Public-Private Roundtables at the Fourth Clean Energy Ministerial

17–18 April 2013, New Delhi, India

CLEAN ENERGY MINISTERIAL

Accelerating the Transition to Clean Energy Technologies

"There is need for inter-country consultation and discussion in these areas to promote information exchange and to identify possible areas of collaboration, and also to learn from each other's experience in addressing common problems. The Clean Energy Ministerial has made a major contribution to such discussions."

Dr. Manmohan Singh, Prime Minister of India

"Through the Clean Energy Ministerial, we are accelerating the transition to clean energy technology around the world. While this is a young process, we are already achieving results—from saving consumers and businesses money with energy-efficient appliances to providing millions with access to clean, affordable energy supply."

Steven Chu, Former U.S. Secretary of Energy

The Fourth Clean Energy Ministerial | 17–18 April 2013, New Delhi, India

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"[The] CEM has now matured into a process with actionable agendas and programs and is working to achieve them. The Indian participation has extended to new initiatives, and we look forward to greater integration of the developing world in the clean energy strategy for the world."

Montek Singh Ahluwalia,
Deputy Chairman of
India Planning Commission

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Foreword

"We need a cleaner, low carbon [energy] model that benefits both people and planet. And we can only achieve that through the leadership and collaboration of governments and the private sector." Those were the words of United Nations Secretary-General Ban Ki-moon as he addressed energy ministers and other high-level government representatives gathered for the fourth Clean Energy Ministerial (CEM4) in Delhi. Since it was formed in 2009, the Clean Energy Ministerial (CEM) has embraced the view that the transition to a global clean energy economy will require the private sector, governments, and other stakeholders to act together, bringing their respective abilities, strengths, and resources to the table.

In addition to engaging the private sector and expert community through a number of its initiatives, the CEM convenes roundtables on select topics at its annual ministerial meetings. These roundtables provide an opportunity for participating ministers and high-level officials to engage in an open discussion with the private sector, nongovernmental organizations, and other experts on clean energy issues identified as being particularly topical and salient. The goal of the roundtables is to literally bring those parties to the table to share their views, increase understanding, and promote collaboration where helpful.

This year, six roundtables addressed reducing soft costs for solar PV, enhancing energy management systems, financing renewables, increasing the deployment of clean vehicles, exploring viable business models for mini-grids, and advancing power markets in emerging economies. Participants included government energy ministers, CEOs of multinational companies, small business entrepreneurs, experts from labs and academia, and executive directors of civil society organizations. The roundtables focused on generating concrete and actionable recommendations and informed policy makers and private-sector participants on key issues.

We offer our sincere thanks to all attendees for their active participation in the roundtables and to the moderators who very skillfully facilitated the discussions to achieve the desired outcomes.

Anil K. Jain, IAS
Adviser, Energy
Planning Commission
Government of India

Graham Pugh
Director, Office of International
Climate Change Policy and Technology
United States Department of Energy

Introduction

The Clean Energy Ministerial (CEM) is a high-level global forum to share best practices and promote policies and programs that advance clean energy technologies and accelerate the transition to a global clean energy economy. The CEM works to increase energy efficiency, expand clean energy supply, and enhance clean energy access worldwide. To achieve these goals, the CEM pursues a three-part strategy that includes high-level policy dialogue, technical cooperation, and engagement with the private sector and other stakeholders.

Each year, energy ministers and other high-level delegates from the 23 participating CEM governments come together to discuss clean energy, review clean energy progress, and identify tangible next steps to accelerate the clean energy transition. The U.S. Department of Energy, which played a crucial role in launching the CEM, hosted the first annual meeting of energy ministers in Washington, DC, in June 2010. The United Arab Emirates hosted the second Clean Energy Ministerial in 2011, and the United Kingdom hosted the third Clean Energy Ministerial in 2012. This year, India hosted the fourth Clean Energy Ministerial (CEM4) in New Delhi.

High-impact, low-cost technical work takes place through the CEM's 13 clean energy initiatives. The work facilitates international coordination that amplifies each government's clean energy deployment efforts. Although it is still a relatively young process, the CEM is already yielding tangible results, such as new appliance efficiency policies, a global renewable resource atlas, and hundreds of thousands of quality-assured off-grid appliances sold. A summary of CEM accomplishments is available at Cleanenergyministerial.org/Accomplishments.

The CEM also recognizes the essential role of the private sector and seeks to leverage its expertise, influence, and capital. As part of this work, the CEM convenes high-level public-private roundtables on select clean energy topics during the annual ministerial meetings. These roundtables capture private-sector input and encourage public-private dialogue and cooperation to advance clean energy.

At CEM4, six public-private roundtables addressed key clean energy topics:

1. Solar PV: Reducing Soft Costs
2. Clean Vehicle Adoption
3. Power Systems in Emerging Economies
4. Renewables Policy and Finance
5. Energy Management Systems
6. Mini-Grid Development

The roundtables brought together energy ministers, business leaders, and experts from nongovernmental organizations and academia to identify the policies, technologies, investments, and capacity-building efforts that may be needed to advance progress in each of the six topic areas. Participants received extensive background information on each topic in preparation for the roundtable discussions. This information is available on the CEM website at Cleanenergyministerial.org/CEM4Roundtables.

Many of the discussions included recommendations for utilizing existing CEM initiatives to drive greater progress. The following sections provide highlights from each of those discussions.

1 Solar PV: Reducing Soft Costs

Introduction

The objective of this roundtable was to identify effective approaches to drive down the non-hardware costs, or "soft costs," of solar photovoltaic (PV) technology and thereby accelerate deployment. Discussion focused on public- and private-sector roles, some of the new and innovative business models and tools that are being used in the sector, and the potential for international collaboration.

Moderator

- Martin Hiller, Director General, Renewable Energy and Energy Efficiency Partnership

Government Representatives

- Germany: Dr. Karsten Sach, Deputy Director-General for International Cooperation, Federal Ministry for the Environment
- India: Ratan Watal, Secretary, Ministry of New and Renewable Energy
- Italy: Gilberto Dialuce, Director General for Energy Supply and Infrastructure, Ministry for Economic Development
- Mexico: Leonardo Beltran, Undersecretary for Energy Planning and Transition, Secretariat of Energy
- United Kingdom: Chris Barton, Director of International and Domestic Energy Security, Department of Energy and Climate Change

Private Sector and Civil Society Representatives

- Galen Barbose, Principal Scientific Engineering Associate, Lawrence Berkeley National Laboratory
- Ardeshir Contractor, Managing Director and CEO, Kiran Energy
- Giovanni Fili, CEO, Exeger Sweden (formerly known as Nlab Solar)
- Stefano Fissolo, Deputy CEO and Board Member, Solesa Srl
- Arunabha Ghosh, CEO, Council on Energy, Environment and Water
- Ajay Goel, CEO, Tata Solar Power
- Vikram Kandula, Business Development Manager, Ravano Green Power
- Ravi Khanna, CEO, Aditya Birla Group
- P.K. Mishra, Chairman, Gujarat Electricity Regulatory Commission
- Teresa Ribera, CEO, ISOFOTON
- Milesh Ruparel, Director, Quanta TowerGen Private Ltd
- Dr. Satyendra Kumar, CTO, Lanco Solar
- Mohammed Reza Shaybani, Chairman, British Photovoltaic Association
- Udayadittya Shome, Vice President, Juwi India Renewable Energies Pvt Ltd.
- Maria van der Hoeven, Executive Director, International Energy Agency
- Lakshmi Venkatachalam, VP, Private Sector and Cofinancing Operations, Asian Development Bank

Operating Agent

- International Renewable Energy Agency

Overview and Background

Large-scale public and private investments in the research, development, and demonstration of solar PV technology have sharply reduced the costs of PV system hardware over the last few decades. According to Bloomberg New Energy Finance, solar PV module prices have fallen 80% since 2008 and 20% in 2012 alone.

The non-hardware costs of installation, or "soft costs," have not seen the same dramatic declines, and they now account for a substantial portion of the total installed cost. With the decline in hardware costs expected to slow over the next few years, addressing soft costs will be essential to ensure continued reductions in the total installed cost and associated acceleration in deployment of solar PV systems.

For the purposes of this roundtable, four main categories of soft costs were identified for solar PV systems:

- **Overhead and financing**: Includes the capital costs of loans, insurance, and the expense of preparing legal agreements such as purchased power agreements and requests for proposals.
- **Customer acquisition**: Includes the preparation of information to persuade businesses and homeowners of the value of installing PV systems, marketing and advertising to disseminate such information, sales calls and site visits, and contract signature and payment.
- **Installation labor**: Includes the installation of PV systems and connecting them to the grid, plus follow-up operation and maintenance once the systems are in service.
- **Permitting**: Includes the time for permits, inspection, and interconnections; labor and other expenses to apply for permits; and utility interconnection expenses.

Solar PV Hard Costs versus Soft Costs

Hard costs (i.e., hardware costs) include modules, mounting hardware, wiring, inverters, and monitoring equipment. Soft (i.e., non-hardware) costs include financing, customer acquisition, design and engineering, installation, permitting, and inspection.

Soft costs can account for 40%–50% of the total installed cost of a system and can typically add $1–$3 to the cost per watt of capacity. There are, however, significant variations in soft costs among different countries. For example, soft costs in the United States are up to five times higher than those in Germany. As Figure 1 illustrates, a number of factors account for this difference.

Countries that have experienced more balanced reductions in both hardware and soft costs have some commonalities. The markets are competitive, there is a skilled labor force, there is generally good information available, and there are well-designed policies with incentives that are aligned with market needs.

Identified Barriers

There are several significant barriers to reducing PV soft costs:

Financing: It is difficult to access affordable financing with reasonable effort. Banks that may not be familiar with PV technology may charge higher-than-usual rates for system loans. The loan application process may also be complex, contributing to overhead costs for installing PV systems.

