class of entrepreneurs and officials who had become wealthy because of coal, had lobbied fiercely against the measure, the tax proved broadly popular with ordinary people who understood the principle of “make the polluter pay.” As the CO<sub>2</sub> tax gradually increased and revenue became available for reductions in the value-added tax, support increased among firms and middle-income households. Low-income households, meanwhile, received transfers that more than compensated them for the additional costs due to higher energy prices.

Firms and households responded quickly to the resulting increased energy costs, first with simple conservation measures that had long been common in advanced economies (automatic thermostats, insulation, and double-glazed windows), then with investments in more sophisticated energy-saving technology, and finally with a burst of investment, innovation, and diffusion of renewables.

Today China has carbon taxes of 50 yuan per ton and is making the transition to a low-carbon economy much more easily, quickly, and with greater economic growth, job growth, and prosperity than the naysayers had deemed possible. Carbon taxes are generating a once unimaginable 5 percent of total government revenues. As carbon taxes have become an increasingly important part of China’s revenue mix and emissions have fallen, there is growing pressure to strengthen enforcement—to be sure that every ton is taxed—and to continually raise the price per ton.

The emissions taxes are part of a hybrid system that combines the strengths of cap-and-trade (setting a quantity cap for major emitters such as power plants, iron and steel, and cement manufacturers to meet regional targets) with the strengths of carbon taxes (predictability and incentives for firms and citizens to press for higher per ton taxes as a means to generate revenue for social services and reductions in more onerous taxes). The parallel cap-and-trade system provides flexibility so that firms with high emissions reduction costs can instead purchase certified carbon tax credits generated by the country’s massive reforestation program—thus paying for most of the reforestation effort.

Emissions have plummeted, of course, from a peak in 2015 of 7 tons per capita to 3 tons per capita in 2030, a level last seen before China’s late-20th-century industrial takeoff. China’s economy, while easing from the breakneck pace of 8 to 10 percent annual GDP growth per year in the late 20th and early 21st centuries has nonetheless continued at an impressive 5 to 7 percent annual growth.

Conventional pollution has fallen rapidly, and acute illnesses and agricultural productivity losses associated with air pollution have declined. Nonetheless, the long-term effects of the extreme pollution levels of the early 21st century will be felt for many years to come. Recent studies warn of a massive “cancer bubble” among prime-age adults—those who were children in the early part of the century. Soil

pollution remains a serious problem. Despite China's extensive investment in the development of new microbial techniques for land detoxification, large areas of farmland have been classed as unsuitable for production of food crops and livestock and are instead being used exclusively for biofuels.

Nobody pays much attention anymore to the carbon intensity of the economy, once put forward as a key measure of China's progress, though of course it has plummeted, too. China had pledged at the 2009 Copenhagen Climate Summit to cut the carbon intensity of its economy by 40 to 45 percent by 2020. While that seemed ambitious at the time, given China's rapid economic growth, it would nonetheless have still implied a potential doubling of emissions by 2020—an outcome incompatible with restoring climate stability. Instead, with high and rising carbon taxes we have seen an absolute reduction in emissions of roughly 50 percent.

## Europe Scraps the EU ETS, Opts for Carbon Taxes

The rapid progress on carbon taxation in the United States and China naturally had far-reaching repercussions for other major emitters. One of the more surprising was the collapse of the European ETS and its replacement in 2016 with emissions fees and cuts in other taxes. This shouldn't have come as a surprise: the EU ETS had been on life support for years. Based on a system of tradable permits, the system had been plagued by overallocation of permits and low prices.

Soon after the launch in 2005, permit prices hit a peak of €30 per metric ton of CO<sub>2</sub> emissions. But it quickly became apparent that actual emissions were lower than the number of permits and demand collapsed. Within the first year, the spot price for EU allowances dropped 54 percent to €13.35 per metric ton. In May 2006, the European Commission confirmed that verified CO<sub>2</sub> emissions were about 80 million metric tons, or 4 percent lower than the number of allowances distributed to installations for 2005 emissions, and prices fell further to under €10 per metric ton. Oversupply of permits and weak demand continued through 2006 resulting in a trading price of €1.2 per metric ton in March 2007 and a further drop to just €0.10 in September 2007.

Carbon prices remained near zero throughout 2007 as market participants became aware that aggregate emissions were well below the number of allowances issued. The price drop dramatically weakened the incentive to continue reducing emissions. The price collapse had two causes. First, EU member states had allocated too many EU allowances, due to sustained lobbying by individual firms and uncertainty about the baseline for business-as-usual emissions. Second, firms had actually reduced their emissions, so they didn't need as many allowances.

EU policymakers tried to rescue the scheme by reducing the number of permits and shifting to auctions instead of the free allocation of permits based on past emissions that had been used to launch the scheme. But the success of the carbon pollution emissions fees in the United States and China, combined with huge new revenue demands associated with aging populations and periodic crises such as the periodic need to bail out fiscally profligate members in the southern tier, made carbon taxes increasingly appealing. As emissions taxes increased an additional benefit became increasingly important: greater reliance on utility-scale solar from southern Europe and North Africa, and reduced reliance on Russia's natural gas. Moreover, the EU has been able to eliminate expensive subsidies for solar, wind, and nuclear energy, which are now cheaper than their fossil fuel alternatives.

Today, the EU enjoys a situation similar to the United States, China, and other former major emitters: high and rising carbon taxes, sharp cuts in other more distortionary and growth-reducing taxes, and a boom in

clean energy investment and job growth.

## The Rest of the World Falls in Line

With the United States and China moving to put in place carbon pollution fees, and Europe rapidly moving in a similar direction, other major emitters followed suit with surprising speed. In hindsight it now seems obvious that first Brazil, then India, Indonesia, South Africa, and finally even Nigeria would move to take advantage of the potential revenue from carbon pollution fees. In many cases ease of collection was a major consideration, since the fees could be collected from a relatively small number of firms and locations, as fossil fuels were extracted from the earth, at the mine mouth or wellhead. Before it happened, of course, it seemed unlikely that countries would move with such speed.

## The IMF Weighs In

An important analytical contribution to the transition had come from an institution that many people initially regarded as an unlikely source: the IMF. In a June 2012 speech at CGD, IMF managing director Christine Lagarde spoke forcefully about a “triple crisis” threatening global stability: “an economic crisis, an environmental crisis, and increasingly a social crisis.” [\[62\]](#)

“Getting the prices right means using fiscal policy to make sure that the harm we do is reflected in the prices we pay,” she said. “I am thinking about environmental taxes or emissions trading systems under which governments issue—and preferably sell—pollution rights. It is basically a variation of the old mantra: you break it, you buy it.” Such fees had the double advantage of raising revenue and cutting pollution, she explained, adding that the IMF would begin providing member countries policy advice on carbon pricing.

The following year the IMF released a study that quantified and sharply criticized energy subsidies [\[63\]](#), the vast majority of which at that time were going to climate-damaging fossil fuels. While supporters of such subsidies often defended them on the grounds that they protected consumers, the IMF concluded that energy subsidies “aggravate fiscal imbalances, crowd out priority public spending, and depress private investment, including in the energy sector.” The subsidies also encouraged excessive energy consumption, artificially promoted capital-intensive industries, reduced incentives for investment in renewable energy, and accelerated the depletion of natural resources, the IMF study found. Moreover, “most subsidy benefits are captured by higher-income households, reinforcing inequality.”

