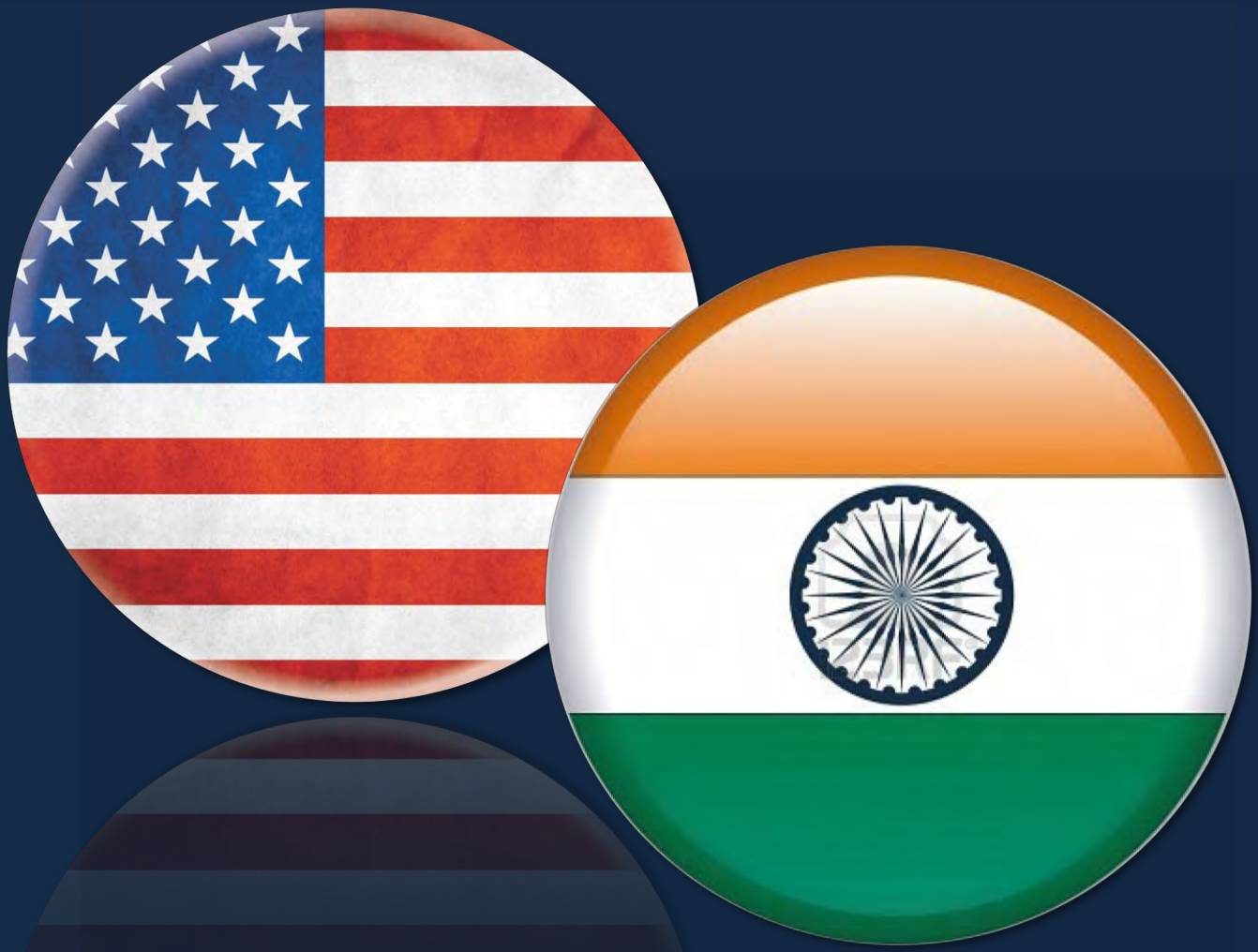
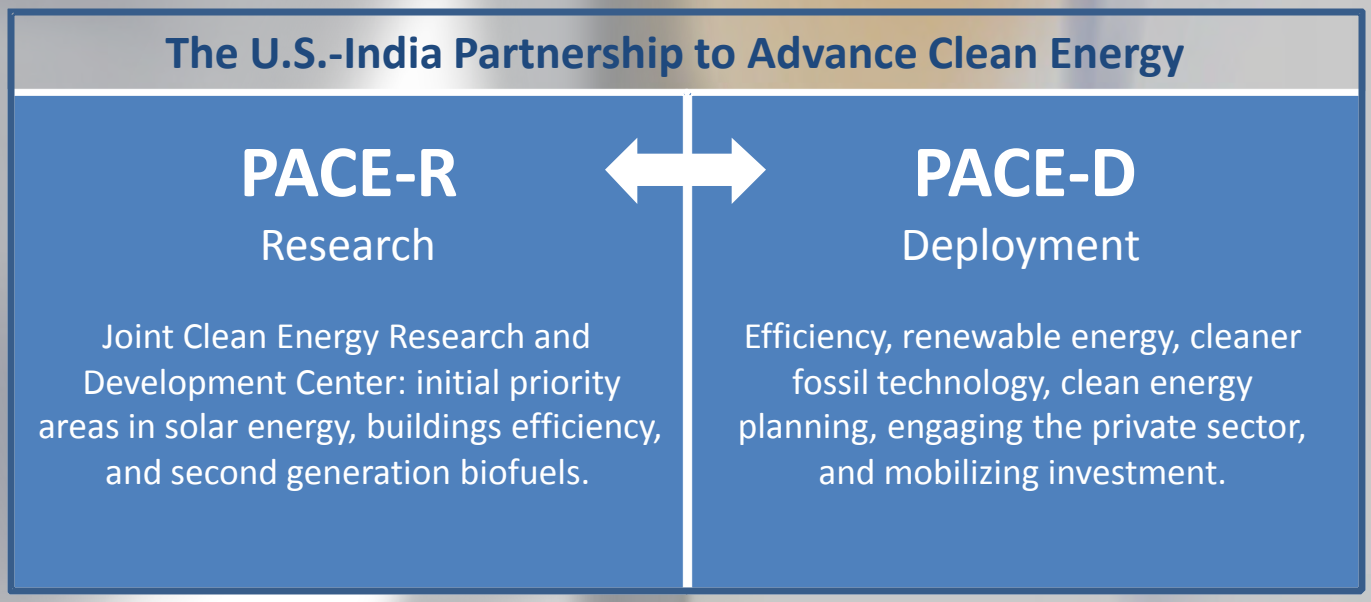


U.S.-India Partnership to Advance Clean Energy (PACE)

A PROGRESS REPORT

U.S. DEPARTMENT OF ENERGY

June 2012



U.S.-India Partnership to Advance Clean Energy (PACE)

A Progress Report

By the U.S. Department of Energy, U.S. Department of State, U.S. Agency for International Development (USAID), U.S. Trade and Development Agency (USTDA), U.S. Department of Commerce, Overseas Private Investment Corporation (OPIC), and Export-Import Bank (Ex-Im).

Photos courtesy of the Department of Energy's ETVC, the White House, State Department, U.S. Agency for International Development, U.S. Trade and Development Agency and Prime Minister of India websites (or as otherwise indicated).

Executive Summary: U.S.-India Partnership to Advance Clean Energy (PACE) A Progress Report

Energy cooperation is a central element of the U.S.-India strategic partnership. President Obama and Prime Minister Singh launched the U.S.-India Partnership to Advance Clean Energy (PACE) in November 2009 to accelerate the transition to high performing, low emissions, and energy secure economies.

Since its inception, PACE has mobilized significant resources from both governments and the private sector to promote clean energy scale-up and low-carbon growth.

Structure of Cooperation

Working under auspices of the U.S.-India Energy Dialogue, PACE engages a diverse array of U.S. and Indian government agencies. On the U.S. Government side, supporting agencies include the U.S. Department of Energy, U.S. Agency for International Development, U.S. Department of State, U.S. Trade and Development Agency, Overseas Private Investment Corporation, Export-Import Bank, U.S. Department of Commerce, U.S. Geological Survey and Office of the U.S. Trade Representative.

PACE has two primary and interlinked components: clean energy research (PACE-R) and clean energy deployment (PACE-D).