Market structure and size: Business markets for PV in residential and commercial buildings are fragmented and limited in scale, making it more difficult to provide

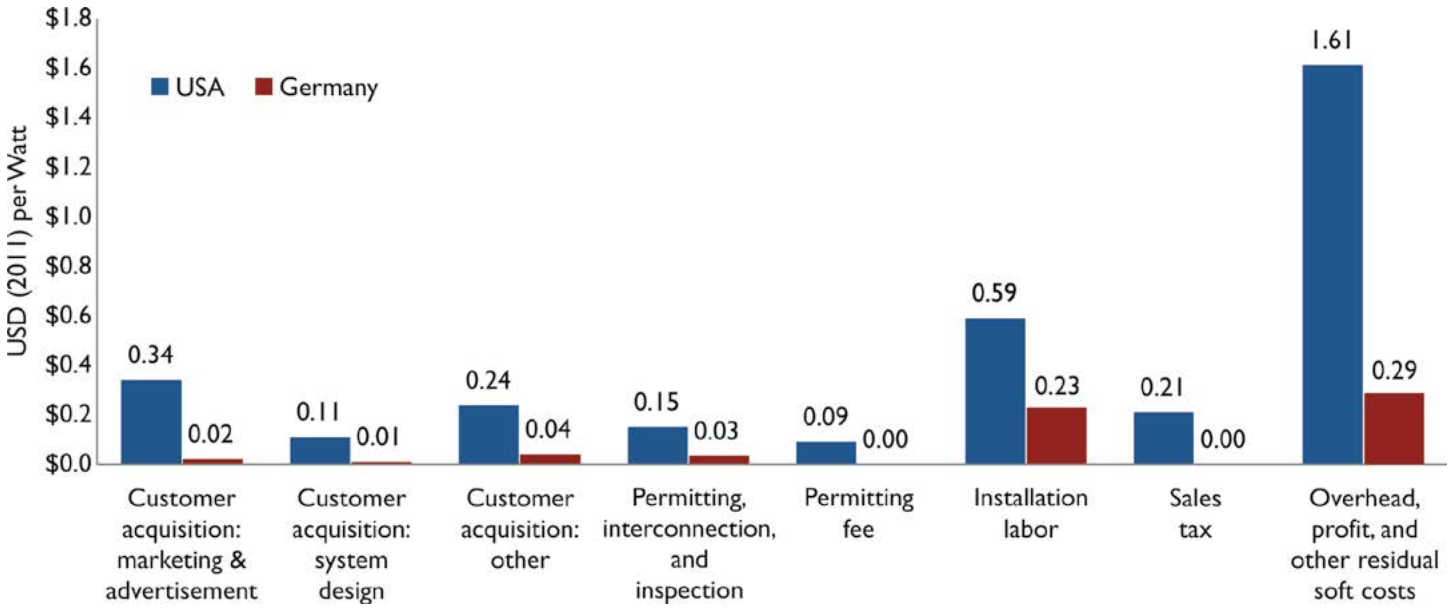

Figure 1. Comparison of soft costs for residential photovoltaic (PV) systems in Germany and the U.S. Source: Seel, Barbose, and Wiser 2013

training and utilize skilled PV installers efficiently. This contributes to a higher installation cost per watt of capacity and presents difficulties in reducing that cost. The small, fragmented market also means that a relatively large effort, per unit of capacity, is required to obtain necessary permits. A wide variety of zoning, construction, and safety permits are often required by different federal, provincial, and local jurisdictions, raising the labor costs associated with the permitting process.

Standardization: Today's PV panels are somewhat complex—in part due to the lack of a simple and standardized design—which also leads to higher installation labor costs.

Public awareness: Public awareness of PV options and benefits is also limited in many locations. In smaller markets, it may not be as cost-effective to provide information and advertise, which contributes to a relatively high cost of customer acquisition.

Potential Solutions

Roundtable participants suggested several steps that public and private stakeholders could take to address the identified barriers and reduce PV soft costs:

Financing: Innovative financing schemes such as rooftop leasing could lower costs and provide other benefits. Under rooftop leasing, a company invests in solar PV equipment and installs the equipment on leased roof space. The company sells the power generated by the panels to the building owner at a competitive rate. Any excess power can be sold through net metering programs. This approach could be endorsed by regulators and managed on a large scale by solar PV management firms. Such schemes could reduce customer acquisition costs, spread permitting costs over a larger base, and spur development of a specialized and more efficient labor force that reduces installation labor costs.

Market structure and size: National, provincial, and municipal governments could implement various regulations to build market scale and reduce PV soft costs, including requiring net metering of generated electricity, allowing payment of feed-in tariffs to building owners, and requiring low net energy use in new buildings.

Standardization: Photovoltaic system manufacturers could contribute to the reduction of permitting and labor costs by sharing information and creating more standardized, easy-to-install roof panels.

Public awareness: Public education programs, with inputs from manufacturers, could reduce customer acquisition costs by better informing building owners about the potential payback from PV investments.

City-level promotion: Municipalities could promote the construction of, or retrofit to, low-net-energy buildings.

International collaboration: There are opportunities for international collaboration on many of these possible solutions. For example, Clean Energy Ministerial participating governments and PV manufacturers might cooperate to reduce installation labor costs by developing innovative training schemes and by standardizing PV panels that are easier to install. In addition, international standards organizations and PV manufacturers could collaborate on educational efforts to promote the costs and benefits of high-quality PV systems for building owners.

Key Recommendations

The roundtable participants made several key recommendations for reducing solar PV soft costs:

- Build economies of scale and facilitate learning curves that reduce PV soft costs.
- Foster the right financing ecosystem to drive down the costs of capital for PV systems, including providing information to financial institutions about the real risks, costs, and benefits.
- Establish a consistent and predictable policy framework to build market confidence.
- Further analyze and identify additional areas for cutting soft costs and share the data.
- Streamline administrative procedures, with a "one-stop-shop" approach to permits.
- Standardize technology testing and certification and set reliable minimum standards.
- Build capacity for proper installation of PV systems in the construction trades.
- Bundle projects and cooperate on research and development to mitigate risks and share the costs of learning.

"The roundtable provided a fascinating range of different angles on the problem of soft costs of solar PV. Pulling all of those distinct views together at one table was immensely informative and valuable."

Martin Hiller, Director General,
Renewable Energy and Energy Efficiency Partnership

2 Clean Vehicle Adoption

Introduction

The objective of this roundtable was to identify opportunities to accelerate the adoption of plug-in electric vehicles (PEVs) and natural gas vehicles (NGVs), with a focus on strategies that can be carried out through public-private collaboration within the context of the Clean Energy Ministerial. The discussion explored policy and technical issues surrounding clean vehicle deployment, addressing public- and private-sector roles in creating sustainable and successful policies and business models to reduce costs, ensure infrastructure rollout and operation, and enhance consumer awareness.

Moderator

- John Podesta, Chair, Center for American Progress

Government Representatives

- China: Wan Gang, Minister, Ministry of Science and Technology
- Finland: Marja Rislakki, State Secretary of Economic Affairs, Ministry of Employment and Economy
- Germany: Wolfdieter Böhler, Head of Division for International Energy Policy, Federal Ministry of Economies and Technology
- India: Praful Patel, Minister, Ministry of Heavy Industries and Public Enterprises
- Ireland: Fergus O'Dowd, Minister of State, Department of Communications, Energy and Natural Resources
- Japan: Isshu Sugawara, State Minister, Ministry of Economy, Trade and Industry
- Sweden: Daniel Johansson, State Secretary to the Minister for Information Technology and Energy
- United States: David Sandalow, Assistant Secretary, U.S. Department of Energy

Private Sector and Civil Society Representatives

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- Rao Chalasani, Director of Advanced Vehicle Development, GM Technical Center India
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- Srinivasan Govindrajan, Deputy General Manager, Tata Motors Engineering Research Centre
- Jyri Häkämies, Director General, Confederation of Finnish Industries EK
- Richard H. Jones, Deputy Executive Director, International Energy Agency
- Chetan Maini, Chief of Technology and Strategy, Mahindra Reva
- Wenwei Rong, General Manager, Shanghai International Automobile City Group
- Rolf Stromberger, Vice President of Business Environment and Public Affairs Strategy, BMW of North America
- Suderson SV, Head of Product Engineering, Daimler India Commercial Vehicles Pvt Ltd.
- Modesto Volpe, President, VT Energy

Operating Agents

- Center for American Progress
- Electrification Coalition

Overview and Background

While personal mobility over the past century has largely been fueled by petroleum, PEVs and NGVs have recently established a foothold in the automotive sector, offering the prospect of a cleaner, more fuel-diverse transportation system. According to the Clean Energy Ministerial's Electric Vehicles Initiative, global PEV sales more than doubled from 2011 to 2012, surpassing 100,000 in 2012. There are also about 15 million NGVs on the road today, with an annual growth rate of 22.9% since 2001.

Price spikes in the global oil market create uncertainty and can lead to high costs for consumers and businesses. Electricity prices, on the other hand, are relatively stable and can mitigate risks from oil price volatility (Figure 2). Natural gas prices are also low in the United States and may fall in other countries as the scale of liquefied natural gas and shale gas production grows. PEVs and NGVs may thus prove more economical than petroleum-powered vehicles because their operating costs are much lower and more predictable.

In the context of rising global greenhouse gas (GHG) emissions, accelerating the adoption of both PEVs and NGVs is also critical to achieving substantial GHG reductions in the transportation sector. PEV and NGV solutions can also help address volatile energy prices while simultaneously spurring job growth in new, advanced industries and enhancing economic prosperity and energy security. The technologies could have a particularly significant impact in the world's major cities, where local air pollution is an important concern.

To realize a market transformation in the transportation sector, existing challenges need to be addressed in the areas of cost, consumer acceptance, technology, and infrastructure. Bloomberg New Energy Finance estimates that PEV sales need to increase 80% per year to reach the goal of having 20 million electric vehicles on the road by 2020. Both the public and private sectors have important roles to play in addressing these challenges and driving transformation.

