



U.S.-China Clean Energy Cooperation

A PROGRESS REPORT BY THE U.S. DEPARTMENT OF ENERGY

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U.S. DEPARTMENT OF
ENERGY



Secretary
Steven
Chu, U.S.
Department
of Energy

Science is not a zero-sum game. In my experience as a scientist, collaborations with other research groups greatly accelerated our progress. Similarly, cooperation between the United States and China can greatly accelerate progress on clean energy technologies, benefiting both countries. As the world's largest producers and consumers of energy, the United States and China share many common challenges and common interests. Our clean energy partnership with China can help boost America's exports, creating jobs here at home, and ensure that our country remains at the forefront of technology innovation. At the U.S. Department of Energy, we are committed to working with Chinese partners to promote a sustainable energy future. Working together, we can accomplish more than acting alone.

Secretary Steven Chu, U.S. Department of Energy

The United States and the People's Republic of China have worked together on science and technology for more than 30 years. Under the Science and Technology Cooperation Agreement of 1979, signed soon after normalization of diplomatic relations, our two countries have cooperated in a diverse range of fields, including basic research in physics and chemistry, earth and atmospheric sciences, a variety of energy-related areas, environmental management, agriculture, fisheries, civil industrial technology, geology, health, and natural disaster planning.

More recently, in the face of emerging global challenges such as energy security and climate change, the United States and China entered into a new phase of mutually beneficial cooperation. In June 2008, the U.S.-China Ten Year Framework for Cooperation on Energy and the Environment was created and today it includes action plans for cooperation on energy efficiency, electricity, transportation, air, water, wetlands, nature reserves and protected areas.

In November 2009, President Barack Obama and President Hu Jintao announced seven new U.S.-China clean energy initiatives during their Beijing summit. In doing so, the leaders of the world's two largest energy producers and consumers affirmed the importance of the transition to a clean and low-carbon economy—and the vast opportunities for citizens of both countries in that transition.

The following joint initiatives were announced in November 2009:

- **U.S.-China Clean Energy Research Center.** Scientists and engineers from both countries are working together to develop clean energy technologies, initially focusing on building energy efficiency, clean coal and clean vehicles. Both countries are contributing equally to \$150 million in financial support from public and private sources over five years.



- **Electric Vehicles Initiative.** This initiative includes the joint development of standards for charging plugs and testing protocols of batteries and other devices, demonstration projects in paired cities to collect and share data on charging patterns and consumer preferences, joint development of technical roadmaps, and public education projects.
- **Energy Efficiency Action Plan.** Both governments are working together with the private sector to develop energy efficient building codes and rating systems, benchmark industrial energy efficiency, train building inspectors and energy efficiency auditors for industrial facilities, harmonize test procedures and performance metrics for energy-efficient consumer products, and exchange best practices in energy efficiency labeling systems.

Energy innovation in one country accelerates clean energy deployment in all countries. And the combined research expertise and market size of the U.S. and China provide an unprecedented opportunity to develop clean energy solutions that will reduce pollution and improve energy security while enhancing economic growth globally.

- **Renewable Energy Partnership.**

The two countries are developing roadmaps for widespread renewable energy deployment in both countries. The Partnership provides technical and analytical resources to states and regions in both countries to support renewable energy deployment and facilitates state-to-state and region-to-region partnerships to share experience and best practices.

- **21st Century Coal.** The two countries are bringing U.S. and Chinese scientists and engineers together to cooperate on developing clean coal and carbon capture and storage technologies.

- **Shale Gas Resource Initiative.** The two governments are working together to assess China's shale gas potential, promote environmentally-sustainable development of shale gas resources, conduct joint technical studies to accelerate development of shale gas resources in China, and promote shale gas investment through industry forums, study tours, and workshops.

