Asia Society

Common Challenge, Collaborative Response

共同的挑战，协作应对

A Roadmap for **U.S.-China Cooperation on Energy and Climate Change**

A PARTNERSHIP BETWEEN:

PEW CENTER ON Global CLIMATE CHANGE

Asia Society
Center on U.S.-China Relations

Initiative for U.S.-China Cooperation on Energy and Climate

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Foreword

The world faces no greater challenge in the 21st century than arresting the rapidly increasing accumulation of greenhouse gases in the atmosphere that cause climate change. The two largest producers of these gases are the United States and China. Their cooperation is essential if there is to be a solution to the daunting climate change challenge. If the United States and China can become active catalysts in bringing about a strategic transformation to a low-carbon, sustainable global economy, the world will take a giant step forward in combating climate change. The United States and China will also edge closer to energy security, protecting their environments and assuring greater prosperity for their citizens. Equally important, they will also succeed in building a far more stable and cooperative foundation for U.S.-China relations as a whole.

In mid-2007, the Asia Society assembled a group of leading experts from the worlds of science, business, academia, politics, and civil society with representatives from the Council on Foreign Relations, the Environmental Defense Fund, The Brookings Institution, the National Committee on U.S.-China Relations, and Pew Center on Global Climate Change, to explore how the United States and China could cooperate more closely on energy and climate change. The result was the establishment of the Initiative for U.S.-China Cooperation on Energy and Climate, generously supported by Asia Society Board Member Jon Anda. The Initiative evolved into a partnership between the Asia Society's Center on U.S.-China Relations, under the leadership of Arthur Ross Director Orville Schell, and Pew Center on Global Climate Change, under the leadership of Eileen Clausen. The Initiative has also been fortunate to gain the sponsorship and assistance of the Chinese People's Institute for Foreign Affairs in Beijing.

The goals are two-fold:

1. To draft a "Roadmap" for leaders of the two countries to scale up sharply U.S.-China cooperative projects on energy and climate change.
2. To catalyze a major new collaboration in this key area of common interest to put Sino-U.S. bilateral relations on a more stable basis.

This Report explicates both a rationale and an outline for beginning a more comprehensive program of U.S.-China collaboration on energy and climate change that builds on decades of U.S.-China cooperation on energy and environment. It calls for initial engagement at a presidential summit, but also outlines some of the critical project areas that should be jointly explored through practical collaboration by officials at other levels of government as well as by the private sector. Each of our recommended areas of common endeavor—which include coal, energy efficiency, "smart" grids, and renewable energy—should be elaborated through the early appointment of Task Forces assigned to develop a detailed plan of collaboration and implementation in each area.

Drafts of this Report were reviewed in both the United States and China by a broad array of specialists, all of whom share the goal of developing a collaborative plan that would be viewed by Chinese leaders and the new U.S. presidential administration as workable and helpful in accomplishing the above goals.

Richard C. Holbrooke
Chairman, Asia Society

Executive Summary

A new comprehensive program for cooperation between the United States and China that focuses on reducing greenhouse gas emissions, and thus mitigating the potentially catastrophic effects of climate change, is both necessary and possible. Indeed, as this Report suggests, if human beings hope to avoid the worst consequences of global climate change, the United States and China—respectively the world's largest developed and developing nations, the two largest energy consumers, and the two largest producers of greenhouse gases—have no alternative but to become far more active partners in developing low-carbon economies.

To prevail in such a common effort, both countries will need not only bold leadership and a new set of national policies, but also a path-breaking cooperative agenda that can be sustained over the long run. The advent of a new U.S. presidential administration in Washington, D.C., coupled with a central leadership in Beijing that is increasingly aware of the destructive impact and long-term dangers of climate change, presents an unparalleled opportunity for this new strategic partnership.

While the current global economic crisis could make joint action between the United States and China more difficult, it could also provide an unexpected impetus. If wisely allocated, funds invested by both governments in economic recovery can help address climate change while also advancing the "green technologies" and industries that will lead to a new wave of economic growth.

Stronger bilateral collaboration on energy and climate change has at the same time the real prospect of helping to build a new, more stable, and constructive foundation under Sino-American relations, the most important bilateral relationship in the 21st century world.

This Report—which was produced in partnership between Asia Society's Center on U.S.-China Relations and Pew Center on Global Climate Change, in collaboration with The Brookings Institution, Council on Foreign Relations, National Committee on U.S.-China Relations, and Environmental Defense Fund—presents both a vision and a concrete Roadmap for such Sino-U.S. collaboration. With input from scores of experts and other stakeholders from the worlds of science, business, civil society, policy, and politics in both China and the United States, the Report, or "Roadmap," explores the climate and energy challenges facing both nations and recommends a concrete program for sustained, high-level, bilateral engagement and on-the-ground action. The Report and its recommendations are based on the following understandings:

- That because there is overwhelming scientific consensus that human-induced climate change is well underway and poses grave economic and environmental risks to the world, the United States and China need to immediately begin acting in concert, without awaiting new domestic legislation or multilateral agreements, to jointly seek remedies for their emissions of greenhouse gases.
- That because climate change is largely a consequence of soaring global use of fossil fuels, addressing the problem will require a fundamental transformation of energy systems in both countries, as well as worldwide, through the development and deployment of new technologies and the widespread introduction of new energy sources capable of enhancing the diversity, reliability, independence, and "greenness" of national energy supplies.

- That even during a time of global economic upheaval, a strong bilateral effort to address the twin challenges of climate change and energy security can succeed while also contributing to economic recovery and laying the foundation for a prosperous, new, low-carbon economy in each country.
- That a meaningful U.S.-China partnership on climate change issues can be forged on the basis of equity, taking into account the respective stages of development, capacities, and responsibilities of each country.
- That while enhanced U.S.-China cooperation must begin with collaboration between the two national governments, success will ultimately hinge on each nation's ability to catalyze action and investment in the marketplace.
- That if fashioned carefully, closer collaboration on energy and climate can address the problem of climate change and enhance the economic prospects of both nations while conferring on neither an unfair competitive advantage.
- That by demonstrating global leadership and making significant new progress toward closer bilateral cooperation, the world's two largest economies will help achieve stronger multilateral agreement and action under the United Nations (UN) Framework Convention on Climate Change.

The Report recommends that, as a first step in forging this new partnership, the leaders of the two countries should convene a leaders summit as soon as practically possible following the inauguration of Barack Obama to launch a "U.S.-China Partnership on Energy and Climate Change." This presidential summit should outline a major plan of joint-action and empower relevant officials in each country to take the necessary actions to ensure its implementation.

The Report recommends that the partnership be directed by two parallel groups. A U.S.-China high-level council would be established to draw up overall plans for the collaboration. The Commission would include high-ranking environment, energy, and finance officials from both countries. It would meet regularly to establish and review the strategic direction of the new partnership as well as to discuss other issues of common concern, including those relating to ongoing multilateral negotiations.

In addition, each of the highlighted concrete priority areas proposed below would be guided by a second tier of bilateral task forces. These would be composed of senior government officials and independent experts in science, technology, business, finance, civil society, and policy from each country. Their responsibilities would involve establishing goals, designating joint-research areas, developing collaborative programs within each of the designated areas, organizing concrete joint projects in each area of cooperation, and overseeing the implementation of these projects.

Areas where direct collaboration is expected to yield the quickest and most substantial results on reducing greenhouse gas emissions have been given highest priority. They are listed below in shortened form, but discussed in greater detail in Section IV.

Priority areas of collaboration include:

- **Deploying Low-Emissions Coal Technologies.**
  The likelihood that both the United States and China will continue to rely heavily on coal for many years to come necessitates immediate and large-scale investments in

the research, development, and deployment of new technologies for the capture and sequestration of carbon emissions from coal-fired power plants.

- **Improving Energy Efficiency and Conservation.**
  Both the United States and China have significant potential to lower their carbon emissions through low-cost, and even no-cost, energy efficiency and conservation measures that would have considerable impact on each country's "carbon footprint" and energy security.
- **Developing an Advanced Electric Grid.**
  Both the United States and China rely on outdated, decentralized, and inefficient electrical transmission systems. Both countries could profit from research, development, and adoption of new "smart grid" technologies capable of enabling these systems to handle larger quotients of low-carbon energy from episodic, but renewable sources of power more cheaply and efficiently.
- **Promoting Renewable Energy.**
  There is an obvious need for both countries to develop a far broader deployment of solar, wind, and other renewable sources of energy in order to de-carbonize their respective electricity systems, expand their low-carbon economies, and thereby diminish their carbon emissions per unit of GDP.
- **Quantifying Emissions and Financing Low-Carbon Technologies.**
  To help facilitate cooperation in the above areas, it will be important to continue to jointly address the cross-cutting issues of quantifying and projecting emissions, and financing technology development and deployment.

That our planet is now approaching a point of no return on the question of global warming is increasingly self-evident. Recognition of the daunting challenges that such moments pose can be unsettling, even paralyzing. However, with bold leadership, they can also be galvanic.

It is unclear as yet whether the growing awareness of our tipping point moment will intersect in a timely manner with the new leadership that is now assuming office in Washington and the increasingly well-informed central leadership in Beijing to catalyze both countries toward mustering the necessary clarity of vision, intellectual resources, funding, technology, and international cooperation. What is clear, however, is that we are in uncharted waters that will beg an unprecedented effort from both the world at large and the United States and China in particular. For whether we choose to recognize it or not, these two countries are both crucial in the effort to address climate change. Simply put, if these two countries cannot find ways to bridge the long-standing divide on this issue, there will literally be no solution.

Fortunately, it is the firm conviction of those who have worked on this Report over the past year that the United States and China will both benefit from the kind of collaboration outlined herein. Moreover, not only would such a collaboration allow the world to take a giant step forward in confronting the global climate change challenge, but both the United States and China would indirectly stand to profit immeasurably from it. If their leaders jointly play their cards astutely, the two countries could find themselves in the forefront of a new green-tech economy, and in a stronger, more strategic partnership, better able to help lead the world to meet other 21st century challenges.

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I. Introduction

Of the many issues crowding the international agenda, there is perhaps none so pressing, nor so quintessentially global, as the rising threat of climate change. In its causes and potential consequences, climate change has implications for every inhabitant of every nation on earth. Yet the power to mobilize an effective response rests largely with a handful of nations. There are two in particular without which it will not be possible to find a meaningful remedy. The United States and China—the world's largest developed and developing nations, the two largest energy consumers, and the two largest producers of greenhouse gases—must be partners in any effort to avert catastrophic climate change and usher in a new and prosperous low-carbon global economy.

The advent of a new U.S. administration presents an unparalleled opportunity for a new strategic partnership between the United States and China that promises a more sustainable future for both nations and for the world.[1] The United States and China should develop a sustained cooperative agenda as well as national policies to catalyze a new global strategic transformation to sustainable, low-carbon economic development. Through direct collaboration, the two countries can together advance key technologies and practices that will help to reduce their greenhouse gas emissions, while also addressing their critical energy security needs. The current global economic crisis, far from being a deterrent, should provide even stronger impetus for efforts to develop a low-carbon economy generating green jobs and sustainable growth. At the same time, stronger bilateral collaboration on energy and climate can provide the leadership and momentum needed to achieve a true global climate accord, and build a stronger foundation for future Sino-American cooperation on other strategic challenges facing both nations in the 21st century.

This Report presents both a vision and a concrete Roadmap for this new collaboration. With input from scores of experts, stakeholders, and policymakers from the worlds of science, business, civil society, policy, and politics in China and the United States, the Report explores the climate and energy challenges facing both nations and recommends a program for sustained high-level engagement and on-the-ground action. The Report and its recommendations are based on the following understandings:

Action is Urgent. The United States and China should start now. There is overwhelming scientific consensus that human-induced climate change poses grave economic and environmental risks. Minimizing these risks requires that global greenhouse gas emissions, now rising at an unprecedented rate, peak as soon as possible and decline dramatically over the coming decades. Accomplishing this goal will be feasible only through concerted and sustained action, beginning immediately. The United States and China should not await new domestic legislation or multilateral agreements before launching stronger collaborative efforts.

[1] For a thorough assessment of the politics and prospects of enhancing cooperation between the United States and China on climate change, see Kenneth Lieberthal and David Sandalow, *Overcoming Obstacles to U.S.-China Cooperation on Climate Change*, The Brookings Institution, Washington, D.C., January 2009.

A Path to Energy Security. Climate change is largely a consequence of soaring global energy use, and addressing it requires a fundamental transformation of energy systems worldwide. This transformation presents an unparalleled opportunity to simultaneously address the urgent energy security challenges confronting the United States, China, and other nations by introducing new sources and technologies capable of enhancing the diversity, reliability, and independence of national energy supplies.

New Economic Opportunity. At a time of global economic upheaval, strong efforts to address the twin challenges of climate change and energy security can contribute to economic recovery, while laying the foundation for a prosperous new low-carbon economy. The near-term investments that are needed will produce substantial long-term dividends through sustainable growth and employment. Conversely, delaying these investments will risk severe economic harm and drive up the cost of minimizing the impact of climate change.

Common but Differentiated Responsibilities. As a point of departure, an equitable partnership must be built on a shared understanding of respective responsibilities and capacities. As the world's largest economy and largest historic greenhouse gas emitter, the United States must demonstrate leadership by moving swiftly to reduce its emissions through mandatory national legislation. Although China has now surpassed the United States as the world's largest annual emitter, its cumulative and per capita emissions are much lower, and development and poverty reduction will remain overriding national priorities for the foreseeable future. Having adopted a comprehensive national climate change program, National Climate Change Program, and agreed on the need to reduce its emissions below "business as usual," China must now deliver an ambitious and effective national effort.[2]

Public-Private Engagement. While enhanced U.S.-China cooperation must begin with collaboration between the national governments, success will hinge on each nation's ability to catalyze action by the private sector. Technology can be advanced, financing secured, and critical obstacles overcome only through a combination of bold leadership, ingenuity, expertise, and the mustering of the resources of leading investors, financial institutions, and companies in both the United States and China. But governments will play a critical role in creating the regulatory environment for large-scale private investment in and commercialization of low-carbon technologies through a wide range of tools, from tax incentives and subsidies to regulations and research.

[2] The G5 Statement issued by Brazil, China, India, Mexico, and South Africa on the occasion of the 2008 Hokkaido Toyako Summit, Sapporo, July 8, 2008, says on this point: "We, on our part, are committed to undertaking nationally appropriate mitigation and adaptation actions which also support sustainable development. We would increase the depth and range of these actions supported and enabled by financing, technology and capacity-building with a view to achieving a deviation from business-as-usual. http://www.g8.utoronto.ca/summit/2008hokkaido/2008-g5.html

Cooperating while Competing. Fear of competitive harm has for too long stood as an obstacle to strong climate action. Competition can also be an engine for innovation and low-carbon growth. Under any scenario, companies and industries in the United States and China will remain vigorous economic competitors in the global marketplace. Fashioned carefully, closer collaboration on energy and climate can enhance the economic prospects of both nations while conferring on neither an unfair competitive advantage.