The IMF study estimated global fossil fuel subsidies were an eye-popping \$1.9 trillion a year, equivalent to 2.5 percent of global GDP. This included some \$488 billion—roughly a quarter—in “direct” or consumer subsidies, those provided mostly in developing countries to hold down consumer prices. The far larger share, however, was so-called “indirect” subsidies—the lack of taxation on emissions corresponding to the damage that they were inflicting. The IMF included in these damages “the effects of energy consumption on global warming; on public health through the adverse effects on local pollution; on traffic congestion and accidents; and on road damage.” These the IMF estimated to be \$1.4 trillion per year.

The IMF estimate was based on the assumption that the damages caused by a ton of carbon emissions—the social cost of carbon, or SCC—was about \$25, an amount based on the findings of a US Interagency Working Group on Social Cost of Carbon. That number seems laughably small today, when the US SCC has been repeatedly revised upward and is now more than \$100 a ton and the average global carbon pollution fee is already at \$50 per ton and rising fast. Already in 2013 the US SCC was recognized as being

too low. In 2012 a paper by Laurie Johnson and Chris Hope published in the *Journal of Environmental Studies and Sciences* presented evidence that the proper SCC—and therefore the appropriate level for a carbon pollution fee—should be somewhere between “2.6 to over 12 times larger” than the US government’s official figure. [\[64\]](#)

In August 2014 the IMF weighed in with a new book, [Getting Energy Prices Right: From Principle to Practice](#), [\[65\]](#) released to a standing-room-only audience at CGD. The book, by Ian Parry, Dirk Heine, Eliza Lis, and Shanjun Li, built upon the growing consensus that fossil fuel taxes should take into account their negative impacts on problems such as climate change, air pollution, and road congestion and offered a practical methodology and tools for calculating appropriate tax levels for the four most widely used fossil fuels: coal, natural gas, diesel, and gasoline. The pathbreaking study applied the model to suggest specific tax levels for 150 countries for each of the four fuels, taking into account differing local and national conditions (for example, population density when calculating the health costs of conventional pollutants).

The report concluded that: “there is pervasive mispricing of energy across developed and developing countries alike... At a global level, implementing efficient energy prices would reduce carbon emissions by an estimated 23 percent and fossil-fuel air pollution deaths by 63 percent while raising revenues (badly needed for fiscal consolidation and reducing other burdensome taxes) averaging 2.6 percent of GDP.”

Returning to CGD in 2014 to launch the new book, Lagarde was careful to stress that the additional revenues should be offset by reductions in other taxes that put a drag on the economy. “Let me be crystal clear,” she said, “we are generally talking about smarter taxes rather than higher taxes. This means recalibrating tax systems to achieve fiscal objectives more efficiently, most obviously by using the proceeds [from fossil fuel taxes] to lower other burdensome taxes. This revenue could also be used for spending priorities, or to pay down public debt.”

## The World Bank and Others

The World Bank, too, played a role, helping to bring the conclusions of climate scientists regarding the risks to developing countries of runaway climate change to the attention of a much wider audience. Soon after he became president in 2012, Jim Kim lent his authority to the release and promotion of what was soon to become the bank’s most downloaded report ever: *Turn Down the Heat: Why a 4°C Warmer World Must Be Avoided*. [\[66\]](#) “Even with the current mitigation commitments and pledges fully implemented, there is roughly a 20 percent likelihood of exceeding 4°C by 2100,” the report warned.

“A 4 degree warmer world can, and must be, avoided—we need to hold warming below 2 degrees,” Kim said at the release of the report. “Lack of action on climate change threatens to make the world our children inherit a completely different world than we are living in today. Climate change is one of the single biggest challenges facing development, and we need to assume the moral responsibility to take action on behalf of future generations, especially the poorest.” [\[67\]](#)

While the bank at the time saw its role primarily in terms of providing finance for climate adaptation, throughout the teens and 2020s World Bank advice and support to countries in administering direct transfers of carbon tax revenue became increasingly important. This activity complemented the IMF advice that was helping countries to generate their own revenues for development and climate change adaptation while at the same time reducing their emissions.

Besides R Street, CCL, the IMF, and the World Bank, many other research and advocacy organizations contributed to the consensus in favor of action, and carbon taxes in particular.

Already in 2006 the World Resources Institute (WRI) had published a remarkable issue brief jointly authored by Craig Hansen, a senior associate at WRI, and James Hendricks Jr., a vice president for environmental health and safety policies at Duke Energy, the largest electric power holding company in the United States and a major emitter that nonetheless backed efforts to charge for carbon pollution. Hansen and Hendricks offered a prescient summary of the advantages of carbon taxation: “policymakers should consider a type of consumption tax new to the United States—an initially modest but gradually increasing tax on the carbon content of fossil fuels—that could generate billions of dollars of revenue, which could be used to finance other reforms of the tax code.” [\[68\]](#)

As the movement for carbon taxes gained momentum in the United States and China, WRI played a critical behind-the-scenes role fostering information exchange and helping the two big emitters to coordinate the rollout of the new policy. WRI president Andrew Steer, an environmental economist who had previously served as the World Bank’s climate envoy and director general of the United Kingdom’s Department for International Development, used his personal connections, trust in WRI in developing countries, and the institute’s global presence, with offices in China, Brazil, India, Indonesia, and Mexico, to gain understanding and support for the new approach. WRI also conducted research and organized a series of international policy forums on critical technical issues in the collection and utilization of carbon tax revenues, accelerating the spread of the new policy approach.

Similarly Resources for the Future conducted extensive research on the design and implementation of carbon taxes, including revenue potential and the likely impacts on carbon emissions, employment, transportation, inequality, and US competitiveness. [\[69\]](#) These and similar studies at other think tanks and universities provided a solid analytical basis for the design of effective legislation once it became apparent—through the efforts of CCL and others—that by framing a US carbon tax as key to overall tax reform and the reduction of other, less popular taxes, a revenue-neutral carbon tax could be a political winner. [\[70\]](#)

## An Accelerating Technological Revolution

Charging for carbon pollution—what the economists called “getting the prices right”—unleashed a torrent of technological change that has built upon and far exceeded the economic and social transformations brought about by computers and the Internet in the late 20th and early 21st centuries. At the core, of course, was a long-overdue technological revolution in energy production, distribution, and use. Technology writers had long noted that energy production and distribution had been oddly immune to the sweeping transformations that had occurred in medicine, communications, music and the arts, and, of course, computing. While these and other fields were transformed during the late 20th and early 21st centuries, advances in energy production and distribution had been held back by a combination of outright subsidies and market distortions brought about by the failure to charge for emissions. Notwithstanding advances in drilling and mining techniques, the basic approach to energy production in the early 21st century was similar to that at the dawn of the electrical age: extract coal, oil, or gas from the ground, ship it to a power plant, and burn it to generate heat that creates steam to drive generators, with the resulting electricity distributed through a grid. Similarly, for transportation the basic approach of extracting oil, refining it into gasoline, and shipping it to service stations for pumping into cars and trucks was largely unchanged since the introduction of the internal combustion engine in the early 20th century.