What Are PEVs and NGVs?

Plug-in electric vehicles (PEVs) run on electricity from an external source stored in on-board batteries. PEVs comprise both battery-electric and plug-in hybrid electric vehicles. Natural gas vehicles (NGVs) are traditional internal combustion engine vehicles configured to run on natural gas that has been liquefied or compressed.

Identified Barriers

The roundtable participants identified a number of barriers to the widespread adoption of PEVs and NGVs in the categories of cost, consumer acceptance, technology, and infrastructure:

Cost: Both vehicle technologies have higher capital costs than traditional petroleum-powered vehicles. Although battery costs have dropped substantially—by more than 50% in 3 years—the battery is still the most costly component of a PEV. NGVs are also seen as expensive. However, because electricity and natural gas are less expensive than gasoline, the total cost of ownership (TCO) for both PEVs and NGVs is potentially lower than for traditional petroleum-powered vehicles. Commercial fleets are particularly sensitive to TCO, so reducing costs under that framework is especially vital to further clean fleet development.

Consumer acceptance: Many consumers lack basic knowledge about both PEVs and NGVs and may not be fully informed when considering the purchase of a new vehicle, particularly around the concept of TCO and "range anxiety" (how far the vehicle can go without

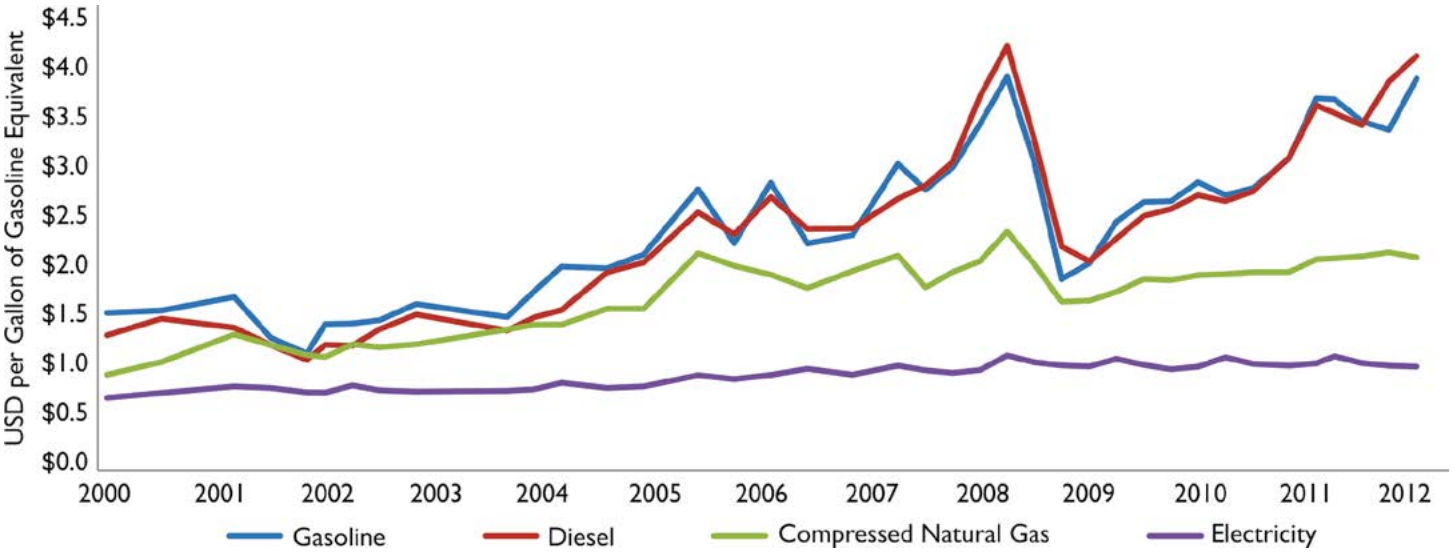

Figure 2. U.S. average retail alternative fuel prices. Source: EERE 2013

refueling or recharging). It is important to recognize that consumers frequently purchase vehicles based on what they may do rather than their average daily driving habits, which can heighten range anxiety. Consumer education, particularly from car dealerships, appears to be lacking. This lack of familiarity with the technologies may be holding back many consumers and will likely persist unless there is more effective consumer education.

Technology: Energy storage limitations are a primary technology obstacle for both PEVs and NGVs. Battery-related issues for PEVs include durability, weather performance, and charge speeds. There are also technology challenges for PEVs related to the potentially limited availability of rare earth materials that many electric motors and some batteries rely on. Although NGVs are a relatively mature technology, they also face challenges related to fuel storage. For example, compressed natural gas tanks require up to six times more space than gasoline tanks and can take about twice as long to refill.

Infrastructure: Both PEVs and NGVs require new or enhanced refueling infrastructure. However, investment in new refueling infrastructure may compete with other infrastructure priorities such as roads, bridges, and rail. Because long-term market growth cannot be maintained on government subsidies alone, sustainable business models (including models for refueling infrastructure) are needed for both vehicle types. There is also a concern that large investments in NGV infrastructure could undermine countries' long-term climate goals. For PEVs, more focused attention on grid connectivity in the context of these broader infrastructure questions could point toward a better menu of solutions.

Potential Solutions

The roundtable participants highlighted a number of success stories that could be used to guide future decisions. These include the dramatic transformation in air quality in New Delhi due in large part to the switch to compressed natural gas in the city's truck and taxi fleets. A variety of progressive taxation systems have also been used in Scandinavian countries and elsewhere to encourage more PEV use. The creation of "Electronic Mobility Showcases" in Germany has helped introduce consumers to PEV product lines. In addition, an innovative system in Paris—the Autolib program—more effectively engages users in an electric vehicle car-sharing program that is integrated with closer access to metro stations and uses dedicated parking spaces and an online reservation system. An aggressive program in the U.S. city of Indianapolis to convert the municipal fleet to PEVs and NGVs is designed to both save taxpayers money and encourage consumer adoption. Finally, a variety of integrated national plans are in place or in progress in India, China, Ireland, Sweden, Finland, the United States, and other places to create the policy infrastructure to accelerate these transformations.

Overall, a range of potential solutions were identified to drive market transformation in the future:

Cost and technology: Both government and industry participants stressed the need to maintain rigorous research and development (R&D) programs to solve key technology barriers, improve fuel and energy storage, increase driving range, and reduce costs. International R&D cooperation is also important because it can help address common areas of need, spread costs, and accelerate technological breakthroughs. At present, focusing on PEVs for personal use and NGVs for long-haul needs and fleets could focus this cooperation, given the ease of applying current technologies to these vehicle classes.

On the demand side, tax and fiscal measures are vital to spurring wider adoption, particularly while PEVs and

NGVs are still emerging technologies. Tax holidays, tax credits, and other financial incentives have proven successful at driving early adoption of these technologies in many countries.

Consumer acceptance: Solutions vary for increasing consumer acceptance of PEVs and NGVs. City governments can be a good place to start deployment, because they can adopt PEVs and NGVs in vehicle fleets, public transportation systems, and other municipal operations. Adopting these technologies can save cities money while demonstrating "proof of concept" to consumers and other fleet operators. Understanding consumer behavior is also important. Ease of parking (especially when linked to recharging), access to dedicated highway lanes, and relief from congestion taxation can be important drivers of consumer adoption.

More "enhanced experiences" for consumers are needed, beyond the traditional limited test drives. Recent car-sharing experiences may also provide ideas for innovation that could be particularly relevant in markets with reduced reliance on cars or reduced desire to own cars, such as some youth-driven markets. In this respect, it may be beneficial to focus more on total mobility paradigms, through public-private partnerships, that can link shared vehicles with rail and other public transportation systems. Investigating how clean vehicles can be integrated into car-sharing and other "mobility access" programs throughout the world is an area ripe for exploration.

Infrastructure: On the infrastructure side, PEVs should be integrated as much as possible with smart grid development. From the onset, each should be designed with the other in mind. This can result in better efficiency and catalyze innovative vehicle-to-grid solutions. If large-scale PEV adoption occurs, the electricity grid must be able to support it.

Key Recommendations

- Overall, more sharing of global experiences is needed, with respect to what works and what does not work.
- More cooperation among governments, researchers, and the private sector is needed to produce detailed empirical studies of the factors currently driving consumer choices. This will help to better identify and anticipate which policy instruments can best serve positive trends in the market.
- To enhance Clean Energy Ministerial contributions in this area, the Electric Vehicles Initiative should work more closely with the 21st Century Power Partnership and the International Smart Grid Action Network to better embed the discussion of clean vehicles in the broader discussion about infrastructure and grid choices.

"Such events provide an excellent international platform for government representatives, industry, and other participating stakeholders to better understand each other's needs, to learn from each other, and to identify new ideas."

Dr. Rolf Stromberger, Vice President of Business Environment and Public Affairs Strategy, BMW of North America

"I was privileged to be the only mayor to participate in this global clean energy summit. The emphasis on clean transportation technology truly holds the potential to positively change the future economy of the world."

Gregory A. Ballard, Mayor of Indianapolis, Indiana, United States

3 Power Systems in Emerging Economies

Introduction

This roundtable sought to identify a set of policy and regulatory principles that could help accelerate power system transformation in emerging economies, including those that can be carried out through the Clean Energy Ministerial's 21st Century Power Partnership. The discussion addressed the impact of key elements driving changes in power systems and how integrating each of these elements into comprehensive planning, policy making, and regulation offers opportunities to provide clean, affordable, reliable power and other energy services.