Bilateral Means to Multilateral Ends. Climate change requires a global response, and stronger bilateral cooperation between the United States and China must contribute to, not deter, an effective multilateral climate agreement. By demonstrating global leadership and achieving bilateral practical progress, two of the world's largest economies can help all nations achieve fair and comprehensive agreements under the UN Framework Convention on Climate Change and beyond as envisioned in the Bali Action Plan.

Roadmap Recommendations

On the basis of these principles formulated from the insights and expert guidance of our Senior Advisors and Contributors, this Report recommends that the United States and China undertake a major new program of enhanced collaboration on energy and climate. This program must provide for focused, ongoing engagement between the two leaderships, and must also effectively enlist key players from government, the expert community, and the private sector with a stake in creating a low-carbon future. This new partnership should include the following key elements:

- **Leaders Summit.** Strong, sustained leadership at the highest level is critical to success. As soon as practical following the inauguration of the new U.S. president, the leaders of the two countries should convene a summit to launch a new U.S.-China Partnership on Energy and Climate Change. This agreement should build on current partnerships, including the Ten-Year Energy and Environment Cooperation Framework under the Strategic Economic Dialogue, established by the two countries in June 2008. To ensure sustained attention at the ranking-leader level, energy and climate should be established as a standing agenda item for all future U.S.-China summits. The partnership should proceed on two tracks:

  - **High-Level Council.** High-ranking energy, environment, finance, and foreign policy officials of both countries should meet regularly to establish and review strategic direction for the partnership and to discuss other issues of common concern, including those relating to ongoing multilateral negotiations.
  - **Task Forces.** In each of the priority areas proposed below, a bilateral task force should be established to set goals, develop programs of action, and oversee implementation. The task forces should include senior officials of the relevant departments and ministries, independent experts, and representatives of the business and financial communities and non-governmental organizations.

- **Priority Areas for U.S.-China Cooperation.** Areas where direct collaboration might be expected to yield the strongest return in greenhouse gas emission reduction should be given highest priority. These areas of recommendation, which are discussed in greater detail in Section IV, include:

  - **Deploying Low-Emissions Coal Technologies.** Continuing to rely heavily on coal, as both countries are likely to do, will necessitate large-scale investments in research, pilot projects, and deployment of new technologies to capture and sequester the resulting carbon emissions.
  - **Improving Energy Efficiency and Conservation.** Both the United States and China have significant potential for no-cost, or low-cost, energy efficiency and conservation improvements that offer near-term benefits to both climate and energy security.
  - **Developing an Advanced Electric Grid.** The development of efficient transmission systems and "smart grid" technologies will be crucial for both countries to transition to a secure, reliable electricity system that relies on much larger shares of low-carbon energy sources.
  - **Promoting Renewable Energy.** The broader deployment of solar, wind, and other renewable sources, and expanded development of renewable energy technologies, would help both countries decarbonize their electricity systems and expand their low-carbon economies.
  - **Quantifying Emissions and Financing Low-Carbon Technologies.** To help facilitate cooperation in the above areas, it will be important to continue to jointly address the cross-cutting issues of quantifying and projecting emissions, and financing technology development and deployment.

These recommendations are offered in the belief that stronger cooperation between the United States and China to reduce greenhouse gas emissions and catalyze a new low-carbon economy is necessary, possible, and advantageous. Without setting ambitious goals, identifying new ways to measure progress, sustaining focus from all levels, and, when necessary, recalibrating efforts, neither country, nor the globe, will be able to meet the climate challenges ahead.

II. Catalyzing a Second Strategic Transformation

China and the United States are closely linked through a vast web of economic, political, and security interests and social networks that have deepened and broadened through government-to-government collaboration and through the process of globalization. The result is an interdependent, bilateral relationship in a world in which the fates of all nations are tied ever closer together, as evidenced by the rapid internationalization of the 2008 financial crisis. China and the United States face similar strategic challenges in seeking to strengthen energy security, combat climate change, and ensure economic growth and prosperity. However, neither can fully meet these challenges—nor can the world—without the full engagement of the other.

Nearly four decades ago, a historic *rapprochement* between the United States and China set in motion the most far-reaching transformation of the international economic, political, and security order since the aftermath of World War II. In opening the door to a new strategic relationship in 1972, China and the United States overcame more than 20 years of mutual isolation, ideological rivalry, and intense hostility, inflamed by a hot war in Korea, a near-conflict over Taiwan, and a proxy war in Vietnam. The initial objective of this *rapprochement* was the containment and strategic isolation of the Soviet Union, and one effect was, indeed, to hasten the peaceful demise of the Soviet Union and its Eastern European empire, thereby ending the Cold War and creating the conditions for a more integrated world economy.

The subsequent normalization of U.S.-China relations in 1979 created the international conditions for China's successful opening to the outside world and its market-based economic reforms, leading not only to the extraordinary reemergence of China on the global stage, but to the acceleration of globalization. Despite periodic bilateral tensions and differences, the U.S.-China relationship has contributed significantly to global economic growth and strategic stability, as well as to solving many pressing political and security problems. As China has grown immensely more powerful over the last thirty years, the United States and China have not engaged in a destabilizing strategic competition for regional and global dominance. Rather, leaders in both nations have recognized their increasing strategic interdependence and have effectively collaborated to solve or manage regional and global threats and challenges. For example, since 9/11, the two countries have cooperated quietly and extensively on a wide range of counter-terrorism measures. They have also engaged in sustained and effective collaboration on proliferation, including the Six Party Talks, to eliminate North Korea's nuclear weapons program; establishing collaborative bilateral and international measures, stimulated by the 2003 SARS epidemic and the later emerging danger of avian flu, to prevent and contain pandemics; and consulting at a high level on a daily basis in response to the fall 2008 global financial crisis. In addition, they have effectively handled the volatile Taiwan issue, leading to more hopeful prospects for long-term peace and stability in cross-Strait relations.

In the 21st century, the United States and China now have a chance to catalyze another major transition in the international economic and political order—this time to help facilitate the emergence of a low-carbon global economy. While the European Union has taken the lead, and other major powers are declaring a willingness to act, they will lack the confidence and clout to effect a real global transformation without the participation, leadership, and commitment of the United States and China. The reality is that prospects for a comprehensive new climate agreement, whether later this year in Copenhagen or beyond, rest heavily on the political will of the United States and China.

A new U.S.-China partnership on energy and climate could also help preserve and strengthen Sino-American relations more broadly. As the two economies have become increasingly intertwined, each has become mutually vulnerable to developments within the other, leading to frequent tensions over trade and financial issues. Against that backdrop, climate and energy issues have given rise to further concerns about a loss of competitiveness in the United States and a threat to continued development in China. In this atmosphere, a failure to cooperate could lead to new recriminations over energy and climate change, deepening suspicions of each other's strategic intentions and straining the bilateral relationship in new ways that harm the ability of the two countries to work together on a wide range of issues.

Conversely, if managed successfully, joint U.S.-China stewardship of the climate challenge could strengthen strategic ties by building mutual trust at a time when the American public is becoming increasingly skeptical of the benefits of bilateral economic integration. If U.S.-China cooperation on climate change is aligned constructively with other U.S. and Chinese objectives, it will add a new common interest to the mix and thereby strengthen the Sino-American relationship. Broadening and deepening areas of long-term, mutually beneficial cooperation and strategic trust between the two countries can only strengthen their ability to cooperate effectively in meeting the broad range of strategic challenges of the 21st century.

III. Our Common Challenge

In its global reach, climate change is for China as for the United States—indeed for all nations—a truly common challenge. The actions of these two countries must be ultimately assayed in terms of their adequacy in contributing to an effective global response. But this shared challenge manifests quite differently in different countries: in the level of their contribution to climate change, their vulnerability to its impacts, and in their options and capacity for response. In the case of the United States and China, these differences have important implications for the respective roles and responsibilities each must assume going forward, as well as for fruitful areas for collaboration.

The Climate Trajectory

Climate change is increasingly understood to pose a grave long-term challenge to humankind. Driven primarily by a century and a half of rising fossil fuel combustion, carbon dioxide concentrations in the atmosphere had reached 379 parts per million by 2005, 35 percent higher than pre-industrial levels.[3] Average global temperatures have risen by 0.76 degrees Celsius since the late 1800s, and the effects are evident in extreme weather events, changed weather patterns, floods, droughts, glacial and Arctic ice melt, rising sea levels, and reduced biodiversity.[4] Average temperatures are projected to increase by another three degrees upon a doubling of carbon dioxide concentrations.[5] Even if all emissions were to stop today, the greenhouse gases already accumulated in the atmosphere will remain there for decades to come, resulting in more warming and stronger climate impacts.

Chinese experts have already observed numerous effects of global warming in China that they forecast will only worsen in the future. These include extended drought in the north, extreme weather events and flooding in the south, glacial melting in the Himalayas endangering vital river flows, declining crop yields, and rising seas along heavily-populated coastlines.[6] The Chinese government, already under pressure to address severe local air and water pollution while allowing for continued economic expansion, has begun to acknowledge these climate change-related impacts and has expressed increasing concern

[3] "4th Assessment Report, Working Group I, Summary for Policy Makers," Intergovernmental Panel on Climate Change (IPCC), 2007. Parts per million (ppm) is the ratio of the number of greenhouse gas molecules to the total number of molecules of dry air.
[4] Ibid.
[5] Ibid. The total temperature increase from 1850–1899 to 2001–2005 is 0.76°C [0.57°C to 0.95°C]. When modeling climate system response to sustained radiative forcing, the IPCC states that global average surface warming following a doubling of carbon dioxide concentrations is likely to be in the range 2°C to 4.5°C, with a best estimate of about 3°C.
[6] "National Assessment Report on Climate Change Released," Chinese Ministry of Science and Technology December 31, 2006, http://www.most.gov.cn/eng/pressroom/200612/t20061231_39425.htm. See Lin Erda, Xu Yinlong, Wu Shaohong, Ju Hui, and Ma Shiming, "China's National Assessment Report on Climate Change (II): Climate Change Impacts and Adaptation," http://www.climatechange.cn/qikan/manage/wenzhang/02.pdf; *China's Policies and Actions to Address Climate Change*, Section II: "Impact of Climate Change on China," White Paper released by the State Council Information Office, October 29, 2008, http://www.china.org.cn/government/news/2008-10/29/content_16681689.htm; and "An Overview of Glaciers, Glacial Retreat and Subsequent Impacts in Nepal India and China," *World Wildlife Fund Report*, March 2005.

that climate change will place additional strains on increasingly scarce resources, especially water, that could threaten economic growth.[7]

In the United States, warmer temperatures and shifts in precipitation are already affecting water and land resources, agriculture, and biodiversity. Observed changes include a northward migration of weeds, and increased incidence of forest fires, insect outbreaks, and tree mortality in the west, southwest, and Alaska. Reduced mountain snowpack and earlier spring snowmelt also have been observed across the western United States and are projected to contribute to worsening water shortages. Other projected impacts include reduced livestock production in the summer, a decrease in vegetation in arid lands, increased spread of water- and food-borne diseases, and decreased urban air quality.[8]

Severe and potentially catastrophic climate impacts are forecast around the world for later in the century unless greenhouse gas emissions are dramatically reduced. In its latest authoritative assessment, the Intergovernmental Panel on Climate Change (IPCC) indicated that to keep the average global temperature increase within 2-2.8 degrees Celsius—viewed by many scientists as a minimum threshold for avoiding dangerous climate change—concentrations must be stabilized at 445 to 535 parts per million carbon dioxide-equivalent. This would require that global emissions peak by 2015 or 2020 and decline 50 percent or more below 1990 levels by 2050.

At present, however, emissions are moving in the other direction at an unprecedented rate. The "business as usual" scenario outlined by the U.S. Department of Energy's Energy Information Administration (EIA) projects that the current world trajectory of emissions growth will lead to a 51 percent increase in global carbon emissions between 2005 and 2030.[10]

Reversing these trends and cutting emissions in half by 2050 presents a daunting technological challenge. Nations now heavily dependent on fossil fuels to power their vehicles, homes, factories, and offices must effectively "decarbonize" their energy systems. According to a recent analysis by the International Energy Agency, this challenge would require average *annual* global deployment over the next 40 years of 55 fossil-fueled power plants with carbon capture and storage (CCS), 32 nuclear plants, 17,500 large wind turbines, 215 million square meters of solar panels, and more than 20 million electric-powered or hydrogen fuel cell vehicles.[11]

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[7] "China's National Climate Change Program," National Development and Reform Commission, June 2007. See also Pan Yue, "Green China, Young China," www.chinadialogue.net.

[8] "The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States," U.S. Climate Change Science Program, May 2008, http://www.climatescience.gov/Library/sap/sap4-3/final-report/Synthesis_SAP_4.3.pdf, and U.S. Climate Change Science Program, "Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems," May 2008, http://www.climatescience.gov/Library/sap/sap4-6/final-report/sap4-6-brochure-FAQ.pdf.

[9] A recent analysis, which asserts that carbon dioxide accumulation has already reached 385 ppm, maintains that even this level of accumulation may pose significant climate dangers. See James Hansen, Makiko Sato, Pushker Kharecha, David Beerling, Robert Berner, Valerie Masson-Delmotte, Mark Pagani, Maureen Raymo, Dana L. Royer, and James C. Zachos, "Target Atmospheric CO_2: Where Should Humanity Aim?", *The Open Atmospheric Science Journal*, vol. 2, 2008, pp. 217-231.

[10] "International Energy Outlook 2008," Energy Information Administration, June 2008, http://www.eia.doe.gov/oiaf/ieo/index.html.

Energy, Emissions, and National Circumstances

The United States and China are the two largest emitters of energy-related greenhouse gas emissions and together account for over 40 percent of all emissions worldwide.[12] In historic terms, the United States is by far the largest contributor to the greenhouse gases now burdening the atmosphere, responsible for 29 percent of energy-related CO_2 emissions since 1850. China accounts for only about eight percent of these historic emissions. But as its economy has boomed, its emissions have soared, and it recently surpassed the United States as the world's largest annual emitter. In 2007, by some estimates, emissions were 14 percent higher in China than in the United States.[13]

Behind these large numbers, however, lays a gulf of differences between the two top emitters. They differ in their stages of development, economic structures, political systems, resource endowments, emission drivers, and opportunities for emission reduction. To begin with, China's population is more than four times the size of the United States', and its per capita emissions are 78 percent lower (although China's *per capita* emissions are growing at a rate four to six times as fast as those of the United States). Despite China's rapid economic ascendancy, it remains a developing country (albeit a strong, emerging economy), with a per capita income 30 percent lower than the world average, and an enormous rural population living on far less.

As more and more Chinese enter the middle class in the coming decades, more cars and bigger homes will account for a growing share of the country's emissions. But at present, China's emissions are dominated by heavy industry. China today produces about 35 percent of the world's steel, 50 percent of its cement, and 28 percent of aluminum manufactured worldwide. Steel alone emits more CO_2 than all Chinese households; the chemical industry uses more energy than all the cars on China's roads; and aluminum smelters consume more electricity than the entire commercial sector.[15] While some of these products are exported, the vast majority are consumed domestically.

