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

An Initiative of the U.S.-India Energy Dialogue

A Progress Report
July 2014

"The relationship between the world's oldest and largest democracies should not only be for the benefit of the two countries, but should emerge as a powerful force of good for peace, stability and prosperity in the world."

Narendra Modi
Honorable Prime Minister of India, on his vision for India-U.S. relations

"The relationship between the United States and India will be one of the defining partnerships of the 21st century."

Barack Obama
The President of the United States

A Progress Report by:
The Department of Commerce (USDOC), Department of Energy (USDOE), Department of State (USDOS), Export-Import Bank of the United States (Ex-Im), Overseas Private Investment Corporation (OPIC), U.S. Agency for International Development (USAID), and U.S. Trade and Development Agency (USTDA).

Photos courtesy of the U.S. Government Agencies (or as otherwise indicated)

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Executive Summary:
U.S.-India Partnership to Advance Clean Energy (PACE)
An Initiative of the U.S.-India Energy Dialogue

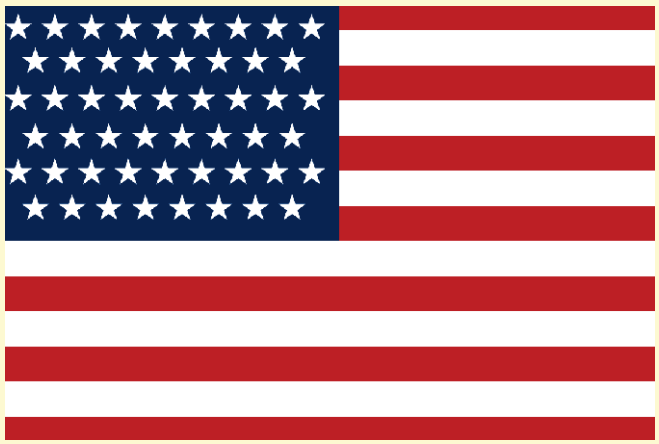
The U.S. Government is supporting clean energy in India through its key initiative, the Partnership to Advance Clean Energy (PACE), announced in November 2009 as part of the U.S.-India Energy Dialogue. PACE focuses on spurring inclusive, low-carbon development by supporting research and deployment of clean energy through PACE-R (research) and PACE-D (deployment) initiatives.

Energy access is a priority for India and there is vast potential for advanced clean energy technologies which, when combined with innovative financing models, market-based solutions, and appropriate policies, can become an engine for economic development. With this in mind, the U.S. and India added a new initiative, "Promoting Energy Access through Clean Energy (PEACE)", under the PACE umbrella in September 2013.

PACE is a "Whole of Government" approach to address energy-related challenges in India. Seven U.S. agencies—Department of Commerce (USDOC), Department of Energy (USDOE), Department of State (USDOS), Export-Import Bank of the United States (Ex-Im), Overseas Private Investment Corporation (OPIC), U.S. Agency for International Development (USAID), and U.S. Trade and Development Agency (USTDA)—are working together on the PACE initiatives. The areas of support include: energy access, renewable energy, smart grids, building energy efficiency, industrial energy efficiency, and clean energy finance.

Since its inception, PACE has provided the much-needed impetus to accelerate clean energy in India through technical assistance; building the capacity of stakeholders; providing finance, grants, and insurance products for clean energy projects; organizing study tours for knowledge transfer; and facilitating public-private partnerships.

This report highlights the key activities and achievements made under the PACE initiative between July 2013 and June 2014. One of the key developments in this period has been the change of leadership in the Government of India with Shri Narendra Modi becoming India's 15th Prime Minister on May 26, 2014. In the new cabinet, Shri Piyush Goyal was appointed the Minister of State with Independent Charge for Power, Coal, and New and Renewable Energy. This is the first time that three energy-related ministries have been brought under one minister to facilitate better coordination to achieve India's vision of an integrated energy portfolio. In March 2014, the USDOE Secretary Dr. Ernest Moniz led the U.S. delegation to the U.S.-India Energy Dialogue meeting in New Delhi.



Recent Highlights

USD 2.38 Billion Mobilized for Clean Energy Finance: Since PACE's inception, the seven U.S. agencies working on the PACE initiatives have mobilized about USD 2.38 billion in public and private resources for clean energy projects in India.

Promoting Energy Access through Clean Energy: In September 2013, the Ministry of New and Renewable Energy (MNRE) and USDOE signed a Memorandum of Understanding (MOU) to launch a new initiative—Promoting Energy Access through Clean Energy (PEACE)—as a new track under the PACE Program. PEACE aims to harness commercial enterprise to bring clean energy access to un-served and underserved Indian villages, capture lessons learned, and develop best practices.

Clean Energy Access Network (CLEAN): USAID has committed USD 1 million for CLEAN, a new initiative under PEACE. CLEAN is an alliance of businesses, not-for-profit organizations, and governments to strengthen India's ecosystem for market driven approaches to energy access. A consortium of ten experienced stakeholders within the decentralized clean energy sector signed an Alliance Charter as partners for CLEAN, which will be initially housed at Small Scale Sustainable Infrastructure Development Fund (S3IDF).

Funding for Clean Energy in India: In 2013/2014, OPIC disbursed the full amount of a USD 250 million commitment to one of India's premier infrastructure lenders to encourage expansion of its lending to renewable energy and infrastructure projects in India. In addition, in early 2014, OPIC made its initial disbursement under a direct loan to an Indian operator of solar-powered telecommunication towers.

U.S-India Joint Clean Energy Research and Development Center: The three bi-national consortia are delivering disruptive research in the areas of solar energy, buildings efficiency, and advanced biofuels. During two years of collaborative work and cross-country cooperation and innovation, researchers from national laboratories, universities and industry partners have submitted approximately 100 papers to journals and proceedings.

Development of Smart Grid: The USAID PACE-D TA Program supported the Ministry of Power (MOP) to prepare the draft smart grid regulatory framework which was submitted to the Forum of Regulators for consideration. The proposed regulations have been developed by the program under the guidance of a technical committee set up by the MOP. An enabling regulatory environment will help drive the overall smart grid business in India through provision of funds and incentives to ensure effective and timely adoption of such solutions by utilities and deployment at the customer end.

Fifth Clean Energy Ministerial: The fifth Clean Energy Ministerial (CEM) took place on May 12 and 13, 2014, in Seoul, South Korea. India was represented by Secretaries of the Planning Commission, MOP, and the MNRE. PACE-D activities in renewable energy, integration, and efficiency are complemented by multilateral activities taking place through CEM initiatives.

U.S.-India Collaboration on Smart and Efficient Air-Conditioning and Space Cooling: Launched in June 2013, the U.S. and Indian governments are working together to advance policies and innovative approaches to drive mass deployment and rapid uptake of high-efficiency cooling equipment and technologies.

U.S.-India Energy Dialogue 2014

The U.S. and India share a rich history of energy sector cooperation going back to the 1950s. This cooperation has expanded over time, as concerns over energy security and the climate impact of carbon emissions and sustainable development pushed energy to the top of the U.S.-India agenda. This culminated in the launch, in May 2005, of the U.S.-India Energy Dialogue – a mechanism for cooperation designed to enhance mutual energy security, promote increased energy trade and investment, and facilitate the deployment of clean energy technologies. Work under the Dialogue is organized into six working groups – Power and Energy Efficiency, New Technology and Renewable Energy, Oil and Gas, Coal, Civil Nuclear Energy, and Sustainable Growth. PACE is implemented and monitored through this Dialogue.

