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A US Strategy for Sustainable Energy Security

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Foreword by Chuck Hagel

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Atlantic Council Strategy Papers
Editorial Board

Table of Contents

Foreword

Energy and the environment are not mutually exclusive. They are interconnected. They both are critical for economic development, productivity and higher standards of living for all people. A changing climate results in more extreme weather events causing damage at home, while intensifying global instability, hunger, poverty, and conflict across the globe. I announced the Pentagon's Climate Change Adaptation Roadmap in 2013. It noted that climate change represents a threat to the national security of the United States, and acts as a threat multiplier for our nation because it has the potential to exacerbate many of the challenges we are dealing with today—from pandemic diseases to terrorism.

In the political debates running up to our 2016 elections, there is a need for an inclusive, informed, and ideology-free national debate about our future policies to address the energy-climate challenge.

In the Atlantic Council's Strategy Paper series sponsored by the Brent Scowcroft Center on International Security, David Koranyi, Director of the Council's Eurasian Energy Futures Initiative, drafted a thought-provoking paper on an ambitious and sustainable US energy strategy that addresses climate change. The author analyzes current trends and threats, and argues for the benefits of a low-carbon transition. He outlines the strategic, national security, and economic rationales, while recognizing the political, economic, technological and regulatory difficulties and complications. He concludes that the United States is well positioned to modernize its energy sector and counter anthropogenic climate change without compromising its energy security, economic development, or lifestyle.

While you or I may disagree with some of the paper's proposals, I believe it will contribute to a more informed national dialogue, and its ideas will help shape the design for bold and bipartisan future policy action.

24th United States Secretary of Defense Chuck Hagel
Distinguished Statesman and International Advisory Board Member
Atlantic Council

Executive Summary

"Men argue. Nature acts." Voltaire

The national energy system of the United States is aging and has to be renewed in a dynamic fashion to adapt to the transformative changes in the world of energy. Failure to do so will result in substantial economic disadvantage and national security vulnerabilities, and risk the United States' position as the leading global power in the twenty-first century. The need for modernization represents a unique opportunity to upgrade the United States to a cutting edge system of energy hardware and software.

Moreover, climate change is a severe threat to the United States and an existential one to much of the rest of humanity. Climate change represents an ever growing, direct risk to the American people as extreme weather events wreak havoc, rising sea levels engulf coastal cities, and natural beauties and wildlife habitats degrade. The impact of climate change on other countries' economic, political, and security postures will have major repercussions on US national security and economic prosperity. The United States cannot isolate itself from political and social instability, mass migration, conflict over resources, poverty, and health epidemics that excessive climate change would induce and future generations will have to endure. Taking resolute action to reduce greenhouse gas emissions is a form of 'insurance' against the most severe and irreversible potential consequences of climate change. The longer action is postponed, the greater the risks and the higher the costs would be.

In today's interconnected world, responding to the growing energy needs of the developing world amidst a changing climate is critical to the United States' national security and economic prosperity. Mankind has within its grasp the wherewithal to engineer a global energy revolution. The international community took an important step towards action in Paris in December 2015. Yet the task at hand—the transformation of the entire energy value chain across the globe—is colossal, and will require political will, technological ingenuity, business acumen, and international cooperation on a whole new level.

Critical to preventing the most catastrophic consequences of climate change, as well as securing the United States' economic and environmental security and prosperity in the future is the transformation of the US energy sector, the single largest emitter of greenhouse gases today. Though the task at hand represents a formidable challenge, the United States can revolutionize its energy sector without compromising its energy security and economic

development, without a major change in consumption patterns and lifestyles. The benefits of such a transition from a strategic, national security and economic perspective vastly outweigh the short-term costs. A United States that uses cutting edge energy technologies to fuel its economy in cleaner and safer ways is a benefit to current and future generations.

American geopolitical, economic, and technological leadership also predisposes the United States to lead and benefit from the energy sector transformation abroad. The global transition to a lower carbon economy plays directly to the comparative advantages of the United States: individual empowerment, innovation, and engineering ingenuity. A world that manages to limit global warming below 1.5 degrees Celsius will be incomparably more peaceful and stable, where it will be easier to promote stability, the prevalence of universal liberal values, and achieve American strategic objectives. Conversely, failure to lead on the global energy transformation and falling behind on climate action will undermine the moral leadership of the United States in the world.

The strategy outlined in this paper offers the United States a pathway to become a global leader in both. It does so by building on the experience and mistakes of pioneers in energy transitions, as well as its own early successes, and putting a strong emphasis on transparent market friendly measures.

The strategy focuses on accelerating the modernization of its energy sector to fuel a robust economic growth, increase the efficiency of the economy and existing energy value chains while reducing emissions, and prevent the catastrophic consequences of climate change, building upon the progress made in the last decade. It would also maintain and enhance the United States' edge in the energy domain; boost the competitiveness of the economy; facilitate the provision of sustainable energy globally; ensure the energy security of key allies in Europe and Asia; prevent rivals and adversaries from using energy resources as a weapon; and reduce the volatility of global energy markets to strengthen global growth.

The three-pillar strategy's first pillar builds upon the United States' unparalleled richness in both human and natural potential. It leverages the United States' abundance of resources to address climate change in a resolute manner without delay by putting the right domestic policies in place. At the center of this pillar is the accelerated decarbonization of the US economy, based primarily on a well-calibrated and progressively increasing carbon fee.

A carbon fee—covering all sectors, not just power generation as the controversial Clean Power Plan—would have several major advantages. It would further boost the competitiveness of cleaner-burning natural gas vis-à-vis coal in the short term. It could propel the upgrade and modernization of fossil fuel generation capacities to cut emissions during the transition, boost the competitiveness of carbon capture and storage techniques to provide a long term future for gas, and propel energy efficiency investments across the whole value chain. It would go

a long way in helping to revive the commerciality of nuclear power to provide essential zero-carbon baseload generation capacity to address seasonal intermittency issues that are likely to prevail in the long term. It could boost the United States' innovative capabilities to maintain a competitive edge in the energy sphere by increasing research and development and early deployment funding.

Revenues from the carbon fee could be used to fund six major purposes:

1. Provide effective assistance to those whose livelihood is disrupted by the energy transition through early retirement schemes, education, and job training programs;
2. Provide targeted subsidies to those struggling to pay their energy bills;
3. Boost public funding for energy technology research and development (R&D), and early deployment;
4. Boost energy efficiency across the whole of the US economy;
5. Renew the crumbling transportation infrastructure of the United States, with special regard to urban mass transportation systems, intercity high speed rail networks, and investment into bridging gaps left by the private sector in an emerging national infrastructure catering to electric vehicles; and
6. Offset the potential decrease of corporate tax revenues in the context of a comprehensive US tax reform that reduces the corporate tax rate.

The second pillar ensures that the United States leads on global climate action and addresses the energy insecurity of key allies. Sustained US leadership is essential to uphold and bolster an international consensus and action on climate change post-Paris COP21, and to prevent countries from turning back. Excessive dependence on external energy supplies from a single source may endanger the ability of US allies to conduct an independent foreign policy that is both in their national and in the allied interest. Therefore, the United States must strive to do everything in its capacity to assist allies and partners in the quest to improve their energy security. The United States should also work with key allies and international institutions to deal with the instability associated with the transformation of the energy sector and its impact on major traditional producers.

The third pillar pushes for energy liberalization to enable better functioning domestic and global markets and aims to build a functioning international energy governance system. The United States should work toward a global web of networks, alliances, and instruments to promote transparent and efficient energy markets and effective climate action.

This strategy may seem ambitious in light of the political realities in the United States today. Yet, as support for climate action and energy sector modernization in the American electorate grows, and associated costs of action shrink at the back of economies of scale and technological development, there is an emerging political space that allows for bold, bipartisan policies. This paper seeks to inform the debate in the 2016 election season and the legislative and executive action beyond.

Introduction

Access to energy and its efficient and sustainable use continue to underpin any state's ability to provide for its citizens' security and economic wellbeing.[1] Energy is a defining element of national sovereignty and national power. Since the dawn of humanity, ways to multiply human strength to grow food, build shelter against harsh weather, and produce weapons to defend themselves have been a defining element of the human endeavor.

Revolutions in energy generation have driven transformational shifts in human history: the prehistoric use of thermal energy in the form of fire; the domestication of animals to leverage their muscle power in agriculture and warfare alike; the use of steam power during the first industrial revolution; and the unleashing of the potential of the atom in the twentieth century. The construction of watermills contributed to the predominance of Ancient Greece and later the Roman Empire. The most effective use of wind power in sailing ships defined naval superiority for millennia. Access to coal resources and the technology to convert them into steam power catapulted Great Britain into building a global empire. The rise of oil as the main fuel for transportation elevated the importance of previously peripheral regions, such as the Middle East. The mastery of nuclear fission cemented the superpower status of the United States in the wake of the Second World War.