- **Energy Cooperation Program.** A new public-private partnership has been formed to leverage private sector resources for project development work in China across a broad array of clean energy projects. The ECP, consisting of 24 founding member U.S. companies, works on cooperation projects in renewable energy, smart grid, clean transportation, green building, clean coal, combined heat and power, and energy efficiency.

In the past year progress under these initiatives has been substantial, with activities including those described in the pages that follow.

U.S.-China Clean Energy Research Center

The \$150 million U.S.-China Clean Energy Research Center is a flagship initiative funded in equal parts by the United States and China, with broad participation from universities, research institutions and industry. The initial R&D focus areas are building energy efficiency, clean coal and clean vehicles. After a competitive review process, the U.S. Department of Energy (DOE) awarded grants under the program to research teams led by West Virginia University on clean coal, the University of Michigan on clean vehicles and Lawrence Berkeley National Laboratory in building energy efficiency. These U.S. teams will conduct joint research with Chinese teams led by Huazhong University of Science and Technology and China Huaneng Group Clean Energy Research Institute for clean coal, Tsinghua University for clean vehicles, and the Ministry of Housing and Urban-Rural Development for building energy efficiency. The U.S. and Chinese research teams have developed joint work plans, with ambitious goals for the years ahead.

Electric Vehicles Initiative

In September 2010, DOE and China's Ministry of Science and Technology hosted the First U.S.-China Electric Vehicle and Battery Technology Workshop at DOE's Argonne National Laboratory. The workshop brought together over 100 U.S. and Chinese scientists, engineers, and representatives from government, industry and academia to discuss areas of common technical interest in three focused roundtable sessions. The workshop identified specific areas—battery technology roadmapping, battery



Secretary Steven Chu, State Councilor Liu Yandong,
Secretary Gary Locke, Minister Wan Gang

“ China is the world’s fastest-growing market for aviation, energy, transportation and healthcare. GE’s initiatives on clean energy in China, including the U.S.-China Clean Energy Research Center, advanced coal technologies, high-speed rail and others will apply GE’s technology and innovation strengths to these growth challenges. These initiatives will support jobs in both China and the United States.”

Jeff Immelt, Chairman and CEO, General Electric

“ Over the last decade, experts from the United States—including DOE’s Lawrence Berkeley National Lab, Natural Resources Defense Council, Energy Foundation and Regulatory Assistance Project—and Chinese policymakers have actively shared best practices for establishing demand-side energy efficiency programs, resulting in a recent Chinese policy in the power sector that can potentially save enough electricity to power 10 million Chinese homes. This program is a testament to the value of long-term cooperation between the U.S. and China on clean energy.”

Barbara Finamore, Senior Attorney and China Program Director, Natural Resources Defense Council



testing procedures, and vehicle demonstration and infrastructure—in which to pursue joint research and exchange. U.S. and Chinese counterparts continue to cooperate on these important issues and are planning another joint meeting in China this spring.

The United States and China are also enhancing their cooperation on electric vehicles through the multilateral Electric Vehicles Initiative, which was announced at the first Clean Energy Ministerial in Washington, D.C., in July 2010. As co-leads of the initiative, the United States and China are working with seven other nations to accelerate and track the deployment of electric vehicles around the world.

The United States and China are the world's largest automobile markets and oil consumers. Working together to accelerate the deployment of electric vehicles will improve both countries' energy security and save American and Chinese consumers money at the pump.

Energy Efficiency Action Plan

The inaugural U.S.-China Energy Efficiency Forum was held in Beijing in May 2010. The Forum brought together more than 150 U.S. and Chinese officials from government, industry, academia and advocacy groups to share experiences and best practices in promoting energy efficiency in buildings, communities, industry and consumer products.

In January 2010, DOE's Lawrence Berkeley National Laboratory (LBNL) and DOE's Oak Ridge National Laboratory helped establish the University Alliance for Industrial Energy Efficiency, which is a coalition of Chinese universities that train students to conduct in-depth industrial energy assessments. The Alliance is modeled after a long standing DOE program involving 26 U.S. universities that conduct energy audits of U.S. factories and has saved at least \$5 billion in energy costs. Under the Alliance, 21 Chinese universities are training students to conduct similar assessments targeting key Chinese industries.