The U.S. Department of Energy Secretary, Dr. Ernest Moniz, led a delegation to the U.S.-India Energy Dialogue meeting in New Delhi in March 2014, hosted by Dr. Montek Singh Ahluwalia, former Deputy Chairman of Planning Commission of India. The discussion emphasized the importance of U.S.-India energy collaboration to both countries. The updates from each Working Group are described below.

USDOE Secretary Dr. Moniz and former Deputy Chairman of Planning Commission of India Dr. Ahluwalia, March 2014

Power and Energy Efficiency: The Power and Energy Efficiency Working Group is co-chaired by the USDOE and USAID on the U.S. side, and by the MOP on the Indian side. This group is responsible for monitoring and implementing the power and energy efficiency elements of PACE. At the March 2014 meeting, the Working Group agreed to expand cooperation in a number of areas, including policy and regulatory cooperation for demand response, load forecasting and scheduling, market design for ancillary services, distributed generation, energy storage, and analytics for Phasor Management Units (PMU). The Working Group also agreed to move forward with cooperation on data center energy efficiency. The two sides also agreed to a joint R&D partnership to advance coal-fired power plant modelling to improve efficiency and reliability, reduce capital and operating costs, and reduce emissions of existing and new generation facilities.

New Technology and Renewable Energy: The New Technology and Renewable Energy Working Group, co-chaired by the USDOE and the MNRE, is responsible for implementing and monitoring the renewable energy component of PACE. This Working Group is focused on promoting the adoption and deployment of clean energy by driving down renewable energy costs, reducing uncertainty for clean energy investment, and building institutional capacity for investment and deployment. Recent accomplishments include: the publication of new satellite-based solar resource maps in India validated by data from five solar ground stations; development of a report identifying innovative renewable energy financing mechanisms; assessment of the role of energy storage technologies for renewable energy deployment in India; and completion of a new nation-wide database of central and state-level policies and incentives, now managed by the MNRE. The Working Group is now also managing "PEACE" which focuses on harnessing commercial enterprise to bring clean energy access to unserved and underserved communities in India. At the March 2014 meeting, the two sides agreed to pursue 16 projects moving forward and to monitor all projects on a quarterly basis.

Oil and Gas: The Oil and Gas Working Group, co-chaired by the USDOE and the Indian Ministry of Petroleum and Natural Gas (MOPNG), aims to strengthen mutual energy security and promote increased trade and investment through a variety of collaborative activities. During the Working Group Meeting, the USDOE and MOPNG agreed to redouble efforts in the areas of energy infrastructure (oil and gas pipeline) security and exchange information in the area of crude oil reservoir development. Both sides are in the final stages of renewing a long-standing Memorandum of Understanding (MOU) for cooperation in gas hydrates to facilitate continued information sharing and research.

Coal: Co-chaired by the USDOE and Indian Ministry of Coal, the Coal Working Group is focused on the efficient and environmentally-responsible use of coal given the key role it plays in power generation in both nations. Past accomplishments include: promoting the use of coal washeries and advanced coal beneficiation techniques to improve the efficiency of coal use in India; the establishment of a Coal-bed Methane Clearinghouse; technical exchanges on improved coal mining techniques and underground coal gasification; and geospatial mapping and remote sensing projects, applied to land reclamation for sustainable mining. The Working Group is focusing on promoting increased trade and investment in the coal sector and works with the private sector to identify areas of collaboration with the business community on joint activities.

Civil Nuclear Energy Working Group: The U.S.-India Civil Nuclear Energy Working Group (CNEWG) fosters exchanges between the Department of Energy and the Nuclear Regulatory Commission (NRC) and India's Department of Atomic Energy (DAE) and Atomic Energy Regulatory Board on peaceful nuclear energy-related initiatives. Since 2006, the CNEWG has been engaging in technical and scientific discussions on nuclear energy-related initiatives, practices, possible research and development (R&D) interests, regulatory oversight and the view of the role of nuclear energy in meeting global energy requirements. At the sixth CNEWG meeting at the Idaho National Laboratory on July 8-10, 2014, the two sides reviewed the status of collaboration and the progress to date on their bilateral engagement in a number of technical areas, including advanced austenitics for light water reactor (LWR) applications. Going forward, they agreed, among other technical topics, to compare U.S. and Indian probabilistic safety analysis models

"The U.S.-India Energy Dialogue is now in the tenth year, and I think that has really been–certainly from my perspective–one of the most successful of our international collaborations."

USDOE Secretary Ernest Moniz

March 11, 2014, New Delhi

Sustainable Growth: Co-chaired by John Beed, Mission Director, USAID/India and Anil Jain, Advisor Energy, Planning Commission of India, the first meeting of the newly formed Sustainable Growth Working Group (SGWG) was organized on March 5, 2014 in which the draft work plan was presented for feedback from the participants. Two workshops were held after this meeting: Workshop on "Geospatial Analysis of Renewable Energy Options" organized by the National Renewable Energy Laboratory (NREL) and the Center for Study of Science, Technology and Policy (CSTEP) on March 4, 2014; and Two-day workshop on energy data and modeling held from April 28-29 in New Delhi. The workshop was led by the Pacific Northwest National Lab (PNNL) and the Brookhaven National Lab (BNL), with the Planning Commission and Integrated Research for Action and Development (IRADe) onthe Indian side.

Partnership to Advance Clean Energy (PACE)

Partnership to Advance Clean Energy (PACE) focuses on combining the efforts of several agencies on both U.S. and India side to increase collaboration on energy security and clean energy. As part of this initiative, both countries are jointly working on developing, deploying, and commercializing innovative clean energy technologies to support and accelerate India's transition to an inclusive low-carbon economy. PACE has three key components: research (PACE-R), development (PACE-D), and a newly-added component on energy access (PEACE).

Partnership to Advance Clean Energy (PACE)

Research (PACE-R)			Deployment (PACE-D)				Energy Access (PEACE)
Solar Energy	EE in Buildings	Second-Generation Biofuels	Finance	Re-newable Energy	Energy Efficiency	Cleaner Fossil	Off-Grid Renewable Energy
• Led by USDOE and the Planning Commission of India. • Supports research and development. • Priority areas include: solar energy, energy efficiency of buildings, and second-generation biofuels. • USDOE and GOI have each committed USD 25 million over five years. • Lead GOI counterparts include: the Planning Commission and The Ministry of Science and Technology.			• Supported by seven U.S. agencies (USDOC, USDOS, USDOE, Ex-Im, OPIC, USAID and USTDA). • Supports deployment of clean energy. • Priority areas include: energy efficiency, renewable energy, cleaner fossil fuel, and clean energy finance. • Includes a USD 20 million technical assistance program (PACE-D TA Program) jointly funded by USAID and USDOS. • Lead GOI counterparts include: the Ministry of Power and the Ministry of New and Renewable Energy.				• New track added under the PACE initiative in September 2013. • Focuses on four key elements to improve energy access: sharing best practices; developing new approaches to increase financing for clean energy access; technology innovation; and building technical capacity of stakeholders. • Lead GOI counterparts include: the Ministry of New and Renewable Energy and the National Institute for Solar Energy.

Clean Energy Finance

The U.S. agencies are currently working on a range of finance-related initiatives to boost the clean energy market in India. These initiatives include long-term financing, grants, insurance, guarantees, and credit enhancements that aim to help technically-and financially-sound projects obtain the required financial assistance at different stages of the project lifecycle, and unblock new sources of capital for clean energy.