In the United States, a principal driver of increasing emissions remains population

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[11] "Energy Technology Perspectives 2008: Fact Sheet – The Blue Scenario," International Energy Agency Paris, June, 2008, http://www.iea.org/Textbase/techno/etp/fact_sheet_ETP2008.pdf. The IEA report points to the urgency, scale, and cost of responding to the IPCC challenge: "To meet the most ambitious IPCC scenario aimed at keeping temperature increases below 2.4°C, global CO_2 emissions would need to be halved by 2050 compared to their current levels. … Total additional investment needs for the period 2010-2050, on top of the investments in the Business-as-usual scenario, amount to USD $45 trillion. … A significant discrepancy exists between current developments and the BLUE scenario targets. We will need in the coming decade a global revolution in the way we produce and use energy, with a dramatic shift in government policies and unprecedented co-operation amongst all major economies."

[12] Energy-related CO_2 emissions make up approximately 80 percent of total of such emissions to the atmosphere.

[13] "China Contributing Two Thirds to Increase in CO_2 Emissions," Netherlands Environmental Assessment Agency press release, June 13, 2008, http://www.mnp.nl/en/service/pressreleases/2008/20080613ChinacontributingtwothirdstoincreaseinCO2emissions.html.

[14] Trevor Houser, "China's Energy Consumption and Opportunities for U.S.-China Cooperation to Address the Effects of China's Energy Use," testimony before the U.S.-China Economic and Security Review Commission, June 14, 2007, http://www.uscc.gov/hearings/2007hearings/written_testimonies/07_06_14_15wrts/07_06_14_houser_statement.php.

[15] Trevor Houser, Rob Bradley, Britt Childes, Jacob Werksman, and Robert Keilmayr, "Leveling the Carbon Playing Field: International Competition and US Climate Policy Design," Peterson Institute for International Economics and World Resources Institute, May 2008.

growth; population and emissions have grown 19 percent and 16 percent, respectively, since 1990. Already well advanced on the development curve, Americans generate high levels of greenhouse gas emissions on a per capita basis, about four times the world average, and twice the typical European or Japanese. Unlike in China, U.S. emissions stem more from consumption than production. Industry accounts for just 25 percent of U.S. emissions, with most of the rest coming from transportation and commercial and residential energy use.

Generally, energy intensity declines as a country develops and becomes more efficient in its energy use. The United States made significant gains following the 1970s oil shocks, attributable in part to the decline of heavy industry and growth of the services sector, but about two-thirds of the savings has been attributed to improvements in energy efficiency.[16] But the rate of efficiency improvement has slowed in recent years, and U.S. energy intensity remains well above that of Europe and Japan.

As part of its economic growth strategy, China was until recently making extraordinary gains in reducing energy intensity. From 1980 to 2000, China quadrupled its GDP, pulling millions out of poverty, while merely doubling the amount of energy it consumed—a dramatic improvement in energy intensity unparalleled in any other country at a similar stage of industrialization. However, this trend of decreasing energy intensity reversed between 2002 and 2005, with energy growth surpassing economic growth for the first time in decades. By 2006, China's energy demand had grown more in just four years than it had during the previous quarter-century, accompanied by a very rapid increase in greenhouse gas emissions. China is currently four times as energy intensive as the United States and nine times less efficient than Japan.[17]

Perhaps the strongest similarity between China and the United States is their heavy reliance on coal; they are, respectively, the world's largest and second largest producers and consumers of coal in the world. This is especially important in the climate context, because coal is the most carbon-intensive energy source commonly used worldwide. In the United States, which has the world's largest coal reserves, coal fuels 22 percent of primary energy and 49 percent of electricity generation. The share of coal used in electricity generation has been relatively level in the United States for the past decade, and the amount of new coal power capacity proposed in the United States has actually declined in recent years. Indeed, in 2007 and 2008, more wind power capacity will be built in the United States than new coal capacity.[18]

China, with 11 percent of the world's proven coal reserves, produces and consumes about twice as much coal as the United States, and it relies on coal for over two-thirds of

[16] Howard Geller and Sophie Attali, "The Experience with Energy Efficiency Policies and Programmes in IEA Countries: Learning from the Critics," International Energy Agency, 2005.
[17] "International Energy Annual 2005," Energy Information Administration, U.S. Department of Energy, October 1, 2007. Table 1g: World Energy Intensity—Total Primary Energy Consumption per Dollar of Gross Domestic Product Using Market Exchange Rates, 1980-2005.
[18] "Planned Nameplate Capacity Additions from New Generators, by Energy Source," Electric Power Annual, Energy Information Administration, U.S. Department of Energy, October 22, 2007, http://www.eia.doe.gov/cneaf/electricity/epa/epat2p4.html.

its energy needs, including approximately 80 percent of its electricity generation. Moreover, the share of coal burned in China's electricity mix has grown in recent years, despite government efforts to diversify the supply with hydropower, nuclear power, and renewable power. In 2006 and 2007 alone, China added about 170 gigawatts (GW) of new coal-fired power plants, more than in the previous six years. Currently, there are more coal-fired power plants in China than in the United States, the United Kingdom, and India combined. Finally, China's coal power use is expected to more than double in size by 2030, generating an additional 86 billion tons of carbon emissions.[19]

Apart from its heavy contribution to climate change, use of coal also presents a serious environmental and public health threat in China. Coal combustion produces a range of harmful air pollutants, including sulfur dioxide, nitrogen oxides, particulate matter, and mercury, as well as significant water pollution. Combustion is the source of 85 percent of the country's SO_2 emissions, which cause acid rain and are responsible for RMB 30 billion ($4 billion) in crop damage and RMB 7 billion ($1 billion) in material damage annually.[20] Although the Chinese government has adopted relatively stringent regulations to reduce coal-related emissions, implementation lags and enforcement is often lax, in part because running pollution control equipment reduces the net power output of a power plant, resulting in lost revenue for power producers.

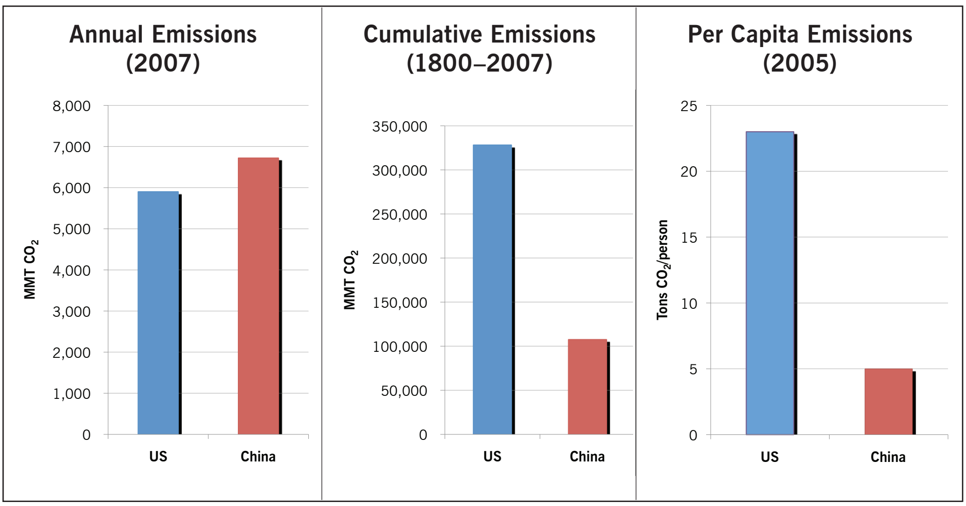
The mining of coal also poses serious environmental and health dangers. The thousands of small mines that produce about a third of China's coal supply, many of them illegal, unregistered, and unregulated, are a major source of air, water, and land pollution.[21] Coal mining and washing can result in overuse of groundwater and a consequent lowering of water tables. This is a particular problem in the already water-scarce regions of northwest China, where mining has been a contributing factor in growing desertification.[22] Mine safety is also a major issue: in 2005, there were 3,306 coal mine accidents in China resulting in 5,938 deaths.[23] A recent study estimates the total environmental costs of coal to China at RMB 1,745 billion ($250 billion) in 2007, equal to 7.1 per cent of China's GDP for that year.[24]

Despite the many differences between the social and economic circumstances of China and the United States, they, like other nations, are confronted with some core common challenges. On the climate front, the challenge is to make economies less energy-intensive and energy systems less carbon-intensive. On the energy security front, the challenge lies in maximizing the supply of sustainable, reliable, affordable, domestic energy. In many

[19] "International Energy Outlook 2007," Chapter 5, Energy Information Administration, U.S. Department of Energy, May 2007, , http://www.eia.doe.gov/oiaf/ieo/index.html.
[20] Cost of Pollution in China, World Bank and China State Environmental Protection Administration, February 2007.
[21] Yang Yang, "A China Environmental Health Project Research Brief: Coal Mining and Environmental Health in China," Wilson Center China Environment Forum, April 2, 2007. Available at http://www.wilsoncenter.org/topics/docs/coalmining_april2.pdf.
[22] Ibid.
[23] Mao Yushi, Sheng Hong, and Yang Fuqiang, "The True Cost of Coal," Greenpeace and the Energy Foundation China Sustainable Energy Program, October 2008.
[24] Ibid.

areas, these two objectives are clearly complementary. For instance, both China and the United States can greatly improve their energy efficiency, which by reducing energy demand, would curb emissions and strengthen energy security. Similarly, an expansion of renewable energy would address both challenges by providing clean, domestic energy alternatives. Reconciling the climate and energy security agendas is more difficult, however, in the case of coal. As a plentiful domestic energy source, coal seems certain to remain a mainstay of both economies' energy systems. But to effectively address climate change, while continuing to rely on coal, will require large-scale investments in technology and infrastructure, a process that can only be made more transformational by new forms of bilateral cooperation.

Figure 1. United States and China: Annual and Cumulative Emissions[25]



[25] Data sources: "CO_2 Emissions From Fossil Fuels," Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center (CDIAC), 2007; The Netherlands Environmental Assessment Agency (MNP), 2007; Statistical Review of World Energy, BP; IEA, 2007; World Bank database (population data), 2007; CDIAC-ORNL, MNP, BP, USGS (cement), IEA, World Bank.

Figure 2. United States and China: Energy Intensity Trends (1980-2005)[26]

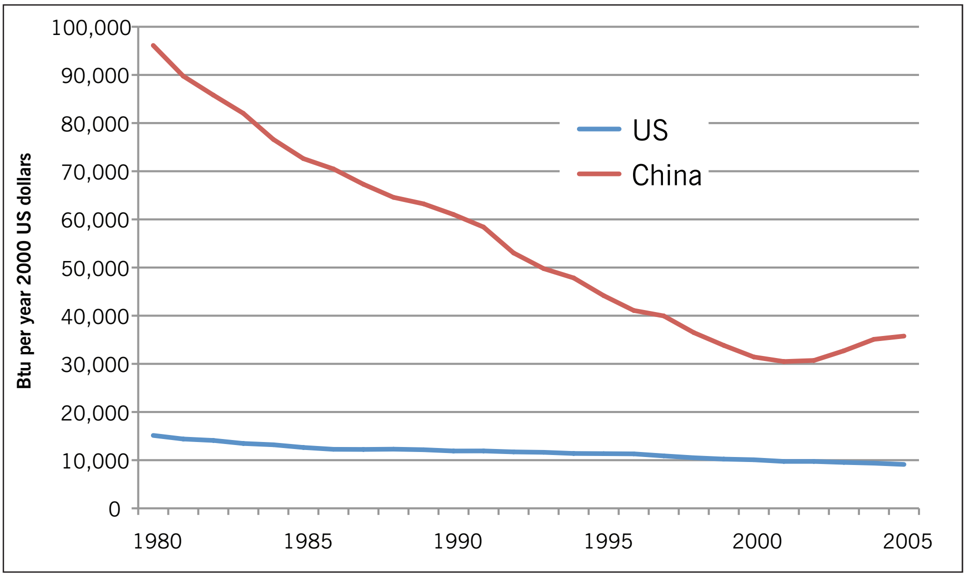
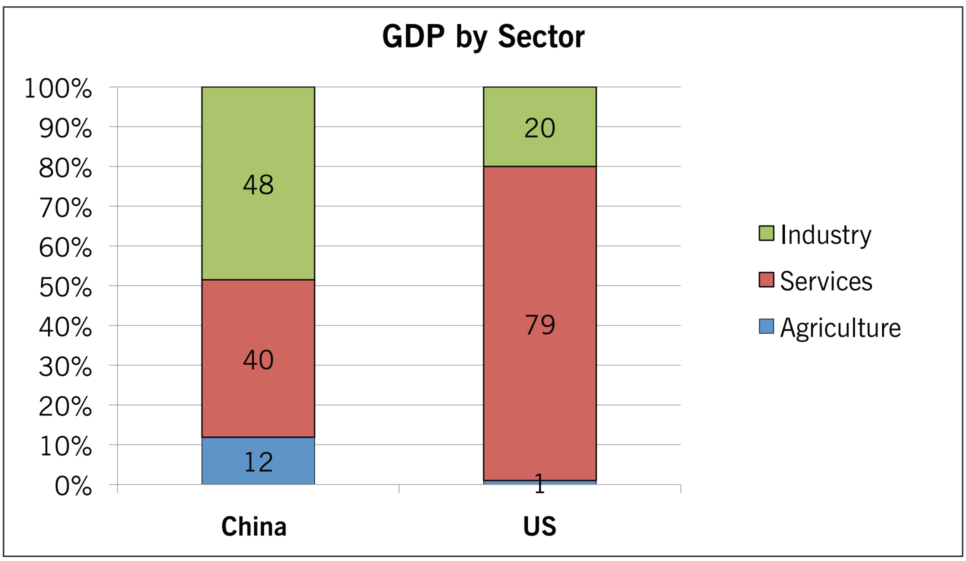


Figure 3. GDP, Energy Demand and CO_2 Emissions by Sector: United States and China[27]



[26] Data source: "International Energy Outlook, 2007," Energy Information Administration, U.S. Department of Energy.
[27] Sources: "CO_2 Emissions from Fossil Fuel Combustion," International Energy Agency; Daniel Rosen and Trevor Houser, "China Energy: A Guide for the Perplexed," Peterson Institute of International Economics, 2007. Most data from 2005.