PACE-Research

Under PACE-R, the U.S. Department of Energy (DOE) and India's Planning Commission established a Joint Clean Energy Research and Development Center (JCERDC) in November 2010 designed to promote clean energy innovation by consortia of scientists and engineers from India and the United States.

In May 2011, DOE and the Government of India each made $25 million available (over five years, subject to appropriations) under a joint solicitation for R&D proposals by consortia in the initial priority areas of solar energy, buildings efficiency, and second generation biofuels.

The U.S. and Indian prime awardees were announced in April 2012 following an extensive merit-review process. Consortia members have pledged an additional $75 million in matching private funds, for a combined funding total of more than $125 million to launch R&D cooperation under JCERDC.

DOE's Office of Policy and International Affairs and the Indo-U.S. Science and Technology Forum are serving as the Secretariat for JCERDC.

PACE-Deployment (PACE-D)

PACE-D is designed to tackle multiple clean energy deployment opportunities, including: energy efficiency and distribution reform; scaling renewable energy, cleaner fossil technology and management; clean energy planning; and engaging the private sector and mobilizing investment.

Significant Progress, Significant Opportunities

Building on a strong legacy of bilateral collaboration, PACE has already achieved some important successes, including the launch of the potentially transformational joint research effort under JCERDC. Yet significant opportunities still remain, and both countries will continue to work hard in the months and years ahead to continue the shared pursuit of a clean energy future.

PACE IN ACTION: SELECTED HIGHLIGHTS

$125 MILLION PUBLIC-PRIVATE JOINT RESEARCH CENTER: In April 2012, both countries announced the first consortia awardees under the PACE Joint Clean Energy Research and Development Center. These joint U.S.-India, public-private consortia will dedicate efforts towards the discovery of transformational scientific and technological solutions in the areas of building efficiency, solar energy and advanced biofuels. The Center will involve over 95 government, private and university organizations in a $125 million effort over five years.

NEW 5-YEAR, $20 MILLION COLLABORATION ON DEPLOYMENT: In June 2012, the U.S. Agency for International Development (USAID) launched a new five-year technical assistance program to support clean energy development and scale up in partnership with the Ministry of Power and the Ministry of New and Renewable Energy. The $20 million contract will improve end-use energy efficiency, increase the supply of renewable energy, and adopt and accelerate deployment of cleaner fossil fuel technologies. The focus of the program will be on strengthening the enabling environment, increasing access to finance, and enhancing institutional and human capacity.

MORE THAN $1.7 BILLION MOBILIZED FOR CLEAN ENERGY FINANCE: The United States has established a Clean Energy Finance Center at the American Center in New Delhi to support the financing of clean technology, staffed with representatives from the U.S. Department of Commerce, the State Department, USAID, U.S. Trade and Development Agency (USTDA), Overseas Private Investment Corporation (OPIC), Export-Import Bank (Ex-Im), and the U.S. Department of Energy (DOE). Since PACE's inception, these agencies have mobilized more than $1.7 billion in public and private resources for clean energy projects in India.

PRIVATE SECTOR ENGAGEMENT: Both countries launched the U.S.-India Energy Cooperation Program (ECP) in late 2010 to better leverage the U.S. private sector role in clean energy deployment. With support from the U.S. Trade and Development Agency (USTDA) the ECP has grown to 16 member companies and has been able to establish strong working channels for government-to-business technical and commercial partnerships and to mobilize funding for a growing portfolio of clean energy projects in India.

STUDY TOURS AND TRADE MISSIONS: USTDA sponsored the Clean Energy Exchange Program, a series of four reverse trade missions to the United States in the areas of smart grid expansion, solar power generation, unconventional gas, and green buildings. Overall, USTDA support for infrastructure feasibility studies, reverse trade missions and other technical assistance in the Indian market has translated into at least $1.7 billion in U.S. exports.

A STRONG BILATERAL PROJECT PORTFOLIO: USTDA has funded feasibility studies and pilot projects for smart grid implementation with utilities in India and private sector led solar power generation. The two sides also continue technical cooperation in support of renewable energy and energy efficiency deployment through USAID and DOE and its national labs, including supporting work on solar resource assessment and mapping, solar technologies training for Indian financial institutions, improved wind resource estimates, data center and IT office building efficiency, and Energy Conservation Building Code implementation at the local level.

“Developing and investing in new technologies is a key component to meeting the goals of a clean energy future.

This innovative approach to collaborative research is a testament to the special relationship shared by the two countries.

By working with our partners in India and sharing a strong commitment to building a clean energy economy, we can get further, faster, than by working alone.”

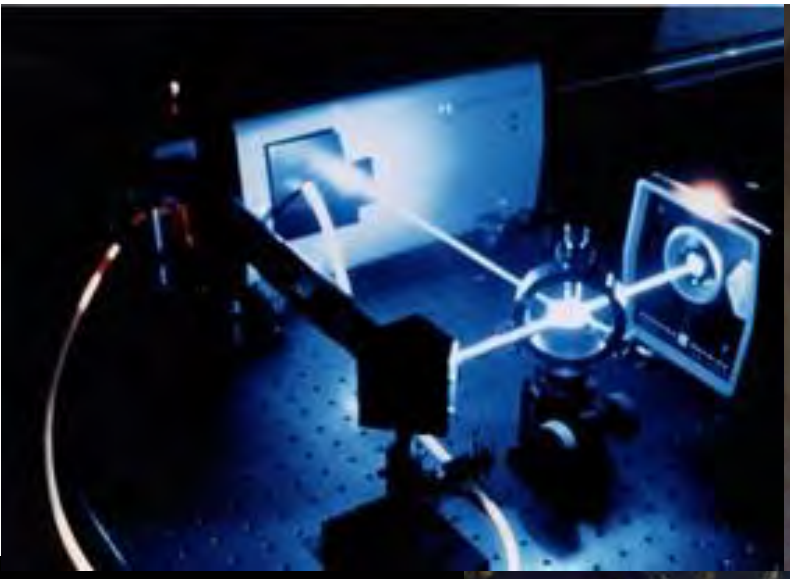
-- Dr. Steven Chu, U.S. Secretary of Energy
Announcing the U.S.-India Joint Clean Energy R&D Center
(May 16, 2011)

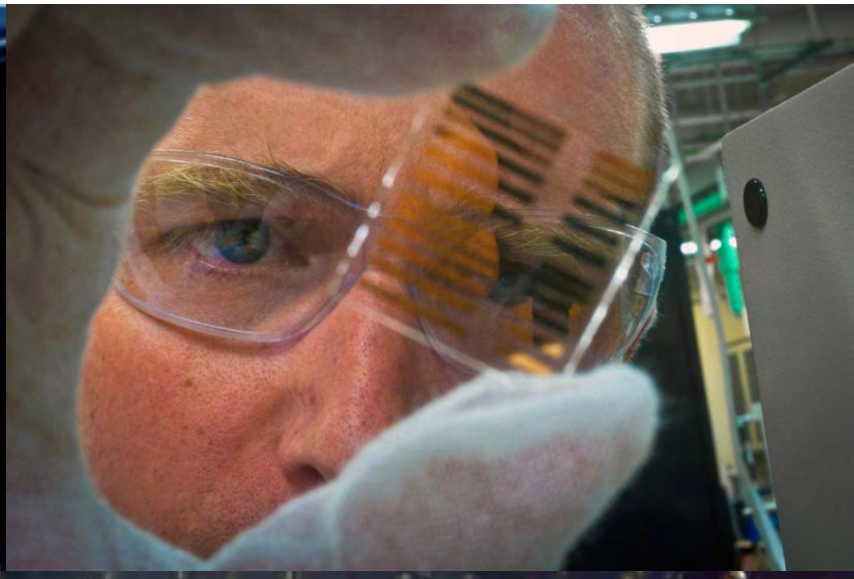
"The cooperation we are forging here should build habits of cooperation and bonds of trust as we strive to make both of our countries stronger, more prosperous, and better equipped to address the challenges we face."