Moderator

- Joan MacNaughton, Executive Chair, World Energy Trilemma, World Energy Council

Government Representatives

- Australia: Subho Banerjee, Deputy Secretary, Department of Resources, Energy and Tourism
- Denmark: Hans Jørgen Koch, Deputy Permanent Secretary, Ministry of Climate, Energy and Building
- India: Jyotiraditya Scindia, Minister of State, Ministry of Power
- Mexico: Leonardo Beltran, Undersecretary for Energy Planning and Transition, Secretariat of Energy
- Norway: Ane Hansdatter Kismul, State Secretary, Minister of Petroleum and Energy
- Russia: Alexandre Mitreykin, Deputy Director of the Department of Energy Efficiency and Modernization of Energy Sector, Russian Energy Agency
- South Africa: Elizabeth Dipuo Peters, Minister, Department of Energy
- United States: Steven Chu, Secretary, U.S. Department of Energy

Private Sector and Civil Society Representatives

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- Brian Dames, CEO, Eskom
- Pramod Deo, Chairman, Central Electricity Regulatory Commission, India
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- Didier Houssin, Director of Sustainable Energy Policy and Technology, International Energy Agency
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- Lawrence Jones, Vice President, Regulatory Affairs, Policy & Industry Relations, Alstom Grid
- Caio Koch-Weser, Vice Chairman, Deutsche Bank
- Takemitsu Kunio, Senior Vice President, NEC
- R.N. Nayak, Chairman and Managing Director, Power Grid Corporation of India
- Reji Kumar Pillai, President, India Smart Grid Forum
- Jim Rekoske, Vice President and General Manager, Renewable Energy and Chemicals Business, Honeywell (USA)
- Richard Samans, Executive Director, Global Green Growth Institute
- Tulsi Tanti, Chairman and Managing Director, Suzlon Energy Limited
- Tom Weirich, Director of International Programs, American Council on Renewable Energy

Operating Agent

- National Renewable Energy Laboratory

Overview and Background

The International Energy Agency estimates that 5,891 gigawatts (GW) of new power capacity will be added between 2012 and 2035, with 64% (3,804 GW) of that added in countries outside of the Organisation for Economic Co-operation and Development (Figure 3). Non-hydropower renewable energy will provide 40% of the added power—2,377 GW of the 5,891 GW added. For all countries, but particularly in fast-growing emerging economies, changes in supply, delivery, and demand are driving the transformation of power systems.

Governments and energy regulators face a number of challenging and complex questions as they move to develop clean, modern power sectors. The rapidly evolving landscape of variable renewable resources, energy efficiency, smart grid technologies, and flexible demand-side management offers the opportunity to create cleaner, lower carbon, and more reliable power sectors. However, it also introduces complex challenges related to the planning, financing, and operation of these systems.

Emerging economies face all of these challenges as well as the additional issues of expanding access to energy services, minimizing technical and nontechnical losses, and improving power quality and reliability, all while ensuring the financial stability of electricity providers. Some countries or regions have been able to address many of these issues through the implementation of policy, regulatory, technology, and market design elements that can serve as valuable examples. Adoption of frameworks based on these design elements may be able to ensure increased energy efficiency, enhanced clean energy supply, and expanded energy access.

Participants in this roundtable focused on four key elements driving change in power systems. First, increasing shares of variable renewable energy increase the need for system flexibility and challenge existing regulatory and market structures. Second, smart grid technologies and demand response programs allow for greater reliability, effective load balancing, and overall system intelligence while also opening up new possibilities for dynamic, interactive energy systems and markets. Demand-side management is not just important for dynamic demand response, however. Significant portions of the world have only intermittent access to electricity due to constraints on generation and on transmission capacity. Demand-side management can optimize that capacity and improve reliability. Third, energy efficiency has proven to be a cost-competitive, quickly deployable strategy for minimizing capacity constraints while lowering costs to end users. Lastly, integrating each of these elements into comprehensive planning, policy making, and regulation offers an opportunity to provide clean, affordable, reliable power and other energy services.

Identified Barriers

When evaluating technology and infrastructure options over long-term investment timescales, the rapidly evolving power system landscape poses distinct challenges to conventional resource planning and policy and regulatory approaches. Simply understanding the ongoing changes in resources, demand, and technology is a fundamental difficulty. On the policy and regulatory side, challenges include the complexity of policies; uncertainties around incentives; the competition for subsidies; and a lack of coordination in the legal, market, and institutional ecosystems.

There are also challenges related to innovation, support, and investment. These include a lack of experience in operating twenty-first century power systems; the diversity of solutions needed for different countries or regions; difficulties in attracting investment; and a lack of public understanding and support, particularly regarding public

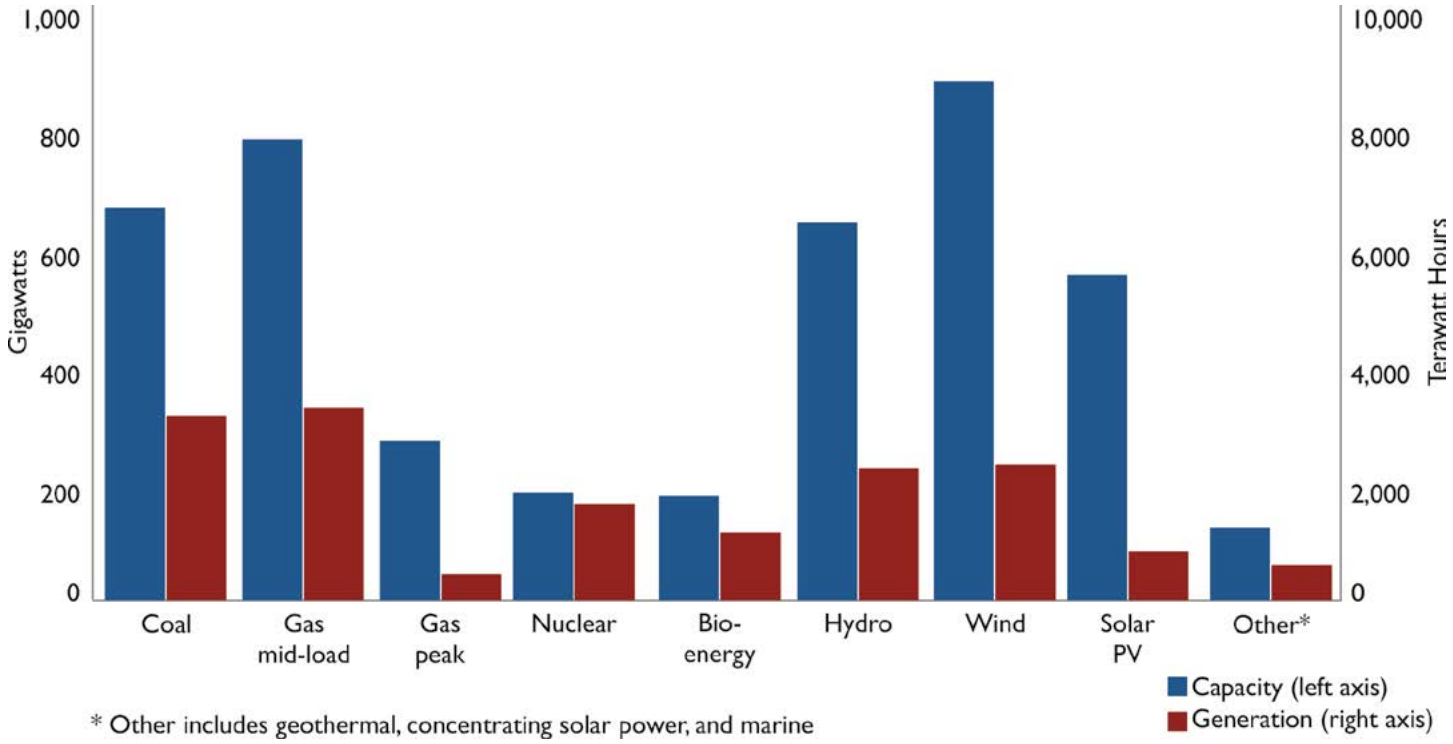

Figure 3. World net incremental capacity additions by type, New Policies Scenario. Source: IEA 2012

expenditures. Overall, there is a lack of comprehensive planning and coordination of policy frameworks to address cross-cutting issues.

Potential Solutions

The roundtable participants agreed that adopting a holistic view of the power system and its relation to other parts of the economy can help provide solutions to these issues. Power sector solutions are motivated by understanding that reliable delivery of energy services, including power for lighting, heating, cooling, and plug loads, enables greater economic productivity and supports sustainable economic development.

Successful approaches to power sector reform share the following key aspects:

- They utilize an integrated approach to planning, which encompasses the comprehensive inclusion of energy efficiency of generation, transmission, and distribution as well as end-use applications and active demand-side management.
- They enable power system flexibility and responsiveness. Regulations governing the system must not impede flexibility, but rather should enable the efficient use of all assets across the system.
- They take into account energy service demands and seek to optimize the efficient, affordable, reliable provision of those services. Examples of this holistic approach include hybrid systems that provide power, water, heating, and cooling.

In addition, it is critical to develop and disseminate innovative, refined planning methods and policy and regulatory approaches that are robust across timescales and dynamic technology landscapes. Greater sharing of lessons learned from past policy and regulatory approaches is essential, including the use of fiscal instruments such as feed-in tariffs and renewable energy credits, as well as ancillary services markets and advanced forecasting and integration regulations. A focus on capturing and sharing best practices in integrated planning and enabling system flexibility is also important. This includes first how to assess flexibility and then how to build it into market design, and incorporate approaches for demand response, use-based valuation, reliability services, and advanced forecasting.

The participants also noted that distributed systems with integrated storage may provide more comprehensive energy services solutions. For example, hybrid systems that use excess power from distributed mini-grid wind or solar could provide cooling or heating, and would be both highly efficient and economically attractive. For many applications, the technologies already exist and could deliver highly reliable, affordable services. In many cases, innovative hybrid systems might be more cost-effective than traditional off-grid generators (such as diesel) or grid extension.