Figure 3. (continued)

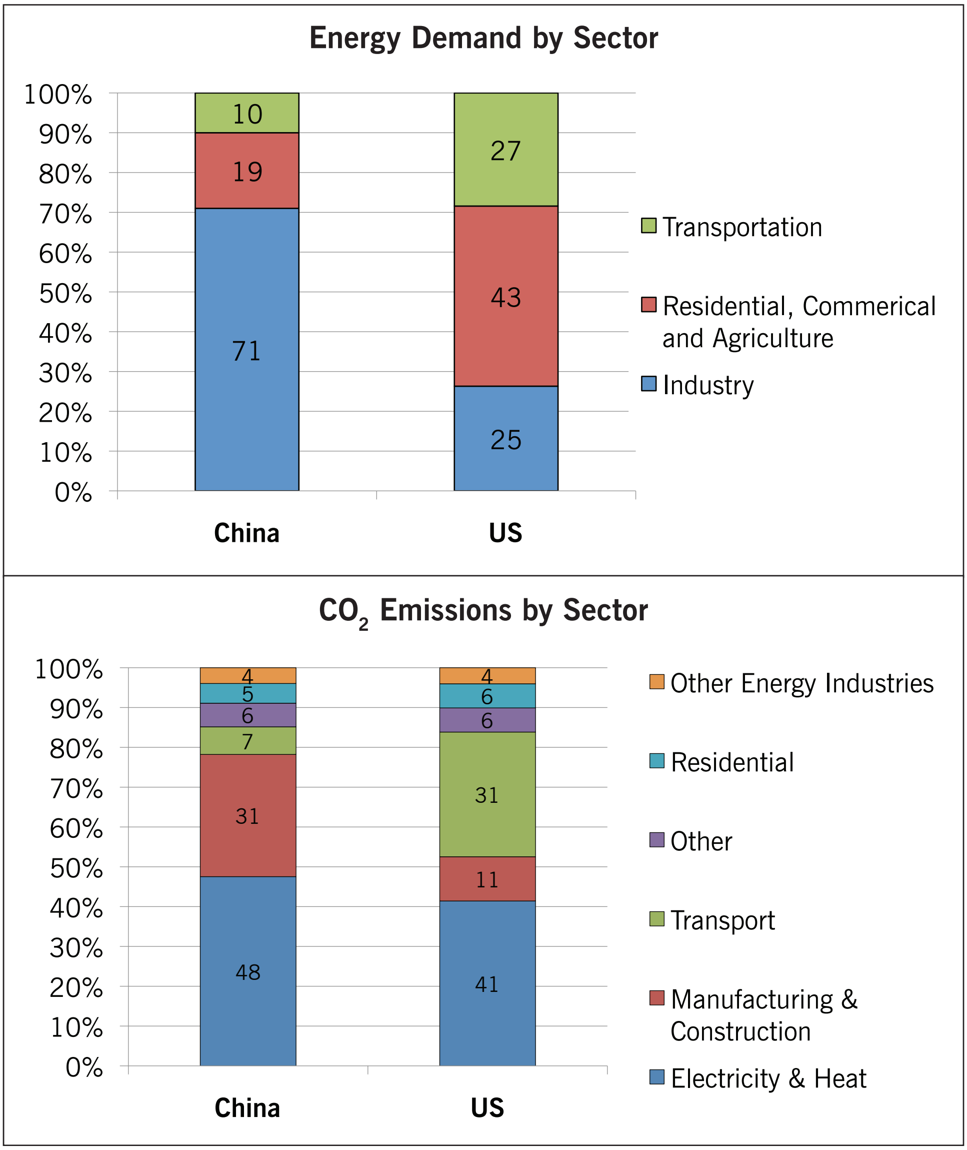
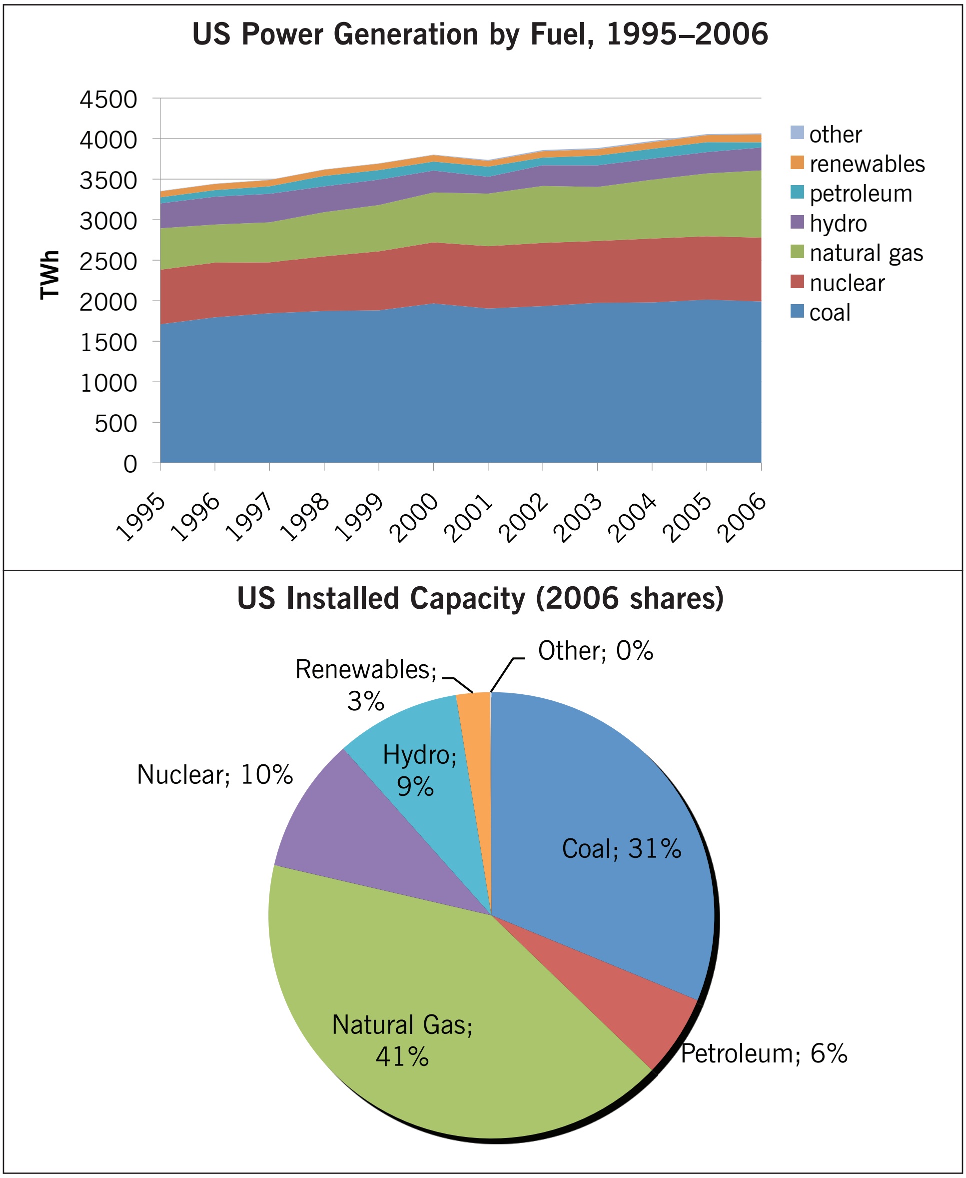
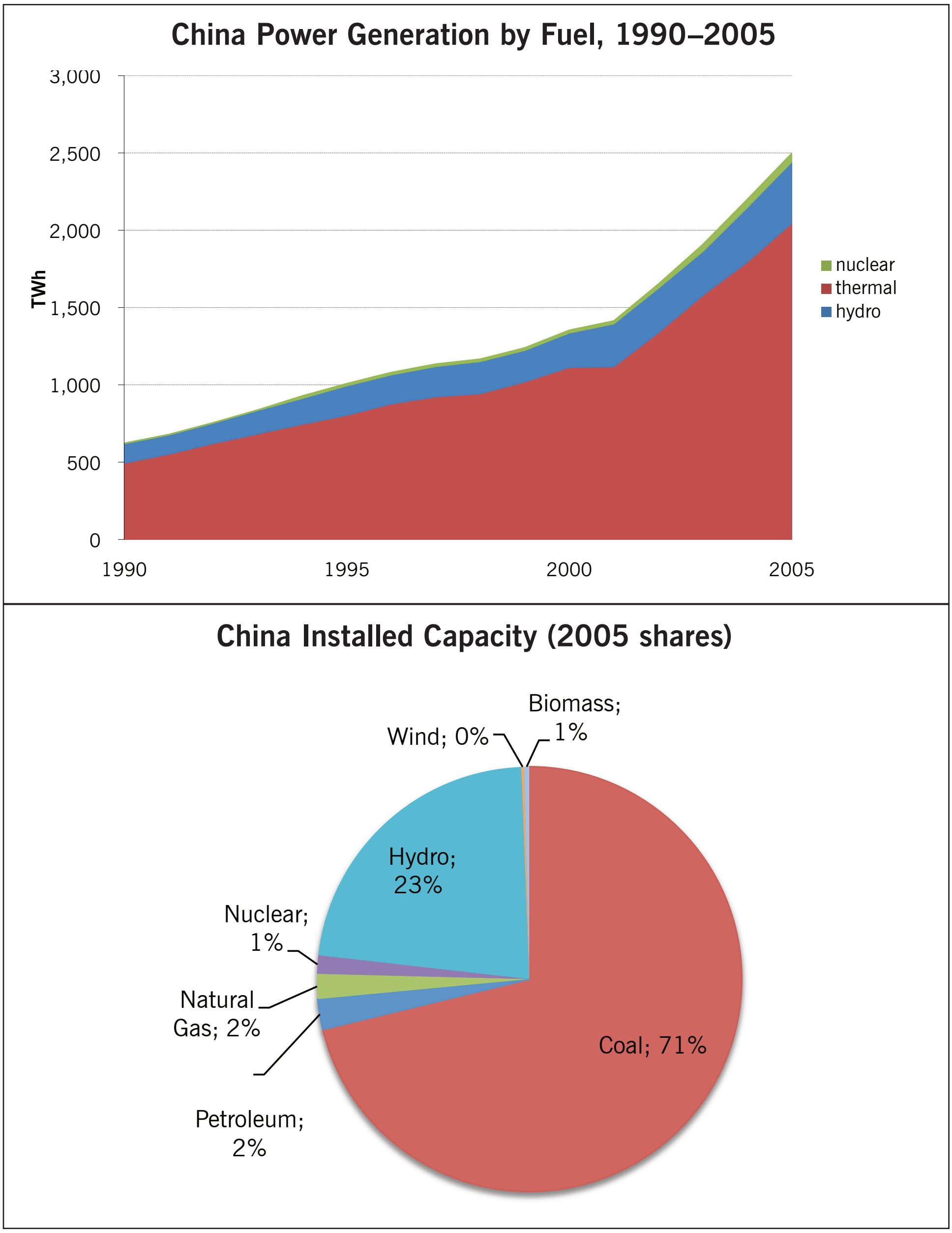


Figure 4. U.S. Power Sector[28]



[28] U.S. Department of Energy, Energy Information Administration, Electricity Data (2008), available at http://www.eia.doe.gov/fuelelectric.html.

Figure 5. China's Power Sector[29]



[29] Note: Renewable electricity (including wind and biomass) represented less than 1 percent of power generation in 2005. Sources: *China Energy Databook, China Energy Group, Lawrence Berkley National Laboratory, Energy Statistics Yearbook*, United Nations Statistics Division, 2005; "World Energy Outlook 2007," International Energy Agency.

Efforts to Date

While neither the United States nor China has yet undertaken efforts of the scale needed to contain global emissions, both countries, sometimes in collaboration, have taken some important initial steps.

In the United States, the federal government has a long track record of support for climate science and technology research initiatives, but it has not undertaken comprehensive or mandatory efforts to reduce U.S. greenhouse gas emissions. Significant reduction efforts have emerged at the state level, however. Twenty-four of the 50 states are now participating in regional initiatives to reduce emissions through cap-and-trade systems:

- The Northeastern States' Regional Greenhouse Gas Initiative recently conducted its first auction of emission allowances.
- California has set a mandatory goal of reducing emissions to 1990 levels by 2020, and has joined six other states (and four Canadian provinces) in the Western Climate Initiative to establish a regional cap-and-trade system with the same goal.
- A similar collaborative effort is underway in the Midwest.

Spurred in part by these state efforts, Congress has begun seriously debating the design of a national cap-and-trade system and other policies to reduce emissions economy-wide. A range of proposed legislative measures that aim to reduce emissions 60 percent to 80 percent by 2050 await congressional action. One of the major challenges before the new U.S. Administration is how best to regulate emissions at the national level in the context of a comprehensive energy and climate strategy.

In China, the government has adopted a National Climate Change Program outlining an array of programs and policies helping to address climate change in the areas of energy efficiency, renewable energy, nuclear power, land use and forestry, and technology development.[30] Domestic policies that could achieve significant greenhouse gas reductions include a national target to reduce energy intensity by 20 percent from 2005 levels by 2010, and a target for 16 percent of electricity to come from renewable energy sources by 2020. In addition, several energy-intensive products are no longer eligible for a Value Added Tax (VAT) refund on exports, creating a disincentive for exporting energy-intensive products from China.[31]

Most, if not all, of these policies have been driven primarily by non-climate related objectives such as economic growth, improved air quality, and energy security. But each makes an undeniable contribution to reducing greenhouse gas emissions growth, with the government often providing specific estimates of projected emission savings. The National

[30] See Joanna I. Lewis, "China's Strategic Priorities in International Climate Change Negotiations," *The Washington Quarterly*, Winter 2007-2008.

[31] "Client Alert: China Adjusts Export VAT Refund Rates," Baker & McKenzie, June 2007, http://www.bakernet.com/NR/rdonlyres/FAF9847C-3EDE-4EF9-BA9C-DF073B3C9DE6/0/china_exportvat_ca_jun07.pdf

Climate Change Program outlines additional policies to be undertaken, and areas where China's efforts would benefit from international cooperation.

For nearly 30 years, the United States and China have collaborated in a wide array of energy and environmental initiatives.[32] This cooperation has led to a much deeper mutual understanding of each country's circumstances and concerns, facilitated valuable exchanges of information and best practices, and forged important ties between leading research institutions. Too often, however, cooperation has been miscellaneous and episodic rather than sustained. It has also been undermined by insufficient funding, shifting policy priorities, and failure to significantly "scale-up" promising projects. The cancellation or down-scaling by the United States of key projects have led to an understandable skepticism in China on the prospects for stronger long-term cooperation. Recent examples include the expiration and eventual renewal of the U.S.-China Protocol on Energy Efficiency and Renewable Energy, and the postponement and significant restructuring of the FutureGEN project to build a commercial-scale advanced generation coal plant with carbon capture and storage, in which China was a partner.[33]

With sustained high-level support, however, these past cooperative efforts could serve as the foundation for a new partnership between the United States and China, one that capitalizes on each country's individual strengths to address common challenges and yield mutual benefits. The following sections recommend key areas and concrete means of collaboration.

[32] See Appendix 1: Timeline of Government Initiatives for U.S.-China Energy and Climate Change Cooperation, at the end of this Report.

[33] "U.S. and China Announce Cooperation on FutureGen and Sign Energy Efficiency Protocol at U.S.-China Strategic Economic Dialogue," U.S. Department of Energy Press Releases, December 15, 2006, http://www.energy.gov/news/4535.htm; and January 30, 2008; "DOE Announces Restructured FutureGen Approach to Demonstrate Carbon Capture and Storage Technology at Multiple Clean Coal Plants," http://www.fossil.energy.gov/news/techlines/2008/08003-DOE_Announces_Restructured_FutureG.html.