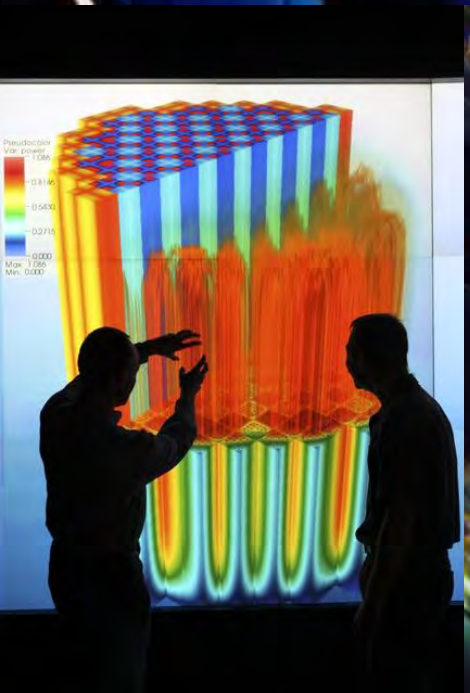
-- Hillary Rodham Clinton
U.S. Secretary of State
U.S.-India Strategic Dialogue (July 2011)

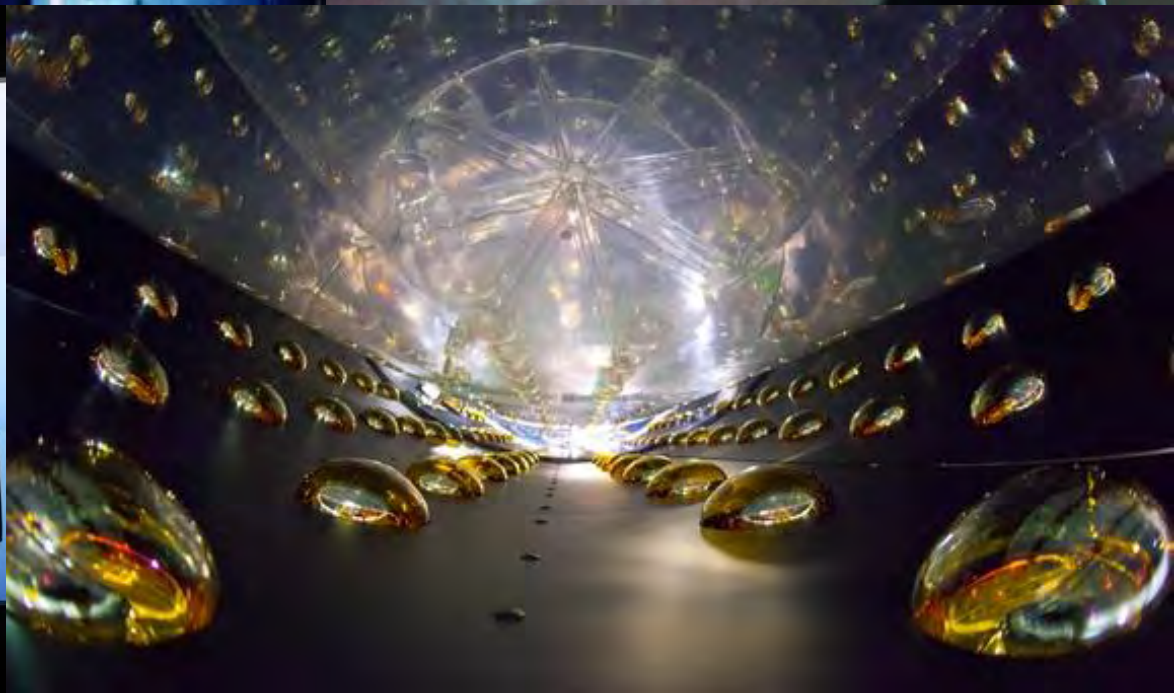
PARTNERSHIP TO ADVANCE CLEAN ENERGY

RESEARCH









PACE-Research (PACE-R) Overview

During President Obama's head-of-state visit to India in November 2010, the U.S. Department of Energy (DOE) and India's Planning Commission entered into an Agreement to Establish a Joint Clean Energy Research and Development Center (JCERDC) to promote clean energy innovation by consortia of scientists and engineers from India and the United States.

JCERDC's structure is designed to encourage partnerships, leverage additional sources of funding, and engage private sector companies best placed to understand the near-term clean energy research and development (R&D) needs for a broad, industry-wide impact.

PACE-R collaboration under JCERDC represents the most integrated joint clean energy undertaking DOE has done with any country, including the Department's first-ever joint funding solicitation with another government.

U.S.-India Joint Funding Opportunity Announcement (Joint FOA):

In May 2011, DOE and the Government of India each made $25 million available (over five years, subject to appropriations) for work conducted by U.S. and Indian institutions and individuals under the first JCERDC Joint FOA for R&D proposals in the initial priority areas of **solar energy, buildings efficiency, and second generation biofuels.** The prime awardees were announced in April 2012 following an extensive merit-review process:

• The National Renewable Energy Laboratory (NREL) and India's Institute of Science at Bangalore in the area of solar energy;

•Lawrence Berkeley National Laboratory (Berkeley Lab) and India's Center for Environmental Planning and Technology (CEPT) University-Ahmedabad in the area of buildings efficiency; and

•The University of Florida and Indian Institute of Chemical Technology(IICT)-Hyderabad in the area of second-generation biofuels.

Consortia members have pledged an additional $75 million in matching private funds, for a combined funding total of more than $125 million to launch R&D cooperation under JCERDC.

Breakthrough PACE Research will advance clean energy deployment under the U.S.-India Energy Dialogue and PACE-D activities

Sustainable Cities: DOE is sharing models, building guidelines, lessons learned, best practices, as well as other tools and information to advance the development of near-zero urban energy cities and communities. Brookhaven National Laboratory (BNL) and Lawrence Berkeley National Berkeley (Berkeley Lab) are working with key partners, including India's Ministry of Urban Development, Ministry of Commerce and Industries, and Ministry of New and Renewable Energy (MNRE) to advance planning and implementation of these cutting-edge urban planning tools.

Solar Technology: DOE's National Renewable Energy Laboratory (NREL) collaborates with MNRE's Solar Energy Center (SEC) on solar resource assessments and mapping. The two institutions are also collaborating on the reliability of photovoltaic (PV) modules and on minigrids.

Wind Technology: NREL collaborates with India's Centre for Wind Energy Technology (C-WET) to accelerate development of testing facilities and deployment of wind energy technologies -- improving wind resource estimates, on-shore and off-shore wind turbine modeling and energy technology field testing.

Advanced Biofuels: DOE and NREL have collaborated with MNRE on advanced biofuels, providing technical support to the Indian Oil Corporation (IOC) for the development of a cellulosic ethanol pilot plant design. Additional efforts include R&D on jatropha biodiesel for use in on-road transport, as well as jatropha crop development and testing. DOE's Argonne National laboratory (ANL) is also collaborating with IIT-Kanpur on the production and evaluation of biodiesel fuels from Jatropha and Karanja feed stocks for heavy-duty engine applications.

Policy Best Practices and Analysis: DOE and NREL are collaborating with MNRE on the development of a database to catalogue national, state and local incentives and policies for energy efficiency and renewable energy in India similar to the DSIRE database in the United States.

Former Ambassador of India to the United States Meera Shankar and Deputy Secretary Daniel Poneman at the Initialing Ceremony for JCERDC at DOE Headquarters in Washington (August 2010)

"We are two nations, both of which are committed to sustainable development, both of which are committed to assuring a clean and prosperous future for all of our people. And we both face many of the same challenges to developing our energy future.

As we move forward together, we will continue to expand our cooperation to promote a secure and stable world, to advance technology and innovation, to expand mutual prosperity and global economic growth, to support sustainable development, and to lead the global community in achieving a clean energy future."

-- Daniel Poneman
DOE Deputy Secretary of Energy

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

INDIAN INSTITUTE OF SCIENCE
Bangalore, India
भारतीय विज्ञान संस्थान
बेंगलूर, भारत

SOLAR ENERGY CONSORTIUM

JOINT CLEAN ENERGY RESEARCH AND DEVELOPMENT CENTER (JCERDC)

Under JCERDC's first joint Funding Opportunity Announcement (Joint FOA), DOE and the Government of India will each award $12.5 million in financial assistance (over five years) to support solar energy R&D by teams of scientists and engineers from India and the United States, subject to appropriations.

Following a competitive merit-review process, the National Renewable Energy Laboratory (NREL) and India's Institute of Science at Bangalore were selected to lead the U.S. team members and India team members, respectively, of a consortium focused on the launch of a Solar Energy Research Institute for India and the United States (SERIIUS).