Renewable Energy Investment

OPIC has committed over USD 500 million, and mobilized more than USD 450 million in additional private sector capital in India's clean energy sector. In 2013/2014, OPIC disbursed the full amount of USD 250 million commitment to one of India's premier infrastructure lenders to encourage expansion of its lending to renewable energy and infrastructure projects in India. OPIC has also been actively reviewing a number of renewable energy power projects in India for potential financing. These include a project for multiple rooftop solar power installations and another project which would include both rooftop and ground-mount solar installations. In addition, OPIC is in the very early stages of reviewing a larger ground-mount solar power project. Finally, in early 2014, OPIC made its initial disbursement under a direct loan to an Indian operator of solar-powered telecommunication towers located in areas with either no access or unreliable access to the electrical grid.

Solar Projects Financing

Ex-Im Bank is today one of the largest financiers of renewable energy projects in India. The bank has financed over 30 percent of the projects allocated under the Indian government's Jawaharlal Nehru National Solar Mission (JNNSM) Phase 1. The bank's current portfolio of India solar projects stands at USD 353.4 million that financed 289 MW. Ex-Im Bank's support was the catalyst that "crowded-in" hundreds of millions of dollars in additional equity investment, and bank lending for these projects.

It also received its first application in May 2014 for support of a solar power project under JNNSM Phase II, and anticipates several more applications in the coming months. Ex-Im Bank also developed a sample term sheet, an application information checklist, and a solar financial model for Indian solar projects.

Roundtable on Export Financing

U.S. Commercial Service organized a roundtable on export financing for the U.S. and Indian companies at the Renewable Energy India (REI) 2013 Expo, September 12-14, 2013. The roundtable was attended by representatives from OPIC, USTDA, USAID, the American Chamber of Commerce's Energy Cooperation Program and the U.S. Commercial Service. The highlight of the roundtable was a case study presented by Azure Power on utilization of programs offered by the U.S. agencies.

Loan Guarantee to Orb Energy

A USD 2.5 million loan guarantee provided to enable Orb Energy, a clean energy service provider, to access USD 2 million in loan from Deutsche Bank. As a result of the loan, Orb will reach its growth target of 500 branches by 2016 in the states of Karnataka, Tamil Nadu, Kerala, Maharashtra, and Andhra Pradesh. Orb's customers, who are largely from underserved communities, will benefit from reduced spending on kerosene and diesel fuel.

Piloting New Financing Mechanisms in India

The USAID PACE-D TA Program is focusing on transforming the clean energy finance market in India by developing innovative financing mechanisms, and building the capacity of stakeholders (project developers and financial institutions). The program developed reports on India's energy efficiency and renewable energy financing landscape with specific recommendations on new financing mechanisms that can accelerate clean energy deployment in India.

The priority financing mechanism for energy efficiency being implemented under the program is the Corporate Energy Audit Program (CEAP), a very successful model developed by the European Bank for Reconstruction and Development. Under the CEAP initiative, the bank offers energy auditing services to its industrial and commercial clients during the evaluation of their corporate loan applications.

A.Srivastava, JS, MNRE; R.Watal, Secretary, MNRE; Jyoti Arora, JS, MOP and S. Padmanabhan, Advisor, USAID/India at the Launch of the Finance Reports, Oct. 2013

The program will run a pilot project on CEAP with Tata Cleantech Capital Limited (TCCL). The energy auditors and loan officers of TCCL will work with their top five client's facility managers, engineers and financing officers to review their energy consumption, conduct energy audits, and assess energy efficiency opportunities that are financially attractive. TCCL will then identify the financing needs for these projects and consider financing them as an addition to their clients' financing requirements.

For renewable energy, the program's focus is on an off-grid renewable energy fund and Green Bonds. The proposed off-grid fund will support applications (which are either off-grid or rely primarily on off-grid and/or on-site renewable energy sources) to promote sustainable development or address issues such as energy access. A detailed concept note on the proposed off-grid fund has been developed and consultations are being undertaken with agencies such as Indian Renewable Energy Development Agency (IREDA), Solar Energy Corporation of India (SECI), and Energy Efficiency Services Limited (EESL) to anchor the fund.

Green Bonds, popularly used in Europe and the U.S., offer benefits to project developers by providing access to international debt markets where the cost of funds are between 4 and 6 percent and have tenure over 15 years. They also benefit domestic financial institutions (FIs) as they can find exit options at any stage of the project cycle. The USAID PACE-D TA Program is exploring options to issue Green Bonds for operating renewable energy projects with well-established resources, a good performance track record, and high quality developers in India. The program is working with financial institutions like IREDA to design and develop Green Bond issues, which could be used for raising capital from international markets. A detailed concept has been presented to IREDA, which has agreed to explore this idea, combining loans from its own portfolio and exploring loan portfolios of other banks to jointly opt for international issuance of Green Bonds.

Renewable Energy

Renewable energy, with an installed capacity of 31 GW, currently forms 12.5 percent of India's total power generation. The GOI has embarked upon an ambitious target to reach 53 GW of renewable energy installed capacity by 2017. The U.S.-India collaboration on renewable energy is focusing on research and development of innovative technologies, institutional capacities at the national and state level, pilot projects, business models for off-grid renewable energy, and linkages between U.S. and Indian companies for knowledge sharing.

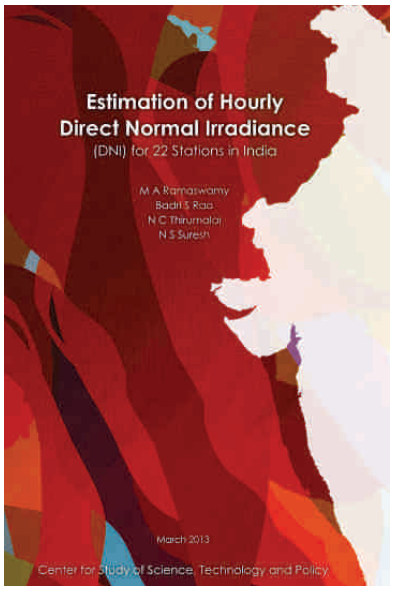
PACE-R Renewable Energy Consortia

Solar Energy Research Institute for India and the U.S. (SERIIUS)

Co-led by the Indian Institute of Science at Bangalore (IISc) and the National Renewable Energy Laboratory (NREL), SERIIUS focuses on accelerating the development of solar technologies by lowering the cost-per-watt of photovoltaic (PV) and concentrated solar power (CSP) through a bi-national consortium. Via cost share from SunEdison and Washington University – St. Louis, the program has also funded 13 graduate and early career bi-national exchanges. Technical progress under SERIIUS includes:

Sustainable Photovoltaic: The program has completed an initial study of the importance of dust and soiling problems in India and developed a coatings-based mitigation strategy. In addition, it has developed new materials for organic and dye solar cells based on computational materials design. It has also completed an initial database for reliability vs. climate across India to provide a basic understanding of failure modes and produce mitigation strategies. New contact and barrier layers have been developed for better PV cell reliability and performance. Similarly, the program has developed a new diagnostic electroluminescence technique as a tool to evaluate solar cell performance.