IV. A Collaborative Response

In the realm of energy and climate, there are countless areas where deeper cooperation between the United States and China could reap benefits for both countries and for the international community. Given limited resources, however, and the urgency of mobilizing effective action, it is critical that a new U.S.-China partnership on climate and energy be not only strategically targeted but also well coordinated. Of highest priority should be those areas that:

a) have the greatest potential for reducing emissions and strengthening energy security;

b) would benefit most from direct collaboration.

1. Deploying Low-Emissions Coal Technologies

Because of the energy security benefits it provides each country, the United States and China have a shared interest in developing a low-carbon means of continuing to rely on coal as a major energy source.

The United States and China share a uniquely common interest in devising strategies to allow them to continue their reliance on coal in a carbon-constrained world. Given the substantial domestic coal reserves in each country and their heavy investment in coal-based electrical generating capacity, coal will likely remain an inescapable mainstay of their economies for decades to come. To render coal a climate-friendly energy source, however, will require significant advances and sustained investment in new technologies to burn it more efficiently as well as to capture and sequester the resulting greenhouse gas emissions.

In the near term, the priority is to ensure that new plants being deployed are high efficiency, and that existing plants run as efficiently as possible. In China, the average efficiency of coal power plants is rapidly catching up to that of developed countries as new, larger units come online and smaller, less-efficient units are shut down. It is estimated that the average efficiency of China's coal-fired fleet was 32 percent in 2005, but is expected to approach 40 percent by 2030 as more large supercritical units come online and older subcritical units are phased out.[35] While China already has a few state-of-the-art ultra-supercritical power plants and coal gasification plants, and an increasing number of supercritical plants are coming online (20 percent of those newly built in 2006), the majority of new plants being deployed in China are still subcritical plants.

In the United States, the majority of existing coal plants were built before 1989 using subcritical pulverized coal technology. While many new coal plants in the approval stage propose using integrated gasification combined cycle (IGCC) and supercritical

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[34] Other areas that were not prioritized in this Report but are important for collaboration include nuclear energy and transportation technologies.

[35] "CO_2 Emissions from Fossil Fuel Combustion," International Energy Agency, op.cit.

technology, the majority of projects in the pipeline still plan to use less efficient subcritical technology.[36]

In both countries, there are clearly opportunities to deploy higher efficiency, commercially available coal power technologies for new plants. In addition, the efficiency of existing coal plants can often be substantially improved through a variety of technical and institutional changes, including the use of higher quality coal, improved plant operation, better maintenance and management practices, and new incentives for greater efficiency (e.g., through routinely auditing plant efficiency and rewarding improvements).

Though not yet commercially available for widespread use in coal-fueled power plants, existing technologies could be used to prevent most of the CO_2 emissions from large-scale combustion or gasification from entering the atmosphere. Such technologies, referred to as carbon capture and sequestration, or CCS, involve separating CO_2 from other exhaust gases, compressing the "captured" CO_2, and transporting it through pipelines for storage in deep, underground geological formations such as depleted oil wells. It is estimated that over 99 percent of CO_2 properly injected into geologic formations will remain there for one thousand years.[37] The capture process can be done pre-combustion along with coal gasification, or post-combustion in pulverized coal plants through either chemical separation or by burning coal in pure oxygen (Oxyfuel capture). However, many of these capture processes and technologies are still in the early stages of development, although several gasification plants have recently been deployed in the United States, and a few demonstration projects are now planned in China.

The United States currently has no complete CCS demonstration projects in operation, although the U.S. Department of Energy (DOE) is planning to support an IGCC demonstration plant with CCS through its FutureGEN program. China, however, is planning several CCS demonstration projects including GreenGen (a 400-megawatt IGCC plant with CCS being added in phase three by 2020),[38] and the Near Zero Emission Coal (NZEC) partnership between China, the European Union, and the United Kingdom, with the goal of having a coal plant with CCS online by 2020).[39]

China's Huaneng Power Company, in cooperation with the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO), has also launched a post-combustion carbon capture project (without storage).[40] Several pilot CO_2 geologic storage projects are also underway in the United States and China, including ones used for

[36] "Tracking New Coal Fired Power Plants," National Energy Technology Laboratory, June 30, 2008, http://www.netl.doe.gov/coal/refshelf/ncp.pdf.
[37] *Carbon Dioxide Capture and Storage*, IPCC, 2005.
[38] Xu Shisen, "Green Coal-based Power Generation for Tomorrow's Power," Thermal Power Research Institute, presentation to the APEC Energy Working Group: Expert Group on Clean Fossil Energy, Lampang, Thailand, February 24, 2006.
[39] "EU-China Summit: Joint Statement," European Commission, September 5, 2005, http://ec.europa.eu/comm/external_relations/china/summit_0905/index.htm; UK Department of Environmental, Food and Rural Affairs, 2005, http://www.defra.gov.uk/environment/climatechange/internat/devcountry/china.htm.
[40] "Carbon Capture Milestone In China," *ScienceDaily*, August 4, 2008, http://www.sciencedaily.com/releases/2008/07/080731135924.htm

enhanced oil recovery (EOR) in depleted oil wells. Assessments show that the United States has extensive potential carbon storage capacity in geologic reservoirs throughout the country.[41] Some initial assessments of storage capacity have been performed in China, but far more detailed assessments are needed before CCS can become more than an idea.

An ultimate goal in both countries must be the commercialization and widespread deployment of carbon capture-and-storage technology. As a critical first step, experts recommend that 10 to 15 large-scale demonstration projects be developed in a variety of settings around the world over the next decade.[42] As China is currently building two large coal-fired power plants a week and is projected to account for as much as 46 percent of global coal demand by 2030, its participation in any such global effort is critical, both to reduce its emissions and to achieve economies of scale large enough to bring down the cost. But key hurdles in meeting this challenge include the large incremental cost and the "energy penalty" of running the capture equipment, which can reduce a plant's combustion efficiency up to 30 percent. This penalty would essentially mean that China would need to build three coal plants a week rather than two to generate the same amount of electricity. China also is wary of pressure to demonstrate and adopt a technology not yet in commercial use in the developed world.

Recommendations

- **Conduct Joint CCS demonstrations.**

  The United States and China should conduct carbon capture and storage demonstration projects in both countries with the goal of jointly assessing their cost, viability, and effectiveness.

The United States and China should initiate a major new coordination of their joint and separate demonstration projects to ensure that they collectively embrace the full spectrum of power generation and capture technologies in as many different sequestration geologies as possible. Both governments should establish a sizable and reliable source of public and private funding to immediately begin the construction of new CCS demonstration projects. Proposals for specific demonstration configurations should come from the private sector, with requirements made for data sharing between both Chinese and U.S. scientists to better understand the performance of the project.

Siting decisions for demonstration projects should be done on a domestic basis, with each national government taking on the liability associated with gas storage or the decommissioning costs in order to best reduce investment risk. Demonstration projects should aim to achieve low-carbon fuel cycles, not just components that are individually attractive, such as enhanced oil recovery. Complete life-cycle emissions assessments should

[41] *Carbon Sequestration Atlas of the United States and Canada*, National Energy Technology Laboratory 2007.
[42] *The Future of Coal*, Massachusetts Institute of Technology, 2007.

then be used to rate and evaluate the demonstration projects.[43]

The funding for these demonstration projects can come from a variety of sources and mechanisms, including through the levying of charges on fossil fuel-generated electricity from plants that do not deploy CCS, or through premium payments for "green electricity" made by companies. In the United States, further experimentation with CCS could be financed through a portion of the value of carbon allowances generated in a future "cap and trade" program to regulate carbon emissions. In China, funding could be generated through international offsets (although CCS is not presently recognized under the Kyoto Protocol's Clean Development Mechanism). China could also opt to utilize development bank loans. In any case, each government would have to experiment with how it might offer the most favorable loan terms to finance CCS demonstration projects using the most promising foreign or domestic technologies.

Once demonstration projects have provided operational experience, a joint assessment of the effectiveness of the projects should be conducted so that the United States and China could then jointly make further key decisions surrounding the future viability, replicability, and scalability of CCS.

- **Ensure any coal plants deployed are high-efficiency.**

  In order to increase the efficiency of existing power plants, and ensure that new plants utilize high-efficiency coal technologies, the United States and China should jointly assess and undertake immediate policy options to create new incentives for these practices.

The United States and China should form a joint government-industry alliance with the specific goal of determining how to ensure that additional coal-fired power plants deployed in either country use high-efficiency coal power, and even CCS technology. Government and industry should offer information about the existing costs and risks associated with advanced pulverized coal and coal gasification technology. Then, governments in both countries should examine relevant policy models to provide co-funding to buy down the technical and financial risks associated with technology advancements in their own countries.

- **Develop regulatory frameworks for CCS to facilitate timely deployment.**

  The United States and China should jointly develop best safety standards and technical practices in national policy design for CCS to facilitate timely deployment.

[43] In addition to the ongoing bilateral governmental cooperation between the United States and China on coal described in Appendix I, there are many non-governmental and academic initiatives, including the Energy Foundation China Sustainable Energy Program's work with Institute of Engineering Thermophysics of the Chinese Academy of Sciences to develop policies and incentives that accelerate the development and demonstration of IGCC technologies with CCS. In addition, researchers at Harvard University's Kennedy School of Government are working with the China Ministry of Science and Technology and the Chinese Academy of Sciences on advanced coal policy and economics. See http://belfercenter.ksg.harvard.edu/project/10/energy_technology_innovation_policy.html?page_id=166.

Regulations governing CO_2 storage should provide the level of predictability that project developers need to make investment decisions. Regulations should also be adaptable to new knowledge gained though joint experience with CCS demonstrations that relates to protecting human health and safety, ecosystems, underground sources of drinking water, and other natural resources.[44]

- **Map geological storage.**
  The United States and China should undertake joint efforts to conduct more extensive mapping of geological storage to directly support the future deployment of CCS.

Public-private collaborations in each country should be encouraged in the mapping of storage sites so that data can be made readily available to governments in both countries as they engage in future capacity planning.

- **Conduct joint R&D on new CCS technologies**
  The United States and China should initiate a major new joint research and development project on innovative CCS technologies.

In addition to the commercial-scale demonstration of existing technologies, U.S. and Chinese scientists and engineers should be supported in a coordinated series of publicly- and privately-funded research collaborations to jointly develop more advanced and innovative CCS technologies that could be used in both countries. While initial demonstration projects will utilize CCS technologies that were primarily developed for other applications, efficiency and performance gains may be achievable with further research in the context of coal-fired industrial plants. Models for the sharing of useful outputs among the researchers of both countries, including intellectual property, technical know-how, and on-the-ground practice should be encouraged and broadened.

2. Improving Energy Efficiency and Conservation

To reduce greenhouse gas emissions, enhance national energy security, and save money, the United States and China both need to prioritize and expand energy efficiency and conservation efforts.

In the near term, the most significant step that the United States and China can take to reduce their emissions and enhance their energy security is to reduce energy demand through greater efficiency and conservation. In many cases, these efforts also promise significant economic benefits, with only modest upfront investments returning substantial long-term savings through lower energy costs.

[44] A stakeholder process that has worked to inform such regulations in the United States is the World Resources Institute CCS Guidelines Process, http://www.wri.org/project/carbon-capture-sequestration.

Indeed, energy efficiency measures are often characterized as “negative cost” opportunities, meaning that they result in positive economic returns over the lifetime of the investment. A recent McKinsey study estimates that 40 percent of emissions abatement opportunities in the United States could be achieved at “negative” cost by, for instance, improving building insulation and lighting, and by using more fuel-efficient vehicles and appliances.[45] However, these potential gains often remain unrealized because of market inefficiencies, lack of information, government neglect, and shortages of upfront capital. More targeted government policies are needed in both countries to overcome these market barriers.

China has made enormous strides through comprehensive national programs to improve energy efficiency. From 1980 to 2000, China was able to quadruple its GDP while only doubling its energy consumption, an unprecedented achievement in any country’s development history. Achieving the government’s current goal of reducing national energy intensity 20 percent below 2005 levels by 2010 would translate into an annual greenhouse gas reduction of more than 1.5 billion tons, making it one of the most significant carbon mitigation efforts in the world.[46] After signs of inadequate progress toward achieving these objectives, the central government recently stepped up efforts to set and enforce corresponding goals at the local level, where much of the slippage was occurring.[47]

Related efforts in China include programs to improve energy efficiency in the country’s largest industrial enterprises and to retire older, inefficient power plants and factories.[48] In the construction and industrial sectors, China’s 1997 Energy Conservation Law initiated a range of programs to increase energy efficiency in buildings, industry, and consumer goods, many of which were modeled after U.S. programs.

In the transport sector, China’s fuel economy standards for its rapidly growing passenger vehicle fleet are now more stringent than those in Australia, Canada, and the United States (although they are less stringent than those in the European Union and Japan). The average fuel economy of new vehicles is projected to reach 36.7 miles per gallon in 2008.[49] However, in the trucking sector, standards are still low, leaving much room for improvement.

Though the U.S. federal government lacks a comprehensive, mandatory efficiency program, individual states have implemented efficiency policies such as incentives and targets. In many cases, state policies have been created to implement efficiency initiatives

[45] “Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?”, McKinsey & Company and The Conference Board, 2007, http://www.mckinsey.com/clientservice/ccsi/pdf/U.S._ghg_final_report.pdf.
[46] Jiang Lin, Nan Zhou, Mark Levine, and David Fridley, “Taking Out 1 Billion Tons of CO_2: The Magic of China’s 11th Five Year Plan?”, *Energy Policy*, no. 36, 2008.
[47] Mure Dickie and Richard McGregor, “Jiangsu Sets the Pace on How to Assess Officials,” *Financial Times*, March 15, 2007; “Chinese Officials Face Scrutiny over Failure to Meet Emission Targets,” Xinhua News Agency, November 29, 2007.
[48] Lynn Price and Xuejun Wang, “Constraining Energy Consumption of China’s Largest Industrial Enterprises Through Top-1000 Energy-Consuming Enterprise Program,” Lawrence Berkeley National Laboratory, June 2007, http://ies.lbl.gov/iespubs/LBNL-62874.pdf.
[49] An Feng and Amanda Sauer, “Comparison of Passenger Vehicle Fuel Economy and GHG Emission Standards Around the World,” The Pew Center on Global Climate Change, December 2004.
http://www.pewclimate.org/global-warming-in-depth/all_reports/fuel_economy.

where no federal policies exist or where states have sought to reduce emissions beyond the federal standards. Federal automotive fuel economy standards (Corporate Average Fuel Economy, or CAFÉ, standards), in place since 1975, were increased in 2007 to require an average of 35 miles per gallon by 2020 for new passenger vehicles and light trucks. At the state level, California established standards to reduce vehicle greenhouse gas emissions in 2002, and 16 other states have now adopted them, but the federal government has yet to issue a waiver allowing them to be implemented.

Energy efficiency has also been incorporated into state and federal policy through building codes, appliance standards, utility demand-side management, and lead-by-example programs. About three dozen states have residential and commercial building efficiency codes, and many have established appliance standards that exceed federal requirements. States have also promoted efficiency by requiring utility-driven energy reductions. Seventeen states now have Energy Efficiency Resource Standards—targets for utilities to reduce energy demand through end-use efficiency while 22 states authorize utilities to collect fees enabling them to implement efficiency programs through use of these "public benefits funds."

