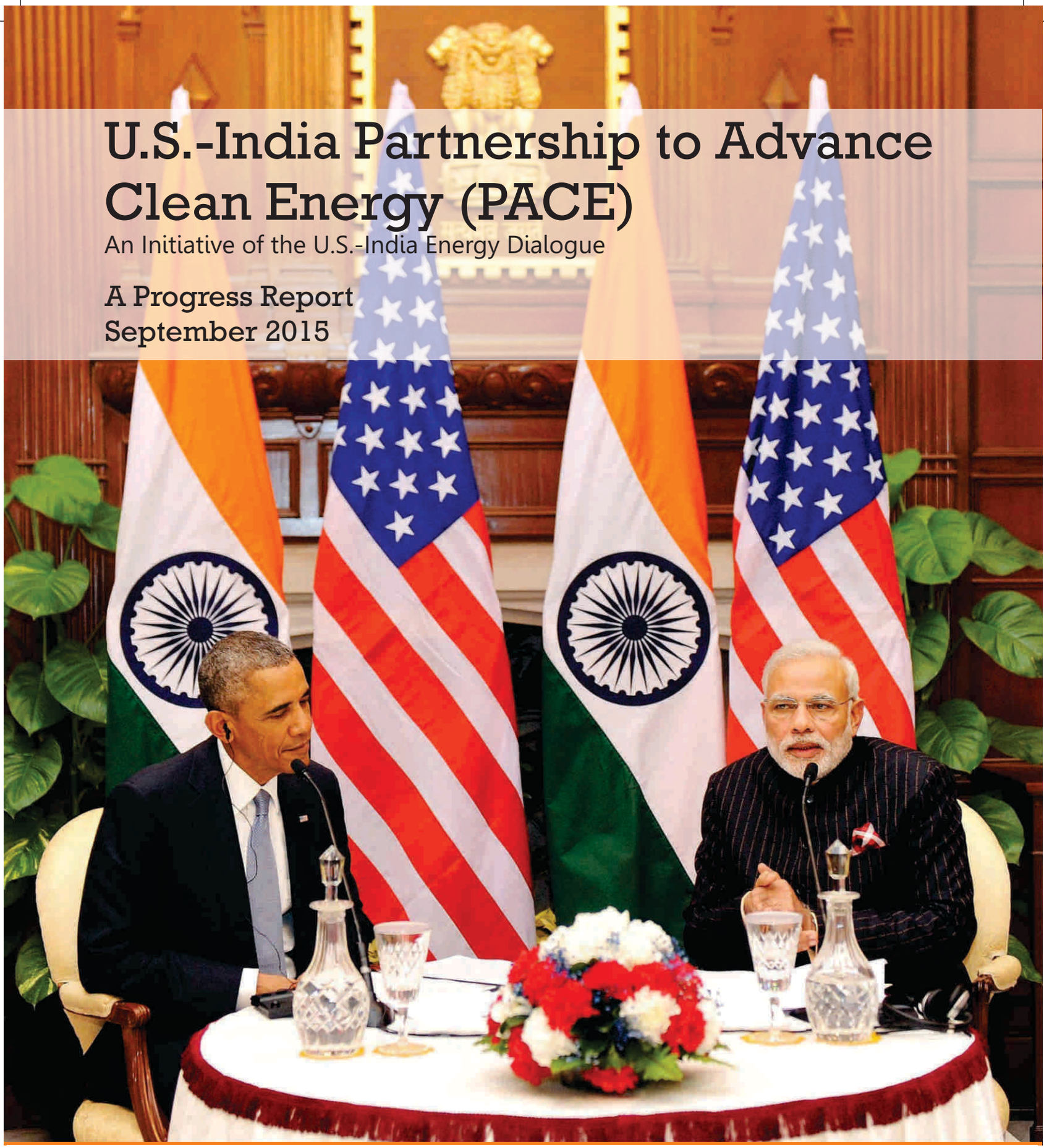
U.S.-India Partnership to Advance Clean Energy (PACE)

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

A Progress Report
September 2015



USAID
FROM THE AMERICAN PEOPLE

"For President Obama and me, clean and renewable energy is a personal and national priority. We discussed our ambitious national efforts and goal to increase the use of clean and renewable energy. We also agreed to further enhance our excellent and innovative partnership in this area."

Indian Prime Minister Narendra Modi
during the U.S. President's visit to India in January 2015

"We have agreed to a number of important steps to promote clean energy and to confront climate change. We very much support India's ambitious goal for solar energy, and stand ready to speed this expansion with additional financing."

U.S. President Barack Obama
during his visit to India in January 2015

"Chalein Saath Saath; Forward Together We Go"

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).

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1 Executive Summary

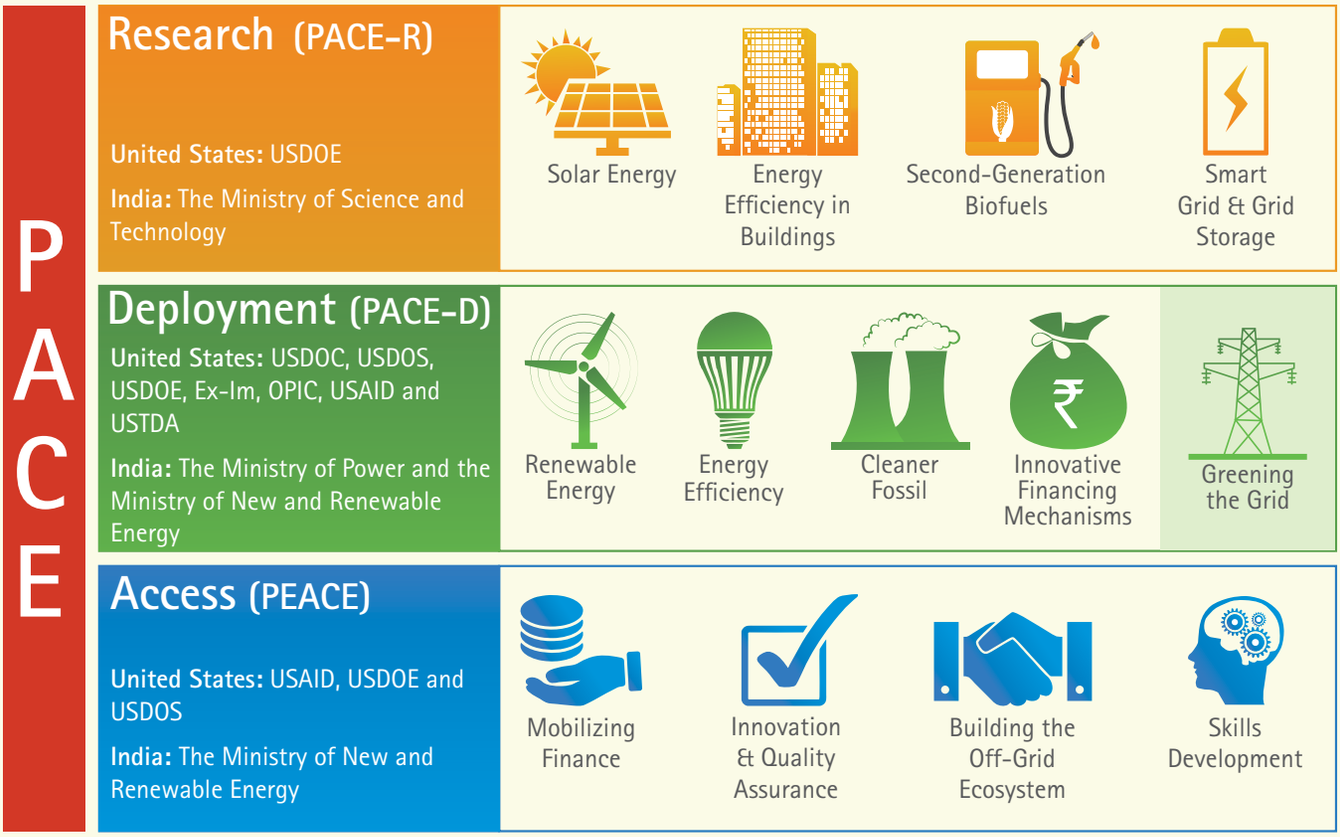
Partnership to Advance Clean Energy (PACE)

The United States and India have a long and successful strategic partnership in the energy sector. The energy cooperation between the two countries, which is technical, economic, and bilateral, is strengthening year on year.