In cooperation with various Chinese research partners, LBNL also developed BEST-Cement, a process-based evaluation tool that benchmarks Chinese cement plants to both Chinese and international best practices and also provides a menu of energy-efficiency solutions that could be implemented in such plants. LBNL has trained over 300 cement plant engineers from about 200 cement plants in China in the use of BEST-Cement.

DOE's Ames National Laboratory is cooperating with Beijing University of Science & Technology,



President Barack Obama and President Hu Jintao

As the two largest energy consumers, the U.S. and China have a shared interest in energy efficiency. Energy-saving technologies deployed in one country will reduce energy costs for the other and benefit both economies.

the Chinese Academy of Science, Shanghai University, Tsinghua University and the University of Electronic Science & Technology on research into magnetic materials that can make practical appliances more energy-efficient.

DOE's Brookhaven National Laboratory has been actively facilitating the pairing of U.S. and Chinese cities such as Columbus and Hefei, as well as Chicago and Shanghai, among others, to catalyze cooperation on clean energy and environmental management projects.

Together with the U.S. Trade and Development Agency and the U.S. Department of Commerce's Foreign Commercial Service, DOE sponsored a training program for 20 Chinese mayors in three U.S. West Coast cities in September 2010 to learn about urban systems management, green building technologies, and clean energy policy development.

Renewable Energy Partnership

In May 2010, the first U.S.-China Renewable Energy Forum and Biofuels Forum were held in Beijing, bringing together 150 officials from

government agencies, multinational corporations, and top research centers to identify the challenges and opportunities of the wind, solar and biofuels industries and formally initiate the U.S.-China Renewable Energy Partnership.

Since then, DOE's National Renewable Energy Laboratory (NREL) has been working with Chinese officials, researchers and industry on analysis, R&D, and commercial partnerships in renewable energy. Together with the China Electric Power Research Institute, the partners organized a workshop in Beijing on renewable grid integration for over 200 Chinese participants in December 2010. The workshop laid the groundwork for ongoing cooperation in advancing renewable grid integration in both countries. NREL and China's Energy Research Institute also lead a multi-agency team developing analysis to support national planning for wind and solar electric generation and transmission. Additionally, a delegation from China's National Energy Administration visited several DOE-sponsored biofuel projects and met with DOE and U.S. Department of Agriculture officials in December 2010. Cooperative research

“Boeing is working with a team of American and Chinese partners to develop a sustainable aviation biofuel industry. Our efforts will stimulate major investments in demonstration and commercial projects and accelerate aviation biofuel technology commercialization in both countries. This innovation platform will support high-quality jobs, create rural development opportunities, and ultimately heighten energy security and help reduce carbon emissions.”

Jim Albaugh, President and CEO, Commercial Airplanes, The Boeing Company

is underway in several biofuels areas and wind technology topics.

The two countries are also developing a public-private partnership to promote joint commercial ventures, holding a workshop in December 2010 to assist Chinese investors in making investments in the U.S. wind industry that will create jobs in the United States. Further reciprocal commercial exchanges are in the planning stages.

DOE's Idaho National Laboratory is working with the Chinese Academy of Sciences on hybrid energy systems, including renewable-fossil and nuclear-renewable-fossil integrated systems, through a series of technical workshops and meetings.

DOE's Pacific Northwest National Laboratory is teaming with the Dalian Institute for Chemical Physics, LanzaTech and the Chinese National Offshore Oil Company to better understand the chemical processes involved in the production of bio-based substitutes for jet fuel, and the economics of moving the technology from R&D phase to pilot scale. DOE's Los Alamos National Laboratory is conducting joint research with the Qingdao Institute of Bioenergy and Bioprocess Technology of the Chinese Academy of Sciences on genomic analysis of oil-producing algal feedstock strains that have basic research and industrial potential.