Recommendations

- **Expand energy efficiency programs.**

  The United States and China should increase national and sub-national cooperation on the exchange and implementation of innovative policies and programs targeting strategies for market transformation.

At the national level, U.S.-China cooperation should focus on best practices for energy efficiency standards and labeling programs, as well as for benchmarking programs targeting energy intensity in heavy industry. At the state and provincial level, U.S. and Chinese experiences implementing energy efficiency resource standards and demand-side management programs should be comprehensively and systematically exchanged.[50]

- **Target company-level incentives and opportunities.**

  New incentives to promote energy efficiency at the firm level should be mandated by the governments and expanded.

Inefficient small and medium enterprises should be targeted through government and industry-sponsored energy efficiency programs that encompass the entire supply chain. Both governments should collaborate on new ways to encourage private sector efforts to

[50] In addition to ongoing U.S.-China bilateral cooperation on energy efficiency described in Appendix I, there is state-provincial cooperation (for example, between California and Jiangsu Province) and extensive non-governmental cooperation, including through projects being implemented by Lawrence Berkeley National Laboratory's China Energy Group (http://china.lbl.gov) and the Energy Foundation China Sustainable Energy Program (http:///www.efchina.org).

reduce energy consumption throughout the value chain by means of energy efficiency incentives that expand beyond the final manufactured product to include the complete supply chain. The final distributor should be responsible for ensuring that such standards are met. Labeling programs can be used to acknowledge high-performance suppliers.[51]

Cooperation on industrial energy audit and benchmarking programs should also be expanded to highlight inefficiencies in major energy-consuming enterprises. The United States and China should exchange information and develop programs that promote information about energy-efficiency equipment and measures available to each industrial sector.

- **Seek a global agreement to improve vehicle fuel economy.**

  The United States and China should lead an effort to develop an agreement among countries that are major automobile producers or markets to promote a new generation of high-efficiency vehicles.

A relatively small number of countries account for the vast majority of automotive production and consumption worldwide. A sectoral agreement among these countries could effectively transform the global automotive market. An agreement could advance low-carbon technologies by coordinating research and development, and by establishing fuel economy or greenhouse gas emissions standards differentiated to reflect national circumstances. It could be a stand-alone agreement or be integrated into a comprehensive climate accord. The United States, as the world's largest auto manufacturer, and China, as the world's fastest growing automotive market, are uniquely positioned to lead other governments in developing such an agreement.

3. Developing an Advanced Electric Grid

An advanced, efficient electric power grid is crucial to ensuring that our transmission and distribution infrastructure can enable the expanded development of renewable energy projects and the secure, reliable delivery of electricity.

As the United States and China explore energy futures likely to include much higher levels of renewable energy, both countries are faced with the same key obstacle to fully utilizing these new sources: outdated and poorly designed electric grids. Current grid technology used in both countries is plagued with inefficiencies, and is ill-suited to handle long distance transmission from sources of renewable power-rich areas to high-load centers, or to handle the intermittent nature of renewable power sources.

[51] For example, Wal-Mart CEO Lee Scott has announced a range of objectives for using its market power to raise standards in its vast supply chain in China, including targets for the reduction of water and energy usage, reductions in packaging, and commitments to develop more sustainable products. "Wal-Mart to Seek Greener Supply Chain," *Financial Times*, October 22, 2008.

In addition, both countries share an important feature: exceptional wind resources and excellent solar thermal power-producing areas that lie far away from the largest power-using population centers. More intelligent grid control systems that exploit cutting edge digital controls, electronic switching, and higher capacity transmission lines will help facilitate the transmission and utilization of much larger amounts of renewable energy.[52] In addition, new technologies for storing electricity will need to be used to counter the variability of renewable resource availability.[53]

Attention to improved grid management and least-cost transmission systems can greatly expand the carbon reduction potential and help stimulate a new expertise base and vitally-needed export industry for both nations.

Recommendations

- **Develop new technologies to improve grid efficiency.**
  The United States and China should undertake joint and parallel efforts to improve the efficiency of their respective transmission and distribution systems, and work to jointly develop new power electronic technologies for smart grid management.

- **Demonstrate smart grid systems.**
  The United States and China should establish joint smart grid demonstration projects. These "test beds" should be used to experiment with the deployment of various configurations of new smart grid technologies.

- **Study grid stability measures for expanded renewable energy systems.**
  Since the United States and China are poised to be the two largest global markets for wind power in the coming years, joint demonstrations should initially focus on barriers to the current power grid handling large amounts of episodic wind-generated electricity. The expanded use of storage technologies should also be jointly examined and explored. Based on this study, both countries should jointly pursue demonstrations in areas of high wind penetration to inform new grid design and related policy developments.

Additional joint efforts should examine how power grids can be upgraded and expanded to allow for and promote the wide-spread use of plug-in hybrid electric vehicles (PHEV), or fully electric vehicles.

[52] *National Electric Delivery Technologies Vision and Roadmap*, U.S. Department of Energy 2004, http://www.energetics.com/pdfs/electric_power/electric_roadmap.pdf.

[53] For example: elevated reservoirs, superconducting batteries, flywheels, magnets, rock and salt storage of heat, and underground compressed air. See Roger N. Anderson, "The Distributed Storage-Generation 'Smart' Electric Grid of the Future," from proceedings, "The 10-50 Solution: Technologies and Policies for a Low-Carbon Future," workshop sponsored by the Pew Center on Global Climate Change and the National Commission on Energy Policy, March 25-26, 2004, http://www.pewclimate.org/global-warming-in-depth/workshops_and_conferences/tenfifty. See also The Pew Center on Global Climate Change and the National Commission on Energy Policy, http://www.pewclimate.org/docUploads/10-50_Anderson_120604_120713.pdf.

4. Promoting Renewable Energy

Renewable energy technologies are the key to achieving a diversified, low-carbon energy future fueled by a wide variety of domestic energy sources, manufactured and installed by an expanding field of companies providing new domestic, green-collar jobs.

China and the United States are two of the world's renewable energy leaders. China now gets about 17 percent of its electricity, and seven percent of its total energy, from renewable sources. The United States derives nine percent of its electricity and six percent of its total energy from renewables. Still, in both countries, renewable sources could be much more broadly deployed, particularly if facilitated by a modernized electrical grid capable of accommodating the intermittent nature of most renewable resources and moving electrical power over longer distances more efficiently.

China's primary source of renewable electricity is hydropower generated from large dams and micro-turbines. Its hydropower capacity, about 145 GW, is the largest in the world and is projected to more than double by 2020, requiring the equivalent of a new dam the size of the Three Gorges Project to be constructed every two years.

China's wind power capacity has been growing at over 100 percent per year, expanding from 1,266 megawatts (MW) in 2005 to 2,600 MW in 2006 and 5,900 MW in 2007. China also has moved aggressively on the solar front and has now become the world's largest manufacturer of photovoltaic cells, currently accounting for 35 percent of the global market.[54] China now manufacturers and utilizes more solar water heaters than the rest of the world combined.

To promote further expansion of sustainable energy sources, China's National Renewable Energy Law has set targets for producing 20 percent of the nation's electricity and 16 percent of its primary energy from renewable sources by 2020. Incentives include a national fund to foster renewable energy development and discounted lending and tax preferences for renewable energy projects. China has also implemented policies supporting the development of new domestic technologies and industries by, for instance, requiring the use of domestically manufactured components. Government policies are also encouraging production of biofuels by promulgating aggressive targets to scaleup biofuel utilization by 2012.

In the United States, renewable energy incentives and mandates have been largely carried out through state policies rather than federal action. Currently, 29 states and the District of Columbia have implemented Renewable Portfolio Standards (RPS), which establish targets for renewable energy integration into state energy production portfolios. Many have also implemented policies requiring utilities to offer net metering, which encourages on-site generation by connecting producers to the main grid, such as a home providing excess

[54] "Solarbuzz Reports World Solar Photovoltaic Market Growth of 62 Percent in 2007," *Solar Daily*, March 18, 2008. http://www.solardaily.com/reports/Solarbuzz_Reports_World_Solar_Photovoltaic_Market_Growth_Of_62_Percent_In_2007_999.html.

electricity produced by its own solar voltaic system to the utility. (A federal RPS has been proposed but has not yet found sufficient support for congressional approval.)

Currently, most federal support for renewable energy has come in the form of tax incentives. For example, the Production Tax Credit (PTC) has, over the last two years, been credited with making the United States the largest wind market in the world.[55] Most recently, the 2008 Emergency Economic Stabilization Act (EESA) extended or expanded tax credits for qualified solar, wind, geothermal, and fuel cell projects as well as low-emission systems such as microturbines and cogeneration.[56] The federal government also has established a federal Renewable Fuels Standard requiring the production of 36 billion gallons of biofuel in 2022, and about 40 states have created their own renewable fuels standards or incentives.

In sum, much is going on in each country, but coordination within each country, much less comprehensive collaboration between the United States and China, is still insufficient. In both countries, renewables could be significantly expanded and the key renewable resources that have only begun to be exploited for power generation are wind and solar. Although wind energy is growing rapidly in the United States and China, it only accounts for a very small share of total electricity generation in each country. In contrast, Denmark now derives about 20 percent of its electricity from wind, and the Schleswig-Holstein state of Germany now gets between 25 and 50 percent of its electricity in any given month from wind.

The global position of both the United States and China as leading wind and solar power technology manufacturers means that scaling-up these technologies could also support major expansion of these domestic industries.[57] Indeed, recent technical advances in solar energy make it poised for significant cost reductions in the coming years. Thin film and plastic solar cells, long of interest to the research community, have now been re-engineered to provide significantly higher efficiencies than seen over the past decade. Organic cells, with the potential for significantly lower costs—well under $0.50 per peak watt—are now beginning to be viewed as potentially commercially viable.[58] Initiatives to demonstrate concentrated solar thermal power technology (CSP) in the desert regions of the United States and China are underway.

[55] Under present law, an income tax credit of 2.1 cents/kilowatt-hour is allowed for the production of electricity from utility-scale wind turbines. This incentive, the renewable energy Production Tax Credit (PTC), was created under the Energy Policy Act of 1992 (at the value of 1.5 cents/kilowatt-hour, which has since been adjusted annually for inflation). In October 2008, Congress acted to provide a one-year extension of the Production Tax Credit through December 31, 2009. Source: The American Wind Energy Association, http://www.awea.org/legislative/#PTC.

[56] Tax credits, while effective in times where companies carry large tax burdens, are likely to be much less effective in times of economic downturn, and renewable development in the United States may suffer in 2008 as a result.

[57] Chinese manufacturers now produce about 40 percent of the wind turbines sold annually in China, and U.S. manufacturers produce 45 percent of the turbines sold in the United States.

[58] Daniel M. Kammen, "Renewable Energy Options for the Emerging Economy: Advances, Opportunities and Obstacles," from workshop proceedings, "The 10-50 Solution: Technologies and Policies for a Low-Carbon Future," op.cit., http://www.pewclimate.org/docUploads/10-50_Kammen.pdf.

Recommendations

- **Jointly refine and develop new renewable energy technologies.**

  Joint research and development initiatives on renewable energy that target specific areas of mutual interest and limited national experience should be pursued. These should include such areas as solar electric and thermal energy storage and biofuel technologies.

Joint projects in solar R&D should include technologies with the potential to drive significant cost reductions. Such areas should include: thin film, plastic, and organic cells.

In the area of storage technologies, R&D should examine a wide range of applications, including small-scale storage (such as appliance batteries); distributed, medium-scale storage (such as battery storage facilities in utility applications); large-scale storage (such as pumped hydroelectric dams); and other forms of storage including flywheels, compressed air, capacitors, heated and salt formations, and superconducting magnetic energy storage systems.

In the field of biofuels, research should include the land and water resource implications of different technologies, and the long-term carbon implications, and the best feedstock options for U.S. and Chinese national circumstances.

- **Address crucial information barriers to renewable energy development.**

  Additional U.S.-China cooperation on renewable energy should target the sharing of expertise in planning for the expanded utilization of renewable energy through the assessment and mapping of renewable resources in the United States and China, the planning of electricity transmission additions and upgrades, the testing and certification of new technologies, and the quantification of the economic benefits of renewables.

The mapping of renewable resources should assess resource availability at a high level of resolution that can inform national planning on achievable renewable energy targets, as well as project-level siting decisions. Based on the joint demonstration of advanced grid technologies, as well as the renewable resource assessment, experts in both countries should develop models for updating and expanding transmission capacity to bring renewable power from resource locations to demand centers. Technology certification programs should be designed to improve consumer confidence in the quality and reliability of new renewable energy technologies being developed in the United States and China, and be based on best practice certification models around the world. To aid policymakers in justifying expansive renewable energy promotion programs, the United States and China should exchange best practice methodologies for quantifying the economic and environmental benefits of renewable energy, with special attention given to employment and spillover benefits throughout the economy.[59]

[59] In addition to the bilateral cooperation on renewable energy listed in Appendix I, there is also some non-governmental cooperation, including the Energy Foundation's renewable energy policy support being provided to key organizations in China, including the NDRC's Center for Renewable Energy Development, Tsinghua University's Institute of Energy, Environment and Economy, the China Renewable Energy Industries Association, and the China Wind Energy Association.

5. Quantifying Emissions and Financing Low-Carbon Technologies

Quantifying and Projecting Emissions

At every stage—understanding energy and emissions patterns, identifying opportunities for improvement, setting goals and policies, and monitoring implementation—reliable data is critical. Working together, the United States and China can strengthen their respective capacities to collect energy data, inventory greenhouse gas emissions, and project future emissions trajectories. Such efforts can also contribute to the measurement, reporting, and verification of actions taken as part of a post-2012 climate agreement.[60]

For any government, the cornerstone of an effective climate mitigation strategy is a full, accurate national inventory of emission sources and sinks. As required under the UN Framework Convention, the United States, like other developed countries, annually submits a detailed emissions inventory subject to international review. In developing countries, due to resource constraints that limit the availability and quality of emissions data, inventories are notoriously inexact.[61] As a result, UN requirements for developing countries are more flexible. The inventory reported in China's only national communication to the UNFCCC thus far, in 2000, was based on 1994 data. China is now working with the developers of the Greenhouse Gas Protocol, a widely used greenhouse gas accounting tool, to customize it for use in its most emissions-intensive industries.[62]

Beyond data on current emissions, sound policymaking also requires the ability to reliably project future emissions. The very wide fluctuations apparent in recent projections of future Chinese emissions underscore the difficulty of generating reliable forecasts, particularly in developing economies. In 2004, the U.S. DOE's EIA projected that annual Chinese carbon emissions would reach 6.5 billion metric tons in 2025. A year later, the EIA revised that figure upwards by 1.5 billion tons. It raised its projection by another billion tons the following year, and again the year after. From 2004 to 2007, the projected increase in Chinese emissions grew by 3.5 billion tons, the equivalent of the current emissions from Central and South America, the Middle East, and Africa combined.[63] Near-term projections were just as inaccurate—as recently as 2004, the EIA predicted China's annual emissions would surpass those of the United States sometime after 2030, and we now know that this likely happened in 2007 (a phenomenon even the 2006 study did not project).