Change in the world of energy traditionally came at a glacial speed. It took humanity thousands of years to pivot away from the use of thermal energy in the form of a simple fire as the primary source of power and heating. Wood and hydropower in the form of watermills were the preeminent forms of energy until the eighteenth century, and wind power remained the primary method to propel ships until well into the nineteenth century. Coal has maintained its centrality in power generation for more than two centuries now, as did oil in transport since the early twentieth century.

The scale of the energy challenge for a planet with a population approaching 10 billion by 2050 is daunting. Vast investments are needed to replace the aging energy infrastructure or create it from scratch, particularly in many developing countries.[2] Energy production capacities need to be deployed to provide energy to hitherto unelectrified billions.[3]

In addition to the scale of change, what further differentiates the current energy transition is the time pressure imposed by climate change. Expansion of the human footprint on Earth and exponentially growing energy usage have compounded mounting environmental concerns.

Until half a century ago, these concerns remained predominantly local and isolated. But with the advent of man-made climate change, humanity faces a challenge on a planetary scale. Therefore, the next big transition to a low-carbon energy system has to happen in a short period of time in comparison with previous paradigm shifts. Humanity does not have the luxury of its forefathers to witness the unfolding of the new energy revolution for centuries or even decades.

The paper seeks to inform current and future policymakers by outlining the major long-term challenges and shifts in global energy and climate dynamics, assessing the most critical trends affecting US energy and climate security strategy, and drawing conclusions for the United States to operate strategically in this new world. The paper endeavors to outline the main elements of a comprehensive US energy strategy to promote immediate and resolute political action that would result in well-targeted and effective government policies. It does not aim to provide detailed policies, but rather the blueprint for a strategy on energy sector reform that takes into account the imperative to act against climate change and addresses the transition to a twenty-first century energy economy. Providing a comprehensive strategy on climate action that involves other key sectors and actors is out of its scope.

The Need for a US Sustainable Energy Strategy

The United States is in a unique position to lead a global climate and energy revolution that may amount to one of the single most important human accomplishments in the twenty-first century. As the world's largest producer of hydrocarbons, the second largest consumer of energy, and the second largest emitter of greenhouse gas emissions, the United States is an essential component in any global climate and energy scenario.[4] The United States as the only global superpower can benefit the most from a clean energy revolution, resulting in a dynamically developing world with reduced risk of climate wars, mass migration, extreme weather, sinking coastal cities, and the premature deaths of millions exposed to severe pollution. This is a world in which the United States and its citizens are the safest, where American business, innovation, and technology thrives, and where its allies and partners are the most secure.

It is important to recognize that the American electorate is concerned about the costs of the transition to a low-carbon energy system, preoccupied with potential job losses and energy price hikes, and demands greater energy self-sufficiency. Any US energy strategy must address those concerns. This paper, building on a large body of research, finds that the transition to a cleaner energy future is achievable at a relatively low cost, would create more jobs than it would destroy, and would boost the energy independence of the United States over the long term.

Ten Key Trends Affecting US Energy Security

1. *A Slow Global Climate Awakening*

The scientific community has been sounding the alarm with increasing urgency since the 1970s: too much carbon is being transferred from the Earth's crust to the atmosphere and the oceans, beginning to exhaust their absorption capacity. Yet the global public as a whole, and the American electorate in particular, have only begun to accept the harsh implications of climate change, its root causes, and potentially catastrophic outcomes.

Man-made climate change is not only a challenge to humanity, but it is also a critical national security threat to the United States. This threat is neither distant nor abstract, but—in the words of US Secretary of Energy Ernest Moniz—"real and urgent."[5] 2015 and 2014 were respectively the hottest and second hottest year on record globally. According to the White House, "climate and weather disasters in 2012 alone cost the American economy more than $100 billion."[6] The 2014 US Defense Strategy identifies climate change as a "threat multiplier," because it has the potential to exacerbate many contemporary challenges, from infectious disease to terrorism.[7] Vulnerable societal groups are most exposed to a range of climate-related negative effects, including heat stress, air pollution, extreme weather events, and diseases. There is an increased frequency and intensity of extreme weather events, such as hurricanes on the East Coast, severe droughts in California, tornadoes in Texas and Mississippi, and heavy rains in Georgia and South Carolina. Major coastal cities, such as Miami, New York, Boston, New Orleans, or Los Angeles are exposed to the rising sea levels. The United States Army Corps of Engineers predicts that sea levels could rise by as much as five feet, while the National Oceanic and Atmospheric Administration predicts up to six and a half feet by the end of this century.[8]

The past ten years have witnessed an emerging global accord around the necessity to address climate change in a much more urgent and robust fashion. Yet, while there is finally an agreement on the diagnosis, preserving the climate requires action by all actors in a coordinated manner and remains challenging and complex in practice.

The negotiations in the framework of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) have gathered pace since COP15 in Copenhagen in 2009. The COP21 meeting in Paris in December 2015 delivered critically important commitments through the Intended Nationally Determined Contributions (INDC) process. Over 150 countries, representing 90 percent of both global gross domestic product (GDP) and greenhouse gas (GHG) emissions, chose to submit intended nationally determined contributions (INDCs). INDCs, if fully implemented can potentially cause energy-related GHG emissions to plateau or decline by 2030 in countries representing half of global economic activity.[9] The Paris Agreement reached at COP21 introduced a five-year review mechanism of the INDCs, compelling every nation to assess its progress towards meeting its climate

US Secretary of State John Kerry addresses COP21. *Photo credit: Arnaud Bouissou/MEDDE/SG COP21*

commitments and submit new plans to strengthen their compliance with the 1.5 degrees Celsius target. The next review will thus occur in 2020.

The Paris Agreement was a major diplomatic victory for the United States. Sustained US engagement with and pressure on key global stakeholders such as China and India paved the way to reach global consensus. If implemented in full—an admittedly ambitious expectation—the agreement will result in an average global temperature increase of around 2.7 degrees Celsius by 2100.[10] This is a much better base for further ambitious action and represents significant progress compared to the previous 4-5 degrees Celsius trajectory. Yet it falls way short of the agreed goal to keep the annual temperature rise "well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels."[11] Despite its achievements, the agreement risks creating a false sense of security and the impression that climate change has been dealt with.

The first challenge for US energy policy, therefore, is to preserve and expand the global consensus on climate action, and cultivate more ambitious, efficient, flexible, and transparent action on a global scale beyond 2020.

2. *From Scarcity to Abundance*

Parallel to the debate on climate action, the world is undergoing another paradigm shift with regard to the availability of energy resources. Scarcity used to be the key word that characterized energy discussions for decades: scarcity of fossil fuel resources, prognosis of 'peak oil,' and the difficulty and increasing costs associated with accessing these assets. This is no longer the case.

The ever-improving understanding of geology, coupled with revolutionary techniques to tap into previously inaccessible or uneconomic oil, gas, and coal resources, has changed thinking about fossil fuels. This does not mean that the world has endless supplies of hydrocarbons, but the 'expiration date' on hydrocarbon production and usage is significantly prolonged.

Meanwhile, the logic of renewable energy has always been that of abundance. There is an endless supply of fusion energy from the Sun that provides for both solar and wind energy (the latter due to uneven temperatures on the Earth's surface).[12] However, scarcity remains a major concern: the scarcity of existing infrastructure to turn these resources into usable forms of energy. There is a limited availability of public funding, and regulatory and market uncertainties hinder private investments. Another major issue is daily and seasonal intermittency and unpredictability.

The second challenge for US energy policy, therefore, is to create regulatory and investment frameworks that will help direct the necessary private and public financial resources to the expansion of low-carbon energy production capacities on a sufficient scale and in a timely

manner. This challenge comes in an age of relative abundance of hydrocarbons and absolute abundance of renewables, when the two are competing for financial resources, and the former—*ceteris paribus*—remains in most places cheaper to extract and more reliable to utilize, at least for now.