In November 2009, the United States and India launched the Partnership to Advance Clean Energy (PACE), which is working to accelerate inclusive, low carbon growth by supporting research and deployment of clean energy technologies. During their first bilateral summit in September 2014, Indian Prime Minister Narendra Modi and U.S. President Barack Obama announced a commitment to strengthen and expand PACE through a series of priority initiatives. When the two leaders met again in January 2015, they announced several new activities under PACE.

Over the past year, India has revised its renewable energy target to 175 GW by 2022. The national solar target was scaled up by five times, reaching 100 GW by 2022, of which 40 GW is expected to come from solar rooftop. The activities of the PACE initiative are aligned to support India's ambitious clean energy targets.

As shown below, PACE includes three components: Research (PACE-R), Deployment (PACE-D), and Off-grid Energy Access (PEACE). PACE is a collaborative interagency effort, combining the efforts of several U.S. and Indian agencies.



Recent Highlights

PACE-R

- **Leaders Announce New Consortium on Smart Grid and Grid Storage:** Building on successful research consortia on solar energy, energy efficiency in buildings, and second generation biofuels, the Joint Clean Energy Research and Development Center will soon expand to include smart grid and grid storage.

- **New Test Bed and Apparata for Building Energy Efficiency:** The U.S.-India Joint Center for Building Energy Efficiency Research and Development set up a new building fault detection and diagnostics lab at IIIT Hyderabad and completed a new hygrothermal test lab for building materials characterization at the CEPT University in India. These test-beds and new equipment will facilitate the growth of building science in India.

PACE-D

- **New Greening the Grid Initiative:** USAID and India's Ministry of Power (MOP) laid the foundations for a major new component of PACE-D entitled Greening the Grid (GTG), an interagency partnership including the USDOE and the USTDA. This five year, USD 30 million effort will identify cost-effective pathways to integrate renewable energy into the Indian power grid at a scale that can drive low carbon growth. It will enhance the capacity of India's states and harness private sector know-how to implement technological, market, operational, and regulatory reforms that can be scaled.

- **Over USD 2.5 Billion Mobilized:** Since PACE's inception, the seven U.S. agencies working on the PACE initiatives have mobilized close to USD 2.5 billion in public and private resources for clean energy projects in India.

- **Clean Energy Finance Forum and U.S.-India Task Force on Clean Energy Finance:** The U.S. Embassy, with support from the Ministry of New and Renewable Energy (MNRE), World Bank, Khemka Foundation, and the Federation of Indian Chambers of Commerce and Industry (FICCI), established the Clean Energy Finance Forum (CEFF), a private-public platform that will recommend policy interventions to facilitate private capital financing for the Indian renewable energy sector. The Governments of India and the United States also launched a bilateral U.S.-India Task Force on Clean Energy Finance to advance government-to-government discussions on these topics.

- **Comprehensive Support for Progress towards Solar Rooftop Deployment Target:** Under the National Solar Mission, India has established an ambitious goal of deploying 40 GW of rooftop solar by 2022. To accelerate this transition, USAID's PACE-D TA Program supported the development of enabling policies for net metering in Karnataka and Rajasthan and provided technical assistance to the Bangalore Electricity Supply Company (BESCOM) to roll out its solar rooftop initiative. In collaboration with the National Institute of Solar Energy, the Program also launched the Solar Energy Training Network comprising 35 partner training institutions to train solar professionals at all levels. A project evaluation tool for financial institutions has also been developed to facilitate investments in solar rooftop projects.

- **New Smart Grid and Demand Side Management (DSM) Regulations:** The USAID PACE-D TA Program provided technical assistance to develop draft Smart Grid regulations under the guidance of a technical committee constituted by the Ministry of Power. The Forum of Regulators formally adopted these regulations in June 2015. Similarly, the Program proposed DSM regulations in Haryana which were adopted by the Haryana Electricity Regulatory Commission in November 2014.

PEACE

- **U.S., India Announce USD 7.9 million PACEsetter Fund for Off-Grid Innovations:** The U.S. and India established the PACEsetter Fund, a joint USD 7.9 million fund to accelerate the commercialization of innovative off-grid clean energy solutions. Proposals for the first funding round of up to USD 2 million are due in October 2015. Details at PACEsetterFund.org.

- **New Initiative to Mobilize USD 41 million for Off-Grid Clean Energy:** USAID/India launched a new public-private partnership that will work to mobilize USD 41 million in finance to enable clean energy entrepreneurs to sustain and scale their business models beyond the early stage targeted by the PACEsetter Fund. This effort, a partnership between New Ventures India, Insitor Management, the Global Social Business Incubator at Santa Clara University, and USAID/India, aims to help one million Indians gain access to electricity through off-grid clean energy solutions.

Strengthening and Expanding PACE

During their September 2014 and January 2015 meetings, President Obama and Prime Minister Modi made a series of announcements related to PACE:

September 2014 U.S.-India Joint Statement

"President Obama and Prime Minister Modi agreed to a new and enhanced strategic partnership on energy security, clean energy, and climate change. They agreed to strengthen and expand the highly successful U.S.-India Partnership to Advance Clean Energy (PACE) through a series of priority initiatives, including:

- A new Energy Smart Cities Partnership to promote efficient urban energy infrastructure;
- A new program to scale-up renewable energy integration into India's power grid;
- Cooperation to support India's efforts to upgrade its alternative energy institutes and to develop new innovation centers;
- An expansion of the PEACE program to unlock additional private sector investment and accelerate the deployment of cost-effective, super-efficient appliances; and
- The formation of a new Clean Energy Finance Forum to promote investment and trade in clean energy projects."

January 2015 India-U.S. Joint Statement

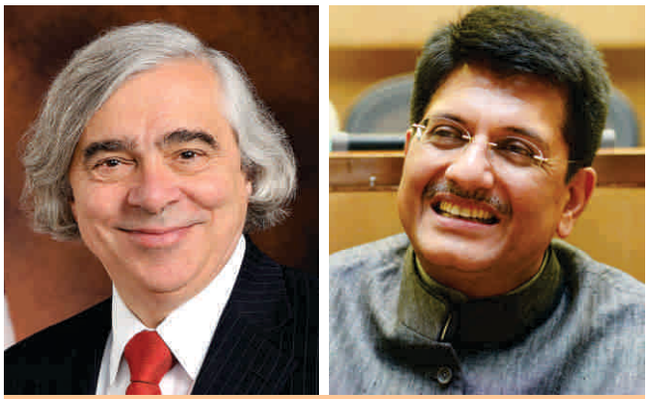
"President Obama and Prime Minister Modi emphasized the critical importance of expanding clean energy research, development, manufacturing and deployment, which increases energy access and reduces greenhouse gas emissions. The leaders announced actions to advance India's transition to low carbon economy. Announcements related to PACE include:

- Expanding the PACE Research track (PACE-R);
- Expanding the PACE Deployment track (PACE-D);
- Accelerating Clean Energy Finance;
- Demonstrating Clean Energy and Climate Initiatives on the Ground; and
- Concluding negotiations on a five year MOU to carry this work forward."