Key Recommendations

There are several key recommendations to advance power markets:

- Provide the appropriate regulatory and business environment to enable financially viable solutions, particularly through public-private partnerships. This includes assigning a monetary value to attributes of clean energy (e.g., through renewable energy credits).
- Utility or energy service business models must adapt and evolve to ensure financial success. This may include taking service-based approaches and deriving revenue from distributed generation assets.
- Policies and regulations need to be examined and revised—to remove barriers and potentially offer incentives—to enable the delivery of clean energy services as quickly as possible.
- Capture and share best practices to address the existing gaps in knowledge. This can be done through the 21st Century Power Partnership and can help lay the groundwork for continued successful dialogue that will meet the challenge of rapidly accelerating energy access in emerging economies while simultaneously decarbonizing power systems globally.

"The discussion threw up some really interesting ideas for how to drive forward a more sustainable power system, using current technologies in innovative ways to focus on serving existing and future customer needs, [and] it also recognized the need for 'disruptive regulation' to drive the needed changes to utilities' business models to enable this to happen—a process which will require deep public/private collaboration of the kind fostered by the Clean Energy Ministerial."

Joan MacNaughton, Executive Chair, World Energy Trilemma, World Energy Council

4 Renewables Policy and Finance

Introduction

This roundtable sought to identify policies and regulatory mechanisms to mobilize larger capital flows into renewable energy. The discussion explored the impact of policy uncertainty, policies that can aid policy makers and the finance community, major risk factors, measures to ramp up the availability of low-cost debt from domestic lenders, the role of multilaterals, and measures to increase capital flows from institutional investors.

Moderator

- Andrew Steer, President and CEO, World Resources Institute

Government Representatives

- Denmark: Hans Jørgen Koch, Deputy Permanent Secretary, Ministry of Climate, Energy and Building
- Germany: Dr. Karsten Sach, Deputy Director-General of International Cooperation, Federal Ministry for the Environment
- India: Montek Singh Ahluwalia, Deputy Chairman, Indian Planning Commission
- Ireland: Fergus O'Dowd, Minister of State, Department of Communications, Energy and Natural Resources
- Mexico: Leonardo Beltran, Undersecretary for Energy Planning and Transition, Secretariat of Energy
- Norway: Jan Øivind Johansen, Assistant Director General, Ministry of Energy
- Russia: Alexandre Mitreykin, Deputy Director of the Department of Energy Efficiency and Modernization of Energy Sector, Ministry of Energy
- Sweden: Daniel Johansson, State Secretary to the Minister for Information Technology and Energy
- United Kingdom: Chris Barton, Director of International and Domestic Energy Security, Department of Energy and Climate Change
- United States: Steven Chu, Secretary, U.S. Department of Energy; and David Sandalow, Assistant Secretary, U.S. Department of Energy

Private Sector and Civil Society Representatives

- Andrew Brandler, CEO, CLP Holdings
- Ardeshir Contractor, Managing Director and CEO, Kiran Energy
- Jyri Häkämies, Director General, Confederation of Finnish Industries
- Caio Koch-Weser, Vice Chairman, Deutsche Bank
- Michael Liebreich, CEO, Bloomberg New Energy Finance
- Jim Rekoske, Vice President and General Manager, Renewable Energy and Chemicals Business, Honeywell (USA)
- Teresa Ribera, Director General of Strategic Development and New International Markets, ISOFOTON
- Parag Shah, Managing Partner, Mahindra & Mahindra Ltd.
- Sumant Sinha, CEO, Renew Power
- Tulsi Tanti, Chairman, Suzlon Energy Limited
- Maria van der Hoeven, Executive Director, International Energy Agency
- Lakshmi Venkatachalam, VP for Private Sector and Cofinancing Operations, Asian Development Bank
- Jonathan Winer, Managing Director, Nereus Capital

Operating Agent

- Bloomberg New Energy Finance

Overview and Background

New investments in clean energy (which excludes large hydropower but includes energy-smart technologies that enable more efficient use of electricity and fuels) declined 11% worldwide in 2012 to $269 billion, according to Bloomberg New Energy Finance (BNEF) (Figure 4). The fall was partly due to regulatory uncertainty in big markets such as the United States, India, Spain, and Italy. In some cases, fiscal austerity led to the rollback of renewable energy subsidies, leaving investors and project developers facing uncertainty and higher risk. Sharply lower prices for solar and wind equipment also contributed to the lower investment volume, although they have also allowed for more capacity to be installed per dollar of funding.

Policy makers are challenged to provide investors with stable and transparent policies or, where that is not possible, flexible policies that address fiscal challenges while still offering sufficient incentive to encourage investment. In emerging economies, policy makers must address these challenges while making the huge investments required to build out their energy infrastructures.

Within this context, policy makers face the dual issues of scope and urgency; BNEF estimates that clean energy investments must increase two to three times in order for carbon dioxide emissions to peak by 2020 and then start to decline.

Identified Barriers

The roundtable participants identified a number of barriers that impact renewable energy financing:

Policy uncertainty: The possibility of governments cutting back previously promised incentives or performing unannounced reviews has created uncertainty regarding the future cash flows of renewable energy projects.

Communication during policy formulation: The private sector is generally not included when policies are being formulated. This lack of involvement and communication tends to create a lack of trust in the resulting policy due to perceived risks or uncertainties that impede investment.

Access to low-cost debt: The cost of debt has a major bearing on the levelized cost of electricity generation from renewables and restricts deployment in countries with high interest rates. In addition, low participation from certain categories of investors, such as pension and sovereign wealth funds, and a lack of focus on innovative mechanisms could impede future growth in financing.

Integrated planning: When policy targets are set for specific sectors such as wind or solar, integrated planning is sometimes neglected, which can result in transmission system unavailability, grid instability, and payment delays. This can result in significant negative consequences. In certain states or provinces within emerging markets, grid curtailment[1] is a growing concern, particularly where renewables compose more than 10% of installed generation capacity. This curtailment may significantly impact the profitability of a project.

1. Grid curtailment occurs when system operators reduce the generation of power from renewables and the output to the grid for various reasons, including limited transmission capacity.

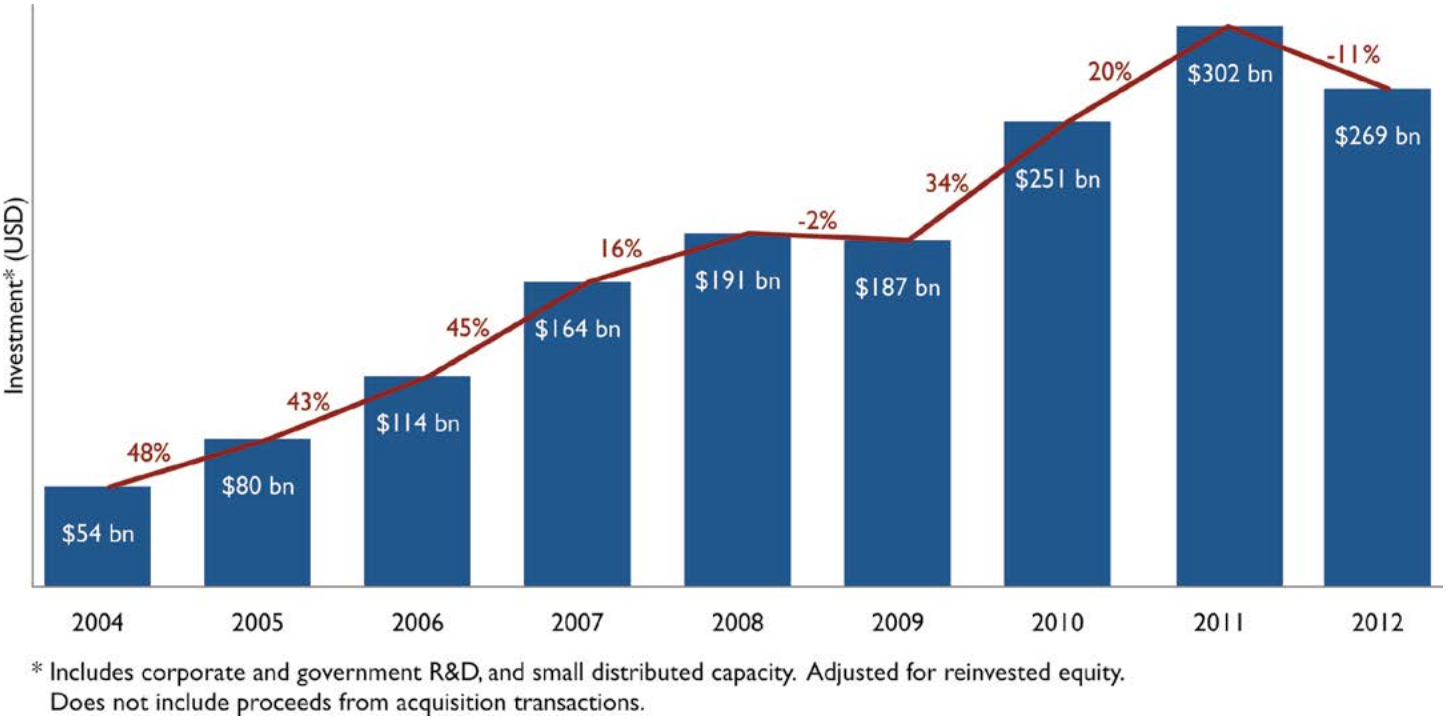

Figure 4. Investments in clean energy, 2004–2012. Source: Liebreich 2013

Public acceptance: Clean energy deployment can also face resistance from local communities that may believe clean energy is more costly than conventional energy or may disrupt their way of living. This can cause delays and increase risk, thereby increasing the costs or stranded assets.

Information access: Overall, a lack of information- and experience-sharing between various public and private entities on policy, technology, and financing may also lead to policies that negatively affect investments.