The first and easiest responses to higher energy prices were changes in household and firm behavior, activities such as insulating homes and commercial and industrial structures, switching to lower-energy lighting fixtures, taking fewer and shorter car trips, and making greater use of public transport. These types of changes had been encouraged as early as World War I as a means to save energy and materials

for the war effort. In the early 21st century they were seen both as a means of economizing and as an act of global citizenship, to reduce the individual or household carbon footprint. Nonetheless, charging for carbon emissions—and the knowledge that such fees were very likely to rise in the future—greatly accelerated such changes. Suddenly investments in low-emissions technology, such as the rooftop solar hot water heaters that had long been standard in places as different as China and Israel, made economic sense in the United States and other industrialized countries.

The second and more powerful wave of change came about due to increased investment in new technology for energy production, distribution, and use. Prices for energy production technologies such as wind and solar had been falling rapidly in the early 21st century but advances in fossil fuel extraction—especially the global natural gas glut that resulted from hydraulic fracturing (“fracking”) first in the United States and then increasingly around the world—meant that low-emissions renewable energy solutions were constantly chasing a receding horizon, always falling short of the tipping point at which they would become price competitive with high-emissions fossil fuels. Emissions fees changed all that. The change in relative prices attracted fresh investment into research, development, and deployment of low-emissions energy solutions, and that in turn led to the explosive rollout of variable energy pricing and smart meters, homes, and grids, new highly efficient batteries, decentralized power generation, lower-cost transmission, and high-efficiency electric cars that we are seeing today. In addition, the natural gas deal between China and Russia also led the majority of power plants in China to quickly shift from coal to natural gas. China’s remaining coal reserves were left underground, it being no longer economical to extract them because of the much-lower-cost natural gas. China also continued with its plan to build many nuclear power plants, to ensure abundant electricity for continued rapid economic growth.

A third wave, less visible to consumers, has been the surge of investment into carbon capture and storage (CCS) technologies for retrofitting existing coal- and oil-burning power plants. Whether this will ever be more than a niche market remains to be seen. Increased awareness of the nonclimate environmental costs of coal and the aging of the coal-fired power plants (the newest are now more than a dozen years old and many are decades old, approaching the age for decommissioning even in the absence of a carbon pollution fee) means that the demand for CCS associated with new emissions at the source is lower than many had expected. There is, however, a burgeoning new market for atmospheric extraction CCS, an area we discuss further below.

## Looking Ahead 2030

With victory in the battle to cut emissions largely in sight, the focus has shifted to removing excess carbon from the atmosphere—and the windfall profits that could be achieved by selling the resulting credits to firms eager for lower-cost tax offsets on their remaining emissions. The natural gas industry in particular is eager for such low-cost credits, which hold out the promise of making natural gas a long-term component of the global energy mix rather than merely a transition fuel. The resulting surge of investment into atmospheric carbon capture and storage (ACCS) has led to some exciting technological advances that may eventually make it possible to bring atmospheric carbon back to preindustrial levels.

Today hardly a month passes without a Bloomberg.net story about investors ponying up money for a promising new ACCS technology, like the recent report about the Chinese-Australian joint venture that achieved a breakthrough in commercially viable atmospheric carbon extraction to produce building materials for ultra-high-efficiency construction. [\[71\]](#) With hundreds of trillions of dollars in sovereign wealth and pension funds chasing such opportunities, there is no shortage of capital. Indeed, the problem



may be too much. Financial analysts in Shanghai, Mumbai, London, and New York are warning about the possibility of an ACCS bubble.

## Forest Focus Shifts to Restoration and Reforestation

Among the far-reaching impacts of carbon taxes has been greatly increased investment in forest protection and reforestation. Deforestation and degradation of intact forests, which had accounted for as much as 20 percent of emissions as recently as the turn of the century, had pretty much come to a halt by 2020. Today, billions are being invested in reforestation and land restoration, in some cases on land that was cleared as recently as a few decades ago, in others on land, such as that in northwestern China and the Sahel, that has been bare of trees for many generations.

As with other changes, many forces were at work. Nongovernmental organization (NGO) advocacy efforts and consumer demand for commodities produced in a sustainable manner prompted consumer-facing companies to push for changes in the supply chain for such products as timber, paper, and palm oil. Already in 2013 Wilmar International, Asia's leading agribusiness group and the world's largest trader of palm oil, had announced a "No Deforestation, No Peat, No Exploitation" policy in response to such pressures. [72] Improvements in satellite imagery and data processing, such as the Global Forest Watch launched by WRI in 2014, made it possible for NGOs to monitor such pledges—and for governments to dispatch law enforcement to areas of illegal deforestation.

Perhaps more important, the combination of widely available, near real-time monitoring at a very high resolution and the arrival of high and rising carbon pollution fees prompted private investors to contract with those who controlled forested lands (such as national, regional, and local governments, firms, indigenous peoples, and other forest communities) to underwrite preservation efforts in exchange for a share of the future revenue that could be generated from selling forest services—carbon sequestration in particular. Inevitably there have been disputes about these contracts, as the value of sequestered carbon soared well above the anticipated levels. Some have been renegotiated and others have been adjudicated in the courts. Even in those instances, however, all parties recognize that continued protection of the forests is crucial to maintaining the value of the disputed asset.

Oil-rich Norway had shown the way with early support for the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD), offering pay-for-performance contracts to tropical countries for forest protection. Others included the World Bank's Forest Carbon Partnership Facility, the Global Environment Facility, Australia's International Forest Carbon Initiative, and the Collaborative Partnership on Forests. In 2016 the Gulf Cooperation Fund dwarfed previous efforts with a \$10 billion program focused on Indonesia's Aceh Province, which included a clause allowing the fund to share in the proceeds if the global price of sequestered carbon exceeded \$250 per ton. Though we aren't there yet, it's looking increasingly like a good bet.

In any event, destruction of intact forests is largely a thing of the past, and the attention has turned in recent years to the reforestation of degraded lands. WRI's 2012 estimate that some 2 billion hectares offered potential for restoration proved accurate, but by the time deforestation had come to a halt in 2020 the area had grown to an estimated 2.5 billion hectares. One pioneering effort was the Bonn Challenge. [73] a global movement launched in 2011 to restore 150 million hectares of degraded and deforested land by 2020. Though the target now seems laughably small relative to what is universally recognized as needed, the program pioneered financial instruments, mechanisms for sharing the benefits with local residents, and improved reforestation techniques all of which have helped to make possible the

rapid scaling up in the past 10 years. Underpinned by carbon pollution fees, a de facto international price on carbon has unleashed a tsunami of investment and an ambitious new goal: reforestation of 1 billion hectares by 2050.

## The End of Big Oil

Few aspects of what has happened in the past 20 years would have been as difficult to foresee as the popping of the carbon bubble and the decline and fall of big oil as a political force.

Looking back, we can see the seeds of this startling transformation in the Fossil Fuel Divestiture Movement, which as early as 2012 was urging universities, faith-based institutions, and pension funds to divest of their shares in fossil fuel companies on ethical grounds. The model was the anti-apartheid divestiture movement of the 1970s, which began in universities and religious institutions, then grew to include pressure on publicly listed firms to disengage from South Africa.