2 U.S.-India Energy Dialogue 2015

The United States 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 pushed energy to the top of the U.S.-India agenda. This led to the launch, in May 2005, of the U.S.-India Energy Dialogue—now the primary mechanism for cooperation designed to enhance mutual energy security, promote increased energy trade and investment, and facilitate the development and deployment of clean energy technologies. The Energy Dialogue is a genuine "whole-of-government" undertaking that provides a high-level platform for engagement by a diverse array of governmental bodies from both countries, as well as with the private sector and the research community. Work under the Dialogue is organized into seven working groups—Power and Energy Efficiency, New Technology and Renewable Energy, Oil and Gas, Coal, Civil Nuclear Energy, Sustainable Growth, and the new PACE-R Working Group. PACE is implemented and monitored through the Energy Dialogue.

USDOE Secretary Dr. Ernest Moniz will host India's Minister of State with Independent Charge for Power, Coal, and New and Renewable Energy Piyush Goyal on September 21, 2015 for the first meeting of the Energy Dialogue under the Modi Government. The discussions will focus on areas of mutually beneficial collaboration and how to promote greater technological innovation, scientific cooperation, research, development and deployment of environmentally friendly technologies and products. The Dialogue will include presentations from the U.S.-India Joint Clean Energy R&D Center consortia on progress in solar energy, building energy efficiency, advanced biofuels, and reports from the Working Groups that will meet just prior to the Dialogue.



Dr. Ernest Moniz and Piyush Goyal to lead discussions at the first meeting of the Energy Dialogue under the Modi Government

U.S.-India Energy Dialogue is a mechanism for policy dialogue and technical cooperation designed to enhance mutual energy security, promote increased energy trade and investment, and facilitate the deployment of clean energy technologies.

3 Clean Energy Finance

Innovative low cost, long term financing is required not only for energy efficiency and renewable energy projects but also for related infrastructure to ensure proper evacuation and last mile connectivity. The revised 100 GW solar energy target itself will require an investment of nearly INR 6 trillion (USD 90 billion). U.S. agencies are working closely with MOP and MNRE to introduce financing mechanisms such as Green Bonds, Infrastructure Debt Funds, securitization, credit enhancement, and risk mitigation options—currency swaps, long term foreign exchange risk management and credit guarantees.

Clean Energy Finance Forum

During their first bilateral summit on September 30, 2014, Prime Minister Modi and President Obama announced the Clean Energy Finance Forum (CEFF), a consortium of public and private sector clean energy stakeholders tasked with identifying practical and innovative policy recommendations tailored to attract substantial private capital financing to the Indian renewable energy sector. The CEFF is comprised of representatives from Indian and international financial, investment, development and government policy spheres. The World Bank, MNRE, Khemka Foundation and FICCI have joined the U.S. Embassy in leading and administering the CEFF. Piyush Goyal, India's Minister of State (Independent Charge) for Power, Coal, and New and Renewable Energy, chaired the first CEFF meeting held during the RE-INVEST Summit, on February 16, 2015. The CEFF deliberations led to the creation of four working groups: 1) counterparty risk and architecture; 2) developing domestic banking and capital markets; 3) concessional financing and fostering international investment; and 4) government incentives—fiscal trade-offs and policies. The working groups have joined forces to develop actionable concepts around these topics. The first of which is a suite of credit enhancement tools that the Government of India can use to attract foreign investment in clean energy solutions. The second is intended to incentivize institutional investments in utility-scale energy projects.

Launch of White Paper on Green Bonds, December 2014
From left to right: Upendra Tripathy, Secretary, MNRE and KS Popli, Chairman, IREDA

Facilitating the Launch of Green Bonds in India

The USAID PACE-D TA Program is facilitating India's entry into the Green Bonds market by providing technical assistance to potential issuers of Green Bonds. The Program published a white paper to highlight international market trends, with recommendations on how best to introduce Green Bonds in India. The paper was formally issued by Upendra Tripathy, Secretary, MNRE, at a consultation workshop organized by the Indian Renewable Energy Development Agency (IREDA) on December 20, 2014. The Program also organized a webinar in the same month, in collaboration with the Climate Bond Initiative, to raise awareness about the benefits of Green Bonds. These knowledge sharing events were attended by financial stakeholders such as Yes Bank and India Infrastructure Finance Company Limited (IIFCL), Indian clean energy project

developers, and bilateral and multilateral development agencies. The Program also developed a concept note on reducing hedging cost, supported by modelling (hedging) scenarios, and presented the same to MNRE and Asian Development Bank. USAID has established a partnership with IIFCL, and similar partnerships are being developed with Yes Bank and IREDA to assist them in the launch of dollar denominated Green Bonds.

Financing of Solar Projects

OPIC committed a USD 20 million loan to Azure Sunlight Private Limited for the development, construction and operation of a 19 MW portfolio of rooftop solar photovoltaic projects located in various cities throughout India. OPIC expects to make the first disbursement under this loan commitment in the last quarter of 2015. OPIC also provided a USD 3 million loan to Simpa Networks to expand its customer base from 5,000 to more than 50,000. Simpa Energy India, a subsidiary of Seattle start-up Simpa Networks, developed a basic, portable solar home system that is simple to install and affordable to even poor villagers through a "pay-as-you-go" model. OPIC is also considering financing various solar power projects under India's Jawaharlal Nehru National Solar Mission.

OPIC's Vice President for Investment Funds, Brooks Preston, visited India in February 2015 and met with various government officials as well as private energy developers and investors. The meetings with the government emphasized various policies, regulatory, and legal framework issues that have prevented OPIC from expanding its capacity for financing on-grid renewable energy projects. Notwithstanding the various issues related to on-grid renewable energy financing, OPIC continues to emphasize its focus and capacity to finance off-grid renewable energy projects in India. OPIC is currently in discussions with Minister of State (Finance) Jayant Sinha and his team on issues related to off-grid financing.

Solar Rooftop Evaluation Tool

The USAID PACE-D TA Program has developed a tool that will help banks and FIs to understand the key parameters that drive the viability and sustainability of commercial and industrial solar rooftop projects. The tool aims to assist investors and financiers in identifying the key risks associated with the solar rooftop projects and facilitate faster credit decisions. The tool was launched on September 9, 2015 at an event in Mumbai which was attended by 15 financial institutions.

USAID to Assist IIFCL Raise USD 665 Million to Green Finance

As part of its clean energy finance initiatives, USAID signed a MOU with IIFCL Asset Management Company Ltd. (IAMCL) to provide technical assistance for designing, developing, and deploying innovative financing mechanisms that will improve funding for India's renewable energy sector. The MOU was signed by Manpreet Anand, Deputy Assistant Administrator, USAID Asia Bureau, and E. S. Rao, CEO of IAMCL in New Delhi on June 30, 2015. USAID will provide technical assistance to IAMCL to enhance its institutional capacity to access financial resources from a new class of institutional investors in international markets. In particular, it will assist IAMCL in the creation of Green Bonds and Infrastructure Debt Fund-Mutual Fund worth USD 665 million. Green Bonds have been identified as one of the key financial instruments that can provide Indian renewable project developers with access to scalable, long-term, low-cost debt capital from institutional investors. Similarly the proposed IDF-MF will enable project developers raise long-term, low-cost debt for renewable energy and help accelerate renewable energy in India.