Potential Solutions

A number of potential solutions were identified to address the barriers:

Policy uncertainty: Governments could reduce uncertainty about future actions by defining predetermined policy review periods. The enforcement of regulations such as renewable purchase obligations needs to go hand-in-hand with the creation of incentives.

Communication during policy formulation: To improve communication during policy formulation, policy makers could invite feedback and incorporate suggestions from key stakeholders such as power generators, government-owned or -regulated power off-takers, large private power buyers, financial regulators, equipment providers, the insurance industry, institutional investors, and public communities. This more integrated approach would then create a better understanding and acceptance of the policy.

Access to low-cost debt: Facilitating a lower cost of capital could have a significant impact on clean energy deployment. However, the provision of low-cost debt from government institutions was not considered a viable long-term solution because it could create inefficiencies in business models, fundraising activities, and project execution. Local commercial banks have the potential to significantly increase access to low-cost debt. Increasing their experience and expertise and expanding capacity through training programs is crucial.

Investment flows in clean energy could also be increased by leveraging the involvement of multilateral financial institutions and institutional investors such as pension and sovereign wealth funds. Green bonds, crowdsourcing, charitable giving, and vendor financing are also mechanisms that could be better promoted.

In some countries, governments have created sectoral lending limits or carve-outs for banks. In such cases, defining a specific proportion for clean energy could increase monetary flows to the sector.

Integrated planning: Integrated planning frameworks and increased coordination between various governmental ministries and departments are needed to address issues such as transmission system constraints. The frameworks should also target the reduction of soft costs, including items such as permitting and clearance fees. Facilitating investments in upgrades to the power transmission network, smart grid solutions, and research and development of storage technologies is also critical to increasing the penetration of renewables.

Public acceptance: Increasing public awareness of the rapidly declining cost of clean energy technologies as well as their life cycle environmental benefits could increase acceptance.

Information access: Governments can play an important role in establishing long-term and flexible support structures to incentivize the deployment of renewable energy technologies. Steps such as organizing resources, increasing data availability, and developing analysis tools will help accelerate the use of best practices.

Key Recommendation

Considering how critical financing is to ramping up the deployment of renewable energy, an increased focus on financing was recommended within the Clean Energy Ministerial's framework. Specifically, ministers asked for a report on clean energy finance to be delivered at the fifth Clean Energy Ministerial. This report could cover the status of clean energy financing, best practices from various countries about policies or incentives that spurred investments, and potential areas for future work. The work stream would comprise various public- and private-sector stakeholders as well as nongovernmental and international organizations, bringing together experts with relevant work experience within the financing area.

"The Clean Energy Ministerial has brought together countries that are committed to the deployment and use of clean, efficient, and sustainable energy. The CEM is making a difference in the energy sector globally by promoting and sharing information on progress in deploying clean energy technologies, policies, and challenges."

Elizabeth Dipuo Peters, South Africa Minister of Energy

5 Energy Management Systems

Introduction

This roundtable sought to identify a set of smart policies and regulatory mechanisms to mobilize energy efficiency at a large scale and accelerate corporate adoption of energy management systems (EnMS). The discussion addressed the roles of government and the private sector—including industry, energy service companies, utilities, and financial institutions—in promoting energy management programs, as well as opportunities and next steps for enhanced public-private cooperation.

Moderator

- Jigar V. Shah, Executive Director, Institute for Industrial Productivity

Government Representatives

- Australia: Subho Banerjee, Deputy Secretary, Department of Resources, Energy and Tourism
- Finland: Marja Rislakki, State Secretary of Economic Affairs, Ministry of Employment and Economy
- Germany: Wolfdieter Böhler, Head of Division for International Energy Policy, Federal Ministry of Economics and Technology
- India: B.K. Chaturvedi, Member (Energy), Indian Planning Commission
- Italy: Gilberto Dialuce, Director General for Energy Supply and Infrastructure, Ministry of Economic Development
- Mexico: Odón de Buen Rodríguez, Director General, National Commission for Efficient Use of Energy

Private Sector and Civil Society Representatives

- Arne Barden, Head of Facility Management, Daimler India Commercial Vehicles
- Frances Beinecke, President, Natural Resources Defense Council
- Anil Chaudhry, Country President and Managing Director (India), Schneider Electric
- John Drexhage, Director of Climate Change and Energy Management, International Council for Mining and Metals
- Kazuo Furukawa, Chairman, New Energy and Industrial Technology Development Organization (Japan)
- Didier Houssin, Director, Sustainable Energy Policy and Technology, International Energy Agency
- Jeung-Soo Huh, Chief Executive Officer, Korea Energy Management Corporation
- Lawrence Jones, Vice President of Regulatory Affairs, Policy and Industry Relations, Alstom Group
- Shishir Joshipura, Managing Director and Country Manager (India), SKF
- Paparao Kodali, Vice President and General Manager, Ingersoll Rand Engineering and Technology Centers (India)
- Ian MacKinnon, Executive Director, Institute for Future Environments - Queensland Institute of Technology
- Kevin McKinley, Deputy Secretary General, International Standardization Organization
- Maria Paatero-Kaarnakari, Senior Vice President, Fortum Asia
- Rolf Stromberger, Vice President of Business Environment and Public Affairs Strategy, BMW
- Jean Sweeney, Vice President of Environmental, Health, and Safety Operations, 3M Company

Operating Agent

- The Institute for Industrial Productivity

Overview and Background

Industrial energy use accounts for roughly one-third of global energy demand and is growing rapidly, particularly in developing countries. In the midst of this growth, there is significant potential to decrease energy consumption and improve energy efficiency in this sector. Yet, opportunities to improve industrial energy efficiency remain severely underexploited. The International Energy Agency's World Energy Outlook 2012 estimates that two-thirds of the economic potential to improve energy efficiency in the industrial sector remains untapped (Figure 5).

As governments and industries look for cost-effective ways to reduce industrial demand for energy, EnMS are proving to be a very effective option. Systematic energy management equips companies with practices and procedures to identify and implement new opportunities for improvement and achieve energy-saving objectives on an ongoing basis. Those industries that have adopted EnMS have reduced total energy use by 10%–30%. That saved energy translates into a number of benefits: reduced energy costs and increased productivity for the adopting industry, and economic growth, increased energy security, and reduced greenhouse gas emissions for the national and international communities.

Some governments have mandated corporate EnMS adoption, while others are encouraging voluntary uptake by providing financial incentives or awards. Other stakeholders are also driving uptake. For example, energy providers, multinational companies, and multilateral and commercial banks around the world have started to initiate large-scale energy efficiency programs based on EnMS. Despite this global push for EnMS, encouraging widespread adoption remains a challenge.

What Is an Energy Management System?

An energy management system is a suite of procedures and practices that ensure systematic tracking, analysis, and planning of energy use in industry. It enables companies to maximize energy savings and continuously improve energy performance through organizational and technology changes.

Identified Barriers

Roundtable participants identified a number of barriers to improving industrial energy efficiency and increasing EnMS implementation:

Market and Operational: Low energy prices, tax structures, and transaction costs may disincentivize investments in EnMS. The real or perceived technical and operational risk associated with implementation may also be a hindrance.

Informational and Organizational: Limited knowledge of new energy-saving technologies and strategies, a lack of institutional focus on energy issues, and a lack of communication and coordination among company personnel who deal with aspects of company energy use also present barriers.

Financial: Investment decisions are made that may not adequately consider the full value of energy efficiency in the financial criteria. Other financial barriers include short payback period requirements, a lack of access to capital, and views that energy efficiency is not a strategic investment in future profitability.

Because of these barriers, widespread uptake of EnMS in industry is not considered likely without supporting programs from government or a third party such as a utility.

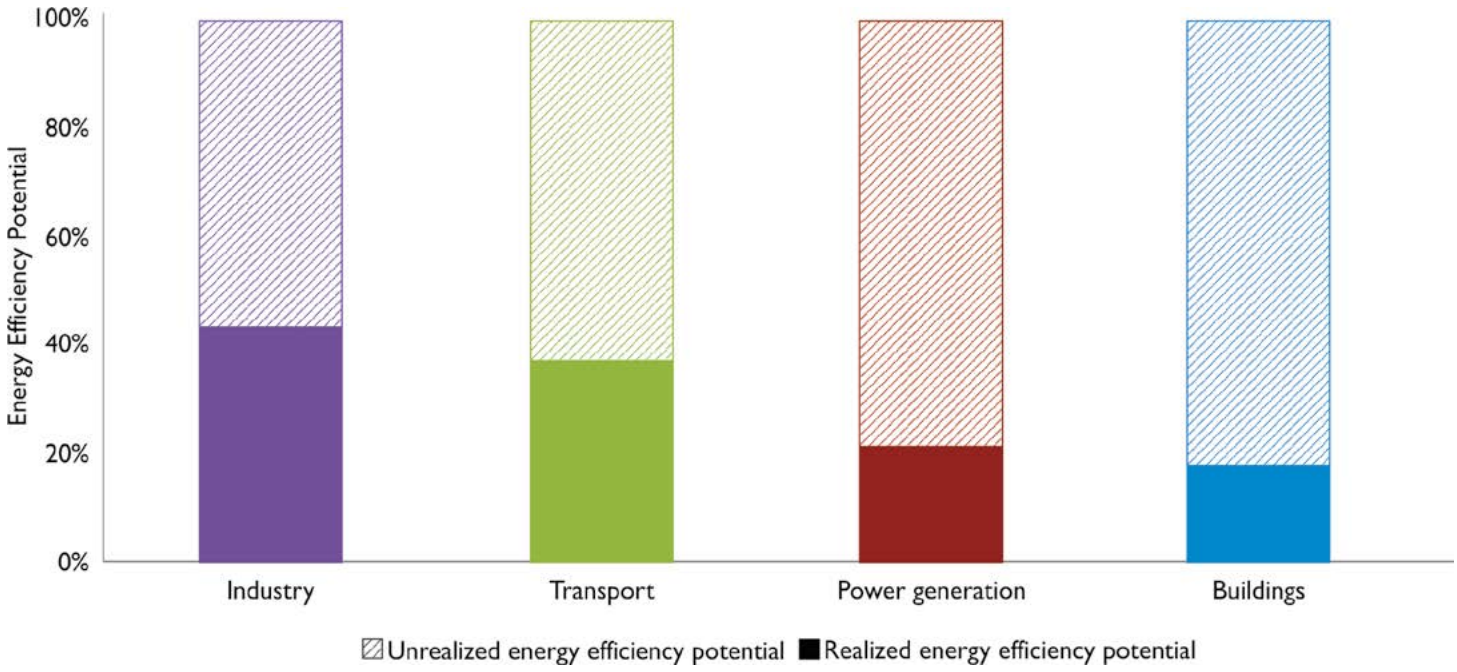

Figure 5. Energy efficiency potential realized by sector in the New Policies Scenario. Source: IEA 2012

Potential Solutions

To address these barriers, roundtable participants noted that governments may need to take an active role in accelerating global EnMS adoption. Even with demonstrated monetary savings and a range of co-benefits, progress is still slow, uptake is minimal, and energy efficiency is not a high priority within corporate culture.