There was an important difference, however. Whereas the anti-apartheid divestiture movement saw the companies as a lever to accelerate political change in South Africa, the fossil fuel divestiture movement sought transformation of the firms themselves. This was arguably a much heavier lift, given the vast wealth and power of the oil companies. Oil companies accounted for three of the top five firms in the 2013 Fortune 500 ranking of America's biggest companies. Exxon Mobil, the world's biggest nongovernment oil company, posted the second-highest annual profit in US history, surpassed only by its own 2008 record. Net income rose to \$44.8 billion, a 9.3 percent jump from the previous year and only slightly below its 2008 record \$45.22 billion. [\[74\]](#)

The industry wasn't shy about using this wealth to extract public subsidies and other favorable treatment including tax breaks and giveaways, loans at favorable rates, price controls, and weak enforcement of environmental protections. Credible estimates of the size of annual US fossil fuel subsidies ranged from \$14 billion to \$52 billion in 2010. Not surprisingly, Congress was receiving massive contributions from these same interests. Oil Change International, a research and advocacy organization, estimated that in 2009 and 2010 fossil fuel industries spent nearly half a billion dollars on campaign contributions and lobbying in the United States, while receiving some \$20 billion in various subsidies—a return of \$59 for every dollar invested in politics. [\[75\]](#)

Against such wealth and influence, ethical arguments seemed unlikely to prevail. But the divestiture movement had a larger, not-so-hidden agenda: to draw attention to the fact that the value of the fossil fuel firms was based on a chimera, the belief that their biggest asset—fossil fuel reserves lying beneath the ground—would one day be extracted and burned. This assumption was incompatible with any scenario that averted runaway climate change, something that investors came to recognize first gradually and then very suddenly in 2015, with a stampede for the exits. All at once the oil company share prices started to resemble Wile E. Coyote when he runs off a cliff and hangs momentarily in the air before realizing there is no longer any ground below him and he comes crashing down.

Investors also became increasingly worried about the prospect of lawsuits against the big oil companies for willful endangerment of the public, much like the 1998 Tobacco Master Settlement Agreement between the four largest US tobacco companies and the attorneys general of 46 states. That agreement provided for payments of \$206 billion over 25 years for the states to recover tobacco-related healthcare costs and exempted the companies from private tort liability regarding harm caused by tobacco use. In exchange, the companies agreed to curtail or cease certain tobacco-marketing practices, as well as to pay, in perpetuity, various annual payments to the states to compensate them for some of the medical costs of

caring for persons with smoking-related illnesses. The settlement also dissolved the tobacco industry groups Tobacco Institute, the Center for Indoor Air Research, and the Council for Tobacco Research.

In the case of the fossil fuel companies, of course, the potential liability is in the hundreds of trillions rather than mere billions (what price a livable planet?). The legal battle is now well under way, and the results may not be known for years. But investors' anticipation of a large adverse ruling, combined with the recognition that the bulk of the "assets" of the fossil fuel companies will never be extracted and burned sparked a stampede out of fossil fuel stocks even in the absence of an adverse ruling.

As with tobacco, there was plenty of evidence that the fossil fuel companies knew that their product, used as intended, was causing vast harm but that they continued to sow public doubt about the science, funding climate-change-denier groups and backing advertising campaigns that confused the issue with false claims about the link between the "energy" industry and jobs. [\[76\]](#) Columbia University's Sabin Center for Climate Change Law was at the forefront of the effort to hold these firms accountable, developing legal techniques to fight climate change, training law students and lawyers in their use, and providing the public with up-to-date resources on key topics in climate law and regulation. [\[77\]](#)

Efforts to hold the chief executives of the big oil companies personally responsible for such actions—and thus create incentives for them to modify corporate behavior—gained momentum in 2015 with a campaign by a small NGO to identify the 52 "dirtiest men in America." The campaign used an index that comprised such elements as proven fossil fuel reserves, share of corporate expenditure devoted to the search for new reserves, and share of corporate expenditures devoted to advertising and lobbying designed to delay sensible climate policies. The 52 men (and it turned out that they were all men) were then "honored" with inclusion on a deck of cards, those ranking highest being aces and kings, the lowest being the twos and threes. Activists were encouraged to confront the men when they appeared in public settings, take their pictures (for posting on a website as a "sighting" of one of the 52 dirtiest men in America), and hand them the card asking: "Why are you so dirty and what are you doing to clean up your act?"

The campaign was controversial, and in the end few executives were actually ever approached by activists. But the prospect that they might be publicly embarrassed in this manner heightened the sense that their actions made them a social pariah and that chief executive officers (CEOs) could eventually be held personally responsible for the actions of their firms. In turn, this accelerated discussions within the firms about the corporate response to climate change. Several big firms reduced or eliminated support for anti-climate-action lobby groups such as the American Petroleum Institute, the American Chamber of Commerce, and the American Legislative Exchange Council; cut back the share of investment devoted to the discovery of new reserves; and accelerated their diversification away from extreme fossil fuels—those that were the most costly and risky to extract, such as mountaintop-removal mining and deepsea drilling—and into renewable energy.

## Big Oil Dumps the Climate Change Deniers, Prepares for Carbon Pollution Fees

The activist push to hold big oil CEOs personally responsible helped bring into the open a split between the large, publicly listed firms, which had privately accepted the inevitability of a carbon pollution fee and begun to include it in their business planning, and the smaller, highly ideological foundations and advocacy organizations that continued to insist that climate change was a leftist hoax and portray efforts to tax carbon as an excuse to expand government.

Businesses and private "charitable" foundations with strongly conservative views had amplified and played upon fears that carbon pollution fees would lead to higher energy prices, lower economic growth,

and fewer jobs. In late 2013 the first peer-reviewed study of anti-climate-action funding shined light on these mostly hidden activities. [78] Robert Brulle, a Drexel University professor, mapped the links in a well-funded and organized effort to undermine public faith in climate science and block action by the US government to regulate emissions. The climate counter-movement, as he called it, involved a large number of organizations, including conservative think tanks, advocacy groups, trade associations, and conservative foundations with strong links to sympathetic media outlets and conservative politicians.

“The climate change counter-movement has had a real political and ecological impact on the failure of the world to act on the issue of global warming,” Brulle said when the study was released. “Like a play on Broadway, the counter-movement has stars in the spotlight—often prominent contrarian scientists or conservative politicians—but behind the stars is an organizational structure of directors, script writers and producers, in the form of conservative foundations. If you want to understand what’s driving this movement, you have to look at what’s going on behind the scenes.” [79]

Brulle identified 118 major climate-change-denial organizations in the United States, then examined financial data the organizations gave to the Internal Revenue Service and data made available by the Foundation Center, a nonprofit group that collects information on fundraising, philanthropy, and grant programs. He found that between 2003 and 2010, more than half a billion dollars was made available as grants to 91 organizations with an agenda of climate change denial.