Inaccurate projections stem in part from the lack of an accurate inventory of current emissions. But another major factor in this case was a poor understanding of the key economic

[60] "Measurable, reportable and verifiable" is the language used in the Bali Action Plan (2007) to describe "nationally appropriate mitigation commitments or actions." http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf.
[61] "Selected Nations' Reports on Greenhouse Gas Emissions Varied in Their Adherence to Standards," GAO-04-98, U.S. General Accounting Office, December 2003, http://www.gao.gov/new.items/d0498.pdf; David G. Streets et al., "Recent Reductions in China's Greenhouse Gas Emissions," Science, November 30, 2001, pp. 1835-1837; Subodh Sharma, Sumana Bhattacharya, and Amit Garg, "Greenhouse Gas Emissions From India: A Perspective," *Current Science*, February 10, 2006, http://www.ias.ac.in/currsci/feb102006/326.pdf.
[62] The Greenhouse Gas Protocol Initiative, http://www.ghgprotocol.org.
[63] EIA's changes to projections of U.S. emissions in 2025 varied by a much smaller margin.

drivers of China's emissions. While there had been no significant shifts in China's energy mix or energy efficiency, the structure of the Chinese economy had changed dramatically as heavy industry outpaced light industry and services.[64] Better understanding of underlying economic dynamics, and their implications for energy use and emissions, would provide a stronger foundation for long-term planning, investment, and policymaking.

Recommendations

- **Improve emissions measurement and monitoring.**

  In order to strengthen national capacity to accurately monitor and measure GHG emissions in key sectors and economy-wide, the United States and China should jointly develop measurement, reporting, and verification procedures on emissions to be implemented nationally.

The further development of programs and training in energy audits and benchmarking at the facility level in targeted energy-intensive industries will contribute to the accuracy of emissions inventories. In all data collection activities, information sharing between the two countries for the purposes of research analysis should be encouraged.[65]

- **Expand scenario analyses.**

  In order to better understand their own and each other's emissions trends, the United States and China should undertake joint research to forecast emissions and economic conditions under different scenarios and evaluate the costs and emission reduction potentials of alternative mitigation approaches.

Joint modeling exercises with leading academics and government energy technology specialists and economists from both countries should be expanded. Efforts should be made to make domestic modeling exercises, including a full description of the key assumptions, available to international experts to better inform analysis.

- **Promote training programs.**

  A cooperative training program for the next generation of interdisciplinary energy and climate specialists in China and the United States should be promoted to develop technical expertise and promote mutual understanding.

[64] Daniel Rosen and Trevor Houser, "China Energy," op.cit.

[65] In addition to the work of the World Resources Institute and the World Business Council for Sustainable Development with the GHG protocol in China, other examples of international efforts with China underway in the area of measurement and verification include the International Energy Agency's project on energy statistics and indicators with the China National Bureau of Statistics; a cement industry benchmarking project with the Lawrence Berkeley National Laboratory, the China Energy Research Institute, China Building Materials Academy, and China Cement Association; the European Union Energy Efficiency Program (EUEEP) benchmarking project for cement, steel, and chemicals; The Asia Pacific Partnership's work with the Cement Task Force on data collection; the U.S. EPA country study program and non-annex I assistance; and California's work in China on a pilot GHG registry modeled after the California Registry.

Programs could focus on energy analysis, modeling, quantification and projection, and technology characteristics in each country. Activities could include conferences, training programs, and student, faculty, and inter-governmental exchanges.

Financing Low-Carbon Technologies

Both the United States and China have the capacity to invest more heavily to develop and deploy technologies that reduce emissions and strengthen energy security. To achieve these goals, both governments must commit greater public resources and do so in ways that effectively leverage private investment in a clean energy future. This will require innovative finance mechanisms and the removal of barriers including concern over intellectual property rights (IPR).

IEA projects that between now and 2030 China will invest $2.7 trillion in its power sector (including generation, transmission, and distribution).[66] Over that time, it is projected that developing countries as a whole will invest $160 billion a year in the power sector, and that "greening" that investment will require an additional $30 billion a year. Globally, the additional annual investment needed in 2030 to return greenhouse gas emissions to current levels is an estimated $200 billion.[67]

Currently, the vast majority of investment in the energy and other sectors relevant to climate change mitigation (86 percent) comes from the private sector. Overseas Development Assistance (ODA) funds make up less than one percent of investment globally.[68] In generating the additional financial flows needed, the central challenge will be to mobilize modest amounts of public funds to best leverage much larger sums of private capital for investment in a low-carbon energy infrastructure.

There are several examples of financial mechanisms that use public finance from developed countries to support climate change mitigation in developing countries, many that specifically target leveraging private investments. Multilateral development bank funds, such as the newly created World Bank Climate Investment Funds, the newly proposed Clean Technology Fund (CTF), and the Global Environment Facility Trust Fund, rely on donor country pledges. A donor-supported fund like the CTF may become part of a post-2012 climate agreement that includes funding commitments from developed countries. Other models of public financing do not rely on existing national budgets, and therefore may be more flexible. These include funds raised from the auctioning of emission allowances in a domestic GHG cap-and-trade program and climate bonds issued by the government to pay for mitigation efforts at preferential credit ratings.[69]

Greater public investment will succeed in unleashing stronger private flows only with other improvements in the investment environment. In discussions with China, the

[66] "World Energy Outlook," IEA, 2007, op.cit.
[67] "Investment and Financial Flows to Address Climate Change," UNFCCC, October 2007, http://unfccc.int/resource/docs/publications/financial_flows.pdf.
[68] "Finance and Investment Flows to Address Climate Change," UNFCCC, October 2007.
[69] Richard Doornbosch and Eric Knight, "What Role for Public Finance in International Climate Change Mitigation?", OECD Roundtable on Sustainable Development, discussion paper, October 2008.

United States and the EU have emphasized the importance of removing tariff and non-tariff barriers to the trade of environmental goods and services so that broader trade in these technologies can occur unimpeded. Another area of concern is the management of IPR. Although China's legal framework and enforcement capacity are still being developed, thousands of U.S. firms have successfully navigated IPR challenges in China. In the energy area, China has adopted innovative policies that have helped to promote the transfer of commercially-available low-carbon technologies through the licensing of IPR by foreign companies to Chinese companies.

One key to stronger investment is developing new models for licensing low-carbon technologies that can make them broadly available while protecting commercial interests.[70] While compulsory licensing models such as those used to make crucial drugs more affordable to developing countries may not be appropriate for commercially-available energy technologies, particularly if incentives for future innovation are reduced, other models of licensing can be used to protect the transferor. For example, licensing agreements can include geographical restrictions in order to protect the transferring company in its home market. Alternatively, governments can aid in the procurement of commercial licenses by facilitating market access to the transferring company. The United States and China could pioneer such approaches, while advancing multilateral solutions through bilateral initiatives targeted to key technology needs.[71] A stronger bilateral partnership would also benefit the world by delivering commercial possibilities in low-carbon technologies at an accelerated speed and unprecedented scale.

These types of financing and technology development mechanisms could be implemented under the umbrella of a "low-carbon" Special Economic Zone (SEZ) in China. China's existing SEZ's have special economic incentives tied to the investment goals of a particular zone, for example encouraging foreign investment through tax and trade tariff concessions. They are widely credited with creating jobs, advancing technical knowledge, and contributing to economic growth. Additional zones could be established with incentives for low-carbon industries, as well as highly efficient models of energy production and consumption, and of environmental regulation and enforcement, with the hope that these zones could become testing grounds for a larger-scale model of low-carbon economic development.[72] Pilot low-carbon economic zones are being explored under the current bilateral cooperation agreement between China and the European Union on energy

[70] See e.g., Jerome Reichman and Keith Maskus, eds., "International Public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime," Cambridge University Press Cambridge, UK, 2005; Mark Levine, testimony before the U.S.-China Economic and Security Review Commission, Hearing on China's Energy Policies and Their Environmental Impacts, August 13, 2008.

[71] This is a different challenge from the one faced by other developing countries that do not possess the indigenous technical capacities of China or India but will still need access to these technologies to reduce their emissions. See, for example, Mark Levine testimony, 2008, op.cit; Joanna Lewis, "Technology Acquisition and Innovation in the Developing World: Wind Turbine Development in China and India," *Studies in Comparative International Development*, vol. 42, issue 3, December 2007.

[72] Hu Angang, "Strengthening Sino-European Cooperation," March 26, 2008, http://www.chinadialogue.net/article/show/single/en/1836-Strengthening-Sino-European-cooperation; "Changing Climates: Interdependencies on Energy and Climate Security for China and Europe," Chatham House and E3G, November, 2007, http://www.chathamhouse.org.uk/files/10845_1107climate.pdf.

and climate change. Several existing SEZs in China are already attracting low-carbon investments such as Tianjin, the port city east of Beijing, which is home to several leading global wind turbine and solar photovoltaic manufacturing companies.

While short-term improvements in greenhouse gas mitigation can be best achieved through the deployment of available technologies, there is still strong rationale to support the development of future technologies through joint research efforts that can result in shared intellectual property. At the pre-commercial stage, technologies require sustained public financial support, and can benefit from the combined resources of many countries. There are multiple models for bilateral research and development, including through the international exchange of researchers to national research laboratories, or through the establishment of a joint research laboratory supported by both governments.

Recommendations

- **Promote targeted technology transfer.**

  The United States and China should identify key technologies within each country that could benefit from public support in facilitating commercial technology transfers.

Innovative licensing arrangements that protect commercial interests should be pursued. Both countries should examine opportunities to promote expansion of IPR protection within national contexts and within models of commercially driven technology transfer, and implement policies to support this expansion.

- **Expand collaborative R&D.**

  The United States and China should jointly determine strategic areas for joint research and development of pre-commercial, low-carbon energy technologies that would contribute to the creation of jointly-held intellectual property rights.

The agreement to conduct joint R&D should include a pre-established model for sharing the intellectual property (including patents) and know-how resulting from the research.

- **Streamline priority import and export technologies.**

  China and the United States should jointly identify advanced energy technologies in their respective countries that should be prioritized for streamlined import or export.

Incentives for improved trade flows in low-carbon and other essential technologies should be negotiated, building upon the discussions to reduce tariff and non-tariff barriers on environmental goods and services. Governments should consider designing trade regulations to promote flows in low-carbon technologies, as well as providing additional support such as low cost loans from the export-import banks to improve access to the technologies. To facilitate these discussions, both countries should increase the resources and support for government outreach with green businesses and entrepreneurs in the United States and China.

V. Getting Started

A new U.S.-China partnership on energy and climate must have sustained support at the highest levels of government if it is to deliver concrete action on the ground. It must provide for focused, ongoing engagement between the two leaderships, and must effectively enlist key players with a stake in creating a low-carbon future from government, the expert community, and the private sector.

The first step in launching this new partnership should be a leaders summit early in the new U.S. administration's term. The partnership should then be implemented through a two-tiered structure: a high-level governing council to provide ongoing direction; and a set of task forces focused on each of the priority areas identified in the previous section.

Leaders Summit. The gravity and the urgency of the energy and climate challenges confronting the United States and China warrant a full-scale leaders summit with significant time devoted exclusively to a common clean energy agenda. Holding this summit early in the administration would ensure that the two governments move as quickly as possible to begin addressing the critical climate change and energy security issues and would signal to the global community their commitment to seeking shared solutions. The outcome should include an agreement to establish a U.S.-China Partnership on Energy and Climate Change. This partnership should build upon existing bilateral cooperation, including the Ten-Year Energy and Environment Cooperation Framework under the Strategic Economic Dialogue (SED). This would provide continuity with previous agreements between the United States and China, demonstrating the U.S. desire to ensure sustained, long-term cooperation.

To ensure sustained attention at the leadership level, energy and climate should be established as a standing agenda item for future U.S.-China summits. Leaders should regularly revisit these issues in the context of the bilateral relationship to better understand the challenges, monitor progress, and seek further opportunities to strengthen cooperation and provide joint leadership toward global solutions.

High-Level Council. With direction from leaders, the partnership should be managed on an ongoing basis by a governing council composed of the heads of environmental, energy, finance, and other relevant ministries and departments in both governments. U.S. representation on the council should include members of Congress, whose support is necessary to ensure adequate and sustained funding. Although aspects of energy and climate may be effectively addressed within the framework of the Strategic Economic Dialogue, primary responsibility for these issues should rest with a new governing council.

The council should meet periodically each year, initially to establish strategic direction and priorities for the partnership, and later to review progress, reassess priorities, and identify new needs and challenges. In addition to directing collaborative efforts, the council should serve as a forum for U.S.-China dialogue on other energy- and climate-related issues, including those arising in other international fora such as the ongoing multilateral negotiations under the UN Framework Convention.

Task Forces. In each of the priority areas described above, a bilateral Task Force should be created to set goals and timelines, develop a program of activities, and oversee implementation. The working groups should be composed of senior officials of relevant ministries and departments, independent experts, representatives of business and financial communities and non-governmental organizations, with decision-making responsibility resting with the government participants. It is especially critical that the Task Forces seek out business engagement and expertise and encourage direct private sector involvement in collaborative efforts.

Working within the direction provided, and within available resources, each working group should develop a detailed implementation plan for approval by the governing council. In developing their plans, the working groups should seek broad input from experts within and outside government, the private sector, non-governmental organizations, and the public.

VI. Conclusion

The challenge of global climate change is unprecedented in world history. The fact that a molecule of carbon dioxide emitted in the United States is just as harmful to Chinese as one emitted in China is to Americans—or, indeed, to anyone on our planet—means that no human being is exempt from our inescapable commons. This new reality begs a completely new set of global responses. One of the most critical responses must come from the United States and China. For without the two largest emitters of greenhouse gases in the world forging a new and extensive collaborative relationship, this global problem will remain intractable and unsolvable.

Whatever our other disagreements may be, failure of the United States and China to cooperate successfully on this unique issue will jeopardize any hope the world community as a whole may have of heading off ever more dire impacts from a changing global climate.

While a Sino-U.S. bilateral effort is a critical element in any overall global climate strategy, it is not an alternative to the multilateral UN climate change process. Collaboration between the United States and China will be crucial both to achieving significant greenhouse gas reductions in both countries, and to creating the joint momentum that will inevitably be required for a larger multilateral solution to this collective challenge.

The time is late and the task daunting, but there are some trends and signs that nonetheless give cause for new hope, if not outright optimism.

China's leadership has shown a growing awareness of the concrete threats that global warming poses to China and the world. With new government policy pronouncements and bureaucratic restructuring to focus on climate change as well as regular public discussion of the issue, there is reason to be optimistic that China is in the process of becoming a more receptive partner with the United States and others to take increasingly concrete and meaningful climate change remedies.

In Washington, the new administration of President-elect Barack Obama also portends a sea change in both awareness of the seriousness of this threat and a commensurate change in government policy. And while the recent global financial crisis will mean even greater competition for government resources, the various economic recovery packages now being adopted in both capitals may well provide opportunities for funds to scale clean techindustries that will be the engines of the next technological revolution, as well as the generators of new jobs.