MOU Signing between USAID and IIFCL, June 2015
From left to right: E. S. Rao, CEO, IAMCL; S. B. Nayar, Chairman, IIFCL and Manpreet Anand, DAA, USAID Asia Bureau

Launch of Energy Efficiency Financing Manual, June 2015
Ajay Mathur, Director General, BEE

Supporting BEE to Scale Up Energy Efficiency Financing

Most banks have limited understanding of energy-saving technologies, and thus shy away from providing loans for energy efficiency projects. To address the high risk perception of banks, USAID's PACE-D TA Program is working with BEE to build the capacity of banks and financial institutions. The Program developed a manual on energy efficiency financing which facilitates technical and financial evaluation of energy efficiency projects and helps bankers take informed credit decisions. The manual was launched by Dr. Ajay Mathur, Director General, BEE, at a training program organized by BEE on June 1, 2015 in Mumbai. The Program also supported BEE in organizing two train-the-trainer workshops (one each in Mumbai and Nainital) to facilitate further capacity building of banks.

The Program is also helping BEE to launch its Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE) that aims to provide partial coverage of risk exposure to commercial banks against loans issued for energy efficiency projects. As part of this initiative, the Program prepared a request for proposal to select a monitoring and verification agency for the Fund and provided inputs on the Fund's operational rules. It also completed a survey of energy service companies (ESCOs) and FIs in partnership with the Alliance on Energy Efficient Economy (AEEE) to identify a potential pipeline of energy efficiency projects best positioned to benefit from BEE's risk and venture capital funds for energy efficiency.

4 Renewable Energy

India has set an ambitious target of 175 GW of renewable energy capacity by 2022 largely to be achieved through 100 GW of solar and 60 GW of wind. The 100 GW of solar will be met through a combination of solar parks (25 GW), large grid-connected projects (20 GW), and solar PV rooftop systems (40 GW). The U.S. agencies have aligned their core renewable energy activities with the Government of India's priorities to ensure that the initiatives under PACE facilitate India's path to a sustainable future and help meet its green targets.

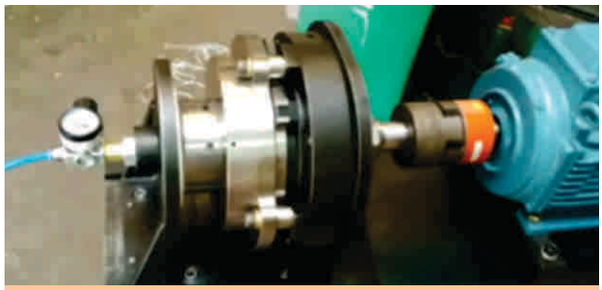
PACE-R Renewable Energy Consortia

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

The overall goal of SERIIUS, co-led by the Indian Institute of Science at Bangalore (IISc) and the National Renewable Energy Laboratory (NREL) in Golden, CO, is to accelerate the development of solar-electric technologies by lowering the cost-per- watt of photovoltaics and concentrated solar power. Technical progress under SERIIUS includes:

Sustainable Photovoltaics (PV): The PV research is focused on the development of atmospheric-based processes to produce all the key elements of photovoltaic devices including absorbers, transparent conductors, contacts, and encapsulants. Some key results over this period are: over 8 percent CZTS and CIGS cells on Corning flexible glass from ink-based precursors; large-area 5.6 percent organic photovoltaic mini-module on Corning flexible glass; and application of multi-scale modeling to optimize Si HIT cells and new efforts in perovskite PV. Work is also focused on understanding and mitigating sources of module degradation and failure in the Indian environment especially hot and humid locations.

Concentrated Solar Power (CSP): Efforts in CSP focused research have moved from the design phase to the construction of prototypes. This is key as multi-scale high-temperature Brayton cycle supercritical CO_2 systems and mid-temperature Rankine cycle systems have no precedent at the scales of interest in India and in the U.S. Additional, recent progress includes development of new optical coatings for reflection and absorption from earth-abundant materials; development of low-cost heliostats and parabolic troughs with the potential to meet current SunShot goals; and initial prototype construction for Brayton and Rankine multi-scale test platforms.



Initial test of novel scroll expander for organic Rankine cycle

Solar Energy Integration (SEI): The SEI task has finished many of the initial studies on the potential applicability and bankability of solar systems in India and has begun to focus on market analysis of critical technology that will inform the research agenda for SERIIUS. Recent SEI progress includes: analysis of the relationship between the native materials, supply chain, and process technologies to enable domestic manufacturing; detailed analysis of solar insolation and reliability data; scenario-based analysis for trough- and tower-based solar thermal systems; engineering and bankability assessment for PV technologies; and integrated renewable system application vs storage integration across a range of scenarios.

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

The Biofuels Consortium, co-led by the Indian Institute of Chemical Technology, Hyderabad, and the University of Florida, is 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. Progress made under this initiative includes:

Bioenergy Crop Improvement: The consortium has identified two switchgrass genotypes with drought and flood stress tolerance. Small-scale field evaluations have demonstrated that on marginal lands switchgrass is considerably more productive than corn and soybean. Large-scale field trials on commercial farms are now being conducted to generate multi-year data sets on inputs, best management practices, and biomass yields. Multiple breeding populations have been developed for the development of improved bioenergy sorghums, pearl millet and bamboo. In addition, two complementary experimental approaches are being pursued to identify sorghum genes conferring flooding tolerance: genetic mapping and high-throughput transcriptome profiling of sorghum root tissues from plants with contrasting responses to flooding.

Pilot Plant: The Stan Mayfield Biorefinery Pilot Plant, operated by the University of Florida, is processing sorghum and sugarcane bagasse to cellulosic ethanol at the 10,000-gallon fermentation level. The pilot plant will later process switchgrass and sorghum biomass to both ethanol and butanol at smaller scales. Techno-economic models, currently under development, will serve to model large-scale processing of sorghum and switchgrass to butanol, and to generate data for life cycle and economic analyses. The techno-economic analysis will also incorporate the use of biorefinery co-products: lignin as a source of renewable polymers with improved mechanical properties and enhanced UV-tolerance; vinasse (the liquid fraction remaining after distillation) as a source of fertilizer, and the solids remaining after fermentation as a source of biogas produced via anaerobic digestion. The pilot biorefinery is available for the Indian consortium members for training purposes.

Assessment Model: 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 on switchgrass-based butanol supply chain analysis is being gathered via questionnaires and focus groups. This effort is mirrored in India by the same researchers to compare and contrast the drivers behind renewable fuels and chemicals in the two countries. Research on the development of certification protocols, life cycle analysis, and regional economic models is in progress. Results from these efforts will provide guidelines for the environmentally and economically sustainable production of fuels and chemicals, and assist in obtaining the necessary approval to qualify as advanced biofuels.

PACE-D Renewable Energy Component

India's solar rooftop growth is at an inflection point with the market poised for a rapid take-off. The country now needs to ensure that the market ecosystem is in place through appropriate regulations, interconnection procedures, financing, and new business models to scale-up the solar rooftop sector. The USAID PACE-D TA Program is working in collaboration with MNRE and other national and state stakeholders to put in place some of the key building blocks required for the solar PV rooftop ecosystem in India.

Support to Utilities for Solar Rooftop Deployment

The USAID PACE-D TA Program is providing technical assistance to the Bangalore Electricity Supply Company (BESCOM) to facilitate implementation of solar PV rooftop installations in Bangalore. As of August 2015, BESCOM has installed nearly 2 MW in its licensee area, and with 17 MW of applications in its pipeline. The Program is also working with the Rajasthan utility—Jaipur Vidyut Vitran Nigam—to launch a similar solar rooftop program in Jaipur.