SERIIUS will develop and ready emerging and revolutionary solar electricity technologies toward the long-term success of India's Jawaharlal Nehru National Solar Energy Mission and DOE's SunShot Initiative. SERIIUS will carry out fundamental and applied research, analysis and assessment, outreach, and workforce development through three research thrusts:

1. Sustainable Photovoltaics (PV) to develop next-generation materials, devices, and manufacturing processes tailored to India's needs, environment, and resource availability.

2. Multiscale Concentrated Solar Power (CSP) to overcome critical science and engineering challenges for reliable multiscale (including small 25–500 kW) CSP systems.

3. Solar Integration to identify and assess key technical, economic, environmental, and policy barriers to enable a research agenda for technical readiness in India and to benefit the United States.

Supported by a planned additional cost-share of approximately $12.85 million from U.S. consortium members, NREL will collaborate with a number of U.S. partners—which include Sandia National Laboratories; RAND Corporation; Lawrence Berkeley National Laboratory; Arizona State University; Carnegie Mellon University; Colorado School of Mines; Massachusetts Institute of Technology; Purdue University; Stanford University; University of Central Florida; University of South Florida; Washington University in St. Louis; Cookson Electronics, Corning Incorporated; General Electric Company; Konarka Technologies, Inc.; MEMC Corporation; and Solarmer Energy Inc.

Supported by a planned additional cost-share of approximately $21 million from Indian consortium members, the Indian Institute of Science-Bangalore will collaborate with a number of Indian partners—which include the Indian Institute of Technology – Bombay; Center for the Study of Science, Technology and Policy; International Advanced Research Centre for Powder Metallurgy and New Materials; Solar Energy Centre; Indian Institute of Technology-Madras; Indian Association for the Cultivation of Science; Clique Developments Ltd.; Hindustan Petroleum Corporation Ltd.; Moser Baer India Ltd.; Thermax Ltd.; TurboTech Precision; Engineering Ltd.; and Wipro Ltd.

Key Facts: Solar Energy in India

With about 300 sunny days a year, India's solar energy potential is among the best in the world -- approximately 5,000 trillion kilowatt hours (kWh) per year incident over India's land area receives an average hourly solar radiation of 200 megawatts (MW) per square kilometer.

According to the India Energy Portal developed by The Energy and Resources Institute (TERI), approximately 12.5 percent of India's land mass (413,000 square kilometers) receives sufficient radiation to generate solar power.

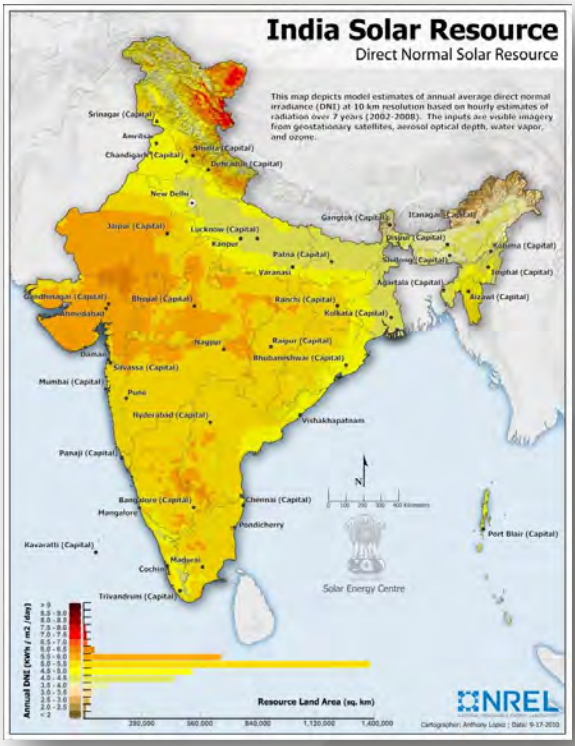
India's solar power generation capacity has grown from 8 MW in January 2010 to over 979 MW as of May 2012 (MNRE, Progress under Jawaharlal Nehru National Solar Mission, May 11, 2012).

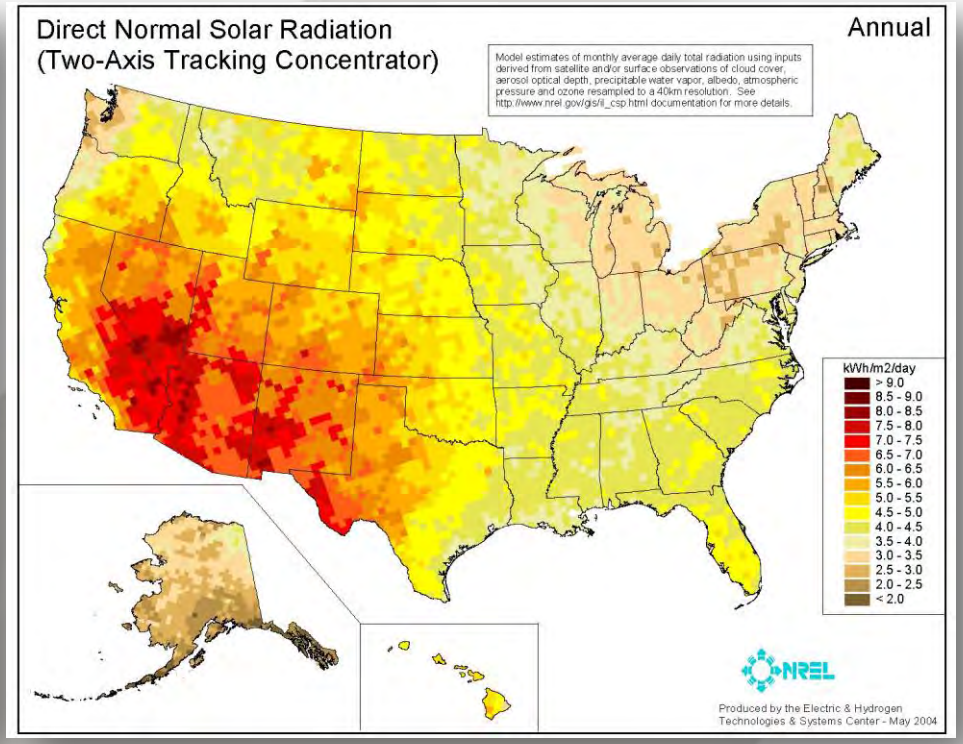
India's Jawaharlal Nehru National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge with a goal to install 20,000 MW of solar power and achieve price parity with India's grid power tariff by 2022.

Key Facts: Solar Energy in the United States

According to DOE assessments, the land area required to supply all end-use electricity in the United States using PV is only about 0.6 percent of the country's total land area. Similarly, the technical potential for Concentrated Solar Power (CSP) is enormous: about 17,500 TWh of annual CSP. Although solar energy currently supplies only a small fraction of energy needs in the United States, solar manufacturing costs and sales prices have dropped dramatically over the past few decades and solar technologies are approaching energy-price parity with conventional generating sources in some regions of the United States. These gains have come partly through research and development (R&D) and partly through private-sector competition by companies in the United States and other international markets.

DOE's SunShot Initiative aims to further accelerate this cost curve, reducing the price of solar energy systems by about 75 percent by the end of the decade. Achieving the level of price reductions envisioned in the SunShot Initiative could result in solar meeting 14 percent of U.S. electricity needs by 2030 and 27 percent by 2050.





BUILDINGS EFFICIENCY CONSORTIUM

JOINT CLEAN ENERGY RESEARCH AND DEVELOPMENT CENTER (JCERDC)

Under JCERDC's first joint Funding Opportunity Announcement (Joint FOA), DOE and the Government of India will each award $6.25 million in financial assistance (over five years) to support R&D for energy efficient buildings, subject to appropriations.

Following a competitive merit-review process, Lawrence Berkeley National Laboratory (Berkeley Lab) and India's Center for Environmental Planning and Technology (CEPT) University-Ahmedabad were selected to lead a new joint U.S.-India research center focusing on energy efficiency technologies for buildings. The consortium's U.S.-India Joint Center for Building Energy Research and Development (CBERD) will conduct research with Indian counterparts focused on the integration of information technology with building systems in commercial and high-rise residential buildings.