Concentrated Solar Power: The program has worked on the optimization of Organic Rankine Cycle (ORC) and Supercritical Brayton CO_2-based Cycle on two mid-scale systems for India and the U.S. It has completed the technical design of a research (laboratory-scale) supercritical CO_2 test loop for the closed Brayton Cycle. Other results include: computational design of a tubular serpentine receiver; design of a laboratory-scale molten-salt-loop system for high temperature storage in Brayton CO_2 cycles; optimization of compressor designs for small-scale ORC; and development of a (Cu-Sn)-based novel hemispherical highly reflective intermetallic mirror material with > 93 percent reflectivity and a much lower cost.



Credit: CSTEP

A report by CSTEP on Direct Normal Irradiance Data

Solar Energy Integration: The program has developed a roadmap for solar power in India until 2032. It has created a GIS-enabled tool for resource potential assessment for Karnataka as an illustration and developed a methodology to assess the potential of both concentrated solar power and PV. In addition, it generated open-source computational models with an intuitive graphic interface for use in assessment of Parabolic Trough Technology.

U.S.-India Consortium for Development of Sustainable Advanced Lignocellulosic Biofuel Systems

The Biofuels Consortium is a collaborative effort focused on second-generation biofuels R&D under the PACE-R initiative. The project focuses on sustainable feedstock cultivation and supply, biochemical conversion technologies for production of second-generation biofuels with minimal environmental impact, and analysis of overall sustainability and supply chain of feedstock and biofuels.

The feedstock development program focuses on breeding high-yielding switch grass and sorghum in the U.S., and sorghum, pearl millet and bamboo cultivars in India that can be grown on marginal lands. These marginal lands are in areas that are flood and drought prone in the U.S. along the Mississippi and Missouri river flood plains and the Midwestern states and salinity and drought prone areas in the central and western states of India. Two switch grass and sorghum lines were identified for high biomass traits and abiotic (drought and flood) stress tolerance. Genomic-assisted breeding will begin this summer for sorghum and next summer for switch grass. Small-scale field planting has proven that switch grass is highly productive on marginal lands compared to corn and soybean; large-scale field trials in collaboration with farmers were conducted this summer.

The feedstock conversion program in the U.S. is developing a genetically engineered Escherichia coli for production of butyric acid, which would be subsequently converted to butanol. The Stan Mayfield Biorefinery Pilot Plant, operated by the University of Florida, is processing sugarcane bagasse to cellulosic ethanol at the 10,000-gallon fermentation level. Ethanol yield using this process averages about 70 gallons of ethanol per dry ton of bagasse. This pilot plant scale process as well as the corresponding microbial biocatalyst is currently being upgraded to increase cellulosic ethanol productivity, and the pilot plant will later process switch grass and sorghum. The pilot plant is available for the India consortium members for training purposes.

The sustainability analysis program in the U.S. has developed an agent-based model for assessing economic impacts of biofuel markets along the supply chain. Stakeholder input is being gathered on switch grass-based butanol supply chain analysis. Work on development of certification protocols, lifecycle analysis, regional economic models, and data collection is in progress.

Scientists Assessing High-yielding Switch Grass field in Missouri, U.S.

PACE-D Renewable Energy Component

The USAID PACE-D TA Program is working closely with the MNRE to accelerate the deployment of renewable energy in India by supporting pilot projects, increasing access to finance, and building the institutional capacity of state-level institutions.

A Kumar, Director, SECI; Rajendra Nimje, MD, SECI; Anurag Mishra, USAID/India and Rakesh Kumar, Director, SECI at the MOU Signing Ceremony, March 2014

Collaboration with SECI: USAID signed an MOU with the Solar Energy Corporation of India (SECI) in April 2014 to jointly work on innovative renewable energy applications and business models. As part of this, the program will support development of plans for four sectors (educational institutes, health centers, oil and gas and railways) in the rural, commercial or industrial segments, and provide technical assistance to SECI in the design and implementation of sector-specific programs.

ACORE-IREF Partnership: The program facilitated the visit of the Indian Renewable Energy Federation (IREF) to the U.S. to meet with the American Council on Renewable Energy (ACORE). Its visit to ACORE's headquarters enabled it to learn communication strategies, measures for enhancing membership, engagement with members, outreach efforts, and engaging with policy makers and industry for promoting renewable energy.

Microfinance Support Initiative: The focus of the microfinance support initiative is to facilitate development of partnerships between MFIs and renewable energy equipment/technology suppliers, business planning and strategy development; build the capacity of the MFIs and technology suppliers to develop clean energy supply chains and facilitate last mile entrepreneurs. Three state-level consultations were organized in April and May 2014 to identify potential partners. Based on the workshop feedback, the program developed a technical assistance package for the sector which will be rolled out across 5 to 6 Microfinance Institutions (MFIs) located in three states.

Energy Storage

Energy storage is evolving as a crucial component of India's energy strategy. The USAID PACE-D TA Program has developed a report that presents a range of energy storage technologies available in the market today and provides an analysis of their costs, performance, and maturity levels. The key applications where energy storage options can play a critical role in India include grid integration of renewable energy projects and rural micro-grids.

The program organized a stakeholder consultation workshop in November 2013 to get inputs for the development of a roadmap for energy storage in India. The program is currently working with the MNRE in identifying pilot projects for energy storage demonstration.

Jeremy Gustafson, Director, CLEEO, USAID/India and P. C. Maithani, Director, MNRE at the Energy Storage Workshop, Nov. 2013

State Level Institutional Support

The USAID PACE-D TA Program is working in three states, Madhya Pradesh, Karnataka and Rajasthan, to support an enabling environment for clean energy deployment . The program conducted gap analysis and developed a detailed Technical Assistance Action Plans for the state agencies to help them design and implement effective clean energy programs. A three day workshop was organized in Puducherry in February 2014, which brought the focal states together to deliberate on clean energy policies and regulations.

Rajasthan: Work is ongoing on the design and implementation of a net metering-based solar rooftop program. The USAID PACE-D TA Program has submitted a background paper on net metering to the state nodal agency along with related inputs that include a comparative evaluation of a third-party finance model vis-à-vis a self-use model for solar rooftop net metering and a draft interconnection scheme. The program is also developing a compliance, monitoring and reporting framework for renewable portfolio obligations (RPO - CMR).

Alok, IAS, Secretary, DOE, Govt. of Rajasthan; and Monali Zeya Hazra, USAID/India at the Stakeholder Workshop, May 2014

Kit Batten, Global Climate Change Coordinator, USAID; P. Ravikumar, ACS, Govt. of Karnataka; and G.V.Balaram, MD, KREDL at the MOU Signing Ceremony, March 2014

Karnataka: The program's focus is on policy and program implementation, particularly in the solar rooftop space. The program team organized a workshop together with Karnataka Renewable Energy Development Ltd., Bangalore Electricity Supply Company, Ltd., and the Electronics City Industries Association on July 9, 2014, to bring together commercial and industrial users in Karnataka, connect them with domain experts, and facilitate an exchange of ideas on the development of a long-term market for rooftop solar in India.

Madhya Pradesh: The program is supporting the development of off-grid renewable energy policy in the state. The draft off-grid policy included comprehensive background research on the key sectors and end-uses where off-grid renewable energy solutions can be adopted. It also included potential areas where programs can be developed, and institutional and programmatic structures for their implementation. In addition, a "Centralized Monitoring Center" is being established for off-grid solar systems for Madhya Pradesh Urja Vikas Nigam Limited, which is the nodal agency in the state.