With the support of the U.S.-China Energy Cooperation Program and the U.S. Trade and Development Agency, the Sustainable Aviation Biofuels Program was created in May 2010, involving U.S. companies such as Boeing, Pratt and Whitney, Honeywell as well as various Chinese organizations and companies. The program will carry out a strategic assessment of the potential for sustainable aviation biofuels in China. In addition,

Boeing along with Air China and other Chinese partners will work to conduct a sustainable aviation inaugural flight in 2011 using biofuel derived from biomass grown in China.

Shale Gas Resource Initiative

DOE and other U.S. government agencies are engaging actively with their counterparts in the Chinese government to share expertise and best practices in policy development, resource evaluation and technical approaches to shale gas development.

The U.S. Department of State is partnering with the U.S. Geological Survey to conduct a shale gas resource assessment of prospective areas in China as well as to hold a series of technical workshops—the first of which was held in December 2010—on various geological aspects of shale gas resources identification and development.

In April 2010, DOE and the U.S. Trade and Development Agency hosted a three-day technical workshop in Beijing involving government officials and industry executives. In September 2010, the Tenth U.S.-China Oil and Gas Industry Forum held in Fort Worth, Texas, brought together almost 200 government and industry participants from both countries to focus on shale gas development, including a site visit to Fort Worth's Barnett Shale. In December 2010, DOE hosted a delegation from China's Ministry of Land Resources for a policy dialogue on shale gas.

DOE's Lawrence Livermore National Laboratory and U.S.-based Advanced Resources International have reached an agreement with China's CNOOC New Energy Research Co. to provide technology training and technical capacity building in shale gas development.

Both the United States and China have ambitious renewable energy deployment goals. Helping each other achieve these targets through policy and technology cooperation will expand market opportunities for both American and Chinese workers and clean energy companies.



The United States is a leader in shale gas technology and is developing shale gas resources in a way that mitigates environmental risks. Bringing this expertise to China will provide economic opportunities for both the United States and China.



Nuclear Energy and Security

The United States and China have long-standing cooperation on the advancement of peaceful uses of nuclear energy. While the United States has the largest fleet of nuclear power plants in the world, China has the world's fastest growing nuclear industry. As a result, the United States is in an ideal position to use its accumulated technical experience to help China build a safe civilian nuclear industry, while creating significant economic benefits for the United States in terms of job creation and technology exports.

In 2007, U.S.-based Westinghouse won the contract to build four state-of-the-art AP1000 units in China. These projects have created or retained over 5,000 high quality American jobs in 13 different states. Both countries are also cooperating on basic research into advanced nuclear technologies—DOE's Princeton Plasma

Physics Laboratory conducts research with Chinese partners on plasma physics and nuclear fusion in a variety of bilateral and multilateral projects.

Under the U.S.-China Peaceful Uses of Nuclear Technology Agreement of 1998, DOE has provided nuclear safety, safeguards and security training to Chinese regulators and technicians to ensure China meets the highest nuclear safety and nonproliferation standards. DOE's National Nuclear Security Administration has been collaborating with Chinese authorities on radioactive source security, nuclear safeguards, export controls, materials and waste management, emergency management, and the establishment of a center of excellence for nuclear security training.



The U.S. and China account for more than half of global coal consumption. Developing and deploying clean coal technology will allow both countries to continue using their abundant energy resources while reducing a wide range of pollutants, from mercury to carbon dioxide, that do not respect national borders and result in significant economic and public-health losses.



Secretary Chu and Administrator Zhang Guobao

“It’s an honor for a company like American Electric Power to have an opportunity to work with such world recognized names as our three Chinese partners—China National Offshore Oil Corporation, Huaneng and State Grid—in these endeavors. It is an extremely logical outgrowth of the relationship between these two great countries, two of the largest economies in the world, jointly working on projects in energy efficiency, clean air, renewable energy and related activities. It’s simply the right thing to do and as we learn from them and they learn from us, the world would be a better place for it.”