However, there was no single government policy or program identified for promoting EnMS. Governments around the world are utilizing voluntary approaches, mandatory approaches, and hybrid mandatory-voluntary approaches, and each type has its own merits. Voluntary approaches feature incentives that may include tax rebates and recognition programs. Support through workshops, technical assistance, tools, and training can also drive implementation. Mandatory approaches require implementation of EnMS. To maximize success in any of these approaches, participants noted that policies should not be too prescriptive. Ambitious targets, strong management by government, and commitment from the private sector to build capacity and foster investment are considered crucial.

To accelerate industry implementation, numerous channels should be used to share and disseminate EnMS best practices and results to educate industry and practitioners. Existing Clean Energy Ministerial (CEM) channels could be utilized to facilitate information-sharing from company to supplier, company to company, and government to government. Mentoring from companies to their suppliers, and other soft drivers such as codes of conduct, have also been effective mechanisms to implement EnMS in supply chains.

Other important aspects of advancing industrial energy efficiency include establishing standardized systems of measurement, monitoring, and benchmarks, and establishing baselines to track progress. In addition, there is a great need for disclosure and transparency in corporate actions to improve energy efficiency. This may be partly driven by investors who are increasingly interested in receiving this information.

Various stakeholders should be involved in adopting and promoting EnMS with the following key considerations:

- Determining how governments can encourage EnMS uptake in the small and medium enterprise (SME) sector is of paramount importance. This sector is likely in need of the most assistance and has great unrealized potential.
- Utilities are not incentivized to promote energy management. Potential policies and programs to motivate them to adopt demand-side management models should be further explored.
- Large industries should be considered "community power blocks," and they should work and share their experiences with industry associations and vendors as well as through peer-to-peer networks.
- There is little coordination within government or between government and the private sector. Enhanced coordination across a large "ecosystem" of stakeholders that includes local and central governments, companies, energy service companies (ESCOs), utilities, and financial institutions to improve policy development and communications would increase efficiencies and create buy-in from that range of stakeholders.

- One participant cited the U.S. Environmental Protection Agency's ENERGY STAR program as a robust and effective platform for institutionalizing EnMS in the United States. The program functions as a mechanism for disseminating and sharing best practices, encouraging transparency for corporate action, and increasing a company's reputation among its suppliers and consumers at large.

Key Recommendations

There are several recommendations for increasing the adoption of EnMS:

- Increase capacity-building efforts and best practice dissemination at all levels: large industries, supply chains, SMEs, third parties, industry associations, and governments.
- Create greater coordination and engagement at the national level among governments, the private sector, and third parties to strengthen energy management programs.
- Build greater consistency in approaches to benchmarking energy use and measuring and verifying energy performance improvements.
- Support efforts to promote greater corporate transparency and disclosure of energy information.
- Encourage companies that have demonstrated a leadership role in implementing EnMS to promote adoption throughout their supply chains.
- Share government best practices on policies and programs to incentivize third parties, such as utilities, financial institutions, and ESCOs, to drive EnMS implementation in industry.

These areas can be addressed by increased effort and collaboration among the CEM's Global Superior Energy Performance Partnership (GSEP), the Institute for Industrial Productivity, the Energy Management Action Network, the United Nations Industrial Development Organization, and other related international initiatives.

"The roundtable on energy management systems brought out an excellent discussion of how government and industry can work together using innovative programs to achieve the common goal of reducing energy consumption. Valuable insights were shared and learned by all participants."

Jean Sweeney, Vice President of Environmental, Health, and Safety Operations, 3M Company

6 Mini-Grid Development

Introduction

This roundtable synthesized lessons learned and brought together practitioners and policy makers to cooperatively identify the barriers to further scaling up mini-grids. The discussion addressed potential solutions to addressing these barriers, recognizing that mini-grids are a key component of achieving universal energy access. Primary discussion topics included mini-grid energy access opportunities, business models, technology, financing, policy, information dissemination, regulatory policy, and capacity-building.

Moderator

- Gauri Singh, Director of Country Support and Development, International Renewable Energy Agency

Government Representatives

- India: Tarun Kapoor, Joint Secretary, Ministry of New and Renewable Energy
- India: Rohit Kansal, Ministry of New and Renewable Energy
- Japan: Isshu Sgawara, State Minister of Ministry of Economy, Trade and Industry
- United Kingdom: Phil Marker, Head of Joint HMG Climate Unit, UK Department for International Development
- United States: William Hammink, India Mission Director, U.S. Agency for International Development

Private Sector and Civil Society Representatives

- Anshu Bharadwaj, Executive Director, Center for Study of Science, Technology & Policy
- Jamshyd Godrej, Chairman and Managing Director, Godrej Group
- Bazmi Husain, Country Manager of India, ABB
- Richard H. Jones, Deputy Executive Director, International Energy Agency
- Yashraj Khaitan, CEO, Gram Power
- Takemitsu Kunio, Senior Vice President, NEC Corporation
- Peter Lilienthal, CEO, HOMER Energy LLC
- Terry Mohn, CEO, General Microgrids
- Jeeva Perumalpillai-Essex, South Asia Manager for Sustainable Business Advisory, International Finance Corporation
- Neeraj Prasad, Manager, Climate Change Practice, World Bank
- Sairam Prasad, CTO, Bharti Infratel
- Sandra Retzer, Managing Director, Younicos
- Rahul Sankhe, Managing Director (India), SunEdison
- Ajay Sharma, Managing Director, Entura India
- Frans Vreeswijk, General Secretary and CEO, International Electrotechnical Commission

Operating Agent

- National Renewable Energy Agency

Overview

Decentralized power systems will play a significant role in efforts to address the large gaps in rural energy access around the world. In 2010, the International Energy Agency estimated that "to achieve universal access to electricity, 70% of the rural areas that currently lack access will need to be connected using mini-grid or off-grid [decentralized] solutions." More than 90% of these systems will be driven by renewable energy sources (Figure 6).

Mini-grids and other decentralized solutions may be more attractive than larger, centralized solutions in rural areas for a number of reasons. First, they can often be deployed more rapidly than grid solutions. Second, they do not rely on extending grid-connected generation capacity, which is a much larger, more resource-intensive, and longer-term effort. Third, mini-grid solutions provide local business development and job creation opportunities—they have been used to provide power for small industrial uses in addition to households and small businesses. Even in areas with the prospect of future power system development, mini-grids can play an important role by providing near-term electrification. Once the grid extends to these areas, the installed mini-grids can provide reliability and ancillary services to the grid-connected regions.

Importantly, mini-grids are customizable to local contexts, needs, and energy resources. Well-designed mini-grid systems are based on local needs and can leverage renewable, clean energy sources such as bioenergy, wind, solar, and hydropower. Hybrid mini-grids—systems that combine renewable energy with fossil-fuel-powered generators—can be used to increase the reliability of a system and provide 24-hour power. Modern, smart mini-grids also incorporate energy efficiency technologies, improving load management, limiting power demand during peak hours, and encouraging conservation.

What Is a Mini-Grid?

A mini-grid is an integrated energy system consisting of interconnected loads and distributed energy resources—including generators and energy storage devices—that, as an integrated system, can operate in parallel with the utility grid or disconnected from the grid in an intentional islanding mode.

Modern mini-grids can be grid connected or operate as a stand-alone system. In addition, they are scalable, meaning additional generation capacity can be added to meet growing loads without compromising the stable operation of the existing mini-grid system.

The majority of mini-grid projects are currently in the pilot phase. However, there is increasing interest in advancing mini-grid technologies and practices and accelerating deployment, due in part to the falling costs of renewable energy generation and improvements that make system maintenance easier.

Barriers

Even with growing interest in mini-grids, there are still a number of barriers to scaling up deployment:

Technology: Renewable-energy-based mini-grids require energy storage technology, such as batteries, which can be expensive and significantly increase overall cost. Hybrid mini-grids can improve the reliability of power generation, but they may also add complexity and cost. Currently, mini-grids are customized for each location, which also adds additional cost. Technical expertise is often difficult to find at the local level, posing a challenge in maintaining mini-grids and ensuring their reliability.