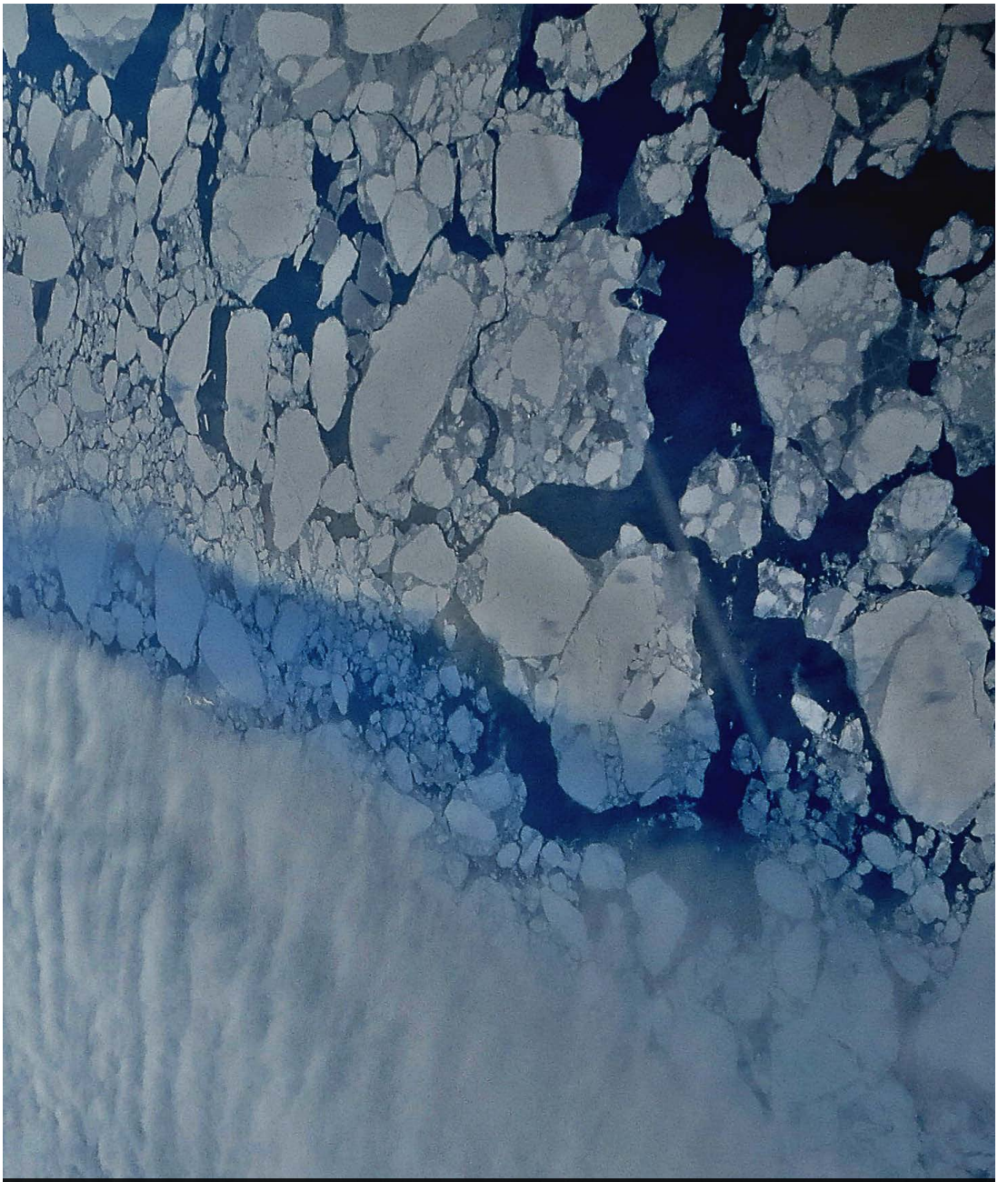
3. *Changing Production and Consumption Patterns on the Macro and Micro Levels*

Population growth and improvement, in living standards have led to an exponential increase in energy demand since the First Industrial Revolution. Until late in the second half of the twentieth century, most of the growth occurred in developed countries. Since then, the world has achieved unprecedented success in providing access to energy, and electricity in particular, to billions in Asia. Just as in the case of the economic weight, the center of gravity of energy usage is shifting: while energy demand has mostly stalled or is already in decline in Organisation for Economic Co-operation and Development (OECD) countries due to lower growth and higher energy efficiency, it has surged in much of the developing world, fundamentally altering the global energy picture.[13] In the coming decades, most energy demand growth will take place in Asia and Africa, where around 1.2 billion people still lack access to electricity, and an additional 2.5 billion people are 'underelectrified,' robbing them of economic growth opportunities and the very basics of human development.

Energy production patterns are undergoing a major transformation. As more players enter the market, the highly centralized universe of oil and gas producers is becoming increasingly diffuse. Coal consumption is rapidly declining in the developed world, while dynamically expanding in many of the emerging economies. Nuclear power, long a prerogative of the developed world, has become a developing world story, even before the Fukushima accident.

Meanwhile, the entire energy world is being upset by the rapid emergence of hitherto peripheral energy sources, which are fundamentally reshaping the global energy picture. Renewable resources, with special regard to solar and wind, are slowly moving from the margins of global energy production capacity to a more central position. Renewables still only provide 3 percent of global energy demand, but with rapidly declining costs, they are increasingly reaching parity with traditional forms of energy generation. Renewable capacity expansion is on an exponential curve. In 2014, renewables already accounted for more than 50 percent of net capacity additions in the global power sector. More solar capacity was installed since 2010 than the previous four decades together.[14] 2015 marked a new record when clean energy investment reached $329 billion.[15]

At the same time, an 'energy efficiency revolution' is gathering pace globally. Despite the increased needs of a growing and more affluent global population, energy consumption growth has begun to slow significantly.[16] Global energy intensity is on track to improve at a rate almost three times faster than the rate between 2000 and 2015.[17] Energy demand growth is predicted



Aerial photograph of Greenland glacier. *Photo credit: Wasif Malik/Flickr*

to further slow until 2050, with the potential of going into reserve even earlier. The slowing growth in primary energy consumption is expected to continue even in the faster growing economies in Asia. The level of energy usage is no longer one of the key benchmarks of development. Denmark and Sweden have among the highest human development indexes in the world, yet they consume less than half of the energy per capita of the United States.

This revolution is not without precedent. On the back of the oil embargo in the 1970s, many European economies and Japan witnessed a fairly rapid transition to a much lower energy and carbon consumption per unit of GDP.[18] Energy efficiency gains—though less impressive due to the differences in lifestyle—have been remarkable in the United States too: 50 percent more energy would be needed to produce current levels of GDP without energy efficiency gains since the 1973 oil shock.[19] Yet there is room for much more energy efficiency improvement across the developed and developing world, and in particular in the United States. Breaking and even reversing the correlation between economic development and energy usage is critical to increase efficiency and reduce emissions.

Despite the increased needs of a growing and more affluent global population, energy consumption growth has begun to slow significantly.

Moreover, energy production, transport, and consumption patterns are also changing on the micro level. The line between producers and consumers is an increasingly blurry one. In the world of renewables, distributed generation is becoming more widespread as power is generated at the point of consumption, often by the consumer (creating a new class of "prosumers").[20] On-site generation significantly reduces waste, but can also add to the complexity of the system and make the balancing of the electric grid a delicate challenge. Many companies are moving away from 'energy goods' and into providing 'energy services,' a fundamentally different business strategy and model (prime examples include German energy giants RWE and Eon, or French ENGIE).

The third challenge for US energy policy is to adjust to the changing global consumption and production picture on the macro and micro levels from a geopolitical, trade, market design, and regulatory perspective, and to improve the energy intensity of the US economy. That also represents a major adjustment challenge to US energy companies.

4. *A New Set of Energy Actors*

The fossil fuel era of energy production was traditionally dominated by national governments and large, centralized, public or private corporations that owned much of the energy sector and controlled the whole supply chain. The energy scene of today and tomorrow is becoming more complex, with a variety of new and increasingly influential actors.

The structure of and business models in the energy sector are undergoing rapid changes. The classical energy world consists of large-scale upstream and power generation operations, with a long-distance backbone transportation system. These operations, owned and run by vertically integrated national and international oil companies (NOCs and IOCs) and public and private utilities, have been ruptured by millions of insurgent smaller-scale shale gas and tight oil producers, as well as household solar panel users. Municipalities and citizens' cooperatives own large segments of the newly added renewable generation capacity. They also play a decisive role in the fight against climate change: pledges from cities and regions add up to almost half the national pledges in the UNFCCC framework. In addition, new corporate actors enter the fray to manage increasing data flows and provide a wide range of energy services, ranging from smart meter installation to insulation. Some traditional energy utilities have already transitioned into energy service companies.[21] IOCs struggle to access lower-cost upstream assets, which are overwhelmingly under NOC control, and have thus endeavored to partner with them. At the same time, many NOCs have started expanding internationally, muddling the lines between the two.

The structure of and business models in the energy sector are undergoing rapid changes.