Tarun Pithode, Addl MD, MPUVNL and S. R. Mohanty, MD, MPUVNL at the Stakeholder Workshop, October 2013

Grants for Renewable Energy

Clean Energy for Telecom Towers: In December 2013, USTDA funded a feasibility study and pilot project to assess the technical, economic and financial feasibility of deploying a solar hybrid methanol-based fuel cell (SHMBFC) system that provide continuous and uninterruptible power to telecom towers. The project, which is being carried out by ICF International (Fairfax, VA), aims to assist Idea Cellular's effort to replace stationary diesel engines by demonstrating SHMBFC technology at five telecom tower sites using 2.5 and 5.0 kilowatt fuel cell units.

P. Sinha, CEO, TPDDL; John McCaslin, U.S. Commercial Service; Mehnaz Ansari, USTDA; and Dave Williams, USDOS, Dec 2013

Deployment of Distributed Energy Resources: In June 2014, USTDA awarded a grant to Tata Power Delhi Distribution Limited (TPDDL), a leading electricity distribution company in India, for the development of a distributed energy resource plan for its service territory in north Delhi. The project will enable TPDDL to prioritize and deploy distributed energy resources that will improve the reliability of its electricity network, reduce emissions, and lower overall power costs for its more than six million customers.

Solar Photovoltaic Reliability Study and Resource Assessment

USDOE and the NREL are collaborating with India's National Institute of Solar Energy (NISE) to increase understanding of how photovoltaic modules perform in different environments over long periods of time and develop testing procedures that help improve product reliability. Tests are ongoing to compare the performance of PV modules deployed in the U.S. and in India. USDOE and NREL are also working with NISE to enhance the quality and accuracy of India satellite-based solar maps and data. The new solar resource data and maps were released in June 2013. It also used data from five ground solar stations in India to validate the satellite-based data. These efforts will address issues of quality assurance and PV reliability, and help identify high-quality, bankable solar energy projects in India.

Solar Energy Training Network

The USAID PACE-D TA Program is working with NISE to set up a "Solar Energy Training Network (SETNET)". SETNET will organize standardized trainings through partners. NISE will accredite training institutions (both public and private) to solar energy industry professionals at all levels. Training will incorporate various technical, managerial, and financial aspects related to solar energy.

Facilitating Market Entry in India

The U.S. Commercial Service facilitated the product launch of BORG Energy Inc. in North India, in January 10, 2014. Headquartered in Houston, Texas, Borg Inc. specializes in the manufacturing of solar power plants and has rich experience in alternative energy and smart grid technology with global project expertise in North America, Europe, South America, China and South East Asia since 2002. The launch event was a direct result of U.S. Commercial Service's efforts to bring U.S. manufacturers of solar power equipment to India through the USDOC certified trade show - Renewable Energy India (REI) Expo 2013.

Large Scale Integration of RE into the Grid

Renewables Integration Modeling: USTDA has offered a grant to Gujarat Energy Transmission Corporation Limited (GETCO), a state-owned power transmission company in India, to support the integration of renewable energy sources into its power transmission system. This technical assistance will allow GETCO to analyze its power system through modeling and statistical techniques, and develop mitigation strategies to ensure appropriate load balancing and frequency regulation for its transmission operations.

Regulatory and Market Design for RE Integration

USDOE and the Planning Commission of India are both active participants and co-leads of the Clean Energy Ministerial's 21st Century Power Partnership (21CPP). Since June 2013, 21CPP has convened numerous multilateral consultations to provide India with expert guidance on regulatory and market design options for topics such as integration of variable renewable energy, grid planning and operation, forecasting, and ancillary services. 21CPP is also providing ongoing peer review support for an India Renewable Energy Roadmap initiated by the Planning Commission, with expected publication in September 2014. The development of a tailored 21CPP program of work for India began in the summer of 2013 and is currently under review.

Report on Grid Integration in Gujarat

In collaboration with GETCO, USDOE/NREL is analyzing the flexibility of existing electricity generation assets as a first step in assessing the potential for renewable penetration in the state of Gujarat. The aim is to identify strengths and opportunities for the existing grid system to incorporate increased penetration of variable renewable energy in India. During the last year, NREL, in collaboration with GETCO, has published a report evaluating grid impacts from increased solar generation (between 500 and 1000 MW) in Gujarat. The report provides five different scenarios of expansion from the current and planned 1.9 GW solar power generation, and discusses how the state of Gujarat could use solar variability profiles in grid operations and planning.

Advanced Wind Resource Assessment

With funding from USDOE, NREL is collaborating with India's Center for Wind Energy Technology (C-WET) to enhance existing wind resource characterization for priority areas in India, with the objective of improving wind resource estimates in India using downscaling methodologies.

During the last year, NREL published a report assessing wind resources in the Indian region of Uttarakhand. Knowledge of such resources helps policy makers, developers and other stakeholders optimize renewable energy deployment and penetration in India.

Energy Efficiency

The U.S. is supporting India's National Mission on Enhanced Energy Efficiency under the National Action Plan on Climate Change (NAPCC) through the PACE program. The U.S. and India are jointly working on a range of activities to promote innovative policy and regulatory regimes, financing mechanisms, and business models to create a sustainable market for energy efficiency.

PACE-D Energy Efficiency Component

Smart Grids

USAID's PACE-D TA Program is supporting the Government of India in establishing smart grids in India to increase power availability, reduce aggregate technical and commercial losses (AT&C), and support integration of renewable energy. As part of this initiative, the program supported the development of a Request for Proposals for selection of a Smart Grid Implementing Agency (SGIA), evaluation criteria for the selection of an SGIA, and a measurement and verification (M&V) framework for the Government's 14 smart grid pilot projects.

The program is currently supporting MOP in the development of a smart grid regulatory framework which has been submitted to the Forum of Regulators (FOR) for consideration. The regulations were prepared under the guidance of a Technical Committee constituted by the MOP. The program is also working towards evolving effective consumer engagement guidelines that help the utilities to engage with customers during the initial design stages.

Four capacity building workshops were organized for the 14 utilities setting up pilot projects, and four technical papers (Demand Response in the Indian context; Smart Imperatives for Grid Integration of Renewable Energy; An Approach to Dynamic Pricing in India; and A Roadmap for Communication and Application Interoperability in India) were published. During the course of the next few years, the program will deepen its engagement by providing focused support to two utilities to implement their pilots.

A high-level study tour to the U.S. was also organized in January 2014 to facilitate knowledge transfer on the latest smart grid technologies. The tour covered a cross-section of institutions including: two U.S. government agencies; five utilities; three public utility commissions; two national-level research institutions; and two agencies related to rural electricity and system operation.

Delegation led by B.N. Sharma, JS- Distribution, MOP visited LBNL Lab as part of the Smart Grid Study Tour to the U.S.

Others Smart Grid Initiatives

Engagement with Private Utilities: In addition to its ongoing support of the Bangalore Electricity Supply Company and the Central Power Research Institute, USTDA is currently supporting smart grid deployment activities with three private Indian distribution utilities in Delhi, Kolkata and Mumbai. During the past year, a delegation from the Calcutta Electric Supply Corporation (CESC) visited leading U.S. utilities to discuss their smart grid implementation programs, and U.S. company Innovari announced plans to expand its USTDA-supported automated demand side management pilot program with Reliance Infrastructure Limited in Mumbai to 100 MW-150 MW. USTDA also announced its support of a Smart Grid Reverse Trade Mission and Workshop, which will take place later in 2014.