Establishing the Solar Energy Training Network

The USAID PACE-D TA Program supported the National Institute of Solar Energy (NISE) to establish the Solar Energy Training Network (SETNET) to deliver standardized formal training to build a high quality solar workforce in India. The call for partnership with SETNET received overwhelming response from 100 public and private sector training institutions. Of this, 35 partner organizations were selected via a consultative process. The Program organized a

Training Program on Solar Energy held in New Delhi, September 2014

consultation workshop in March 2015 to discuss the SETNET approach and framework, industry interface, curriculum and content development, and training delivery. The Program also helped NISE in organizing five technical training programs and one training-of-trainers program. The Green Jobs Sector Skills Council and *Surya Mitra* initiative, launched in May 2015 by MNRE and the Ministry of Skill Development and Entrepreneurship, are expected to leverage the SETNET initiative. The *Surya Mitra* training activities will be delivered through SETNET and all *Surya Mitra's* will be certified by Green Jobs Sector Skills Council. USAID is also commissioning a comprehensive training needs assessment for the solar sector to meet the 100 GW target. The last such assessment was carried out by MNRE in 2010, much before the launch of the National Solar Mission.

Pilot Projects: Demonstrating the Feasibility of Innovative Solutions

Solar Rooftop in Public Sector Undertakings

The Program is assisting two of India's largest public sector undertakings—Indian Oil and Indian Railways—in developing programs for solar PV rooftop deployment. As a part of this initiative, assistance is being provided to Indian Oil on the design and development of solar PV rooftop projects of 5 MW capacity at its refineries in Panipat, Baroda and Barauni. The Program is in the process of providing technical assistance to Indian Oil for allocation of 30 MW of solar rooftop capacity from MNRE under the Solar Rooftop Program. Once this allocation is sanctioned by MNRE, the Program will work towards identification of sites and deployment across various IOCL facilities. In addition, the Program introduced the concept of implementing solar rooftop projects under the Renewable Energy Service Company (RESCO) model to Indian Railways. It is currently providing assistance to Indian Railways for developing a standard Request for Services for selecting RESCOs, and a standard Power Purchase Agreement for procuring electricity through the RESCO model.

Energy Storage

Understanding the need for efficient energy storage technologies and services to scale renewable energy, the USAID PACE-D TA Program carried out an assessment of the role of energy storage technologies in renewable energy deployment in India. Cost-effective energy storage technologies can not only help make India's grid more efficient and reliable, but also compensate for the variability inherent in wind and solar power. The Program provided support to MNRE in drafting an Expression of Interest (EOI) for stakeholders for the design and development of new and innovative energy storage solutions for integration of renewable energy technologies. MNRE issued the EOI in August 2015 and expects to announce the shortlisted projects by December 2015. This demonstration pilot program will facilitate knowledge creation on technical and economic aspects of energy storage technologies in India.


Credit: Cyrielle Jean/Arc Finance

Off-Grid Irrigation Pumping through Solar PV

The USAID PACE-D TA Program is working with The Climate Group, India Grameen Services and Vayam on a pilot project in Bihar wherein it will install 12 irrigation pump sets across three villages to demonstrate the techno-commercial feasibility of solar irrigation pump-based micro-grids. Solar-powered water pumps are an ideal solution for rural areas that have no access to grid-based electricity services and depend on expensive and polluting diesel for irrigation. The pilot project aims to showcase how community-based institutional structures can deliver and manage water services and ensure payment security on the investments.

Grant for Energy Storage

USTDA Director Leocadia I. Zak signed a grant agreement with IL&FS Energy Development Company for the development of innovative Wind Integrated Solar Photovoltaic Energy Storage (WISES) projects. IL&FS Energy, a renewable energy producer in India, is evaluating the development of integrated wind and solar PV projects with energy storage to enable the supply of dispatchable utility-scale renewable energy to meet the Indian grid's needs. This project will demonstrate how India's grid can absorb large penetration of variable wind and solar PV generation.

Solar Resource Assessments and PV Reliability Testing

The USDOE is collaborating with NISE to enhance the quality and accuracy of India's solar resource maps and data. These maps and data help identify high-quality, bankable solar energy projects, accelerating the deployment of solar energy in India by reducing risk. NREL used data from five ground solar stations in India to validate the satellite-based data from 2002-2011 and published this solar resource data and maps in early 2014. In 2014, NREL organized workshops in India, providing more than 250 solar developers, consultants, and investors throughout India with information on the solar resource data and training on how to leverage the data in financial analysis to improve the performance of solar projects in India. NREL is currently in the process of extending the dataset from 2011 to 2014 and improving the aerosol optical depth dataset to reduce uncertainty in the dataset.

Strengthening U.S.-India Bilateral Trade

U.S. Under-Secretary of Commerce for International Trade Stefan M. Selig visited India in August 2015 and held several bilateral meetings with Government of India officials, including the Minister of Commerce and Industry Nirmala Sitharaman, Minister of State for Finance Jayant Sinha, and Minister of State (Independent Charge) for Power, Coal, and New and Renewable Energy Piyush Goyal. Mr. Selig highlighted the mutual benefits of achieving the goal set forth by U.S. and Indian leaders to increase U.S.-India bilateral trade five-fold to USD 500 billion annually.

Knowledge Exchange Workshops

The USAID PACE-D TA Program organized its second knowledge exchange workshop for its partner states on February 18-19, 2015 in New Delhi wherein representatives from state nodal agencies, distribution utilities, electricity regulatory commissions, and electricity departments took part. It fostered knowledge sharing and peer learning amongst various states on emerging issues such as solar rooftops, solar pumping and municipal DSM. The Program also organized an international workshop on "Clean Energy Policies and Regulations" in New Delhi on April 8-9, 2015 to bring together national as well as international stakeholders to discuss effective policy and regulatory frameworks required to attract private sector investment in India's clean energy sector.

USAID, GOI representatives, and international experts at the Clean Energy Policies and Regulations Workshop, April 2015

5 Energy Efficiency

India's National Mission on Enhanced Energy Efficiency seeks to achieve total avoided capacity addition of 19,598 MW and fuel savings of around 23 million tonnes per year. U.S. agencies, through the PACE initiative, are working with MOP, BEE, and other Indian agencies to introduce highly efficient technologies, innovative financing mechanisms, and sustainable business models to unlock the energy efficiency potential in India and grow the market.

PACE-D Energy Efficiency Component

Model Smart Grid Regulations

Regulatory decisions drive the overall smart grid business through approval of smart grid investments, recovery of these investments through different modes, provision of incentives and penalties to promote adoption of such solutions by the utilities, deployment at the customer end, and protection of customer interest. USAID's PACE-D TA Program prepared draft Smart Grid regulations under the guidance of the technical committee constituted by the MOP. The proposed regulations covered different themes such as investments, tariff design, customer engagement, establishment of a Smart Grid cell, and engagement of state nodal officers. The Forum of Regulators formally adopted these regulations in June 2015. The states can now adopt and adapt these regulations to best match their respective requirements.

Capacity Building of Smart Grid Stakeholders

As part of its Smart Grid initiative, the USAID PACE-D TA Program is building the capacity of the 14 utilities that are implementing Smart Grid pilot projects. In the last year, the Program organized capacity-building workshops in Puducherry, in April 2014, and in Udaipur in October 2014. These workshops aimed at providing technical and commercial knowledge to utility participants that would help them effectively progress towards implementing Smart Grid projects. While the Puducherry workshop focused on issues faced by utilities during the pre-award stage, the Udaipur workshop focused on the importance of communication technology in the successful deployment of Smart Grid projects. The Program is currently developing a short film on Smart Grids to create awareness about the transformative impact of such technologies on utilities and consumers. The film is expected to be released during the formal launch of India's National Mission on Smart Grid.

Smart Grid Capacity Building Workshop, October 2014
B. N. Sharma, Additional Secretary, Ministry of Power

Pilot Project

The USAID PACE-D TA Program is collaborating with Ajmer Vidyut Vitran Nigam Ltd. on a smart grid pilot in Ajmer. The pilot project aims to demonstrate benefits of select functionalities to the utility by implementing a proof of concept on single selected feeder (Phase 1), and subsequently prepare a base for a larger roll-out (Phase 2).