Michael Morris, Chairman and CEO of American Electric Power

21st Century Coal

Three DOE national laboratories are deeply engaged in cooperation with Chinese researchers on carbon capture, utilization and storage. The National Energy Technology Laboratory (NETL) and the Pacific Northwest National Laboratory (PNNL) are jointly cooperating with the Chinese Academy of Sciences (CAS) on high-volume carbon dioxide capture, sequestration, and utilization; advanced gasification and gas turbines; and advanced syngas conversion technologies. Under the cooperative work plan, researchers from CAS will work at NETL in the spring of 2011 to conduct experiments on fluid flow in Chinese rock cores and also go to PNNL, where data from these experiments will be used to develop computational models. DOE’s Lawrence Livermore Laboratory (LLNL) has struck various partnerships with Chinese companies such as ENN, CNOOC, Huaneng Group and Shenhua Group to advance technologies and know-how for various coal gasification and underground carbon sequestration applications.

Both countries celebrated the tenth anniversary meeting of the Fossil Energy Protocol in August, 2010, where a number of accomplishments over the past year were reviewed, including convening the 3rd U.S.-China CO₂ Emissions

Control Science & Technology Symposium with over 130 participants and completion of a joint prefeasibility study by West Virginia University and Shenhua Group, with support from LLNL, on capturing and storing carbon dioxide from the world’s first direct commercial coal liquefaction plant in Inner Mongolia. Agreement was also reached among NETL, PNNL and CAS on pursuing new R&D cooperation on advanced coal-based energy systems research development and simulation.

Reflecting the priority attached to this topic by both governments, there have also been a number of commercial developments in the sector over the past year. Future Fuels LLC of Texas signed an agreement to use Chinese pre-combustion carbon capture technology for a new coal plant in Pennsylvania. Duke Energy signed agreements with China’s ENN and Huaneng to share experiences with respective IGCC projects in each country, with the goal of jointly exporting these technologies to other countries. AEP of Columbus, Ohio, signed agreements with China’s Huaneng and CNOOC on carbon capture, utilization and storage, and with State Grid on integrating power generated from cleaner coal with the electric grid.

Energy Cooperation Program

DOE, together with the U.S. Department of Commerce and U.S. Trade and Development Agency, leverages the expertise of U.S. companies through the U.S.-China Energy Cooperation (ECP), a private-public partnership that develops clean energy solutions in both countries. From its founding in late 2009, ECP has grown from 24 to 39 member companies across ten sector-based working groups through which it develops and realizes clean energy commercial opportunities.

Some early successes include the formation of the Sustainable Aviation Biofuels Program; a distributed energy-combined heat, cooling and power pilot project by Caterpillar, GE, Capstone, Honeywell, United Technologies, and Vanderwell with Beijing Huajian Power Design & Research Institute; a diesel retrofit project in the public transportation sector led by Corning and Shanghai Ba-Shi Public Transportation Group; and development of a five-year roadmap for the clean coal sector.

ECP has generated other business opportunities for member companies and has organized two trade missions for Chinese government delegations to the United States to promote U.S. clean energy exports and U.S. job creation in the areas of building energy efficiency, renewable energy and sustainable city development.

Looking Ahead

The energy and climate challenges facing the United States and China will not be solved in weeks or months. Instead, this will require sustained work over years and decades. Our two countries will compete in the global marketplace and many other arenas, but we have much to learn from each other. There will be many opportunities to cooperate in meeting these challenges—bilaterally as well as in multilateral fora including the Clean Energy Ministerial, Major Economies Forum, UN Framework Convention on Climate Change and G-20. Working together, we can accomplish more than acting alone.



President Barack Obama

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