“Money amplifies certain voices above others and, in effect, gives them a megaphone in the public square,” Brulle wrote. “Powerful funders are supporting the campaign to deny scientific findings about global warming and raise public doubts about the roots and remedies of this massive global threat. At the very least, American voters deserve to know who is behind these efforts.” [80]

Consistent funders of organizations orchestrating climate change denial included a number of well-known conservative foundations, such as the Searle Freedom Trust, the John William Pope Foundation, the Howard Charitable Foundation, and the Sarah Scaife Foundation. The Koch Affiliated Foundations and the ExxonMobil Foundation had been heavily involved in funding climate-change-denial organizations from 2003 to 2007, but after 2008 they were no longer making publicly traceable contributions. As traceable funding declined, the amount of funding given to denial organizations by DonorsTrust, a donor-directed foundation whose funders cannot be traced, rose sharply, to account for about 25 percent of all foundation funding used by organizations engaged in promoting systematic denial of climate change.

Brulle found that most funding for denial efforts could not be traced. Despite extensive data compilation and analyses, only a fraction of the hundreds of millions in contributions to climate-change-denying organizations can be specifically accounted for from public records. Approximately 75 percent of the income of those organizations came from unidentifiable sources.

But while financing to erode public understanding of climate change was substantial, increasingly it did not come from the big oil companies. The *New York Times* reported in December 2013 that, according to the nonprofit Carbon Disclosure Project, at least 29 companies, some with close ties to Republicans, including Exxon Mobil, Walmart, and American Electric Power, were incorporating a price on carbon into their long-term financial plans. More than two dozen of the nation’s biggest corporations, including the five major oil companies, were among the firms planning their future growth on the expectation that the government would require them to pay a price for carbon pollution as a way to control global warming. [81] Although that shift provided a welcome opening for the advancement of carbon pollution fees, it was too little and too late to save many of the big fossil fuel companies.

A striking example of how quickly things have changed: a recent exhibition at the National Climate Science and Education Center drawing on academic histories and recent NYT.com and WaPo.com investigations into who knew what when includes a rogues' gallery of oil company CEOs and others who did the most to undermine the consensus for climate action and stave off carbon pollution fees. Most are now dead (two from suicide), and only a handful were ever charged and prosecuted in connection with their actions. But the companies they led—Exxon, Chevron, Peabody Coal—have either collapsed or been bought out by the burgeoning renewable energy giants.

Looking back today, it's hard to imagine what these men were thinking when they competed to discover new "reserves" of extreme fossil that would never be burned, sponsored massive public disinformation campaigns to confuse people about climate science, and spent heavily on lobbying to delay the inevitable carbon pollution fees. Of course, back in 2013 their behavior was considered normal, and it seemed impossible that things would change as fast as they have.

## Afterword

The patient reader who has reached this point—or perhaps even the impatient reader who has skimmed the first few pages and then jumped to the end—will have soon realized that this essay is what might be called a future history, a work of imagination set in 2030 that looks back at one possible scenario for global climate policy. We are tempted to call it "policy fiction" or perhaps "political science fiction"—a tribute to science fiction—except that such terms seem to suggest that the scenario we have sketched could never come true. Our intention to persuade the reader that some rough approximation of the events we have described is indeed possible, and thus to increase the likelihood that something like it will come to pass.

The events described here may seem unlikely; if they were self-evidently probable there would be no need for such an essay. We contend, however, that they are much more likely than the scenario on which many in the climate policy community continue to pin their hopes: that the UNFCCC negotiations will lead to a binding agreement on emissions reductions in time to avert runaway climate change. We passionately wish that were true, but we doubt the prospects of success. We believe that the burgeoning climate action movement is badly in need of alternative stories. If not the UNFCCC and multilateral negotiations leading to a binding treaty, then what? If you find the scenario in this essay implausible, we hope that you will consider writing an alternative vision. For us, the one thing less plausible than a binding UNFCCC agreement of sufficient ambition is that the world will continue current inept climate policies long after we have passed the point of no return.

One of us, Lawrence MacDonald, was inspired to write this account by the 50th anniversary of the August 1963 March on Washington and Dr. Martin Luther King's famous "I Have a Dream" speech. Sweltering in the August sun at the newly opened King Memorial in Washington, DC, he listened as a street actor delivered King's moving address. He realized then that we in the climate action movement do not have a collective dream, only shared nightmares. We push for more sensible climate policies—restrictions on extreme fossil fuel extraction projects and support for higher fuel efficiency standards and renewable energy—on an ad hoc basis, all the while knowing that such measures will not be sufficient to avert catastrophe. We tell ourselves this is the best we can do given current politics. We work to change the politics, but toward what specific set of policies we are unsure. We hope that our misguided critics, the climate change skeptics, will miraculously turn out to be right, that the atmosphere will be more resilient and forgiving than climate scientists expect.

“High and rising carbon taxes, independently implemented by the United States and China, with other countries quickly following suit” lacks the soaring rhetoric of “I have a dream!” We hope that it is nonetheless an inspiring and plausible dream, one that will encourage people around the world, especially Americans and Chinese, to begin working toward such a day before it’s too late.

Lawrence MacDonald wrote this while serving as vice president for communications and policy outreach at the Center for Global Development (CGD). Shortly before publication he began working as the vice president for communications at the World Resources Institute (WRI). Jing Cao is an associate professor at school of economics and management of Tsinghua University, a research fellow at the Center for China in the World Economy and the National Institute of Fiscal Studies, Tsinghua University, an affiliated researcher at the Harvard China Project, and a nonresident fellow at CGD. The views are the authors’ and should not be attributed to the institutions with which they are affiliated. Comments are welcome and should be sent to [LawrenceMacDonald@gmail.com](mailto:LawrenceMacDonald@gmail.com).

[1] Ulrich Cubasch, Donald Wuebbles, Deliang Chen, Maria Cristina Facchini, David Frame, Natalie Mahowald, and Jan-Gunnar Winther, introduction to *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley (Cambridge, UK, and New York: Cambridge University Press, 2013), [http://www.climatechange2013.org/images/report/WG1AR5\\_Chapter01\\_FINAL.pdf](http://www.climatechange2013.org/images/report/WG1AR5_Chapter01_FINAL.pdf).

[2] Climate policy historians disagree on the relative importance of international negotiations and national politics in driving more sensible policies. Whereas some argue that the very idea of negotiations delayed national actions, others note that the talks sometimes served as a catalyst, as major emitter nations pushed to overcome domestic policy obstacles in order to put forward credible commitments at the annual negotiations. These modest steps in turn may have helped open the way for more ambitious policy responses. One example of that is the 2014 US Environmental Protection Agency effort to regulate emissions from power plants described later in this essay.

<sup>3</sup> Ian W H Parry, Dirk Heine, Eliza Lis, and Shanjun Li, *Getting Energy Prices Right: From Principle to Practice*, 2014, International Monetary Fund, <http://www.imfbookstore.org/ProdDetails.asp?ID=GEPRPPEA>

[4] Wikipedia, s.v. “Pigovian tax,” last modified July 21, 2014, [http://en.wikipedia.org/w/index.php?title=Pigovian\\_tax&oldid=617910295](http://en.wikipedia.org/w/index.php?title=Pigovian_tax&oldid=617910295).