The R&D tasks are designed to accelerate buildings efficiency technology with R&D in a number of areas, including: (1) simulation; (2) monitoring; (3) controls; (4) envelope/passive design (insulation, cool roofs); (5) advanced technologies (HVAC, lighting); (6) thermal comfort; (7) grid responsiveness, (8) renewable integration; and (9) scientific collaboration. This outcome-based R&D will result in significant energy savings by driving development of cost-effective technologies and their implementation across buildings.

Supported by a planned additional cost-share of approximately $15.5 million from U.S. consortium members, Berkeley Lab will collaborate with a number of third-party partners. The U.S. partners include Oak Ridge National Laboratory; University of California Berkeley; Carnegie Mellon University; Rensselaer Polytechnic Institute; Autodesk, Inc.; California Energy Commission; Delphi; enLighted, Inc.; Honeywell; Infosys Public Services; Ingersoll-Rand/Trane; Lighting Science Group Corp.; Nexant; Saint Gobain Corp./SAGE Electrochromics; SynapSense; The Weidt Group; Bay Area Photovoltaic Consortium; City of San Jose; HOK Architects; Natural Resources Defense Council.

Supported by a planned additional cost-share of $17.8 million from India consortium members, CEPT University-Ahmedabad will collaborate with a number of third-party partners. The Indian partners include Asahi India Glass, Biodiversity Conservation India, Confederation of Indian Industry– Sohrabji Godrej Green Business Center, Glazing Society of India, Indian Society of Heating Refrigerating and Air-conditioning Engineers, Indian Society of Lighting Engineers, Infosys, Neosilica Technologies, Oorja Energy Engineering Services, PBC Ventures, Philips, Pluss Polymers, Rajasthan Electronics and Instruments Limited, Saint Gobain, Schneider, Sintex, Skyshade Daylights, and Wipro EcoEnergy.

Key Facts: Buildings EE in India

According to the Energy Conservation and Commercialization (ECO) Bilateral Project, India's residential and commercial sectors account for about 33 percent of the total electricity used in India.

An estimated 66 percent of commercial building stock in India is yet to be constructed with 1.3 billion square meters of new floor space added over the next 20 years. Commercial sector electricity consumption has been growing at 12-14 percent per year on average, attributed to the increasing electricity consumption in existing buildings as well as increasing energy intensity of newly constructed commercial buildings.

Under the Energy Conservation Act 2001, the Government of India launched Energy Conservation Building Code (ECBC) on a voluntary basis to implement minimum energy performance standards for new commercial buildings having a connected load of 500 kW or contract demand of 600 kVA. The Bureau of Energy Efficiency (BEE) is implementing capacity building programs and developing technical documents and training material to raise awareness about ECBC and to enhance the professional skills of building design professionals. Accomplishment include:

• Over 700 ECBC-compliant buildings are at various stages of construction.

• Two States have adopted ECBC, making it mandatory for all new, large-commercial buildings to comply with the Code.

• Performance contracting through Energy Service Companies (ESCOs) is being promoted to enable the retrofit of existing buildings.

• In September 2011, the U.S.-India CEO Forum also pledged to support ECBC in two Indian cities.

Launched by the Confederation of Indian Industry (CII) in 2001, the Indian Green Building Council (IGBC) is also supporting efficiency in buildings through a voluntary, market-driven building rating system tailored to India based on the U.S. Green Business Council's Leadership in Energy and Environmental Design (LEED) rating system.

Key Facts: Buildings EE in the United States

In the United States, buildings use more energy than any other sector of the U.S. economy, consuming more than 70 percent of electricity and over 50 percent of natural gas.

According to DOE studies, after losses in generating and delivering electricity, about 11 Quads of fossil fuels and 9 Quads of electricity were consumed in buildings in 2009. That energy was principally used for heating, ventilation, and cooling (HVAC); lighting; water heating; and electronics.

Electricity accounts for 40 percent and 53 percent of site energy use in residential and commercial buildings, respectively; fuels for heating and cooking comprise the balance. Commercial buildings use 75 percent more energy per square foot than residential buildings. On average, American households spend $2,200 per year on energy at home.

DOE's Building Technologies Program (BTP) has set the ambitious goal to make grid-connected buildings 60 to 70 percent more energy efficient than today's typical buildings, with renewable energy providing a portion of the power needs.

Although building codes are legislated at the individual state level in the United States, the Energy Policy Act of 1992 mandated that DOE participate in the model national codes development process to help states adopt and implement progressive energy codes.

DOE's Building Energy Codes Program (BECP) supports the adoption and enforcement of energy codes in the states, maintaining free software and tools to support those codes and standards (including the award-winning RES*check* software for low-rise residential building energy code compliance, and the COM*check* software for commercial building energy code compliance). BECP also conducts outreach and deployment activities related to energy codes and high-performance sustainably designed buildings.

System integration can reduce loads by integrating building design aspects (such as size, siting, and daylighting) with intelligently coordinated components and controls. DOE's EnergyPlus software allows calculation of the savings potential of a variety of building energy options. Since 2001, more than 100,000 copies have been downloaded.

SECOND GENERATION BIOFUELS CONSORTIUM

JOINT CLEAN ENERGY RESEARCH AND DEVELOPMENT CENTER (JCERDC)

Under JCERDC's first joint Funding Opportunity Announcement (Joint FOA), DOE and the Government of India will each award $6.25 million in financial assistance (over five years) to support R&D for second generation biofuels, subject to appropriations.

Following a competitive merit-review process, the University of Florida and Indian Institute of Chemical Technology(IICT)-Hyderabad were selected to lead team members of a consortium focused on the launch of cutting edge R&D in second generation biofuels production. The goal of this project is to develop and optimize selected non-food biomass based advanced biofuels and biobased products systems for the United States and India.

This R&D will also advance the development of sustainable, replicable feedstocks production, logistics, processing, and biofuels distribution systems with the development of a well-coordinated and synergistic approach to second generation biofuel production in these areas.

Supported by a planned additional cost-share of $6.25 million from U.S. consortium members, the University of Florida will collaborate with a number of third-party partners—which include the University of Missouri; Virginia Tech; Montclair State University; Texas A&M University; Show Me Energy; and Green Technologies.

Supported by a planned additional cost-share of $5.3 million from Indian consortium members, the Indian Institute of Chemical Technology-Hyderabad will collaborate with a number of third-party partners—which include the International Crops Research Institute for the Semi-Arid Tropics-Hyderabad; Directorate of Sorghum Research-Hyderabad; Jawaharlal Nehru Technological University-Hyderabad; Tamil Nadu Agricultural University; Rajamatha Vijayaraje Sindia Krishi Vishwa Vidyalay; Centre for Economic and Social Studies; Indian Institute of Technology-Delhi; Indian Institute of Technology-Chennai; and Abellon Clean Energy.

Key Facts: Biomass in India

Diesel and petrol (gasoline) meet more than 95 percent of the requirement for transportation fuel.

India is the fourth largest producer of ethanol in the world. According to India's Ministry of Agriculture, India has 330 distilleries which produce 4 billion liters of rectified spirit (alcohol) per year. Of those distilleries, approximately 115 have the capacity to distill conventional ethanol with a capacity for 1.8 billion liters per year, sufficient (given bumper crop sugarcane and sugar production) to meet a government mandated 5 percent blending requirement that took effect in October 2008.

Given the steady rise in demand for passenger and freight vehicles in the transport sector, the development of latest generation biofuels represents a significant energy source for India to diversify its energy mix and narrow the import-export balance for its upstream petroleum supply needs.

Nevertheless, biofuel production and consumption in India remains in early stage development. Although India currently produces conventional bio-ethanol from sugar molasses, production of advanced bio-ethanol and second-generation are still in the research and development phase.

In December 2009, the Government of India approved a new Ministry of New and Renewable Energy (MNRE) "National Policy on Biofuels" with a proposed target of 20 percent blending for bio-diesel and bio-ethanol by 2017. The policy targets biofuel feedstocks derived from agricultural wastes and non-food feedstock grown on degraded acreage or wastelands.

India has also launched a National Bio-diesel Mission (NBM) which identified *jatropha curcas* as the most suitable tree-borne oilseed for bio-diesel production.