A plethora of other actors have emerged to influence the energy sector on the political side: trans- and subnational actors, such as

- *international organizations (e.g., the United Nations [UN] and its various agencies, the International Energy Agency [IEA], the World Bank, the Energy Charter Treaty, the Organization of Petroleum Exporting Countries [OPEC], International Renewable Energy Agency [IRENA]);*
- *regional governments (e.g., Iraqi Kurdistan or Quebec);*
- *terrorist organizations (e.g., ISIS or the PKK); and*
- *non-governmental organizations (NGOs) (e.g., Greenpeace or the Clinton Climate Initiative).*

NGOs in particular have been driving the energy and climate discussions with unprecedented impact. Giants of the new economy, such as Google and Tesla, are spearheading technological change and experimenting with disruptive business models and smart solutions across the entire value chain. Activist investors, philanthropists, and even actors have a major impact on investment decisions and technological development.[22]

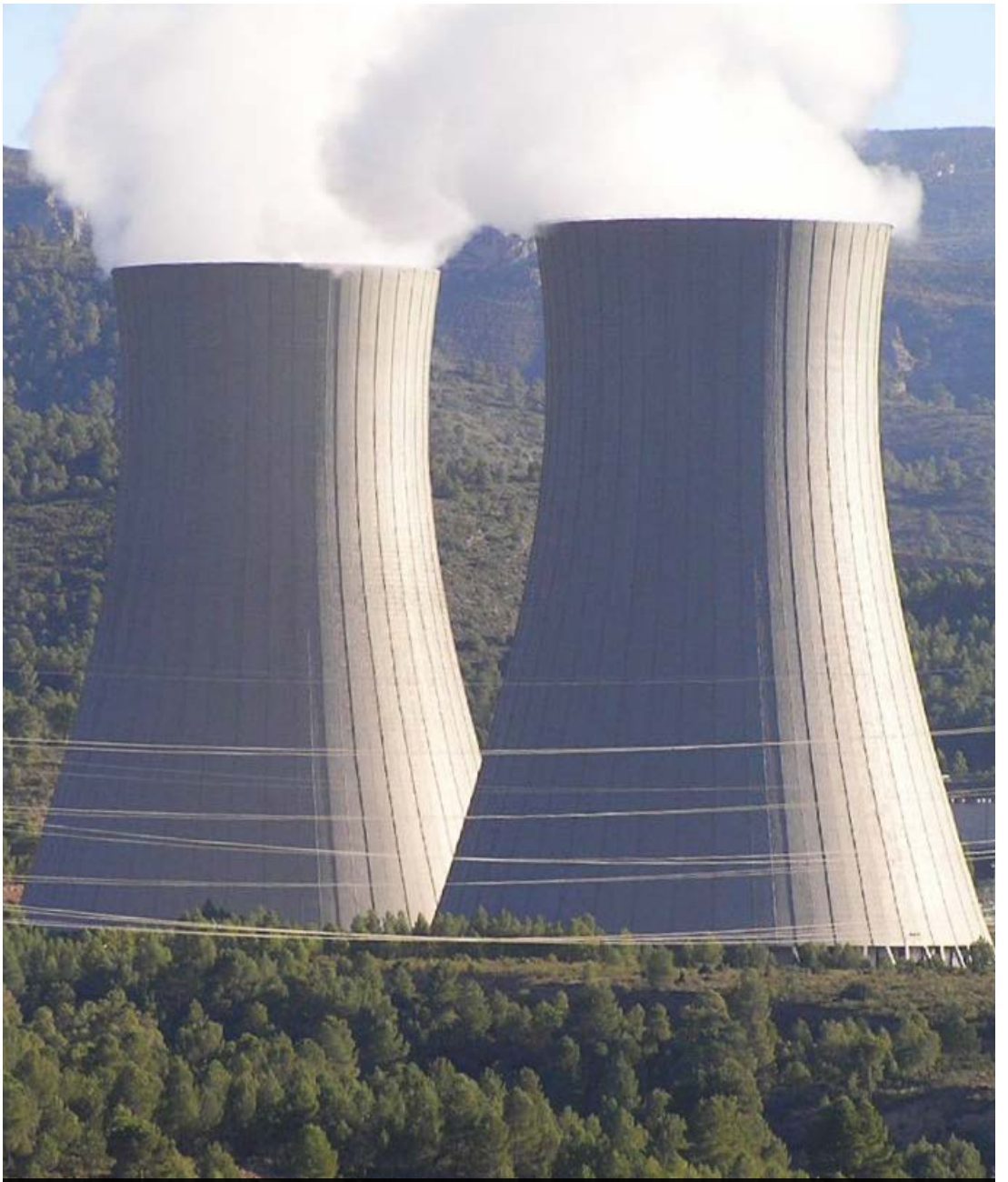
Thus, the fourth challenge for US energy policy is to ably navigate and promote better multilevel, multilateral, and multi-stakeholder governance in an immensely complex and diffuse energy world that contains more actors and theaters than ever before.

5. *A Brave New World of Constant Technological Disruptions*

New ways to produce, transform, and consume energy cause fundamental disruptions to societies at large, and the energy sector in particular, by upsetting global, regional, and local energy usage and trade patterns. The speed of this technological change in the energy sector accelerated especially in the past ten years.

The unconventional hydrocarbon revolution in the United States—the foundations of which go back more than three decades—revolutionized the power sector and had a major impact on the global oil and gas markets. Enhanced oil recovery (EOR) vastly increases the productivity of oil wells.[23] Combined cycle gas turbines boost the efficiency of electricity and the heat generation capacities of gas-fired power plants. Cheaper light-emitting diode (LED) lighting radically reduces electricity usage. Passive buildings that produce as much energy as they consume can feed excess electricity back into the grid. Energy efficiency solutions reduce the energy demand of everything from household appliances to public transportation. Smart meters and grids govern energy systems in a much more sophisticated way, using real-time feedback and big data to efficiently target energy usage.

The already significant transformational potential of and the often dramatic cost reductions in proven energy technologies pale in comparison to what is in the pipeline. Hydrogen power cells could revolutionize the entire transportation sector. Admittedly an ever distant prospect, fusion promises abundant zero-carbon energy without the radioactive waste and meltdown risks of nuclear fission. Small-scale modular reactors have the potential to reintroduce nuclear energy into the mix in a more efficient manner. Coal liquefaction techniques promise to drastically decrease the carbon footprint of coal usage, just as carbon capture and storage (CCS) does. Methane hydrates may be the next frontier of gas development, holding multiple times the size of global conventional and unconventional reserves combined. The disruptive capacity of third-generation renewable technologies—such as multi-layered photovoltaic cells that can turn any man-made surface into a solar panel, enhanced geothermal systems, tidal power generation facilities, cellulosic ethanol biorefineries, or algae—is immense.



Cofrentes nuclear power plant cooling towers. *Photo credit: Wikimedia Commons*

Last but not least, the Holy Grail of energy technologies: advanced small- and grid-scale battery storage that would resolve the lingering problem of intermittency that plagues the large-scale deployment and usability of renewables and can make electric vehicles ubiquitous. Battery costs are already on a declining trajectory. Forecasts anticipate that by 2020 the cost of lithium-ion battery systems for the grid (an existing technology) will drop by 50 percent, from about $500 per kilowatt-hour (kWh) to less than $230.[24] This makes them competitive with coal, oil, and natural gas on the grid. Moreover, ambitious projects like Tesla's Gigafactory, which will endeavor to produce more lithium ion batteries annually than were produced worldwide in 2013, promise to bring down the costs and increase supply even more.[25]

To be sure, most of these technologies are still in their infancy. They still face formidable competition from traditional sources of energy as well as technical, regulatory, and commercial hurdles. Their commercial viability and timeline of large-scale deployment remain in question.

The fifth challenge for US energy policy, therefore, is to encourage and accelerate technological advancement, cost reduction, and large-scale deployment of zero-carbon energy solutions in the most effective and least intrusive way.

6. *A Global "Energy Deflation"*

Technological change will likely be the main energy price driver in the decades to come. In theory, energy prices will continue to rise due to increasing global demand, the rising average cost of hydrocarbon extraction, and the 'prohibitive' cost of climate action and expensive renewable energy deployment. Yet a wholly different scenario may actually arise: a global energy deflation based on the assumption of rapidly falling costs of both hydrocarbons and renewables, increasing economies of scale, and energy efficiency investments bankable in the short term.[26]

Under these circumstances, the nature of the challenge to provide reliable, affordable, and sustainable supplies radically changes. The emphasis will increasingly be on reliability, as policymakers will have to sustain sufficient investment levels in the energy system even at a new normal of lower prices, ensure that a highly complex and diffuse grid is amply stable and resilient, and disincentivize fossil fuel investments over the medium- and long-term, while keeping the lights on during the transition.

Because of this, the sixth challenge for US energy policy is to devise and maintain a policy environment that is conducive to investment in the energy sector so as to allow sustained energy production under all circumstances to provide energy security for the nation. Another challenge is to incentivize and regulate energy sector investments in a much more complex and decentralized environment, which is characterized by distributed generation and the blurring of the lines between consumers and producers.

7. *Localization of Energy Production, Globalization, and Regional Interaction of Energy Markets*

Paradoxically, the simultaneous globalization and integration of what were once highly fragmented hydrocarbon markets is occurring parallel to the localization of energy production and consumption that characterizes the renewable energy and distributed generation scene. Meanwhile, regional integration of energy markets improves the efficiency of energy transport and usage, while weakening the limit and expanding the options of traditional suppliers to these markets. Regional integration also in effect limits the sovereignty of nation-states in choosing their energy mix. Each of these contradicting trends will pose policy challenges.