[5] Stephen Castle, “Europe, Facing Economic Pain, May Ease Climate Rules,” *The New York Times*, Jan. 22, 2014, <http://www.nytimes.com/2014/01/23/business/international/european-union-lowers-ambitions-on-renewable-energy.html?hp&r=1>

[6] Properly designed and implemented, taxes and auction-based tradable permits offer similar economic incentives. In practice, however, taxes have proven to have political advantages because of their greater transparency, as we describe below.

[7] Ben Goldsmith, “A Green Industrial Revolution,” *Forbes*, May 29, 2013, [www.forbes.com/sites/bengoldsmith/2013/05/29/a\\_green\\_industrial\\_revolution/](http://www.forbes.com/sites/bengoldsmith/2013/05/29/a_green_industrial_revolution/).

[8] Wikipedia, s.v. “Resource curse,” last modified August 31, 2014, [http://en.wikipedia.org/wiki/Resource\\_curse](http://en.wikipedia.org/wiki/Resource_curse).

[9] Some high-cost producers managed for a while to continue to export oil and gas by selling into smaller markets that had yet to put a price on emissions, but as global demand for fossil fuels declined prices in these markets also fell.



[10] “U.S.–China Joint Statement on Climate Change,” Beijing, February 15, 2014, <http://en.ccchina.gov.cn/Detail.aspx?newsId=42977&TId=98>.

[11] Todd D. Stern, “The Shape of a New International Climate Agreement,” remarks at Chatham House, London, October 22, 2013, U.S. Department of State, <http://www.state.gov/e/oes/rls/remarks/2013/215720.htm>.

[12] Wikipedia, s.v. “2011 United Nations Climate Change Conference,” last modified July 15, 2014, [http://en.wikipedia.org/wiki/2011\\_United\\_Nations\\_Climate\\_Change\\_Conference](http://en.wikipedia.org/wiki/2011_United_Nations_Climate_Change_Conference)

[13] Pew Research Center for People & the Press, “GOP Deeply Divided Over Climate Change,” released study, Nov. 1, 2013, <http://www.people-press.org/2013/11/01/gop-deeply-divided-over-climate-change/>

[14] Elizabeth Kolbert, *The New Yorker*, December 10, 2012, <http://www.newyorker.com/magazine/2012/12/10/paying-for-it>.

[15] [R Street Institute home page](http://www.rstreet.org/), <http://www.rstreet.org/>.

[16] Although R Street’s political orientation was crucial in winning conservative attention and support, the idea of revenue-neutral carbon taxes was not new. In June 2007, Gilbert Metcalf proposed a “[green employment tax swap](#)” in which a tax of \$15 per metric ton of CO<sub>2</sub> would be used to rebate the federal payroll tax on the first \$3,660 of earnings per worker. Gilbert E. Metcalf, “A Green Employment Tax Swap: Using a Carbon Tax to Finance Payroll Tax Relief” (policy brief, Brookings Institution / World Resources Institute, 2007), [http://pdf.wri.org/Brookings-WRI\\_GreenTaxSwap.pdf](http://pdf.wri.org/Brookings-WRI_GreenTaxSwap.pdf). In June 2009, Metcalf and David Weisbach published “[Design of a Carbon Tax](#),” in which they showed that “a well-designed carbon tax can capture about 80% of U.S. emissions by taxing fewer than 3,000 taxpayers and up to almost 90% with a modest additional cost.” The authors recommended that “adjustments should be made to the income tax to ensure that a carbon tax is revenue neutral and distributionally neutral,” and they proposed “an origin-based system for trade with countries that have an adequate carbon tax and a system of border taxes for imports from countries without a carbon tax.” The paper became a touchstone for subsequent legislation. Gilbert E. Metcalf and David A. Weisbach, “Design of a Carbon Tax” (Olin Working Paper 447, University of Chicago Law and Economics, 2009), [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1324854](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1324854).

[17] Some thinkers on the right opposed such transfers as a further government intrusion into citizens’ private lives and a possible source of dependency. By their reading, to be “revenue neutral” required that all revenue from carbon taxes would be recycled through cuts in other taxes.

[18] Center for Global Development, “Climate Conference – Session III: Policy Reform: Reducing Costs, Ensuring Effective Use of Resources,” October 9, 2013, speech, “<http://www.youtube.com/watch?v=vizqvQK5-cQ>

[19] An alternative revenue-neutral approach put forward by CGD research associate Kevin Ummel in a 2014 paper proposed rebating pollution fee revenue directly to households using a formula that provided the largest transfers to the coal-dependent southern and midwestern states. The proposal had many supporters, especially on the left, but it alienated conservatives who saw it as an extension of government power, and it lacked support from the business community.

[20] “Climate Protection Act, S.332,” *Citizens Climate Lobby*, April 6, 2013, <http://citizensclimatelobby.org/climate-protection-act-s-332/>

[21] Regional Economic Models Inc, “Environmental Tax Reform in California: Economic and Climate Impact of a Carbon Tax Swap,” *Citizens Climate Lobby*, March 3, 2014, <http://citizensclimatelobby.org/wp-content/uploads/2014/03/REMI-CA-Carbon-Tax.pdf>

[22] “Frequently Asked Questions,” Alaska Permanent Fund Corporation, accessed September 16, 2014, <http://www.apfc.org/home/Content/aboutFund/fundFAQ.cfm>.

[23] “[BC’s Carbon Tax Shift after Five Years: An Environmental \(and Economic\) Success Story](#),” Sustainable Prosperity, July 24, 2013, <http://www.sustainableprosperity.ca/article3685>.

[24] Andrew Nikiforuk, “[Oh, Canada: How America’s Friendly Northern Neighbor Became a Rogue, Reckless Petrostate](#),” *Foreign Policy*, July 2013, [http://www.foreignpolicy.com/articles/2013/06/24/oh\\_canada#sthash.VDGPoO0y.dpuf](http://www.foreignpolicy.com/articles/2013/06/24/oh_canada#sthash.VDGPoO0y.dpuf).

[25] Obama approved the pipeline in his second term as part of an ill-fated effort to win Republican acquiescence to a range of strengthened environmental regulations, prompting an upsurge in climate-related civil disobedience that delayed completion of the pipeline until 2020. The pipeline was abandoned in 2025 following a series of spills as high and rising carbon pollution fees in the United States and much of Latin America made the Alberta tar sands oil uneconomical.

[26] Canada’s international standing fell further in December 2013 when foreign minister John Baird announced shortly before Christmas that Canada intended to lay claim to the North Pole, the mythical home of Santa Claus, as part of a bid to assert control over a large part of the resource-rich Arctic. David Ljunggren, Reuters, “Canada Risks Tensions with Russia by Claiming Ownership of the North Pole,” NBC News, <http://www.nbcnews.com/news/world/canada-risks-tensions-russia-claiming-ownership-north-pole-v21845764>.

[27] Alan Durning and Yoram Bauman, “All You Need to Know about BC’s Carbon Tax Shift in Five Charts,” *Sightline Daily*, March 11, 2014, <http://daily.sightline.org/2014/03/11/all-you-need-to-know-about-bcs-carbon-tax-shift-in-five-charts/>.

[28] “Low Income Climate Action Tax Credit,” British Columbia, accessed September 16, 2014, <http://www2.gov.bc.ca/gov/topic.page?id=E9258ADE1AE3423080A1B2674F4EAABD>.