Under the upcoming 12th Five Year Plan, India's Planning Commission is also seeking to build upon its previous target to cover 11.2 to 13.4 million hectares of land under jatropha cultivation by the end of the 11th Five Year Plan (2011/12).

Key Facts: Biomass in the United States

Almost 95 percent of U.S. transport energy and 37 percent of primary energy comes from oil, nearly half of which is imported.

Ethanol is the most widely used biofuel in the United States today. It may be available at your local gas station. Ethanol is currently sold as E-10, a blend of 10 percent ethanol and 90 percent gasoline. E-10 helps cars run better and results in less pollution than regular gasoline. At some gas stations, ethanol is also sold as an alternative fuel known as E-85. E-85 contains 85 percent ethanol and is used in specially designed cars and trucks known as flexible fuel vehicles (FFVs). More than seven million FFVs are on the road today.

A Renewable Fuel Standard (RFS) administered by EPA sets minimum amounts of biofuels that must be blended into vehicle fuels. The Energy Policy Act of 2005 established RFS1, which sets a minimum amount of ethanol (7.5 billion gallons) that must be blended into gasoline by 2012. The Energy Independence and Security Act of 2007 established RFS2, broadened the RFS to include second- and third-generation biofuels, set a new target (36 billion gallons in 2022), established separate volume requirements for new categories of fuel based on feedstock and vehicle compatibility.

Biofeedstocks can be divided into several categories: (1) conventional crop-based carbohydrates or lipids (e.g., corn and other starches, sugarcane, or vegetable oils), (2) cellulosic feedstocks (e.g., switchgrass, crop and wood byproducts), and (3) non-land based organisms (algae and other concepts).

Resource requirements (e.g., water and land intensity) and interactions with food and feed markets complicate the deployment of crop-based biofuels at material scales, driving research into alternative feedstocks. At the same time, increasing productivity of the corn crop will produce large amounts of starch and the easy conversion of starch to ethanol makes it likely that corn ethanol will continue to contribute to the U.S. fuel supply.

Cellulosic feedstocks are likely to be of growing importance, driven by RFS2 and the potential for minimizing impacts on food and feed markets.

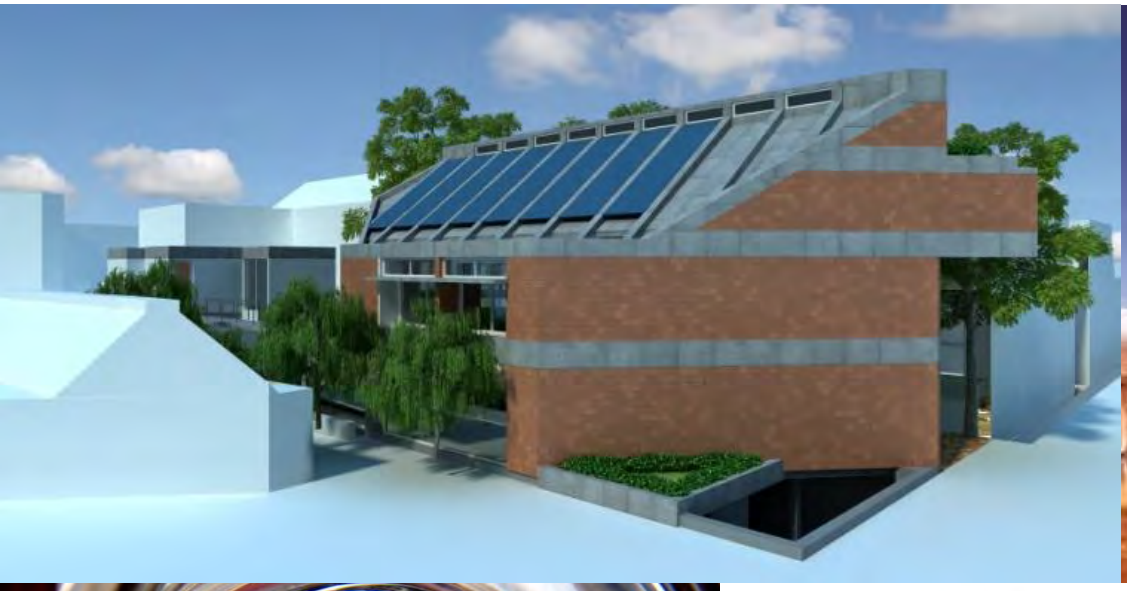
Planning Commission Deputy Chairman Ahluwalia meets with Secretary Chu and DOE Assistant Secretary David Sandalow in New Delhi (November 2009)

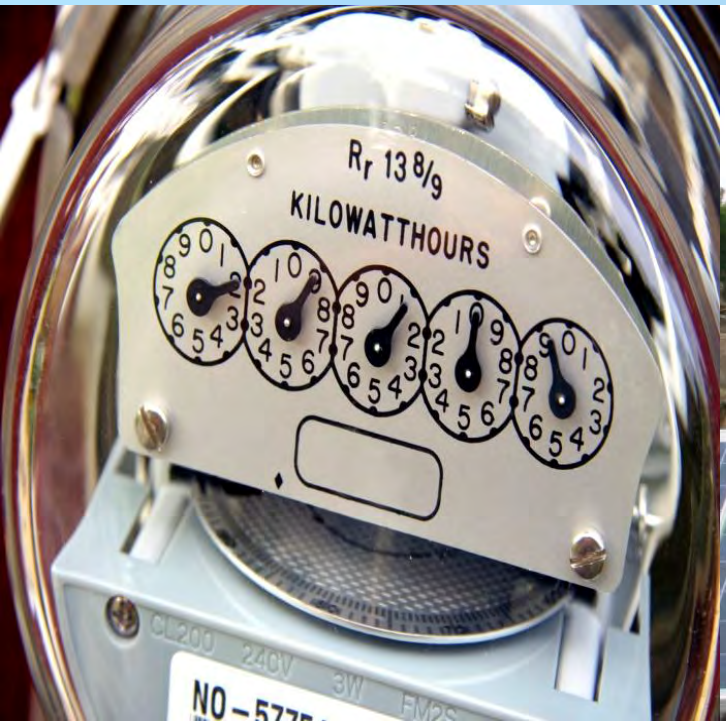
"This innovative research program will help promote clean energy, create jobs, and open export opportunities for U.S. business. By bringing some of our best scientific and technical minds together, we can strengthen both our great nations."

-- David Sandalow
Assistant Secretary, U.S. Department of Energy
Office of Policy and International Affairs

Partnership to Advance Clean Energy

Deployment





PACE Deployment (PACE-D) Overview

The Deployment component of PACE (PACE-D) is designed to support India's accelerated transition to a high performing, low emissions and energy secure economy by tackling multiple clean energy deployment opportunities, including:

- Energy efficiency and distribution reform;
- Scaling renewable energy technologies;
- Cleaner fossil technology and management;
- Enhanced greenhouse gas (GHG) mitigation
- planning and programs; and
- Engaging the private sector and mobilizing investment.

A Whole-of-Government Effort

Several U.S. government agencies contribute to PACE-D efforts under the auspices of the U.S.-India Energy Dialogue. The U.S. Agency for International Development (USAID) plays a lead role in shaping the overall approach to PACE-D, supported by active engagement from the U.S. Department of Energy (DOE), U.S. Department of State, U.S. Trade and Development Agency (USTDA), Overseas Private Investment Corporation (OPIC), Export-Import Bank (Ex-Im), U.S. Department of Commerce, and Office of the U.S. Trade Representative (USTR). This work is shaped to a large extent by two separate bilateral agreements between the two governments, one between USAID and the Ministry of Power, and the other between USAID and the Ministry of New and Renewable Energy.

Energy Efficiency and Distribution Reform

The energy efficiency and distribution reform component of PACE-D is focused on:

- Deployment of market driven energy efficient technologies such as Smart Grids, Net Zero Energy Buildings, Waste Heat Utilization, and Heating Ventilation and Air Conditioning.
- Support for the Bureau of Energy Efficiency (BEE) through technical assistance and capacity building activities to implement India's National Mission on Enhanced Energy Efficiency under the National Action Plan on Climate Change.
- Support for State Development Agencies to develop and implement state EE action plans, and improve regulatory environment for rapid deployment of EE technologies.