The globalized nature of hydrocarbon production and trade has led to increased interconnectedness and interdependency. Political upheavals or terrorist attacks resulting in disruptions in remote parts of the world (e.g., civil war in Libya or insurgency in the Niger Delta) affect American consumers directly at the pump. Abundant availability of coal supplies from the United States—as coal is replaced by natural gas and renewables in power generation—affects coal consumption and markets in Europe and Asia. Upcoming American and Australian gas exports will fundamentally affect Russia's gas production and export strategies in both Europe and Asia.

Therefore, the seventh challenge for US energy policy is twofold. Domestically, the United States must maintain stability and coherence between increasingly interconnected yet highly localized energy sectors, with a growing role for diffuse energy production and consumption. Globally, the United States must spearhead a model for energy integration across national boundaries in other regions.

8. *Uncertainty and Volatility of Energy Markets*

Due to the political, technological, and market shifts outlined above, the world of energy is in a constant state of upheaval. In a sector that by default requires stability and long-term planning, disruptors have continuously upset the established order in the last decade, a harbinger of what is to come. Confusing and contradictory government policies and signals further complicate planning for producers, investors, and consumers alike.

The interconnectedness of global energy markets also brings increased volatility, complicating economic policy planning and potentially undermining the international order, domestic political stability, and economic growth. Uncertainty and volatility will remain the most important characteristics of the energy scene, posing immense difficulties for public and private sector decision-makers alike.

COP21 family photograph. *Photo Credit: Wikimedia Commons*

The eighth challenge for US energy policy is therefore to strive for a relatively predictable and stable policy environment to enable all actors to plan and implement energy sector reform and to promote investments.

9. *Growing Physical and Cyber Threats to the Energy Sector*

Increased complexity and interconnectedness also create risks for energy systems. The comprehensive application of information technology introduces additional layers of security threats and multiplies attack points. Cyberattacks can and will be used by state and nonstate actors alike with the potential of extreme scenarios, such as the breakdown of public order, posing an existential challenge to modern societies. Moreover, international cooperation on the protection of physical and cyber infrastructure is still in an embryonic stage, lacking any institutional or legal framework.

At the same time, the emergence and spread of decentralized energy systems reduce the risk posed by attacks against physical infrastructure. Blowing up a windfarm has a much smaller effect compared to blowing up a coal-fired power station or an oil pipeline. Nevertheless, the importance of energy asset protection will remain central to providing energy security to any nation.

Thus, the ninth challenge to US energy policy is to design, implement, and police a national and international physical and cybersecurity regime that protects energy infrastructure and minimizes the risk of disruptions in the energy sector.

10. *Changing Geopolitics of Energy*

All these trends lead to series of coups in the geopolitics of energy. Long established tenets of the energy world, such as the centrality of the Middle East in oil production, the enduring natural gas relationship between the European Union (EU) and Russia, or the excessive import needs of major consumers without significant hydrocarbon resources, are already under pressure. The supplier-consumer nexus changes globally, new trade patterns form, and new mutual dependencies are created. Climate change introduces an additional layer of challenges as natural disasters affect energy systems, nations experience climate-induced conflicts, and migratory patterns change. The Syrian crisis is an omen of what may come; among the root causes of the raging civil war, the enduring climate-change-induced drought and the resulting spike in food prices contributed significantly to the revolution and subsequent breakdown of the state.

In the future, the role and importance of energy in international and especially great power relations will likely be a roller-coaster ride. As the center of gravity for hydrocarbons consumption shifts to the East, policing international energy routes will bring aboard new actors

and new global security challenges. The decline in the importance of hydrocarbons over time may lead to heightened instability and social tensions, resulting in possible state collapse for traditional producers that are unable to diversify their economies in time. The rise of trans- and subnational actors can disrupt the established relationships and alliances between producers and consumers, and induce new political and military conflicts. Vying for resources essential for key energy technologies such as lithium or certain rare earth materials will move to the center of international relations.

At the same time, the gradual spread of localized renewable energy production holds the distant promise of a largely 'depoliticized and desecuritized' global energy scene. This does not mean that energy will cease to be one of the key benchmarks of national competitiveness and a tool to maintain and project national power. Instead, the new geopolitics of energy will revolve less around direct energy relationships and more around the possession and deployment of technology, financial wherewithal, and the ability to transform and sustain a robust and resilient energy system domestically and regionally.

The tenth and final challenge is, therefore, to anticipate and assess the impact of these geopolitical changes on the stability and security of the United States, other nations, and broader regions, in order to prepare for contingencies and crises fundamentally affecting global stability and order.

A US Strategy for Sustainable Energy Security

What are the prerequisites for the United States to prevail in this new world of climate and energy trends and threats? How can US energy policy contribute to a sustainable global climate? How should the United States navigate the pitfalls of a rapidly changing global energy scene that not only poses great danger to US interests but also represents opportunities to cement and project American values and power? What are the main components of a US energy strategy that maximizes the geopolitical, economic, and social benefits for the nation?

For historical reasons, US energy policy consists of a plethora of state-level and regional energy market designs and policies that are often contradictory and confusing. Arguably this colorful tableau worked relatively well for most of the past two centuries. While it is important to respect the diversity and special needs of the various states, and recognizing the legal, political and practical limits of a truly federal US energy policy, a more comprehensive framework strategy is needed to address the challenges outlined in the previous chapter in a more effective fashion.

The United States should follow three core principles in pursuit of this strategy:

1. ***Treat climate and energy security as intertwined public goods***. An absolutely essential starting point for a new strategy is building a societal consensus on the pivotal importance of preserving the climate and providing sustainable energy security for the nation. This requires recognizing that the two objectives are not inherently contradictory. Preserving the climate and providing energy security are intertwined public goods that require government action. The actions needed to tackle climate change will also reinforce energy security and propel innovation and economic growth. Acting against climate change in a robust fashion will not only reduce risk but will also boost the competitiveness and resiliency of the US energy system and economy.

2. ***Develop clear, robust, and market-based climate-energy policies***. The United States is behind the curve in climate action compared to other regions of the world. Europe in particular has taken leadership and blazed trails to devise public policies addressing climate change through measures in the energy sector. Yet European policies, while achieving significant results, offer lessons for policymakers in the United States. Chief among them is the convoluted and inherently ineffective, multi-layered 'interventionist' approach, which sets out multiple targets (GHG emissions, share of renewables, energy efficiency) on multiple levels (European, national) using multiple tools (dysfunctional

US Department of the Navy–Energy Security Flag. *Photo credit: US Navy/Wikimedia Commons*

emissions trading schemes and carbon tax systems featuring numerous exemptions parallel to renewable energy portfolio standards). This approach results in confusing and contradictory pressures on principal actors in the energy system. Instead, climate action in the US energy sector should aim to transcend the current, similarly convoluted, patchwork of US federal- and state-level policies and aim for a simpler system that provides clear signals and incentives for producers, investors, and consumers. Such a market-based approach would play to the strengths of the United States.

3. ***Adopt an inclusive and collaborative approach***. The United States should recognize that the challenges require an inclusive and collaborative approach on an unprecedented scale. It needs to both sustain and strengthen a collective global framework for climate action that covers all countries and construct a collective global energy security architecture that shares the burdens in an equitable fashion and includes all crucial players. Simultaneously, a collaborative approach is critical for providing energy security throughout the whole duration of the transition to a low-carbon future in the energy sector. It is clear that even under the most optimistic technological scenario, fossil fuels will cohabitate with zero-carbon energy resources for a long time to come. US energy policy should recognize this reality and work with traditional energy providers to ensure the continuous security of supply.

The United States should modernize its energy strategy based on these three principles. The transition to a new, sustainable energy system will require tackling tough political challenges and generating public support through raising awareness and engaging in a national dialogue about the need for energy sector modernization and the risks of climate change. It is critical to assure Americans that the transition will serve their interest, not only from a macro perspective, but also on a personal level. It is also imperative to overcome the rigidity of an entrenched energy system that is resistant to wholesale change, facilitating an energy sector transformation that is fast and deep enough to address climate change, while providing predictability and energy security during the transition.