[29] Chris Mooney, “British Columbia Enacted the Most Significant Carbon Tax in the Western Hemisphere. What Happened Next Is It Worked,” *Mother Jones*, March 26, 2014, <http://www.motherjones.com/environment/2014/03/british-columbia-carbon-tax-sanity>.

[30] *Pacific Coast Action Plan on Climate and Energy*, October 28, 2013, <http://www.pacificcoastcollaborative.org/Documents/Pacific%20Coast%20Climate%20Action%20Plan.pdf>.

[31] Exec. Order 14-04, “Washington Carbon Pollution Reduction and Clean Energy Action,” State of Washington, Office of the Governor, April 29, 2014, <http://www.governor.wa.gov/office/execorders/documents/14-04.pdf>.

[32] Oregon governor John Kitzhaber said in mid-2014 that carbon pricing in the state was “inevitable” and that both the California approach and the British Columbia approach should be considered. Earlier a 2013 Portland State University study, [Carbon Tax and Shift: How to Make It Work for Oregon’s Economy](#) (<http://www.pdx.edu/nerc/carbontax2013.pdf>), made the case for carbon taxes and a bill was introduced in the state legislature mandating a state study of the British Columbia approach.

[33] California was not alone. Rumors of emissions certificate fraud had long troubled the reputation of the EU ETS as well. Will Bierbower, “A Brief History of Fraudulent Activity on the EU-ETS,” *Re-Volt* (blog), February 25, 2011, <http://blogs.worldwatch.org/revolt/a-brief-history-of-fraudulent-activity-on-the-eu-ets-2/>.

[34] One unanticipated development was the emergence of voluntary CERCs developed by private investors in Indonesia and Brazil working in collaboration with indigenous peoples and other forest steward communities.

- [35] RGGI Inc., “CO<sub>2</sub> Allowances Sold at \$4.00 at 23rd RGGI Auction,” news release, March 7, 2014, [http://www.rggi.org/docs/Auctions/23/PR030714\\_Auction23.pdf](http://www.rggi.org/docs/Auctions/23/PR030714_Auction23.pdf).
- [36] Environmental Protection Agency, “Carbon Pollution Standards, Clean Power Plan Proposed Rule,” June 2, 2014, <http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule>
- [37] Wikipedia, s.v. *Massachusetts v. Environmental Protection Agency*, last modified June 25, 2014, [http://en.wikipedia.org/wiki/Massachusetts\\_v.\\_Environmental\\_Protection\\_Agency](http://en.wikipedia.org/wiki/Massachusetts_v._Environmental_Protection_Agency).
- [38] Natural Resources Defense Council, *NRDC Summary of EPA’s Clean Power Plan*, June 2, 2014, <http://www.nrdc.org/air/pollution-standards/files/pollution-standards-epa-plan-summary.pdf>.
- [39] Center for Deliberative Democracy, <http://cdd.stanford.edu/>.
- [40] For more on how Deliberative Polling can help drive sensible climate policy, see Lawrence MacDonald, “[Deliberative Polling as a Catalyst for Action on Climate Change](#),” Center for Global Development, August 21, 2014, <http://www.cgdev.org/publication/deliberative-polling-catalyst-action-climate-change>.
- [41] World Resources Institute, <http://www.wri.org/>.
- [42] MacNeil/Lehrer Productions, <http://www.macneil-lehrer.com/about-us/>.
- [43] Wikipedia, s.v. “Jon Huntsman, Jr.,” last modified September 13, 2014, [http://en.wikipedia.org/wiki/Jon\\_Huntsman,\\_Jr](http://en.wikipedia.org/wiki/Jon_Huntsman,_Jr).
- [44] Aaron Blake, “Jon Huntsman Believes in Evolution and Global Warming, So Can He Win a Republican Primary?” *Washington Post*, August 18, 2011, [http://www.washingtonpost.com/blogs/the-fix/post/jon-huntsman-believes-in-evolution-and-global-warming-but-can-he-win-a-republican-primary/2011/08/18/gIQAlYuBOJ\\_blog.html](http://www.washingtonpost.com/blogs/the-fix/post/jon-huntsman-believes-in-evolution-and-global-warming-but-can-he-win-a-republican-primary/2011/08/18/gIQAlYuBOJ_blog.html).
- [45] Glenn Kessler, “Rick Perry’s Made-Up ‘Facts’ about Climate Change,” *Washington Post*, August 18, 2011, [http://www.washingtonpost.com/blogs/fact-checker/post/rick-perrys-made-up-facts-about-climate-change/2011/08/17/gIQApVF5LJ\\_blog.html](http://www.washingtonpost.com/blogs/fact-checker/post/rick-perrys-made-up-facts-about-climate-change/2011/08/17/gIQApVF5LJ_blog.html).
- [46] Elyse Siegel, “Mitt Romney Pressed on Climate Change: ‘Do You Still Think the Rising of the Seas Is Funny?’” *Huffington Post*, November 2, 2012, [http://www.huffingtonpost.com/2012/11/02/mitt-romney-climate-change\\_n\\_2068608.html](http://www.huffingtonpost.com/2012/11/02/mitt-romney-climate-change_n_2068608.html).
- [47] In February 2013, Senator Bernie Sanders (I, Vermont), joined by Senator Barbara Boxer (D, Calif.), had introduced a proposed [Climate Protection Act](#) (<https://www.govtrack.us/congress/bills/113/s332#overview>, accessed September 18, 2014) that included provision for using three-fifths of the revenue resulting from a carbon tax for a Family Clean Energy Rebate Program with a monthly payment to every legal US resident. The bill was given just a 6 percent chance of passage.
- [48] “China Releases Third Plenum Communiqué,” *China Briefing*, November 15, 2013, <http://www.china-briefing.com/news/2013/11/15/china-releases-third-plenum-communicue.html>.
- [49] Mu Xuequan, “China reaffirms resolve to fight climate change,” *Xinhuanet*, Sept. 24, 2014, [http://news.xinhuanet.com/english/china/2014-09/24/c\\_127024444.htm](http://news.xinhuanet.com/english/china/2014-09/24/c_127024444.htm)
- [50] Environomist Ltd., *Environomist China Carbon Market Research Report 2014* (Beijing: Environomist Ltd., 2014), [http://www.southpolecarbon.com/public/140227\\_Environomist\\_China-ETS\\_ResearchReport.pdf](http://www.southpolecarbon.com/public/140227_Environomist_China-ETS_ResearchReport.pdf).
- [51] Kathy Chen and Stian Reklef, “China’s National Carbon Market to Start in 2016—Official,” Reuters, August 31, 2014, <http://www.reuters.com/article/2014/08/31/china-carbontrading-idUSL3NOR107420140831>.
- [52] Xinhuanet, “China Approves Plan to Combat Climate Change,” Sept. 19, 2014, [http://news.xinhuanet.com/english/china/2014-09/19/c\\_133656618.htm](http://news.xinhuanet.com/english/china/2014-09/19/c_133656618.htm)