Workshop on Smart Grids

In connection with India's Smart Grid Week, USTDA hosted a Smart Grid Workshop in Bangalore, India on March 2, 2015. Building upon a prior workshop in the U.S. last December, the event brought together U.S. and Indian companies and utilities to discuss innovative solutions to India's energy challenges.

Building Energy Efficiency

The U.S. Government has a long history of working with MOP and BEE to promote building energy efficiency. USAID supported BEE in developing a draft Energy Conservation Building Code (ECBC) which was launched by MOP in May 2007. Since then, various U.S. agencies including the USDOE and USTDA have undertaken significant collaborative initiatives with Indian stakeholders to promote green buildings in India.

Net Zero Energy Buildings (NZEBs)

To catalyze the interest of architects, engineers and homeowners in NZEBs, the USAID PACE-D TA Program is focusing on two key initiatives: NZEB knowledge portal and pilot projects. The proposed NZEB knowledge portal will serve as a one-stop information hub for NZEB and include NZEB definitions and policies, case studies, and technical aspects of achieving a NZEB through passive and active strategies. The portal is in the final stages of development and is expected to launch by October 2015. USAID continues to provide technical assistance to two NZEB pilot projects—Nalanda University and Uttar Haryana Bijli Vitran Nigam Limited. The assistance being provided to the pilot projects will help demonstrate the feasibility of NZEBs in India.

Supporting MNRE's Vision of an Iconic NZEB Building

The USAID PACE-D TA Program organized a workshop on August 5, 2015 to formulate a vision for *Akshay Urja Bhawan*, the new headquarter building that has been planned for MNRE in New Delhi. Leading architects, engineers, green building experts, and officials from Central Public Works Department, MNRE and BEE deliberated on the design and technological goals for the proposed building and the ideal selection process for design consultants. The Program is working with MNRE to develop and implement the design competition process and the related terms of reference.

Consultation Meeting on MNRE's Vision for Akshaya Urja Bhawan, August 2015
From left to right: Upendra Tripathy, Secretary, MNRE; Diwakar Garg, DG, CPWD; & Varsha Joshi, JS, MNRE

Energy Efficient Data Centers

The USDOE, BEE, the Lawrence Berkley National Laboratory (LBNL), and the Confederation of Indian Industry (CII) have teamed up on a project to improve the energy efficiency of Indian data centers. The team has conducted detailed analysis of international standards and the Indian context, and presented their findings at workshops and a major conference in Bangalore in July 2015.

Best Practices Guide for High Performance Indian Office Buildings

A team of researchers from the LBNL, in collaboration with government and industry representatives from India and the U.S., are developing a guide that can empower building designers, owners, and operators to create commercial buildings in India that are best-in-class in terms of energy efficiency, cost efficiency, and occupant comfort. This multiyear project will culminate in the publication and dissemination of the second version of the *Best Practice Guide for High-Performance Indian Office Buildings*. The report, expected to be published by the end of 2015, will provide ambitious (but achievable) energy performance benchmarks that have been derived from a set of representative state-of-the-art office buildings in India.

U.S.–India AC Challenge

As part of the U.S.-India Collaboration on Smart and Efficient Cooling, a scoping study is underway with support from the USDOE and BEE to define major market barriers to deployment of transformational, super-efficient, climate-friendly, smart, and affordable air conditioning products. This initial phase of the project is expected to conclude in late 2015 with recommendations for the structure and scope of the U.S.-India AC Challenge.

Technical Update of ECBC and Implementation

The USAID PACE-D TA Program is working with BEE to facilitate a technical update of ECBC 2007 to keep the code current and relevant to today's market practices. The Program has finalized the methodology and structure of the code update after consultations with the working groups constituted to oversee the update process. It has also established a baseline of standard Indian commercial building types across five climatic zones. The Program is currently developing stringency analysis reports for building envelope, lighting, electrical and comfort systems. The stringency reports will be presented to the technical working groups in the last quarter of 2015. The Program is also providing technical assistance to Rajasthan to implement the ECBC. It supported Rajasthan Renewable Energy Corporation Limited (RRECL) to draw up an action plan for ECBC implementation, and supported the establishment of a high level task force to undertake strategic planning for ECBC implementation and to ensure its timely execution.

ECBC Implementation Pilot in Rajasthan

The USDOE and the Pacific Northwest National Laboratory (PNNL) are helping accelerate the adoption and successful implementation of India's ECBC at the state and local level. PNNL is conducting an assessment of ECBC impacts in Gujarat. Showing the quantitative impacts of ECBC will help stakeholders understand benefits of ECBC and facilitate code adoption in Gujarat. In Rajasthan, PNNL, in collaboration with Malaviya National Institute of Technology (MNIT), is piloting the process of code implementation and compliance in MNIT's Lecture and Theater Complex and the *Prabha Bhawan* building. The ECBC-compliant *Prabha Bhawan* building raised various issues regarding procurement of energy efficient technologies in public buildings and contributed to the change of "Schedule of Rates", which included more energy-efficient technologies and thus helped improve energy efficiency in public buildings.

Heating, Ventilating and Air-conditioning (HVAC)

USAID's PACE-D TA Program undertook a HVAC market assessment study, which was the first of its kind to map the penetration of energy-efficient HVAC systems in India. The study report was launched by Dr. Ajay Mathur, Director General, BEE, at a stakeholder workshop in August 2014.

Greening The Grid

Scaling grid-connected renewable energy to meet India's revised target of 175 GW will require accelerating the growing competitiveness of solar and wind power with India's thermal generators. Of equal importance is ensuring that the power system itself can absorb such a vast increase in renewable energy and deliver it to Indian utilities and final consumers without placing unmanageable pressure on the system's finances and operation. This is a huge challenge because India's renewable energy is more concentrated (by region, season, and time of day), and output is more variable and uncertain than conventional power. Experience in power systems with high penetration of renewable energy has shown that integrating significant levels of it will challenge the capacity to deliver power from renewable energy-rich regions, avoid instability from system imbalances, provide a reliable supply of high quality power, and ensure adequate markets for renewable energy.

Indian Delegation to the U.S. for a Study Tour on Renewable Energy Integration, November 2014. The delegation included Jyoti Arora (MOP); Subir Sen (Power Grid Corporation of India); Hemant Pandey (Central Electricity Authority); and then Secretary of State, Nandita Berry (center)

Since the Indian PM's visit to the U.S., USAID and MOP have laid the foundations for a major new component of PACE-D entitled Greening The Grid (GTG) - a five year USD 30 million effort to identify cost-effective pathways to integrate renewable energy into the Indian power grid at a scale that can drive low carbon growth. GTG is a multi-agency effort with contributing programs supported by USAID, USTDA and USDOE.

GTG will center on three components: a) national, regional, and local renewable energy integration studies; b) six grid integration pilots; and c) peer exchange. A rigorous analytical foundation for solutions to integrate 175 GW of renewable energy though integration studies will ensure that the GOI and state governments have the tools and capacity to conduct renewable energy integration studies, and key power sector stakeholders understand the solutions. The pilot projects will provide a platform to test and evaluate building blocks to improve integration of renewable energy in India's state and national grids. They will enable grid operators to more accurately schedule renewable energy and maintain system reliability. Similarly, the peer exchanges will enable capacity building, sharing of lessons, and access to relevant knowledge between Indian regulators, grid operators, utilities, and technology vendors and their U.S. and international counterparts.