This transition, which has been underway for some time, needs to be accelerated. Per capita emissions (16.6 tonnes of CO_2 annually in 2013) in the United States are still far higher than in any other major economy in the world. An average European citizen emits less than half (7.3 tonnes of CO_2 annually), and though China became the largest emitter by absolute numbers, its per capita emissions are still small compared to that of the United States (7.3 tonnes annually).[27] By 2050, the United States will have to reduce its GHG emissions to 80 percent of its 1990 levels, limiting overall net GHG emissions to 1.7 tonnes per capita (or 1,080 million metric tons of carbon dioxide equivalent [$MtCO_2e$] total annual emissions, including fossil fuel combustion emissions of no more than 750 $MtCO_2$).[28]

This is feasible both from a technical and economical perspective. Conservative estimates show that such a GHG reduction can be achieved at an incremental cost to the energy system of around 1 percent of GDP (excluding non-energy benefits, such as the avoided human health and infrastructure costs), taking into account only commercially already viable or near viable technologies with relatively flat cost-reduction projections.[29] Breakthrough technologies would further reduce the costs and increase the economic benefits of the transformation, but would not be prerequisites of it.[30]

The United States is in a unique position to transform its energy sector to lower carbon emissions. It has the great advantage of a protected geography and a vast supply of natural resources. The shale gas revolution already enabled the reduction of carbon emissions from coal usage, and the United States can also exploit its immense renewable and hydro energy potential. The National Renewable Energy Laboratory (NREL) estimates that the economic potential of renewable energy ranges from one third to over ten times the total 2013 US generation from all sources. This potential increases considerably over time due to historic and projected technological cost reductions.[31] The potential is relatively evenly distributed across the United States, with at least one renewable technology having strong potential in every state. Traditional major hydrocarbon producer states such as Texas or Oklahoma are already turning into major renewable energy producers.

Research shows that the transition to a low-carbon economy will fully allow US citizens to maintain an economy and lifestyle consistent with present day realities. This includes electricity bills that, in the worst-case scenarios, are only slighter higher than today, and a strong likelihood there will actually be a significant drop over time—even given current or higher levels of driving, heating and cooling, and use of appliances.[32] Thus, contrary to alarmist predictions, the energy transition will not require sacrificing the American way of life. Moreover, decarbonization will eventually lead to the decrease of energy costs as a share of GDP over time, from about 7 percent today to around 6 percent in 2050, in addition to offering significant other benefits to the US economy, such as the reduced volatility of energy prices.[33] Increased investments in low-carbon power generation and fuel usage, efficient buildings and appliances, and a new alternative vehicle fleet could amount to more than $1 trillion annually by 2050, which would be widely distributed across regions, industries, and energy types.[34] Moreover, both the prerequisite and the byproduct of a decarbonization process would be a boost in science and technologies. This would reinforce the comparative advantage of the United States in information technology, biosciences, and nanotechnology, thereby boosting its global competitiveness.

A collaborative approach is critical for providing energy security throughout the whole duration of the transition to a low-carbon future in the energy sector.

A modern US energy system could foster the "re-industrialization" of the US economy, potentially generating many high-end jobs.[35] The US solar sector already employs more people than vehicle manufacturing. There are legitimate concerns about job losses in the traditional energy sectors. Yet even a conversion to a fully renewable (wind, water, hydro) system would provide a net job increase in the US economy, creating 3.9 million forty-year construction jobs and 2.0 million forty-year operation jobs for energy facilities alone, outweighing the estimated 3.9 million job losses in the traditional energy sector according to a Stanford University study.[36] Such a conversion would also eliminate 62,000 premature deaths per year caused by air pollution in the United States today.[37] It would also result in significant cost savings on direct energy costs ($260 per year in 2050) and health costs ($1,500 per year in 2050).[38]

Most importantly, the United States is best positioned to develop and benefit from new energy technologies. The United States has been at the forefront of energy innovations since the birth of the country. Energy innovation goes back to the fascination of Benjamin Franklin with electric power and lightning, Tesla's and Edison's groundbreaking research that enabled the second industrial revolution, the ground breaking work in Los Alamos on unleashing nuclear power, and

Solar array at Nellis Air Force Base. *Photo credit: US Air Force*

the pioneers of unconventional hydrocarbon revolution in the past three decades. This ingenuity helped the United States to fuel its unprecedented wealth and prosperity over the course of the last two centuries. To preserve and enhance this competitive edge, the United States must remain at the vanguard of energy technologies. Creating the right incentives for public- and private-sector-led research and innovation in the energy sphere plays to the core strengths of the American business model: creativity, entrepreneurship, and risk-taking. Cutting-edge innovation will spill over into other areas as well, creating synergies and boosting economic growth.

To best achieve these goals and accomplish this transition, the United States should adopt an energy strategy that rests upon three pillars. The first pillar builds upon the United States' unparalleled richness in both human and natural potential. It leverages the abundance of resources in the United States to address climate change in a resolute manner without delay by putting the right domestic policies in place. At the center of this pillar is the accelerated decarbonization of the US economy. The second pillar ensures that the United States leads on global climate action, addresses the energy insecurity of key allies, and prepares for energy and climate change induced crises. The third pillar pushes for energy liberalization to enable better functioning domestic and global markets and aims to build a functioning international energy governance.

Pillar 1. Accelerate the Energy Sector Transition and Solidify the American Innovative Advantage

The unconventional hydrocarbon revolution fueled economic growth, significantly expanded the room for maneuver of US diplomacy, and contributed to GHG emission reduction through a massive replacement of coal with gas in electricity generation. The United States achieved impressive reductions in CO_2 emissions in the past ten years, partly owed to market forces (cheaper gas pushing out coal and increasingly competitive renewables), and partly to the implementation of progressive energy and climate policies. The actions and efforts of both the Bush and Obama administrations, from increased vehicle corporate average fuel economy (CAFE) standards to renewable tax credits and increased funding for research, have been critical steps to the right direction.

Yet more resolute action is required if the United States wants to rapidly transform its energy sector. A sustained low fossil fuel price environment risks discouraging innovation and investment into low-carbon options, thus locking the US economy into a high-carbon path. The low oil price, coupled with the abundance of natural gas, provides a strategic opportunity to put in place measures and incentives that would accelerate the decarbonization of the US economy without putting too much strain on the system from an affordability standpoint or compromising the security of supplies with a hastened transition. This wealth must therefore be leveraged strategically to accelerate the transition to a low-carbon economy.

Political leadership is critically important to ensuring that a fundamentally market-driven energy sector transformation takes place in an expeditious and most efficient manner. The social cost of all greenhouse gas emissions—measured as the discounted monetary value of damages current and future by anthropogenic climate change, such as the costs of adverse agricultural effects, health effects, rising sea levels, and damages by extreme weather—should be the basis of action.[39] On that basis, and in line with the recommendation of the Carbon Pricing Leadership Coalition that includes the International Monetary Fund, the World Bank, key national and regional governments, as well as leading private sector players and NGOs, a well-calibrated and gradually increasing national carbon fee should be introduced to discourage carbon usage.[40] Experience in Europe in particular shows that, though not immune from the possibility of design flows itself, an outright carbon fee is a preferable and more transparent option than a cap-and-trade system. An across-the-board carbon fee system with no exemptions would provide a technology neutral signal that could even out the playing field, while preserving market principles and generating revenue. Close to forty nations and more than twenty-six subnational jurisdictions in North America and elsewhere adopted some form of carbon taxation with encouraging results.[41]

A carbon fee—covering all sectors, not just power generation as the controversial Clean Power Plan proposed—would have several major advantages. It would further boost the competitiveness of cleaner-burning natural gas vis-à-vis coal in the short term. It could propel the upgrade and modernization of fossil fuel generation capacities to cut emissions during the transition, boost the competitiveness of carbon capture and storage techniques to provide a long-term future for gas, and propel energy efficiency investments across the whole value chain. It would go a long way in helping to revive the commerciality of nuclear power to provide essential zero-carbon baseload generation capacity to address seasonal intermittency issues that are likely to prevail in the long term even with significant development in storage technologies. It would also help to preserve a robust American nuclear industry that is critical in maintaining a technological edge.

Natural gas would play an even bigger role in electricity generation with the introduction of a carbon fee.[42] Yet even though natural gas replacing coal in electricity generation provides a quick short-term pathway to lower emissions, it could hinder the long-term full decarbonization goal.[43] Therefore, while recognizing the importance of gas as a bridge fuel to a low-carbon future, public policy must ensure that the switch to natural gas is not permanent, but allows for the power sector to transition beyond—and see to it that gas eventually cedes a leading role to carbon-free energy sources. Thus, the carbon fee must be progressively elevated over the course of the next decade to incentivize investment in zero-carbon energy instead of gas, parallel to technological development and cost reduction in energy storage solutions in particular.