DistribuTECH 2014

On January 28-30, 2014, the U.S. Commercial Service led a fifteen-member Indian delegation to DistribuTECH 2014 in San Antonio, Texas where the team introduced the Indian delegates to U.S. Smart Grid technology providers and counseled over twenty U.S. companies that are exploring opportunities in India. Commercial Specialist participated in a country briefing session and gave a presentation on the market opportunities in the Indian Smart Grid sector.

Smart Grid Testing and Modeling

MOP and USDOE coordinate their countries' respective participation in the International Smart Grid Action Network (ISGAN), which operates under the auspices of the Clean Energy Ministerial and an International Energy Agency (IEA) cooperative framework. Through ISGAN, USDOE and its national laboratories have worked with MOP on the assessment of its motivating drivers and technological priorities for smart grids, with Power Grid Corporation of India on discussion papers meant to disseminate international smart grid discussions, and with Central Power Research Institute (CPRI) on a network of research and test bed facilities.

CPRI hosted a meeting of that network in Bangalore in March 2014, at which smart grid testing experts from India, the U.S., Europe, and Japan reviewed progress on joint work on test protocols for advanced inverter functions, smart grid systems modeling, and power systems' testing.

ISGAN brings together more than two dozen countries to improve global understanding of smart grids, address gaps in related tools, and support adoption of policies that enable smart grids deployment. ISGAN is currently developing an international community of practice on loss reduction that is intended to support implementation of international best practices.

Building Energy Efficiency

The U.S. Government has been working closely with MOP and BEE in India to promote green buildings. USAID's Energy Conservation and Commercialization (ECO) Project, 2000-2011, contributed to the establishment of India's first energy efficiency code (ECBC) for buildings and also developed tools to implement it. The PACE-D TA Program builds on ECO's earlier successes in a number of areas:

Energy Conservation Building Code (ECBC) Implementation

USAID, via its PACE-D TA Program, is supporting BEE in the update and implementation of ECBC 2007 with the vision of moving towards Near-Zero Energy Buildings. The team has identified update priorities and methodology, along with specifications of dominant building types. These specifications will be used to determine revised performance thresholds for ECBC. The program is also supporting ECBC compliance in three focal states of Haryana, Rajasthan and Karnataka. In addition, the program is developing an ECBC Professional Certification program to build a quality compliance enforcement workforce.

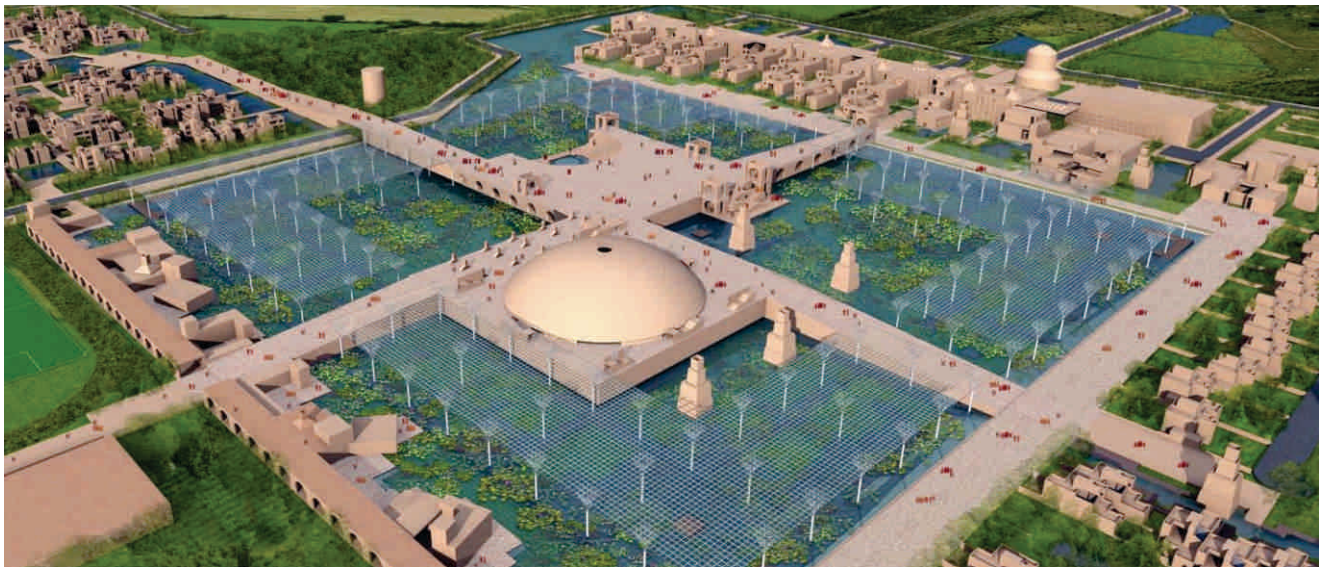
Near-Zero Energy Buildings (NZEB)

The USAID PACE-D TA Program continued to provide regular technical assistance to its two NZEB pilots—Nalanda University and Uttar Haryana Bijli Vitran Nigam Limited—identified last year. A stakeholder workshop was organized in June 2014 to determine the feasibility, resource requirements and structure of an NZEB alliance, NZEB knowledge portal and NZEB design competition.

B. J. Sarma, Secretary, BEE at the NZEB Workshop, June 2014

Heating, Ventilation and Air-Conditioning (HVAC)

HVAC technologies form a core part of USAID PACE-D TA Program's energy efficiency activities. A study was conducted to assess the diffusion of energy-efficient HVAC technologies in the Indian market; based on which a report on HVAC Market Transformation has been prepared. The report will be launched in August 2014.



Credit: Nalanda University

Artist Impression of Nalanda's NZEB Campus

Promoting Green Buildings and Sustainable Cities in India

Energy Conservation Building Codes' Implementation: USDOE, the Pacific Northwest National Laboratory (PNNL) and the Brookhaven National Laboratory (BNL) are helping accelerate the successful implementation and enforcement of India's Energy Conservation Buildings Code (ECBC) at the local level, thus supporting the adoption of energy-efficiency technologies in commercial buildings. Recent accomplishments include the development of several sets of training materials, including an introductory training on ECBC requirements, and on compliance-checking procedures and requirements. In collaboration with India's Malavyian National Institute of Technology (MNIT), PNNL is piloting the process of code implementation and compliance in a recently built Design Center at the MNIT campus in Jaipur.

Demand Responsive Buildings Technologies: USDOE and the Lawrence Berkeley National Laboratory (LBNL) are promoting demand-side building technologies that interact with electricity supply, while developing public partnerships between U.S. and Indian stakeholders. During the last year, LBNL produced a report proposing short- and long-term demand response and energy-efficiency integrated action plans for pilots in India. The report also identifies the transformative technologies that can mitigate peak power shortage and contribute to improving the reliability of electricity supply in India.

Ajay Mathur, DG, BEE and Giresh Pradhan, Chairman, CERC at a Demand Responsive Buildings Workshop

Energy Efficiency Data Centers: USDOE and LBNL are collaborating with Indian and U.S. public and private stakeholders to develop and implement incentives and policies to promote energy-efficiency practices and technologies in data centers. Last year, USDOE and LBNL organized training workshops in collaboration with the Confederation of Indian Industry and Data Center Dynamics.

Energy Efficiency in IT Buildings and Special Economic Zones: USDOE and LBNL are collaborating with India's Infosys, Metro Valley, and GreenSpaces to improve energy efficiency performance of exemplary commercial buildings in India. LBNL developed and delivered a Best Practice Guide for High Performance Office Buildings in India and completed the technical evaluation of a plug load controlling device in collaboration with Infosys and U.S. companies to identify new markets for plug-load energy efficiency.