In July 2015, the modeling team, led by NREL and MOP, held a kickoff meeting for the grid integration studies with Indian and U.S. stakeholders. Power Systems Operation Corporation (POSOCO) was designated as the lead from the Indian side. The first training for 45 power system operators and transmission planners took place on production simulation models in September 2015. The Power Grid Corporation of India Limited (PGCIL), Central Electricity Authority (CEA), POSOCO and authorities from all of India's renewable energy-rich states, and some renewable energy-deficit states participated in this workshop. In July 2015, USAID supported a mission by the U.S. Energy Association to plan the peer exchange for grid operators and utilities. Similarly the U.S. National Association of Regulatory Utility Commissioners (NARUC) visited India in September 2015 to plan the cooperation with India's Forum of Regulators. The competition to select the implementing agency for the grid integration pilots initiative (called Renewables Integration for Sustainable Energy, or RISE) is currently under procurement.

PACE-R Energy Efficiency Component

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

The Center for Building Energy Research and Development (CBERD), co-led by the Lawrence Berkeley National Laboratory (LBNL) in the U.S. and CEPT University in India, focuses on advancing buildings energy efficiency in India and the U.S. The vision for CBERD is to build a foundation of collaborative knowledge, technologies, human capabilities, and relationships that position the U.S. and India for a future of high-performance buildings. Technical progress under CBERD includes:

Creation of New Knowledge: A major thrust of CBERD is to enhance the experience and knowledge base of both nations by facilitating peer-to-peer collaborations between researchers and scientists, joint tools and technology development, and coordinated R&D on integrated low-energy building systems. Some examples of CBERD's core knowledge creation include: research and development of a new 'Model Predictive Control' method for driving deep energy savings in thermally activated building systems; development of a prototype occupancy-based smart light fitting controller; advanced design integration of a novel dedicated outdoor air systems for driving HVAC energy savings; and the development of a performance evaluation methodology for passive building design and construction.

Pathways to Demonstration and Deployment: CBERD activities are establishing pathways towards demonstrations and deployment of tools and technologies, creation of standards, and educational dissemination. Such activities include: expanded practitioner-oriented tools for rapid design, modeling, and optimization; development of two online window and fenestration design performance tools; launch of Energy Information Systems Springboard (ESP) program in order to accelerate the adoption of building energy monitoring and benchmarking; and design of an online thermal comfort satisfaction tool extended for the Indian context.

Test Bed and Apparata Development: Technology testing and development is an important part of the CBERD program. Examples include: new fault detection and diagnostics Lab at IIIT-Hyderabad; completion of a new hygrothermal test lab for building materials characterization at the CEPT University; cool roof test apparata for standardized testing in Indian climate zones; and a new earth air tunnel at the Malaviya National Institute of Technology.

CBERD Directors Rajan Rawal and Reshma Singh at the FLEXLAB facilities at LBNL, U.S., June 2015

6 Energy Access

Access to clean and reliable energy is central to India's economic growth. The new Modi Government is committed to delivering 24x7 power for all and has intensified rural energy interventions including technological collaboration and the mobilization of finance for off-grid clean energy projects.

Promoting Energy Access through Clean Energy

In September 2013, the United States and India jointly launched the Promoting Energy Access through Clean Energy (PEACE) initiative, a new track under the U.S.-India Partnership to Advance Clean Energy (PACE). One year later, Prime Minister Modi and President Obama agreed to expand PEACE to include new activities designed to unlock private sector investment and accelerate the deployment of cost-effective, super-efficient appliances. The objective of PEACE is to harness commercial enterprise to bring clean energy access to un-served and underserved Indian villages, capture lessons learned, and develop best practices.

Fund to Accelerate Innovation in Off-grid Renewable Energy

In June 2015, Upendra Tripathi, Secretary, MNRE and Richard Verma, U.S. Ambassador to India, signed an MOU establishing the "PACEsetter Fund," a new joint USD 7.9 million fund to accelerate the commercialization of innovative off-grid energy solutions. The PACEsetter Fund is the principal funding arm of the PEACE initiative. In August 2015, Ambassador Verma announced that up to USD 2 million in grants will be made available in the first funding round, with initial expressions of interest due October 16, 2015. More information is available at PACEsetterFund.org.

Announcement of First Funding Round for the PACEsetter Fund, August 2015
From left to right: Svati Bhogle, CLEAN; Mark Kenber, TCG; Alphonsus Stoelinga, Netherlands Ambassador to India; Upendra Tripathy, MNRE; Richard Verma, U.S. Ambassador to India; and Krishnan Pallassana, TCG

Mobilizing Finance for Private Sector to Enable Energy Access

On August 19, 2015, the U.S. Ambassador to India announced a new partnership to mobilize USD 41 million in financing to provide clean energy services to one million Indians over three years. The partnership between USAID/India and the New Ventures India (NVI) consortium will build the business case for investments in companies that offer clean energy services to communities not served by the power grid. NVI is a consortium of the Global Social Benefits Institute (GSBI) of the University of Santa Clara, an Indian clean technology consulting firm (Regain Paradise), and Insitor Management, which operates an impact investment fund focused on frontier markets in South and Southeast Asia.

Enhancing Clean Energy Lending in Rural India through Microfinance

The USAID PACE-D TA Program is also promoting clean energy lending portfolios of microfinance institutions (MFIs). It is doing so by building the capacity of partner MFIs and technology suppliers to develop and expand clean energy product markets through improved service delivery and efficient after-sales service. The Program has partnered with eight MFIs and is helping them to develop a strategy for clean energy lending. Of this, four partner MFIs have finalized their business plans. The Program organized a technology showcase and networking event in Kolkata in April 2015 where MFI partners got an opportunity to see "live" energy-lending operations, and were able to engage with MFI management and field staff to understand the business models and the operation processes. Nearly 10,000 products have been sold by partner MFIs as of August 2015.

Making Debt Available for Decentralized Energy

USAID's PACE-D TA Program is supporting The Climate Group (TCG) to set up a debt fund focused on provision of debt for new and emerging business models that will provide decentralized energy services to rural areas in India. The Program jointly developed a business plan with TCG and subsequently finalized the structure of the fund and a financial model. TCG is expected to receive a formal approval from its Board shortly to engage a host institution to manage the fund.

Leveraging Corporate Social Responsibility Funds for Energy Access

Deployment of distributed clean energy systems is capital-intensive and requires substantial bridge financing to scale up. The USAID PACE-D TA Program is working with Chhattisgarh State Renewable Energy Development Agency to set up a "Distributed Renewable Energy - Community Fund (DRE - CF)". The Fund will draw upon Corporate Social Responsibility (CSR) contributions to create community assets focusing on off-grid and grid-interactive distributed onsite renewable energy systems. These systems will serve the needs of households, schools, health centers, irrigation, drinking water, and other commercial and local industrial activities.

Launch of Clean Energy Access Network (CLEAN)

The CLEAN initiative was officially launched on April 8, 2015 in New Delhi. Since its launch, CLEAN has started work on all four of its focus areas: a) publication of three strategy papers on access to finance, skills and training, and technology standards; b) events on policy and financing including the dialogue with MNRE in April; c) development of policy brief on off-grid solar technology and engagement with MNRE on draft Renewable Energy Act; and d) identification of a contractor for developing a solar microgrid technician module and organization of residential capacity building workshop for strategy level leaders of member organizations. As of August 2015, CLEAN has a membership of 50 organizations with representation from solar, biomass, cookstoves, pico hydro, and pico wind sectors.

Sustainable, Clean, Access, Livelihoods, Energy (SCALE)

USAID/India's supported SCALE initiative is implemented by SELCO Foundation to establish a network of six labs to act as centers of innovation for technology, finance, process, market linkages, entrepreneur development, enterprise creation, and policy (inter alia) to provide sustainable energy solutions to the poor. The three labs on Urban Poor, Rural Poor and Tribal had identified specific needs and developed energy solutions for urban migrant communities, building designs for poor, solar pumping, agro-processing, etc.