- [53] Zhu Chen, Jin-Nan Wang, Guo-Xia Ma, and Yan-Shen Zhang, "China Tackles the Health Effects of Air Pollution," *Lancet* 382, no. 9909 (2013): 1959, <http://www.thelancet.com/journals/lancet/issue/vol382no9908/PIIS0140-6736%2813%29X6061-1>.
- [54] Edward Wong, "Air Pollution Linked to 2.1 Million Premature Deaths in China," *The New York Times*, April 1, 2013, [http://www.nytimes.com/2013/04/02/world/asia/air-pollution-linked-to-1-2-million-deaths-in-china.html?\\_r=0](http://www.nytimes.com/2013/04/02/world/asia/air-pollution-linked-to-1-2-million-deaths-in-china.html?_r=0)
- [55] Yuyu Chen, Avraham Ebenstein, Michael Greenstone, and Hongbin Li, "Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy," *Proceedings of the National Academy of Sciences* 110, no 32 (2013): 12936–12941, <http://www.pnas.org/content/110/32/12936.abstract>.
- [56] Jonathan Kaiman, "Chinese Struggle through 'Airpocalypse' Smog," *The Observer*, February 16, 2013, <http://www.theguardian.com/world/2013/feb/16/chinese-struggle-through-airpocalypse-smog>.
- [57] Chris P. Nielsen and Mun S. Ho, *Clearer Skies over China: Reconciling Air Quality, Climate, and Economic Goals*, Massachusetts Institute of Technology Press, 2013, <http://mitpress.mit.edu/books/clearer-skies-over-china>.
- [58] Jing Cao, a co-author of this essay, was a co-author of the Harvard/Tsinghua study.
- [59] Ian Johnson, "In China, 'Once the Villages Are Gone, the Culture Is Gone,'" *New York Times*, February 1, 2014, <http://www.nytimes.com/2014/02/02/world/asia/once-the-villages-are-gone-the-culture-is-gone.html>.
- [60] Ian Johnson, "China's Great Uprooting: Moving 250 Million into Cities," *New York Times*, June 15, 2013, <http://www.nytimes.com/2013/06/16/world/asia/chinas-great-uprooting-moving-250-million-into-cities.html?pagewanted=all>.
- [61] Bento, Antonio, Mark Jacobsen and Antung Anthony Liu, "Environmental Policy in the Presence of an Informal Sector," Environment for Development (EfD), discussion paper, November 2013, <http://www.efdinitiative.org/publications/environmental-policy-presence-informal-sector>
- [62] Lawrence MacDonald, "IMF Chief Warns of Triple Crisis—Economic, Environment, Social—Details IMF Actions to Help on Climate," *Global Development: View from the Center* (blog), June 12, 2012, <http://www.cgdev.org/blog/imf-chief-warns-triple-crisis%E2%80%94economic-environment-social%E2%80%94details-imf-actions-help-climate>.
- [63] International Monetary Fund, "Energy Subsidy Reform: Lessons and Implications," policy paper, January 2013, <http://www.imf.org/external/np/pp/eng/2013/012813.pdf>
- [64] Laurie T. Johnson and Chris Hope, "The Social Cost of Carbon in U.S. Regulatory Impact Analyses: An Introduction and Critique," *Journal of Environmental Studies and Sciences* 2, no. 3 (2012) 205–221, <http://link.springer.com/article/10.1007%2Fs13412-012-0087-7>.
- [65] Ian W. H. Parry, Dirk Heine, Eliza Lis, and Shanjun Li, *Getting Energy Prices Right: From Principle to Practice* (International Monetary Fund, 2014).
- [66] World Bank, *Turn Down the Heat: Why a 4°C Warmer World Must Be Avoided* (Washington, DC: World Bank, 2012), <http://documents.worldbank.org/curated/en/2012/11/17097815/turn-down-heat-4%C2%B0c-warmer-world-must-avoided>.
- [67] World Bank, "New Report Examines Risks of 4 Degree Hotter World by End of Century," press release, November 18, 2012, <http://www.worldbank.org/en/news/press-release/2012/11/18/new-report-examines-risks-of-degree-hotter-world-by-end-of-century>.
- [68] Craig Hansen and James R. Hendricks Jr., *Taxing Carbon to Finance Tax Reform* (Washington, DC: World Resources Institute, 2006), <http://www.wri.org/publication/taxing-carbon-finance-tax-reform>.

[69] “Considering a Carbon Tax: Frequently Asked Questions,” Center for Climate and Electricity Policy, accessed September 18, 2014,

[http://www.rff.org/centers/climate\\_and\\_electricity\\_policy/Pages/Carbon\\_Tax\\_FAQs.aspx](http://www.rff.org/centers/climate_and_electricity_policy/Pages/Carbon_Tax_FAQs.aspx).

[70] Other US groups pushing for a carbon tax included the [Carbon Tax Center](http://www.carbontax.org/) (<http://www.carbontax.org/>).

[71] Such processes are not science fiction. The California-based firm [Calerea](http://calera.com/site/beneficial-reuse-of-co2/process.html) (<http://calera.com/site/beneficial-reuse-of-co2/process.html>) is one example of efforts to commercialize such approaches. With a high and rising carbon pollution fee in place, many such emerging technologies would become commercially viable, attracting increased investment due to stronger demand and driving down prices through learning and economies of scale.

[72] Frances Seymour, “A Big Deal for Tropical Forests,” *Global Development: Views from the Center* (blog), December 16, 2013, <http://www.cgdev.org/blog/big-deal-tropical-forests>.

[73] “Bonn Challenge,” World Resources Institute, Forest and Landscape Restoration, accessed September 18, 2014, <http://www.wri.org/our-work/project/forest-and-landscape-restoration/bonn-challenge>.

[74] “Fortune 500 2013,” *Fortune.com*, <http://fortune.com/fortune500/2013/>.

[75] “Fossil Fuel Funding to Congress: Industry Influence in the U.S.,” Oil Change International, accessed September 18, 2014, <http://priceofoil.org/fossil-fuel-industry-influence-in-the-u-s/>.

[76] Roger Cox’s *Revolution Justified* (Planet Prosperity Foundation, 2012, <http://www.amazon.com/Revolution-Justified-Roger-H-J-Cox/dp/9081797514>), advocated a central role for the judiciary in responding to the climate change threat and the outsize role of fossil fuel money in preventing appropriate policy responses. It became a standard reference for a generation of judges, litigators, and legal scholars in the burgeoning climate law movement.

[77] Sabin Center for Climate Change Law, <http://web.law.columbia.edu/climate-change/about-center>.

[78] Robert J. Brulle, “Institutionalizing Delay: Foundation Funding and the Creation of U.S. Climate Change Counter-Movement Organizations,” *Climatic Change* 122, no. 4 (2014): 681–694, <http://www.drexel.edu/~media/Files/now/pdfs/Institutionalizing%20Delay%20-%20Climatic%20Change.ashx>.

[79] Ibid

[80] Ibid.

[81] Coral Davenport, “Large Companies Prepared to Pay Price on Carbon,” *New York Times*, December 5, 2013, [http://www.nytimes.com/2013/12/05/business/energy-environment/large-companies-prepared-to-pay-price-on-carbon.html?\\_r=0](http://www.nytimes.com/2013/12/05/business/energy-environment/large-companies-prepared-to-pay-price-on-carbon.html?_r=0).