Business models and financing: Mini-grids often have significant up-front capital costs because they are customized for each location and frequently rely on renewable energy technologies. There are very few

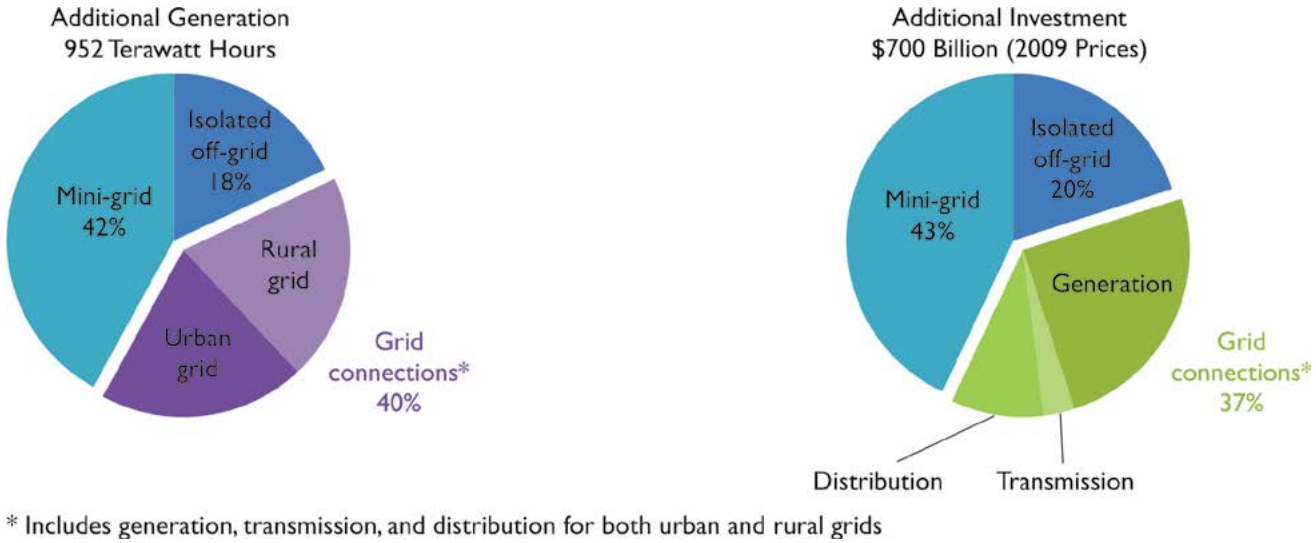

Figure 6. Incremental electricity generation and investment in the Universal Modern Access Case, 2010–2030. Source: IEA 2010

established financing models for mini-grids. Banks often prefer to provide loans for large projects that are grid connected, leaving mini-grid developers to rely on government subsidies and grants from donors. The lack of sustainable business models, uncertainty over demand, and concern about consumers' ability to pay for service also raise the perceived risk for investors.

Policy: Existing policies often do not address the variety of available methods for achieving rural/remote electrification and instead encourage electrification through the central grid. Policies also may not clarify where and when the central grid will be extended and what business models or rules may apply when the grid does arrive. Tariff structures, ill-defined service areas, and a lack of clarity regarding operating licenses may also impede mini-grid solutions. Subsidy policies are often designed with short-term goals in mind and are not effective in promoting long-term performance.

Regulatory: No standard operating procedures, quality standards, or health and safety standards currently exist for establishing mini-grids. This results in a perception that mini-grids are high-risk, which may discourage private investment and funding opportunities. There is also a lack of protection for developers when areas served by mini-grids become grid connected, which makes it unlikely that developers and investors will support mini-grids in regions with any potential for future grid connection.

Information: There is a shortage of information in the public domain regarding process issues, permitting, and standards for mini-grid developers. There is also a lack of consumer awareness and access to information. Large global corporations and very small local players both need information in order to evaluate whether to enter the market.

Potential Solutions

The roundtable discussion focused on a variety of potential solutions to the identified barriers:

Technology: Mini-grid system design must respond to local needs and available energy resources. Remaining technology-agnostic will provide maximum flexibility and financial feasibility. Research and development, along with demonstration projects, can continue to improve energy storage technologies and reduce costs. Standards are important to level the playing field and drive down prices. A complete set of mini-grid standards could be developed by convening a wide range of stakeholders. Local involvement and training is essential for a successful and reliable power system. Training and scheduled operations and maintenance services can increase system life and reliability. It will be important to invest in mini-grid capacity-building to facilitate more widespread and easier installation and maintenance of systems. Load management technologies that enable grid managers to limit power demand during peak hours and encourage conservation should be leveraged.

Business models and financing: Business solutions based on high-value, bankable "anchor tenants" such as telecommunications companies could represent a new solution driven by the private sector. The incorporation of smart solutions, including theft protection and prepayment meters, will also help advance the development of viable business solutions.

Encouraging the banking sector to recognize that mini-grids are different from the rest of the electricity sector will be important. Support for development projects conducted in parallel with mini-grid projects can improve the standard of living for consumers, increasing demand for electricity as well as consumers' ability to pay. There may also be a possibility to leverage advance market commitments (binding contracts that secure revenues) to finance mini-grids.

Policy: It is important to create policies that make concessions for aggregated anchor loads, such as telecommunications loads, with obligations for local electrification and support for development opportunities. Other potential solutions include creating specialized, higher-valued renewable energy certificates for mini-grids; defining areas that are likely to be grid connected in the near future; creating beneficial tariff structures for mini-grids; and creating an incentive structure that rewards small and large installations.

Regulatory: Regulatory and policy regimes that support near-term mini-grid expansion are needed. Regulations also need to be light-handed and simplified to streamline permitting, clearances, and application procedures. Ideally, they should provision for the various types of mini-grids as well as local circumstances, and they could perhaps delegate regulatory authority to regional or local bodies. Quality standards need to be realistic and affordable. Clarity is also needed regarding guidelines and rules for when the grid may reach a territory served by a mini-grid.

Information: Collecting and sharing information is a priority, particularly in terms of how it can help inform smart policies. One potential solution is to create databases that track region-specific demand-side information, assess energy resources, and document best practices.

Key Recommendations

The following recommendations and proposed actions emerged from the roundtable discussion:

- Develop standards to set a level playing field, encourage investment, and help drive down prices. The International Electrotechnical Commission proposes to develop a complete set of mini-grid standards, including conformity assessment schemes and certification of installation and repair companies, among other elements. Additional potential stakeholders include the International Finance Corporation (IFC) and the United Nations Foundation Mini-grid Practitioner Network, both of which are working on or have expressed support for the creation of standards.
- Establish viable and long-term business models for mini-grids, including those backed by anchor tenants and prepaid meters, along with methods for increasing private and public financing options. As a representative of a telecommunications anchor tenant, Bharti Infratel (India) expressed a strong need for reliable, quality power and offered to broadly share telecommunications requirements with mini-grid providers. India's Ministry of New and Renewable Energy is working on a scheme to provide 60%–70% of the capital for mini-grid installers, with the remaining capital to be provided by financial institutions and long-term players providing the service. The United States Agency for International Development (USAID) recently approved a credit guarantee to mobilize $100 million in financing, part of which will focus on off-grid renewable energy to improve access to energy.
- Develop energy resource and demand-side information, especially for rural areas, as well as data on existing mini-grid companies and projects. Platforms for making the information readily available also need to be established. The International Renewable Energy Agency proposed to undertake data collection within its 120 member countries. The IFC is also creating a database of mini-grid companies in India.
- Invest in capacity-building. Design, installation, operations, and maintenance skills are critical components to a sustainable solution. Within India, USAID, with input from the Council on Energy, Environment, and Water, is exploring creating an alliance of stakeholders to help developers mobilize funds, assist with training and capacity-building, test and certify technologies, and advocate for investor-friendly policies and regulations.

"The paradigm shift in mini-grids is happening. Policy makers, financial institutions, and funding agencies are viewing mini-grids as a viable option, integrated into the larger energy of the country, for supporting entrepreneurs through policy and requisite funding."

Gauri Singh, Director of Country Support and Development, International Renewable Energy Agency

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II Annex II: Clean Energy Ministerial Initiatives

Thirteen wide-ranging initiatives have been launched through the Clean Energy Ministerial that build on Technology Action Plans that were released by the Major Economies Forum Global Partnership in December 2009. The initiatives' low-cost, high-impact technical work facilitates international coordination that amplifies each government's clean energy deployment efforts. Progress in the initiatives can help nations reduce carbon emissions, improve energy security, provide energy access, and sustain economic growth.

Energy Efficiency	
Appliances	**Super-Efficient Equipment and Appliance Deployment (SEAD) initiative** promotes energy-efficient appliances and equipment.
Buildings and Industry	The **Global Superior Energy Performance Partnership (GSEP)** targets energy savings in commercial buildings and industry.
Electric Vehicles	The **Electric Vehicles Initiative (EVI)** works to accelerate the global scale-up of electric drive vehicles.
Clean Energy Supply	
Bioenergy	The **Bioenergy Working Group** focuses on bolstering the deployment of bioenergy.
Carbon Capture	The **Carbon Capture, Use, and Storage Action Group** creates greater political momentum to advance the deployment of CCS.
Hydropower	The **Sustainable Development of Hydropower initiative** promotes the development of sustainable, cost-effective hydropower.
Solar and Wind	The **Multilateral Solar and Wind Working Group** works to lower the costs of solar and wind energy in regions around the world.
Energy Access	
Energy Access	The **Global Lighting and Energy Access Partnership (Global LEAP)** aims to facilitate access to affordable, clean, and quality-assured off-grid energy devices.
Cross-Cutting	
21st Century Power	The **21st Century Power Partnership** works to transform the electricity sector through the integration of smart grids, clean energy, and energy efficiency.
Smart Grid	The **International Smart Grid Action Network (ISGAN)** works to accelerate the development and deployment of smarter electricity grids worldwide.
Sustainable Cities	The **Global Sustainable Cities Network** provides a platform for sustainable city initiatives throughout the world.
Human Capacity	
Clean Energy Policy	The **Clean Energy Solutions Center** is a first-stop resource for clean energy policy, best practices, data, analysis tools, and expert assistance.
Women in Clean Energy	The **Clean Energy Education & Empowerment (C3E) initiative** strives to close the gender gap and help advance women's careers and leadership in clean energy.

III Annex III: Acknowledgments

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PLUG-IN HYBRID

CLEAN ENERGY MINISTERIAL

Accelerating the Transition to Clean Energy Technologies

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