Quality Assurance Framework for Mini-Grids

The USDOE is working to develop a Quality Assurance Framework for Mini-Grids to address root challenges of providing quality power to remote customers through financially viable mini-grids. The Quality Assurance Framework defines standard thresholds for different service levels, and a standard accountability and performance reporting protocol to validate power delivery. The USDOE, in partnership with MNRE, hosted a stakeholder engagement workshop on the Quality Assurance Framework in New Delhi in August, 2014. Feedback from this workshop and other stakeholder engagement efforts have been incorporated into the draft framework and it will be institutionalized through the International Electrotechnical Commission (IEC) as part of its rural electrification standards.

Super-efficient Off-Grid Appliances and Equipment

Building on the work of the Clean Energy Ministerial's Global Lighting and Energy Access Partnership (Global LEAP), the U.S. Government has committed funds to support a range of technology, policy and market development activities to accelerate deployment of affordable, high-quality super-efficient appliances and equipment for off-grid use in India. U.S. DOE and USAID India hosted a side-event on the margins of the first India Off-Grid Energy Summit in New Delhi on August 20, 2015 that brought together a diverse group of Indian energy access stakeholders to discuss the key opportunities and barriers, and inform the design and implementation of forthcoming PEACE programs in this area. This new work stream will also leverage the CLEAN platform to promote strong linkages with Indian off-grid companies.

wPower Global Partnership Forum

wPOWER, a USAID-funded program to promote energy access through a network of women entrepreneurs, organized its global forum on April 16-17, 2015 in New Delhi. Nearly 25 members from Africa and 15 Indian *sakhis* (women entrepreneurs) along with representatives from the Government of India, NGOs, and private sector participated in the forum. The *sakhis* shared their experiences on how clean energy business has brought about economic and social transformation in their lives. The private sector acknowledged the role of grassroots women entrepreneur network in helping them design and co-create clean energy solutions for rural households besides providing them critical access to the rural last mile. wPOWER has significant impact on women's entrepreneurship, awareness of clean energy technologies, access to products and support over the last mile.

Clean Energy Women Entrepreneurs from India and Africa, April 2015

7 Cleaner Fossil

India is heavily reliant on thermal power, most of which is derived from coal, and is responsible for over 60 percent of the enhanced greenhouse effect. While it is prudent for the thermal power plants to improve their operational efficiency, the power industry as a whole faces challenges due to limited awareness about emerging technologies and best practices. To address this challenge, USAID, via the PACE-D TA Program, partnered with MOP and NTPC to introduce pilot technologies and management practices for supercritical and subcritical thermal power plants.

The Program successfully introduced best practices for heat rate improvement in a thermal power station each in Maharashtra and Haryana. This has resulted in 68,000 MT of GHG emissions reduction, leveraging USD 9.5 million. It also developed a best practices manual and a benchmarking guide for supercritical technologies at NTPC's Sipat thermal power plant, and introduced coal blending and advanced pattern recognition software applications. These inputs, when utilized and replicated, are expected to significantly reduce GHG emissions. The Program also facilitated the establishment of the Indian Heat to Power Alliance (IH2PA), an industry organization that provides a knowledge sharing platform for stakeholders including utilities, manufacturers, technology providers, service companies and research institutions. The IH2PA is patterned after the Electric Power Research Institute in the U.S. which was set up with a similar vision.

The cleaner fossil component of the USAID PACE-D TA Program commenced in August 2012 and closed in October 2014. In this period, nine training events, one international conference and two study tours to the U.S. were organized to promote cleaner fossil technologies.

Launch of Indian Heat to Power Alliance, October 2014

8 Clean Energy Ministerial

The Clean Energy Ministerial (CEM) is a multilateral forum for clean energy policy dialogue and cooperation. The sixth Clean Energy Ministerial (CEM6) took place on May 27-28, 2015, in Merida, Mexico, where India was represented by the BEE, MOP and MNRE. At CEM6, governments agreed to:

- Establish a new **CEM Steering Committee**, through which China, Denmark, the European Commission, France, India, Mexico, the United Arab Emirates and the United States will provide strategic guidance to prioritize continued global cooperation;
- Launch a **Global Lighting Challenge** to accelerate the phase-in of high-efficiency, high quality and affordable advanced lamps and lighting systems. The campaign is co-led by the United States and India and has set a target of achieving cumulative global sales of 10 billion units as fast as possible. India announced an initial commitment of 1 billion units over three years thought the Domestic Efficient Lighting Program;
- Launch a **Power System Challenge**, endorsed by 14 other governments, to set a vision for global power system transformation and steps each countries will take to achieve that vision; and
- Expand the technical assistance resources and expert network of the **Clean Energy Solution Center**, which offers no-cost expert assistance on topics such as RE Integration and Clean Energy Finance.

In addition, the United States and India continue to engage through the CEM's year-round research and policy dialogue initiatives. The following initiatives, in particular, produced outputs that contribute to PACE-D objectives:

21st Century Power Partnership (21CPP)

India and the United States co-lead the 21st Century Power Partnership, which supports multilateral cooperation on power system transformation through collaborative research and publication authorship, practitioner dialogues, events and technical assistance. In February 2015, MNRE released its Report on India's Renewable Electricity Roadmap 2030, which 21CPP supported with an international peer review; in March 2015, NREL participated in India Smart Grid Week to present a paper on Participatory Decision-Making for Distributed Generation Regulatory Reform; and in May 2015, the U.S., India and other countries co-authored the publication: *Status Report on Power System Transformation*, which collected global examples of power system innovations. 21CPP also launched a fellowship program, which was inaugurated by two power system modelers from PGCIL and POSOCO traveling to LBNL and NREL for seven weeks of knowledge exchange and training on advanced modeling techniques.

Energy Leaders at CEM6 in Mexico, May 2015

Electric Vehicle Initiative

India's Department of Heavy Industry and the USDOE are two of the most active participants in the Electric Vehicles Initiative. They continued to deepen their technical and analytical cooperation on electric vehicle deployment policies, particularly on items that directly inform India's National Mission on Electric Mobility. A recent report by LBNL, upon the request of the Department of Heavy Industry, found that significant deployment of battery powered electric vehicles in India can lower the cost of integrating renewable energy while also substantially reducing greenhouse gas emissions.

International Smart Grid Action Network

MOP and USDOE coordinate their countries' respective participation in the International Smart Grid Action Network (ISGAN), which provides a cooperative framework to advance progress on smart grids. Under the auspices of this network, Brookhaven National Laboratory has begun training Central Power Research Institute (CPRI) on the use and programming of an integrated system model that enables automated simulation and analysis of smart grids deployment and operations. The work will increase CPRI's capacity to perform comparisons of how alternative and sometimes sequenced smart grid investments can support power system policy goals.

Super-efficient Equipment and Appliance Deployment (SEAD)

India and the U.S., as co-leads of the SEAD initiative, continue to promote best practice technical exchange through the recently re-launched superefficient.org website and SEAD Policy Exchange Forum, including highlighting BEE's product prioritization tool in May 2015. With support from CLASP, SEAD is working with Indian city governments and local partners to train municipalities on the use of SEAD's Street Lighting Tool to identify energy efficient and cost-effective options for upgrading street lights. This, and previous LED lighting technical exchange activities, have helped lay the groundwork for the preliminary launch of the CEM Global Lighting Challenge on May 28, 2015 which builds on the momentum from Prime Minister Modi's January announcement of an ambitious Domestic Efficient Lighting Program.

April 20, 2015: U.S. Ambassador to India Richard R. Verma at a conference organized by the U.S. Embassy and CII

January 12, 2015: U.S. Secretary of State John Kerry in a meeting with India's Minister of State (Independent Charge) for Power, Coal, and New and Renewable Energy Piyush Goyal at "Vibrant Gujarat"

November 18-19, 2014: Dr. John P. Holdren, Science Advisor to President Obama and Director of the Office of Science and Technology Policy at the India-U.S. Technology Summit