Sustainable, Energy-Efficient and Connected Communities: The World Resources Institute (WRI) with the support from USDOE launched the Green Power Market Development Group (GPMDG) in Bangalore. The GPMDG has helped five companies secure collaborative solar procurement and continues to expand the renewable energy market in India. The urban development arm of the project is developing methodologies to estimate the reduction in energy use in urban communities as well as cost-benefit analysis for developers. The goal is to partner with large housing developments in Bangalore to incorporate renewable energy and adopt urban development solutions that promote efficient transport options.

U.S.-India Eco-Partnership: USDOE and LBNL are developing city action plans in Pune and Jaipur following analysis from a road mapping tool – City Implementation Tool for Environmental Action. The tool allows cities to forecast their energy and water consumption to 2030, and helps city governments select and prioritize areas of energy and water savings and emissions reduction potential through appropriate efficiency interventions. During the last year, LBNL facilitated the signature of a Memorandum of Understanding between the cities of Jaipur and Fremont, California, and organized meetings in Jaipur and Pune focusing on energy, water and waste management.

U.S.-India Collaboration on Smart and Efficient Air-Conditioning and Space Cooling: The U.S. and Indian governments are working together through this initiative, launched in June 2013, to advance policies and innovative approaches to drive mass deployment and rapid uptake of high-efficiency cooling equipment and technologies. As part of this collaboration, BEE and USDOE organized a stakeholder workshop in coordination with Super-efficient Equipment and Appliance Deployment Initiative (SEAD) and 21CPP on Space Cooling Efficiency Enhancement and Demand Response on June 24-25, 2014, in New Delhi. In a series of panel discussions, air-conditioning manufacturers, demand response providers, and regulatory and international experts focused on the impact of ACs (air-conditioners) on the Indian electric grid.

Industrial Energy Efficiency

Waste heat utilization (WHU) is a core component of the USAID PACE-D TA Program's energy-efficiency activities. The program is currently working closely with the BEE to carry out a situational analysis of low grade WHU (150-300°C); with a view to develop a strategy and policy paper to attract investment in identified high priority low grade WHU technologies in industries.

The program has prepared a technology compendium which includes a situational analysis of WHU technology penetration in India, review of established and new technologies (recuperator, regenerator, low temperature recovery systems such as ORC and Kalina, vapor absorption and compression systems, and thermo-electric conversion) along with cases studies.

A macro potential assessment covering three focus sectors—sugar, textile and steel—was carried out, and has been assessed at 9.7 metric tons carbon equivalent. The technology compendium will be presented to stakeholders at a meeting jointly organized with BEE. Based on the feedback of stakeholders, target markets will be identified, and policy and strategy recommendations will be proposed to the BEE. In addition, the program is exploring the formation of a stakeholder platform as a strategy for increasing the market penetration of WHU technologies in India.

PACE-R Building Energy Efficiency Consortium

U.S.-India Joint Center for Building Energy Efficiency Research and Development (CBERD)

Led by Lawrence Berkeley National Laboratory (LBNL) in the U.S. and CEPT University in India, CBERD supports eleven recognized R&D organizations and over 20 industry partners to promote innovation in energy efficiency.

PACE-R Consortia Meeting in New Delhi in March 2014

The 18 months of CBERD activity has strongly emphasized the creation of a vibrant consortium of R&D and industry partners, and organizational partners in both countries; produced tangible outcomes and publications and facilitated numerous research exchanges. CBERD placed substantial focus on initiating a productive collaborative relationship with its industry partners through work sessions, ongoing communications, and development of an over-arching common technology management plan for intellectual property (IP) – an IP management plan. The technical R&D outcomes for CBERD include:

Energy Analysis and Tools: The Simulation and Modeling R&D team has developed a semi-automated tool for Model Predictive Control based on EnergyPlus for low-energy cooling systems (e.g., radiant and night-flush natural ventilation), which will be field-tested in the cost-share partner's facilities. The Envelope/Passive Design R&D team's outcomes included an early stage, web-based windows and façade optimization tool; WinOpt development; joint development of the new COMmercial FENestration (COMFEN-India); and a cool roof calculator updated to optimize use of radiant barriers, bulk insulation, and reflective roofing to save energy and money.

Methodologies and Models: The Monitoring and Benchmarking R&D team has developed a roadmap for advancing state-of-the-art building energy benchmarking in India. A recently developed benchmarking model for hotels and hospitals in India will provide useful information for the development of U.S. benchmarking models. The team has also developed a data center energy information system guide, which is a methodology for selecting and installing an appropriate EIS. An outcome of the advanced heating, ventilation and air-conditioning systems R&D team included the creation of a new methodology for chiller performance evaluation. The research outcome of the Comfort Studies R&D team included new methods for assessing Indian clothing values for adaptive thermal comfort.

Technology Development: The Controls and Communication R&D team has developed a new, smart, wireless luminaire controller with temperature, illuminance, electrical power, and occupancy sensors. The team also developed a low-cost energy meter that logs energy data for the connected device, producing algorithms to identify load types plugged into an outlet based on device-level metering. There is ongoing technology development in the area of advanced HVAC systems that includes a new micro-channel heat exchanger for use in a unitary HVAC system, which is being developed in coordination with a cost-share partner.

Promoting Energy Access through Clean Energy (PEACE)

Recognizing the compelling need to promote commercially-viable clean energy solutions for energy access, a new bilateral initiative—Promoting Energy Access through Clean Energy (PEACE)—was added under the New Technology and Renewable Energy (NTRE) Working Group of the U.S.-India Energy Dialogue in September 2013. At the March 2014 NTRE Working Group meeting, the governments finalized an initial Plan of Activities including:

- **PACEsetter Fund:** Contribute approximately USD 4 million each to establish a "PACEsetter fund" to support the development and testing of innovative clean energy products, systems and business models.
- **Off-Grid Alliance:** Support the establishment of an alliance of businesses, not-for-profit organizations, and government to strengthen India's off-grid ecosystem.
- **Quality Assurance Framework:** Develop a quality assurance framework, including control standards and performance benchmarks that can serve consumers better in terms of safety, reliability, performance and cost comparison.
- **Smart Micro-grid Study:** Make recommendation on the design of a smart micro-grid pilot to test and validate a business model for scaling up smart micro-grids commercially.

Clean Energy Access Network (CLEAN)

CLEAN is a new alliance of businesses, not-for-profit organizations, and government to strengthen India's ecosystem for market driven approaches to energy access. The network's value proposition is to deliver a range of services to reduce the transaction costs of participating in the off-grid market, help reduce operational barriers, provide a platform for policy dialogue, as well as mobilize finance and accelerate innovation. CLEAN aims to operate as a demand-driven program and deliver services in five areas: a) information and networking; b) technology development, testing and certification; c) skills, training and capacity building; d) policy advocacy; and e) access to finance.

In February 2014, ten non-profit institutions—Ashden India Collective, CEEW, Indian Renewable Energy Federation, SELCO Foundation, Shakti Sustainable Energy Foundation, The Energy and Resources Institute, The Climate Group, The Nand and Jeet Khemka Foundation, UN Foundation, and WWF-India—signed an Alliance Charter as partners for CLEAN. The network will be housed at Small Scale Sustainable Infrastructure Development Fund (S3IDF) for a period of three years before it establishes itself as an independent entity. USAID has committed USD 1 million to support CLEAN activities. Three organizations—GIZ, Shakti Foundation and ICCO—have also joined USAID to support CLEAN for next three years.