New USAID Five-Year Technical Assistance Program

In June 2012, USAID launched a new five-year, $20 million PACE-D technical assistance program that will work to increase India's supply of renewable energy, improve end-use energy efficiency, and adopt and accelerate deployment of cleaner fossil fuel technologies. In partnership with the Ministry of Power and the Ministry of New and Renewable Energy (MNRE), the focus of the program will be on strengthening the enabling environment, increasing access to finance, and enhancing institutional and human capacity to support deployment of clean energy at scale.

- Facilitation for the development of innovative financial instruments and process for new investments deployment of energy efficiency technologies at scale.

One example of this cooperation is the Bureau of Energy Efficiency (BEE) and Ministry of Power's implementation of **Energy Conservation Building Codes (ECBC).** This collaboration started more than ten years ago -- USAID's ECO program, launched in 2000, supported the creation of BEE and the establishment of India's first ECBC – and continues today.

Under PACE-D, USAID is providing technical assistance support to implement ECBC, and DOE—with partners Alliance to Save Energy, Brookhaven National Laboratory (BNL) and Pacific Northwest National Laboratory (PNNL) — is supporting BEE with the roll-out of the codes at the local level. This activity is also being implemented in coordination with the Energy Cooperation Program (ECP) and the U.S.-India CEO Forum.

Scaling Renewable Energy Technologies

The renewable energy technologies component of PACE-D is working to improve access to clean energy through scale-up of renewable energy power generation by driving down costs towards grid parity and supporting cost-effective off-grid applications. Focus areas include:

- Support to three states in strengthening policy and regulatory frameworks to enable renewable energy market development.
- Support for market driven deployment of renewable energy technologies (i.e., renewable energy based mini/micro grids, off-grid applications for industrial power and process heating).
- Development and testing of innovative finance mechanisms to leverage public and private sector financing for renewable energy projects.
- Support for partnerships between micro finance institutions and renewable energy service providers, including capacity building to increase clean energy access to rural communities.

These efforts contribute to the implementation of the Jawaharlal Nehru National Solar Mission (JNNSM) and other renewable energy policies and programs.

Enhanced GHG Mitigation Planning And Programs

USAID and the U.S. Departments of Energy and State will collaborate with the Government of India to exchange knowledge and expertise under a new Joint Working Group on Low Carbon Growth under the U.S.-India Energy Dialogue. The partnership will enhance planning, integration, and implementation of GHG mitigation efforts. This will be accomplished through technical, analytic, institutional and capacity building exchanges between the two countries.

Building a Smarter Grid

PACE partners are working to advance smart grid deployment in India.

As an outcome of a smart grid study tour in 2010, USAID supported the Government of India in the development of a request for proposals on smart grid pilot projects to be launched by the Ministry of Power (MOP). Through its Distribution Reform, Upgrades and Management program, USAID has worked to sensitize partner utilities to smart grid opportunities and is supporting a train-the-trainers course on smart grid in collaboration with MOP. Smart grid is also a major component under USAID's new PACE-D technical assistance program, which will support the Government of India as it develops a roadmap and common operability standards and a centre of excellence on smart grid, which will be housed at the MOP.

USTDA's strategic application of technical assistance, training, reverse trade missions, business workshops, and cooperative programs support India's development and clean energy deployment priorities while expanding export opportunities for U.S. businesses.

For example:

CESC Smart Grid Feasibility Study: A USTDA-funded feasibility study and pilot project is supporting the implementation of a smart grid roadmap for the Calcutta Electric Supply Corporation Limited. The assistance will develop requirements and specifications to address a range of improvements and investments including the integration of smart meters and automated meter reading into CESC's distribution system.

Tata Power Delhi Distribution Limited Project: USTDA is supporting Tata Power Delhi Distribution Limited's (TPDDL) Automation Roadmap by providing technical assistance to develop the requirements and specifications for smart grid implementation. TPDDL plans to improve power quality and reliability to its customers by adopting a distribution automation system and network reliability augmentation program. The project is designed to improve the efficiency and reliability of TPDDL's one-million customer distribution system and to help provide application models for other distribution networks in India.

Bangalore Smart Grid Project: USTDA and USAID are supporting the Bangalore Electricity Supply Company Limited's (BESCOM) effort to integrate smart grid technologies into its existing power system. USTDA is helping to develop the requirements and specifications for a smart grid implementation plan that will enable the integration of smart meters and automated meter reading into BESCOM's distribution system. Ultimately, this program will advance BESCOM's efforts to meet the challenge of improving the efficiency and reliability of energy supply amidst growing demand from its diverse customer base.

Rural Micro-Grid Power Feasibility Study: USTDA is partially funding a Feasibility Study grant for Azure Power regarding the development of a Rural Micro-Grid Solar Power project that will be deployed in remote non-electrified villages in India. The study will assess and provide planning assistance for two 500 kilowatt photovoltaic pilot projects in the states of Chhattisgarh and Gujarat.

Bankura and Phalodi Solar PV Power Project: India's rapid economic expansion and population growth are placing a growing strain upon the country's energy infrastructure. In response, India's federal and state level governments are looking to increase the country's domestic clean power production. To further this goal, USTDA is supporting Astonfield Renewables Private Limited in its efforts to prepare the design and deployment of two solar photovoltaic power projects in India – a 5 MW plant in Bankura, West Bengal and a 50 MW plant in Phalodi, Karnataka. The USTDA-funded feasibility study will provide technological and economic assessments of both solar PV power projects, as well as assist Astonfield with permitting requirements and a plan for full implementation.

Industrial Efficiency Technical Outreach: DOE workshops in Chennai, New Delhi and Mumbai with India industry are working to increase awareness of energy management and energy saving tools and techniques. This outreach will also train energy auditors on energy management, plant assessment, the ISO 50001 standard and other energy audit areas.

Bilateral Cooperation in the Context of the Clean Energy Ministerial (CEM)

In 2013, India will host the fourth meeting of the Clean Energy Ministerial (CEM4), a gathering of more than 20 governments accounting for 90 percent of global clean energy investment. The United States and India are collaborating on a number of CEM initiatives, including the Global Efficiency Awards competition for flat-panel televisions through the Super-efficient Equipment and Appliance Deployment (SEAD) initiative; a Cool Roofs demonstration project and rating & certification program in India under the Global Superior Energy Performance Partnership; and Lighting Asia, a program aimed at providing safe, clean and affordable off-grid lighting to two million rural Indians over the next three years.

Cleaner Fossil Technology and Management

The Cleaner Fossil Technology and Management component of PACE-D is focused on reducing or avoiding GHG emissions through accelerated deployment and commercialization of cleaner coal technologies.* Focus areas include:

- Support for two utilities in improving heat rates in power plant performance.
- Support for the development of concept of Model Power Plant and development of Service Provider Network.

The activity is also expected to contribute to the implementation of India's Energy Policy and National Perspective Plan for Renovation & Modernization (R&M).

The U.S. Department of Commerce's Commercial Law Development Program is engaging with the Ministry of Petroleum and Natural Gas on the responsible development of India's unconventional gas resources, sharing U.S. experience in establishing necessary environmental protection and regulatory frameworks as the GOI prepares for its first shale gas bid round - presently scheduled for 2013. This collaboration is in line with the Unconventional Gas Technical Engagement Program (UGTEP) under the State Department's Bureau of Energy Resources.

(* FY10 appropriation legislation prohibits using certain funds for coal technology and production. USAID's PACE-D contract will support clean coal activities with $2 million allotted in FY09 funding.)

Clean Energy Finance and Private Sector Engagement

A major focus of PACE-D is engaging the private sector and mobilizing investment in clean energy. Since PACE's inception, the U.S. government has mobilized more than $1.7 billion in public and private resources for clean energy deployment in India.

A New Clean Energy Finance Center

To facilitate this work, the United States has established a Clean Energy Finance Center at the American Center in New Delhi, hosted by the U.S. Department of Commerce and staffed with representatives from USAID, USTDA, the Overseas Private Investment Corporation (OPIC), Export-Import Bank of the United States (Ex-Im), and the U.S. Departments of State and Energy.

These agencies each bring distinct comparative advantages to the work of financing clean energy deployment in India and furthering business, export, and investment opportunities for U.S. companies.