US Navy F-14 flies over burning oil field. *Photo credit: Wikimedia Commons*

Revenues from the progressively increasing carbon fee—a modest $25 per ton carbon fee could raise over $100 billion a year—should be used to fund six major programs:[44]

1. Provide effective assistance to those whose livelihood is disrupted by the energy transition through early retirement schemes, education and job training programs.
2. Provide targeted subsidies to those struggling to pay their energy bills, as introduction of a carbon fee to the tune of $25 per ton would result in an increase in electricity prices across the country between 3 and 25 percent, though higher increases will occur in states where electricity prices are the lowest.[45]
3. Boost public funding for energy technology research and early deployment through programs such as the Advanced Research Projects Agency-Energy (ARPA-E) and the Department of Energy's (DOE) National Laboratories with special regard to grid scale storage and carbon capture and storage technologies.
4. Boost energy efficiency across the whole of the US economy by dismantling financial and institutional obstacles and providing public support, loan guarantees, and tax credits for upfront investment costs.[46] This would dramatically improve its energy efficiency, securing up to $1.2 trillion in gross energy savings by 2020.[47]
5. Renew the crumbling transportation infrastructure of the United States through public-private-partnerships.[48] Special regard should be paid to urban mass transportation systems, intercity high speed rail network, and investment into bridging the gaps left by the private sector in an emerging national infrastructure catering to electric vehicles.
6. Offset some of the potential decrease from corporate tax revenues from a reduced corporate tax rate in the context of a comprehensive US tax reform.[49]

In the absence of a carbon fee, another more politically challenging option would be to bring the US gasoline tax level in line with that of the rest of the developed world in order to finance the proper upkeep and modernization of transport infrastructure. Lower oil prices helped by the US boom offer a great political opening to introduce a significant and long overdue tax hike. The federal excise tax has not been raised since 1993, and federal plus state and local gasoline excise taxes still only amount to an average of $0.48 per gallon for gasoline (compared to $4.19 in the Netherlands).[50] A modest 50 percent gasoline tax increase (amounting to a less than 25 cents increase at the pump) would still result in lower gasoline prices than before the oil price collapse of 2014. The gasoline tax increase on such a modest scale would yield approximately $20 billion a year.[51]

As subsidies propel overconsumption and disincentivizes energy savings, all implicit and explicit fossil fuel subsidies should be phased out of the system.[52] Parallel to the elimination of fossil

fuel subsidies and the introduction of the carbon fee, the phasing out of renewable subsidies beyond 2021 should also be explored.

It is critically important to create a more conducive policy environment to the renewal of the aging US nuclear fleet and the potential expansion of nuclear power generation capacities to provide baseload electricity generation capacities in the long term to offset the effect of seasonal intermittencies of renewables. Special regard should be given to the provision of loan guarantees and the resolution of the longstanding political dispute over a permanent repository of spent nuclear fuel.

The electrification of the bulk of energy demand, with special regard to transport and heating systems, must be the priority in order to satisfy energy consumption with zero-carbon emissions. The US electricity grid will need to be completely revamped to adapt it to the requirements of a much more complex electricity system and make it more efficient and resilient against natural disasters and man-induced physical and cyber threats.

The transition will require an across-the-board decarbonization extending beyond electricity generation and the transport sector. This must occur in industry, and in the buildings and appliances sectors in particular. Rapid and widespread consumer adoption, facilitated by government policies and incentives, is critical. The federal government will need to work with state and local authorities in charge of building codes to devise a system of stringent requirements for both new and existing buildings.

In order to create a more transparent, accountable and efficient governance system, the jurisdiction of and cooperation between key federal, regional, state, and municipal bodies responsible for energy policies and regulations must be streamlined, with special regard to the Department of Energy, the Environmental Protection Agency, the Federal Energy Regulatory Commission, and various regional, state, and local agencies.

Pillar 2. Lead on Global Climate Action and Sustain Robust Energy Diplomacy Capabilities

To assume global leadership with firm moral underpinnings on climate change, sustained US leadership is essential to upholding and bolstering an international consensus and action on climate change post-Paris COP21, and to prevent countries from not following through on their commitments.

The United States must firmly commit to an 80 percent reduction in GHG emissions by 2050 within the UNFCCC COP process, a goal well within reach, building on American ingenuity and technological prowess. The current US government commitment to reduce GHG emissions by 26-28 percent below 2005 levels by 2025 is a good step forward and is in line with the 80 percent reduction goal by 2050. The United States should also spearhead and co-fund a robust

mechanism to monitor and enforce the pledges within the UNFCCC process, upon which the ultimate success of global climate action will hinge.

Mirroring the domestic policies outlined above, the United States should strongly encourage other nations to adopt a price on carbon, coupled with a sustained push for the dismantling of all fossil fuel subsidies as agreed in the G20 framework, and the introduction of a global carbon floor price with regional variations beyond 2020.

US leadership is essential to upholding and bolstering an international consensus and action on climate change post-Paris COP21.

The United States—building on the successes of existing initiatives, such as Power Africa, that aims to increase access to power in the continent—should continue to be at the forefront of fighting energy poverty and promoting sustainable energy investments across the world. Financing the energy transitions in the developing countries will be a particularly tough challenge. According to the UN's Sustainable Energy for All (SE4All) Initiative, annual investments of $45 billion are needed to achieve universal access by 2030, a five-fold increase from the 2010 spending of $9 billion. In addition, $393 billion is needed annually to boost energy efficiency investments and $320 billion to double share of renewable energy in the global energy mix.[53] While the majority of financing currently comes from the public sector, the bulk of the required increase must come from private sources. This represents an enormous investment opportunity for American companies with cutting edge technology and know-how in the access, efficiency, and renewable energy space. Companies, from the financial sector to utilities and service providers to the technology giants and startups in Silicon Valley, can profit from the herculean task of providing power to peoples and nations all across the world. To exploit this opportunity, political leadership and business acumen must work together. The United States should take the lead in pooling experience and capital into sustainable energy access projects on a global scale. It should also more robustly support—also from public funding—the Green Climate Fund set up in the UNFCCC framework, which funds low-emission electrification and climate-resilient development projects and "help[s] vulnerable societies adapt to the unavoidable impacts of climate change."[54]

While the progress made in cost reduction and deployment of zero-carbon energy technologies is nothing short of remarkable, the pace of innovation and the scale of transformation and dissemination needs to be dramatically speeded up. The United States recognized this challenge when President Obama launched the 'Mission Innovation' project with other key

global government and private sector leaders at the Paris COP21 Summit. It is critical to accelerate clean energy innovation on a global scale to make clean energy more widely affordable. Moreover, expensive research on breakthrough technologies like fusion requires burden sharing on a planetary scale and should continue to be pursued in international research collaborations, such as the International Thermonuclear Experimental Reactor (ITER). The prospect of creating a major international geoengineering research project, which would act as a failsafe in case climate action flounders, should also be explored.

The United States should build global and regional alliances to promote energy security and liberalized energy markets. The United States has a vested interest in helping to shore up the energy security of key allies and partners. Compromising energy security and corrupting the energy sector are at the heart of malevolent actors' strategies. Excessive dependence on external energy supplies from a single source may endanger the ability of allies to conduct an independent foreign policy that is both in their national and in the allied interest. Therefore, the United States must strive to do everything in its capacity to assist allies and partners in the quest to improve their energy security.

Allies in Europe and Asia are in particular danger. As a revanchist Russia flexes its muscles in Ukraine and beyond, Europe's import dependence on fossil fuels continues to grow. The United States should continue to assist the EU to solidify achievements in integrating its energy market and enhancing its resiliency, while boosting its indigenous and diversifying its external energy supplies. The United States has a vested interest in fueling economic growth in a sustainable way in Asia, particularly by ensuring the energy security of key allies there. The United States should play an active role in minimizing the risk of conflict over resources in the Asian space by defusing territorial disputes, promoting open and integrated markets, facilitating access to global energy supplies, assisting in the development of sustainable indigenous energy solutions, and actively promoting and supporting the transformation of energy systems.

The United States should work toward a global web of networks, alliances, and instruments to promote its goals in the climate and energy space. The focal point of this web must be the transatlantic relationship. Forging an ever closer partnership on climate and energy issues will be central to the cohesion and strength of the relationship between the United States and Europe. The Transatlantic Trade and Investment Partnership's (TTIP) prospective energy provisions could take the relationship to the next level in many ways: it can become the basis for global norms in the energy trade, create a competitive market for transatlantic energy innovation, bolster a strong commitment to promoting open investment policies, prevent new trade restrictions, and eliminate existing barriers. This is essential to creating an attractive environment for much needed capital flows. It is critical to create a common transatlantic intellectual property and standards policy that promotes vigorous competition, develops complementary competition and property laws, and encourages innovation, while enhancing economic efficiency and consumer welfare.[55]

The United States must assist the EU in seeking greater diversity in its suppliers, supply routes, and overall energy mix, especially in taking steps to reduce the dependence of European energy markets on single suppliers of oil and in particular natural gas.[56] Empowering the EU in its pursuit of energy security and greater independence from monopoly suppliers remains critical to enhancing the EU's growth potential and preserving its diplomatic ability to act more forcefully on the global stage.