Quality Assurance for Mini-grids: A team at the U.S. National Renewable Energy Lab (NREL) is developing the elements of the QA framework. The framework will both define standard thresholds for level and quality of service for decentralized power systems, and establish a reporting protocol whereby third parties will be able to observe the characteristics of service being delivered by a small grid and hold the installer/operator to account. A consultative workshop will be hosted by India's National Institute of Solar Energy in 2014 to get stakeholder feedback.

Grants for Off-grid Energy Access Solutions

USAID awarded a number of grants to support innovative clean energy access solutions in India. These include:

Sustainable, Clean, Access, Livelihood, Energy (SCALE): A USD 200,000 grant to the SELCO Foundation to help establish six "innovation labs" that will develop and test sustainable energy solutions to address the diverse needs of India's poor. The labs will serve as centers of innovation for technology, finance, process, market linkages, entrepreneur development, enterprise creation, and policy.

Nisha Biswal, U.S. Assistant Secretary of State (South and Central Asian Affairs) at the Grant Ceremony

Development Innovation Ventures (DIV): Support Gram Power to rollout and complete evaluation of up to 40 micro-grids across rural India, with a focus on Rajasthan and Uttar Pradesh. These micro-grids will bring power to roughly 4,200 households and raising the standard of living for almost 30,000 people. The project will measure the social impact of Gram Power micro-grids vs recently connected households to the electricity grid.

Powering Agriculture Projects: A USD 1.9 million grant to two Indian projects through "Powering Agriculture: A Grand Challenge for Development," a global competition to identify innovative solutions that can transform agriculture by improving access to clean energy services. The winning Indian projects are:

- Promethean Power Systems-Hatsun Agro and Orb Energy: for a project on reducing milk spoilage through solar-powered milk-chilling in rural India.
- Motivo Engineering-Feuerlabs and the KVK Foundation: for development of a system that will use solar, wind, micro-hydro, or the grid to support plowing, well-drilling, cold storage, and transporting crops to market.

wPOWER: Promoting Women's Entrepreneurship

USAID's wPOWER program provided training to 550 rural women entrepreneurs (Sakhis) on clean energy technologies and businesses, and mobilized USD 580,000 in working capital and consumer finance through microfinance institutions, foundations and national banks. The program established 13 partnership MOUs with the private sector for clean energy products sales and product customization. It also established a 'Clean Energy Hub' in Maharashtra, which facilitates access to clean energy products, finance and markets to the rural women entrepreneurs and also provides the last mile access to private sector players.

wPOWER also added the "India to Africa" exchange component which entails transfer of best practices/innovations from India to Africa and vice versa. A Training of Trainers workshop on Sustainable Clean Energy and Entrepreneurship was organized in July 2014 in Nairobi. SSP, the wPOWER implementation partner, won several awards including Cook Stove Global Alliance - Sankalp Award - 2013 and was also one of the finalists in Ashden International awards 2014.

Cleaner Fossil

India plans to add an additional 71 GW of electrical power generation in the next five years, of which 68 GW will come from coal-based plants. As such, it is critical to focus on measures that will mitigate environmental impacts and progressively reduce emissions. Significant opportunities exist in the cleaner fossil technologies' space for collaboration between India and the U.S., which has more than fifty years of experience in supercritical thermal power technology.

Supply-side Efficiency from Existing Coal-based Power Plants

USAID's PACE-D TA Program is working with the Ministry of Power through NTPC Ltd., India's largest power producer, on a range of efficiency improvement interventions in coal-based thermal power plants. The operational improvements for supercritical thermal power plants included developing a best practices manual – a compilation of best practices deployed in U.S. supercritical plants, which was officially launched at the NTPC's Annual O&M Conference on February 13, 2014, in New Delhi. The program, in close consultation with NTPC engineers, has drafted the "Baseline Benchmarking Study Report" for NTPC's Sipat Supercritical Power Station. In addition, a coal blending study was completed using the VISTA™ model for two units at the Sipat supercritical plant.

A.R Choudhury, MD, NTPC; P.K Sinha, Secretary, MOP; Neerja Mathur, Chairperson, CEA; and Monali Zeya Hazra, USAID/India launching the Best Practices Manual, Feb. 2014

An international conference was organized on November 21-22, 2013 in New Delhi, featuring both U.S. and Indian experts on supercritical technology. Prior to this, a technical exchange visit was organized to the U.S. in August 2013 to observe the country's best practices of cleaner fossil fuel technologies. The program has also developed a heat rate improvement plan for two selected state-owned utility plants of Chandrapur and Panipat. An on-site workshop was conducted at both Chandrapur and Panipat in September 2013, to train their engineers on how to implement the recommended heat rate improvement practices. The program is currently working towards launching the Indian Heat Rate Alliance.

Shale Gas Development

USTDA continues to support the development of cleaner domestic energy resources in India, including two studies analyzing the potential for the development of shale gas in India with private sector partners Essar Oil Limited and Deep Industries Limited. Both studies are ongoing with results expected later this year. A delegation from Essar visited the United States in May 2014.

Essar Delegation visits Williamsport, PA in May 2014

Clean Energy Ministerial

The Clean Energy Ministerial (CEM) is a high-level global forum to promote policies and programs that advance clean energy technology. The Fifth Clean Energy Ministerial took place May12-13, 2014, in Seoul, South Korea, and India was represented by Secretaries of the Planning Commission, Ministry of Power, and the Ministry of New and Renewable Energy.

Super-efficient Equipment and Appliance Deployment (SEAD): India co-leads the SEAD initiative with the U.S., and has used the knowledge developed and exchanged through SEAD to inform India's comprehensive quality and performance standards for solid-state lighting, expand the coverage of its television label, and update the BIS distribution transformer standard. The Super Efficient Equipment Programme (SEEP) developed by BEE benefited from technical and policy expertise through SEAD, and is being showcased to other SEAD participating governments as an example of innovative policy design for incentivizing the manufacture and deployment of ceiling fans that are twice as efficient as what existed on the market.

Electric Vehicles Initiative: India's Department of Heavy Industry and USDOE both actively participate in activities of the Clean Energy Ministerial's Electric Vehicles Initiative (EVI). They have strengthened their cooperation on electric vehicle (EV) deployment policy through rigorous technology and market analysis. A recent report supported by EVI, and carried out by LBNL, finds that the benefits of EV deployment in India are greater than expected when real-world driving conditions are taken into account. India could save 4.8 billion barrels of oil and 270 million tons of CO_2 emissions by 2030 if the passenger car EV adoption rates necessitated by government targets continue into the decade beyond 2020.

U.S.-India Energy Cooperation Program (ECP)

The last year brought new leadership for the ECP, a public-private partnership on clean energy. Venkatesh Valluri, Chairman and President, Ingersoll Rand India, took over the Chairman role. In March 2014, the ECP met with Secretary Moniz and Ambassador Powell during the U.S.-India Energy Dialogue, and co-hosted a workshop on clean energy finance with the Confederation of Indian Industry as part of the Dialogue.

ECP Meet and Greet 2014 with USDOE Secretary Moniz and Former U.S. Ambassador to India Nancy Powell, March 2014

The U.S.-India Partnership to Advance Clean Energy (PACE) improves energy access and promotes low-carbon growth through the research and deployment of clean energy technologies.