Overseas Private Investment Corporation (OPIC)

To date, OPIC, the U.S. Government's development finance institution, has committed $740 million in financing and insurance for clean energy projects in India under PACE.

In March 2012, OPIC's Board of Directors approved $250 million in financing to help India's premier infrastructure lender, Infrastructure Development Finance Company (IDFC), expand its lending to renewable energy and infrastructure projects, providing much-needed long-term capital to keep pace with the clean energy sector's massive potential.

IDFC is using the OPIC guaranty to expand its lending to solar photovoltaic projects, energy efficiency projects, projects that reduce energy consumption and/or demand, and wind farm projects, among others. The OPIC financing also supports IDFC's "Go Green" initiative, which aims to mitigate the social, environmental and carbon footprint of its projects, as well as lending to infrastructure projects.

USTDA's Clean Energy Exchange Program

USTDA launched the Clean Energy Exchange Program to introduce energy sector officials and private project sponsors from India to U.S. clean energy technologies through a series of four reverse trade missions to the United States. These missions, organized in conjunction with the U.S.-India Energy Cooperation Program, support India's efforts to improve the supply, cost, and efficiency of energy throughout the country in order to improve standards of living and promote economic growth. The four exchanges focus on unconventional gas development, smart grid expansion, solar power generation and green buildings/energy efficiency.

U.S.-India Energy Cooperation Program

The U.S.-India Energy Cooperation Program (ECP) is a public-private partnership between U.S. member companies and the governments of the United States and India. It was established to leverage private sector resources in both the United States and India in order to promote commercial development of clean energy projects, and to support the sustainable development of the energy sectors in both countries.

By providing a forum for unified communication between the Government of India and U.S. public and private sector entities, the ECP supports the acceleration of clean and sustainable energy initiatives. The ECP Secretariat functions as the focal point for identifying government and industry priorities and it recommends training programs and technical assistance activities that can be implemented through the ECP. USTDA provides funding for these activities and the U.S. and Indian energy industries provide support through in-kind contributions.

USAID's Development Credit Authority

USAID's Development Credit Authority (DCA) credit guarantee is a powerful tool for unlocking private financing in support of development priorities. Currently, USAID/India is in the process of establishing a credit guarantee facility to help a clean energy entrepreneur access private finance to help expand the business. Earlier, USAID provided India's Yes Bank with a 10-year, U.S. $20 million loan portfolio guarantee to support financing of renewable energy, energy efficiency, and water conservation management projects by small and medium enterprises (SMEs).

Export-Import Bank (Ex-Im Bank)

Since January 2011, the Export-Import Bank has approved 9 solar energy financings in India with an aggregate value of over $300 million, supporting 238 MW of generation. Additionally, there is another $100M (60MWs) of solar energy transactions in India under consideration by the Board of Directors. While accompanying President Obama on his trip to India in November 2010, Ex-Im Bank Chairman and President Fred P. Hochberg also signed a $5 billion Memorandum of Understanding with Anil Ambani, Chairman of Reliance Power, that included a proposal for the purchase of 900 megawatts of renewable energy generating equipment over a period of five years.

Clean Technology Trade Mission

Led by Under Secretary for International Trade Francisco Sanchez, the U.S. Department of Commerce organized a Clean Technology Trade Mission in November 2011 to New Delhi, Hyderabad, and Ahmedabad. During the mission, representatives from U.S. clean technology firms promoted U.S. goods and services through one-on-one business appointments with pre-screened buyers, agents, and distributors; meetings with national and regional government officials; and networking events. The U.S. delegation also participated in a roundtable with interlocutors from Haryana, Himachal Pradesh, Uttarkhand, and Punjab.

MNRE/NREL/ADB Finance Training

DOE's National Renewable Energy Laboratory (NREL) and the Asian Development Bank (ADB) are working with the Ministry of New and Renewable Energy (MNRE) on a series of training sessions for commercial bankers on solar power financing. After successful workshops in Mumbai and Delhi in 2011, MNRE, NREL, and ADB conducted follow-up workshops in Ahmedebad, Bangalore, and Calcutta in May 2012.

Case Study: Renewable Energy in India's Rice Belt

Rice husks, the hard protective coatings that surround grains of rice, are typically discarded in the milling process.

In 2002, childhood friends Gyanesh Pandey and Ratnesh Yaday discovered that some small rice millers were mixing these discarded husks with the diesel they burned as a way to reduce their diesel consumption and save money.

They realized that the technology needed to convert the husks to electricity was relatively simple and that, when not combined with diesel, the rice husk biomass could be gasified without emissions, resulting in clean energy for rural villages from distributed power generation.

Joined by Gyanesh's college friend Manoj Sinha and his fellow alumnus from the University of Virginia's Darden School of Business, Charles Ransler, the team formally launched Husk Power Systems by bringing electricity to the village of Tamkuha in the Dhanaha region of West Champaran on August 15, 2007.

In June of 2009, OPIC committed a $750,000 loan to Husk Power for the development of an additional 36 rice husk-powered generation facilities. Husk Power now operates more than 50 power plants in India.

- The basic connection through Husk provides a household with two 15-watt compact fluorescent lights, together with mobile phone charging throughout the period each day that the plant runs (up to eight hours in the evening).
- Each mini-power plant serves about 500 customers.
- Husk works strategically to build plants in remote villages where it can reach a large number of households.
- Husk has achieved an average penetration rate of 75 percent within the first two months of operation in a new village.

Husk Power cites Shell Foundation, Acumen Fund, Draper Fisher Jurvetson, the IFC, LEG Venture Philanthropy, Bamboo Finance, Cisco and the Ministry of New and Renewable Energy (MNRE) as key partners.

PACE builds on a rich legacy of past and ongoing cooperation under the U.S.-India Energy Dialogue

Selected examples:

Energy Conservation and Commercialization (ECO) Bilateral Project:

The $23 million ECO project was launched in January 2000 to enhance commercial viability and performance of the Indian energy sector and to promote clean and energy-efficient technologies. The first two phases of the ECO project supported the creation of India's Bureau of Energy Efficiency (BEE) and the establishment of India's first energy conservation building code (ECBC). The third phase concluded in September 2011. The final phase supported implementation of ECBC, promoted institutional capacity development at National and Sub-National level and developed a Net Zero Energy Buildings (NZEB) Strategy Roadmap for India which outlines the approach for driving NZEBs to scale in India.

Greenhouse gas pollution prevention (GEP) program:

Concluded in September 2011 after 16 years, this $39.2 million USAID initiative reduced GHG emissions through efficient coal conversion and alternative bagasse cogeneration. According to independent assessment, the program helped India avoid about 100 million tons of GHG emissions and also reduced coal consumption by 78 million tons, worth, a savings of approximately U.S. $1.5 billion.

Water-Energy Nexus Activity (WENEXA-II):

The program, which concluded in July 2011, aimed at improving the co-management of energy and water resources in agriculture, urban and industrial sectors through enhanced power distribution and end use efficiency, coupled with sound water management practices. WENEXA resulted in an innovative public-private partnership between a public utility and Energy Service Company (ESCO) for energy conservation in the agricultural sector and a pioneering program to reuse municipal waste water for power generation. So far 300 pumps have been replaced with highly energy efficient pumps, reducing energy consumption by 30 percent.

Distribution Reform, Upgrades and Management Program (DRUM):

USAID and India's Ministry of Power (MOP) developed the DRUM program in 2004 to create replicable, sustainable, and scalable "centers of excellence" in the electricity distribution sector. DRUM helped develop the vision for "smart grids" for India's power sector -- integrating information technology with transmission and distribution networks for finer control of energy flow and the integration of renewable energy power generation.

DRUM will close on September 2012. In this last phase of the program, three train-the-trainer modules are being developed on smart grid, improved distribution equipment, and business process re-engineering.

Above: Projects supported by DRUM: the Distribution Reform, Upgrades and Management Program. (Top two photos courtesy of USAID/India; bottom photo by Melissa Fraser, USDA)

Looking Ahead

The energy and climate challenges facing the United States and India 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, the UN Framework Convention on Climate Change, the International Partnership for Energy Efficiency, and the G-20. Working together, we can accomplish more than acting alone.

The PACE program relies on the commitment and dedication of numerous people in agencies and ministries in both countries. We are grateful for their continued support and participation.