Given the interconnectedness and exposure of the two economies, it is in the strategic interest of both the EU and the United States to ensure the flow of safe, secure, and reliable energy supplies. Any disruption might result in serious economic losses for both. A robust transatlantic energy diplomacy is needed to ensure the security of supplies, defend chokepoints and physical infrastructure, eliminate bottlenecks, and diversify supplies. The United States should lead NATO to explore a more robust role in protecting critical energy infrastructure and transit lines, and should engage in contingency planning for potential disruptions of vital energy supplies.

The United States should build global and regional alliances to promote energy security and liberalized energy markets.

A coordinated approach toward third players is of special importance given the energy import dependence of both economies. Thus, the EU and the United States should jointly engage in dialogues with major energy producers and consumers around the world. The United States must actively consult and collaborate with the EU on partnerships with third countries, through platforms such as the US-China Energy Policy Dialogue or the Africa-EU Energy Partnership. The EU and the United States should coordinate their positions through the EU-United States Energy Council before entering into negotiations on energy issues of strategic importance with third players.

The United States should work with key allies and international institutions to deal with the geopolitical volatility and instability associated with the transformation of the energy sector and its impact on major traditional producers by exploring the establishment of an international stabilization and modernization fund for economies excessively dependent on hydrocarbon revenues.

Early on, the United States recognized the importance of developing government capacities to tackle the challenges above, analyze global and regional energy markets and trends, and exert diplomatic influence in the energy space. The State Department's Bureau of Energy Resources, in lockstep with the Department of Energy, plays a key role in promoting American energy

interests abroad while supporting US allies and partners in their quests for energy security. It is critical to reinforce and expand American energy diplomacy and intelligence capabilities in order to boost US power projection capabilities, build alliances, and shore up allies.

Pillar 3. Promote a Liberalized and Rules-based Global Energy Trade System and Build a Functioning Global Energy and Climate Governance Network

The United States should exploit the increased room for maneuver that comes with its energy abundance to promote a global energy trade liberalization agenda, increase liquidity on the global oil and gas markets, reinforce the prevalence of markets over power politics in international energy relations, and build a flexible and nimble global energy and climate governance architecture.

An Atlantic Council Task Force, co-chaired by Senators Lisa Murkowski and Mark Warner, published a report on the US energy boom and its national security implications. It concludes that many of the foreign policy challenges the United States faces today have a strong energy component, and full US participation in energy markets can play a critical and positive role in addressing them.[57] Natural gas exports in particular can accelerate the transition to a lower carbon global economy by facilitating the emergence of a more global market for liquefied natural gas.

Fully liberalizing the American natural gas trade is important not only to help allies and to provide extra liquidity to the international markets to dampen volatility in oil prices, it also sets the example for the rest of the world. The United States should always stand for open markets and liberalized energy trade, instead of resource nationalism and protectionism. The lifting of the crude oil export ban as part of the December 2015 budget deal was a critical step that should be followed by the full liberalization of natural gas exports.

Energy remains one of the least governed international spaces, yet one of the most consequential to the security and wellbeing of nations. There is, therefore, a great need for an international energy governance system that introduces more predictability, fairness, and transparency. To design and manage such a system, the United States must recognize the vacuum in the current international and regulatory framework and the plethora of international treaties and organizations that have varying degrees of remit and often overlapping responsibilities in the energy space. Creating one single global agency to deal with the myriad aspects of energy security and related climate issues is neither plausible nor desirable. Instead, the United States should strive to turn the current patchwork of international bodies and treaties into a coherent and interconnected system that works together more seamlessly, in order to introduce clarity and predictability into a rather chaotic global climate and energy world.

Waves break over coastal defenses in the United Kingdom. *Photo credit: Geography.org.uk*

The United States should work toward a global energy system that is characterized by the reduction of excessive price volatility on global energy markets and the minimization of the impact of geopolitical upheavals. This requires the introduction of more competition, transparency, liquidity, better rules and regulations for energy trade, and the stabilization of global energy trading routes in concert with other key stakeholders. The liberalized global energy trade would be coupled with transparent and efficiently functioning global and regional markets. This necessitates energy market integration and interconnections in Europe, Asia, Africa, and Latin America alike to enhance regional synergies and create markets. This integration process should be supported by US experience and technical assistance.

It is of utmost importance to ensure that competition is not distorted, with special regard to cartelization in the regional and global gas markets. The United States should promote global principles for competition in the energy markets to reduce the risk of cartelization and price-setting, cripple the disruptive ability of irresponsible players on the market, enhance security of supplies, and promote open and efficiently functioning markets.

Monitoring the implementation of global and regional climate agreements; promoting dialogue and cooperation between consumer and producer countries; introducing and enhancing dispute resolution mechanisms; increasing transparency and reducing volatility on the international

Deepwater Horizon oil spill. *Photo credit: Defense.gov/Wikimedia Commons*

energy markets; and devising international standards of physical and cyber energy infrastructure protection will be at the center of the US international energy governance agenda. Therefore, international institutions that serve US national interests need to be strengthened further with special regard to the International Energy Agency (IEA), the United Nations Sustainable Energy for All Initiative (SE4All,) the International Renewable Energy Agency (IRENA), and the Energy Charter Treaty. In particular, the IEA's mandate, organization, and budget should be reinforced to allow the organization to conduct a global energy dialogue with all key stakeholders, and to play a robust role in facilitating the exchange of best practices in green technology deployment, energy efficiency, and other key issues in the context of the Paris Climate Agreement.

The United States should promote global principles for competition in the energy markets to reduce the risk of cartelization and price-setting, cripple the disruptive ability of irresponsible players on the market, enhance security of supplies, and promote open and efficiently functioning markets.

As the energy sector undergoes a fundamental transformation, new global actors emerge and play a decisive role in how to produce and consume energy and control the climate. The new 'lateral energy regime' vastly widens the circle of interested and invested actors and influencers.[58] This new paradigm requires a fundamentally different approach to governance on all levels: local, national, and international. The United States should invest in the empowerment and inclusion of constructive new actors to co-govern the energy space, while depowering spoiler actors, such as terrorist organizations that target energy infrastructure. Designing a new model for public-private-people-partnerships (PPPP) is essential to managing the complex interplay between the traditional and new producers, transporters, and consumers of energy—municipal and regional governments and civil society actors.

Conclusion

The first of the Atlantic Council Strategy Paper Series, *Dynamic Stability: US Strategy for a World in Transition*, identified the protection of global commons by the United States as critically important for both material and moral reasons. It rightly argued that "it is important to include climate in the definition of global commons."[59] That paper defined *'dynamic stability'* as the key conceptual framework to deal with a fast-changing 'Westphalian-Plus' world and argued for "harnessing change to preserve the liberal international order."[60]

Harnessing change in the energy sector expeditiously is an existential issue for all humanity. Dynamic stability in the US energy sector would mean leveraging the unique natural bounty and technological prowess of the United States and using the very momentum created by the unconventional hydrocarbon revolution to gradually pivot away from fossil fuels. Leaving the current system unreformed and unmodernized will threaten the security and well-being of American citizens, hurt the US economy at home, and isolate the United States internationally. By compromising on market-friendly public policy measures and leveraging the low oil price environment, the United States can introduce the right incentives into the energy system to shepherd an accelerated energy transition into a more modern, low-carbon energy era that still relies heavily on natural gas—particularly during the transition—and nuclear power to provide baseload generation and counter seasonal intermittency.

The strategy outlined in this paper may strike many readers as overly ambitious given the political realities in the United States today. Although the majority of American voters recognize the threat of climate change, the issue still ranks lower on their priority lists compared to concerns about the economy or terrorism. Shrinking but still sizeable communities remain skeptical about anthropogenic climate change, despite the overwhelming scientific evidence.

Yet the politics of climate action is changing in the United States. Despite concerns about the cost of adaptation, an ever-increasing majority, including a stable majority in both Democratic and Republican voters, support action against global warming.[61] Eighty-one percent of the electorate (up from 71 percent in 2011), which includes 88 percent of Democrats, 83 percent of Independents, and 71 percent of Republicans, agree that human activity plays a role in climate change. In the wake of natural disasters in the past decade such as hurricanes Katrina or Sandy, 71 percent of Americans expect to be personally hurt by the consequences of climate change. Two-thirds of Americans are more likely to vote for a candidate who advocates climate action than one who does not. Previously ardent antagonists to climate action are now recognizing

the need for action and even advocating for a carbon fee to introduce more certainty in their business planning.[62] It is of paramount importance to raise awareness and generate an informed conversation around energy and climate challenges throughout the country.

The strategy outlined in this paper offers the United States a path to modernize its energy sector and become a low-carbon leader, to the great advantage of American citizens as well as the planet. This paper endeavored to show that the energy transition is both inevitable and beneficial if the United States wants to preserve its global leadership and competitive edge. It plays directly to the values and comparative advantages of the United States: individual empowerment, creativity, innovation, and technological and engineering prowess. The United States is uniquely positioned to lead this transition without compromising the American lifestyle.

Endnotes

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