Moreover, while at first blush the faltering global economy may seem to present an inhospitable environment in which to confront such a massive and costly challenge, historically it has been precisely during such times of stress and crisis that rigid structures and systems that have outlived their usefulness have often become malleable and susceptible to change or replacement. This change will, of course, take wise leadership. If such leadership is forthcoming, however, there will be an incomparable opportunity not only to reformat the energy systems of both countries, but also to gain a new and welcomed measure of energy security.

If over the next year the U.S. and Chinese leaderships are, in fact, capable of forging a new and effective alliance, not only will they succeed in taking a giant step forward for the world as a whole on the question of climate change, but they will also afford Americans and Chinese a second incomparable benefit: a new, more collaborative, and stable basis for interaction in their countries' relations, which is now commonly acknowledged to be the most important bilateral relationship in the world.

That our planet is now on the precipice of a point of no return seems increasingly self-evident. And while it is true that recognition of the perils implicit at such moments can be unsettling, it is also true that with bold leadership, such moments can also be galvanizing. It is as yet unclear whether growing awareness of this tipping point moment will converge with new leadership in Washington and an increasingly well-informed central leadership in China to catalyze both countries toward the requisite clarity of vision, mustering of intellectual resources, and appropriation of funds, technology, and international cooperation to remedy the challenge of climate change. But what is clear is that we are in uncharted waters. The moment now upon us begs an unprecedented effort from both the world at large and, in particular, from the United States and China, the most important players in this "game." If the United States and China can find ways to bridge the divide, the benefits will not be limited to helping solve the climate change challenge alone.

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Appendix I. Timeline of Government Initiatives for U.S.-China Energy and Climate Change Cooperation

Year(s)	Name	Actors	Purpose
1979	Scientific and Technology Cooperative Agreement	Official bilateral governmental agreement established by President Carter and Vice Premier Deng Xiaoping	Started with focus on high-energy physics. Served as an umbrella for 30 subsequent bilateral environment and energy protocols.
1979	MOU for Bilateral Energy Agreements	U.S. DOE and the China SDPC	Led to 19 cooperative agreements on energy, including fossil energy, climate change, fusion energy, energy efficiency, renewable energy, peaceful nuclear technologies, and energy information exchange
1979	Atmosphere and Science and Technology Protocol	NOAA and Chinese Meteorological Administration	Bilateral climate and oceans data exchange, research, and joint projects.
1983	Protocol on Nuclear Physics and Magnetic Fusion	DOE and SSTC	Long-term objective to use fusion as an energy source.
1985, 2000, 2005-2010	Protocol on Cooperation in the Field of Fossil Energy Research and Development (the Fossil Energy Protocol)	DOE and Ministry of the Coal Industry (later MOST)	First major bilateral agreement on fossil energy. Now includes 5 annexes: power systems, clean fuels, oil and gas, energy and environment technologies, and climate science. Protocol is managed by the Permanent Coordinating Group including members of both countries.
1987	Annex III to the Fossil Energy Protocol Cooperation in the Field of Atmospheric Trace Gases	DOE and CAS	Cooperative research program on the possible effects of CO_2 on climate change.
1987	Fossil Energy Protocol—Additional Annexes	DOE, Ministry of the Coal Industry	Coal preparation and waste stream utilization, and atmospheric fluidized bed combustion (FBC) information exchange.
1988	Sino-American Conference on Energy Demand, Markets and Policy in Nanjing	LBNL/DOE and SPC/ERI	Informal bilateral conference on energy efficiency that led to an exchange program between ERI and LBNL, and the first assessment of China's energy conservation published by LBNL in 1989.
1991	5-year extension of the Science and Technology Cooperation Agreement	High-level umbrella agreement DOE and SSC	
1992	Implementing Accord for a Program of Collaboration on the Superconducting Super Collider (SSC)	DOE and SSC	$18 billion project that ultimately was not funded by Congress.

Year(s)	Name	Actors	Purpose
1992	U.S. Joint Commission on Commerce and Trade		Facilitate the development of commercial relations and related economic matters between the United States and China. The JCCT's Environment subgroup supports technology demonstrations, training workshops, trade missions, exhibitions, and conferences to foster environmental and commercial cooperation.
1993	U.S. Commercial Mission to China	U.S. DOE and Commerce	For U.S. companies to promote their electric power technology services in China. Industry representatives identified a potential for $13.5 billion in U.S. electric power exports between 1994-2003 (not including nuclear power), equating to 270,000 high-salary U.S. jobs and an opportunity for introducing cost-effective, environmentally sound U.S. technologies into China's electric power industry.
1993	Establishment of the Beijing Energy Efficiency Center (BECon)	ERI, LBNL, PNNL, WWF, EPA, WWFN, SPC, SETC, SSTC	The first non-governmental, non-profit organization in China focusing on promoting energy efficiency by providing advice to central and local government agencies, supporting energy efficiency business development, creating and coordinating technical training programs, and providing information to energy professionals.
1994	2 Annexes to the Fossil Energy Protocol	DOE and SSTC	1) To make positive contributions toward improving process and equipment efficiency, reduce atmospheric pollution on a global scale, advance China's Clean Coal Technologies Development Program, and promote economic and trade cooperation beneficial to both parties. 2) Cooperation in coal-fired magnetohydrodynamic (MHD) power generation.
1994	China's Agenda 21 Document Released	SSTC and China's National Climate Committee	Lay out China's request for international assistance. The United States agreed to support China through DOE's Climate Change Country Studies and Support for National Action Plans programs.
1995	Series of DOE bilateral agreements signed by Secretary of Energy O'Leary	Bilateral agreements on Energy between DOE and ministries as noted below: 1) MOU on bilateral energy consultations (with SPC) 2) Research on Reactor Fuel (with CAEA) 3) Renewable Energy (with Ministry of Agriculture) 4) Energy Efficiency Development (with SSTC) 5) Renewable Energy Technology Development (with SSTC) 6) Coal Bed Methane Recovery and Use (with MOCI) 7) Regional Climate Research (with the CMA) Also established: -Plan for mapping China's renewable energy resources (DOE and SPC) -Strategies for facilitating financing of U.S. renewable energy projects in China (with DOE, SPC, Chinese and U.S. Ex-Im banks) -Discussions for reducing and phasing out lead in gasoline in China (DOE, EPA with China's EPA and SINOPEC)	

Year(s)	Name	Actors	Purpose
1995	U.S.-China Oil and Gas Industry Forum (OGIF)	DOE, SPC, plus ministerial-level oil and gas organizations	
1995 (some annexes in 1996)	Protocol for Cooperation in the Fields of Energy Efficiency and Renewable Energy Technology Development and Utilization	DOE and various ministries	This Protocol has seven annexes: policy, rural energy (Ministry of Agriculture), large-scale wind systems (with MOEP), hybrid village power, renewable energy business development (with SETC), and geothermal energy, energy efficiency (with SPC), hybrid-electric vehicle development. Energy efficiency includes 10 teams of Chinese and U.S. government and industry representatives focusing on: energy policy, information exchange and business outreach, district heating, cogeneration, buildings, motor systems, industrial process controls, lighting, amorphous core transformers, finance.
1995-2000	Statement of Intent for Statistical Information Exchange (later became a Protocol)	DOE and NBS	Five meetings to discuss energy supply and demand and exchange information on methods of datacollection and processing of energy information.
1997	U.S.-China Forum on Environment and Development	Established by Vice President Al Gore and Premier Li Peng	Venue for high-level bilateral discussion on sustainable development. Established 4 working groups: energy policy, commercial cooperation, science for sustainable development, environmental policy. Three priority areas for cooperative work: urban air quality, rural electrification, clean energy and energy efficiency.
1997	Energy and Environment Cooperation Initiative	DOE and SPC	Targeting urban air quality, rural electrification, and energy sources, and clean energy sources and energy efficiency. Involved multiple agencies, participatants from business sectors, and link energy development and environmental protection.
1997	U.S.-China Energy and Environmental Center	Tsinghua University and Tulane University, with DOE and SSTC/MOST	An initiative centered at Tsinghua and Tulane Universities co-funded by DOE and MOST to 1) provide training programs in environmental policies, legislation and technology, 2) develop markets for U.S. clean coal technologies, and 3) help minimize the local, regional, and global environmental impact of China's energy consumption.
1998-ongoing	Agreement of Intent on Cooperation Concerning Peaceful Uses of Nuclear Technology (PUNT)	DOE and SPC	Paved the way for the exchange of information and personnel, training, and participation in research and development in the field of nuclear and nuclear non-proliferation technologies.
1998	Joint Statement on Military Environmental Protection	U.S. Secretary of Defense and Vice-Chairman of Chinese Central Military Commission	MOU provides for the exchange of visits by high-level defense officials and the opening of a dialogue on how to address common environmental problems.

Year(s)	Name	Actors	Purpose
1998	Peaceful Uses of Nuclear Energy Agreement	DOE and NDRC	
1999-2000	Fusion Program of Cooperation	DOE and CAS	Plasma physics, fusion technology, advanced design studies, and materials research.
2002-2003	U.S.-China Fusion Bilateral Program	DOE and CAS	Plasma physics, fusion technology, and power plant studies.
2003	Carbon Sequestration Leadership Forum	DOE	Includes 13 countries, including China.
2003	FutureGEN	DOE with many international partners	Initially an IGCC plus CCS plant, restructured in January 2008 as potential federal funding to support CCS on a privately funded IGCC or PC plant. Companies can bid for participation and funding.
2004	U.S.-China Energy Policy Dialogue	DOE and NDRC	Resumed the former Energy Policy Consultations under the 1995 DOE-SPC MOU. Led to a MOU between DOE and NDRC on Industrial Energy Efficiency Cooperation and includes energy audits of up to 12 of China's most energy-intensive enterprises, as well as training and site visits in the United States to train auditors.
2004	U.S.-China Green Olympic Cooperation Working Group	DOE, Beijing Government	Included opportunities for DOE to assist China with physical protection of nuclear and radiological materials and facilities for the Beijing Olympics as they had done in Athens.
2006	Asia-Pacific Partnership on Clean Development and Climate	U.S., China + India, Japan, Korea, Australia (later Canada)	Created public-private task forces around specific sectors; Aluminum, Buildings and Appliances, Cement, Cleaner Use of Fossil Energy, Coal Mining Power Generation and Transmission, Renewable Energy and Distributed Generation, Steel.
2006	U.S.-China Strategic Economic Dialogue	Vice Premier Wu Yi and U.S. Treasury Secretary Henry Paulson. Includes DOE, EPA, NDRC, MOST	Bi-annual, cabinet-level dialogue that includes an energy and environment track.
2007	MOU on Cooperation on the Development of Biofuels	USDA and NDRC	Encourages cooperation in biomass and feedstock production and sustainability; conversion technology and engineering; bio-based product development and utilization standards; and rural and agricultural development strategies.

Year(s)	Name	Actors	Purpose
2007	U.S.-China Bilateral Civil Nuclear Energy Cooperative Action Plan	DOE and NDRC	To complement discussions under the Global Nuclear Energy Partnership (GNDP) toward the expansion of peaceful, proliferation-resistant nuclear energy for greenhouse gas emissions-free, sustainable electricity production. Bilateral discussions include separations technology, fuels and materials development, fast reactor technology, and safeguards planning.
2007	U.S.-China Westinghouse Nuclear Reactor Agreement	DOE, State Nuclear Power Technology Corporation (SNPTC)	DOE approved the sale of 4 x 1,100-megawatt AP-1000 nuclear power plants that use a recently improved version of existing Westinghouse pressurized water reactor technology. The contract was valued at $8 billion and included technology transfer to China. The four reactors are to be built between 2009 and 2015.
2008	Ten Year Energy and Environment Cooperation Framework (SED IV)	DOE, Treasury, State Commerce, EPA, NDRC, SFA, NEA, MOF, MOEP, MOST, and MFA	Establishes five joint task forces on the five functional areas of the framework: 1) clean efficiency and secure electricity production and transmission 2) clean water 3) clean air 4) clean and efficient transportation 5) conservation of forest and wetland ecosystems.

Sources: Robert S. Price, "A Chronology of U.S.-China Energy Cooperation," The Atlantic Council of the United States, 2008; Pamela Baldinger and Jennifer L. Turner, "Crouching Suspicions, Hidden Potential: United States Environmental and Energy Cooperation with China," Woodrow Wilson International Center for Scholars, 2002; "Fact Sheet: U.S. Department of Energy Cooperation with the People's Republic of China," U.S. DOE, April 2006; Katharine A. Fredriksen, Acting Assistant Secretary, Office of Policy and International Affairs, U.S. DOE, Statement before the U.S.-China Economic and Security Review Commission, August 13, 2008.

List of Acronyms

BECon Beijing Energy Efficiency Center

CAEA China Atomic Energy Authority

CAS Chinese Academy of Sciences

CCS carbon capture and storage

CMA Chinese Meteorological Administration

CSIRO Commonwealth Scientific and Industrial Research Organization

CSP concentrated solar thermal power technology

CTF Clean Technology Fund

DOC U.S. Department of Commerce

DOE U.S. Department of Energy

DOS U.S. Department of State

DOT U.S. Department of Transportation

EESA Emergency Economic Stabilization Act

EIA Energy Information Administration, U.S. Department of Energy

EOR enhanced oil recovery

EPA U.S. Environmental Protection Agency

ERI China Energy Research Institute

GNEP Global Nuclear Energy Partnership

IEA International Energy Agency

IGCC integrated gasification combined cycle

IPCC Intergovernmental Panel on Climate Change

IPR intellectual property rights

JCCT U.S.-China Joint Commission on Commerce and Trade

LBNL Lawrence Berkeley National Laboratory

MCI China Ministry of Coal Industry

MFA China Ministry of Foreign Affairs

MHD magnethydrodynamic

MOA China Ministry of Agriculture

MOEP China Ministry of Environmental Protection (formerly State Environmental Protection Administration SEPA)

MOF China Ministry of Finance

MOST China Ministry of Science and Technology

MOU memorandum of understanding

NDRC China National Development and Reform Commission

NEA China National Energy Administration

NOAA U.S. National Oceanic and Atmospheric Administration

NZEC Near Zero Emission Coal

OGIF U.S.-China Oil and Gas Industry Forum

PC Pulverized Coal

PHEV plug-in hybrid electric vehicles

PNNL Pacific Northwest National Laboratory

PTC Production Tax Credit

PUNT Peaceful Uses of Nuclear Technology

RPS Renewable Portfolio Standards

SDPC China State Development Planning Commission

SED Strategic Economic Dialogue

SETC China State Economic and Trade Commission

SEZ Special Economic Zone

SFA China State Forestry Administration

SINOPEC China Petroleum and Chemical Corporation

SNPTC State Nuclear Power Technology Corporation

SPC China State Planning Commission

SSC Superconducting Super Collider

SSTC China State Science Technology Commission

UNFCCC United Nations Framework Convention on Climate Change

USDA U.S. Department of Agriculture

WWF World Wildlife Fund

WWFN World Wide Financial Network