Public-Private Roundtables at the Sixth Clean Energy Ministerial

27–28 May 2015 • Mérida, Mexico

CLEAN ENERGY MINISTERIAL

Accelerating the Transition to Clean Energy Technologies

The Clean Energy Ministerial is contributing to the clean energy transition and helping promote human development goals. The roundtables and other public–private events bring in new ideas to accelerate that transition.

Pedro Joaquín Coldwell, Secretary of Energy, Mexico

Mobilizing engagement of the private sector is very important for the CEM. As the CEM focuses on various work streams, we must look to the private sector to accelerate the development and deployment of clean energy technology.

Ajay Mathur, Director General, Bureau of Energy Efficiency, India

The Sixth Clean Energy Ministerial
27–28 May 2015, Mérida, Mexico

Clean Energy Ministerial Secretariat
U.S. Department of Energy
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Foreword

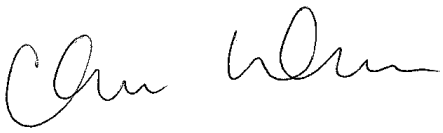
2015 marks a critical year for clean energy. The sixth Clean Energy Ministerial (CEM6), held in Mérida, Mexico, marked an important step forward to further scale up the CEM and improve its ability to help accelerate the global clean energy revolution. The CEM brings together the world's largest and most forward-leaning economies to efficiently collaborate on a suite of clean energy policy and technology initiatives. Especially given that energy production and use is responsible for two thirds of global greenhouse gas emissions, CEM6 was also a useful opportunity to build momentum on the "Road to Paris" climate negotiations in December 2015.

CEM6 recognized at a fundamental level that our climate and energy challenges cannot be solved through country actions alone. The private sector is a driving force behind the clean energy revolution and brings invaluable abilities, strengths, and resources to the cause. Every year, the CEM engages the private sector and stakeholders through a series of public–private roundtables. These roundtables are one of the highlights of the CEM and provide the opportunity for ministers to engage with private sector leaders on the most pressing clean energy topics. The roundtables aim to convene a set of key high-level participants to discuss respective views, share ideas, promote collaboration, and generate a set of concrete and actionable recommendations, which you will find in the pages of this report.

Only by working together will we fully achieve our clean energy goals. U.S. President Barack Obama, who addressed ministers at CEM6 through a video message, recognized the CEM as a key mechanism for this collaboration, noting that "working with partners like you to increase adoption of clean energy technologies worldwide is critical. We can share technical know-how. We can build on each other's progress. So let's keep this partnership going."

President Obama announced that the United States will host the seventh Clean Energy Ministerial (CEM7) in 2016; China's Minister Wan Gang announced China's intention to host in 2017. Back-to-back CEM meetings in the United States and China will continue building momentum toward achieving the CEM's ambitious goal to accelerate a global clean energy revolution.

On behalf of the CEM Secretariat, I would like to thank all the CEM member governments, private sector leaders, and other stakeholders for their active participation in the CEM and this year's successful set of roundtables. Let us also be mindful that success in our respective clean energy and climate goals will require sustained focus on innovation, cooperation, smart policies, and global leadership for many years to come. The CEM—and its ability to convene top government officials, private sector leaders, and other stakeholders—can play a critical role in this equally important "Road *from* Paris."



Christie Ulman
On behalf of the Clean Energy Ministerial Secretariat
Office Director (Acting), Office of International Climate and Clean Energy
U.S. Department of Energy

Introduction

The Clean Energy Ministerial (CEM) is a high-level forum for the world's major and forward-leaning countries to promote policies and share best practices with the goal of accelerating the transition to a global clean energy economy. The CEM is voluntary and collaborative, enabling countries to work together to implement their self-determined clean energy goals and create opportunities to increase ambition over time.

As an action-oriented forum, the CEM brings together high-level energy policymakers, private sector leaders, technical experts, and project implementers for decision making, implementation, and market-driven solutions.

Many of today's breakthroughs in the energy sector came about through government-sponsored research. Governments also provide policy signals, incentives, capacity building, and other tools to drive progress. It is the private sector that takes technologies to market and implements solutions. Engagement of the private sector is an essential component of the CEM to ensure tangible, ambitious outcomes are achieved. Meeting the challenge of transitioning to a global clean energy economy requires all actors—the private sector, governments, civil society, investors, and other stakeholders—working together to leverage respective strengths and resources.

The private sector and other stakeholders are engaged in many aspects of the year-round initiatives that are operational through the CEM. Participation in the roundtables that are convened each year during the annual ministerial meetings provides an opportunity to engage in high-level discussion and bring knowledge, expertise, and perspective to particularly topical issues and challenges.

The sixth Clean Energy Ministerial (CEM6) featured six public–private roundtables on key clean energy topics:

1. Accelerating Energy Productivity
2. The Sustainable Urban Energy Transition
3. Achieving a Social Licence for Clean Energy Deployment
4. Finance for Clean Energy Access
5. Power System Transformation and the Smart Utility of the Future
6. Public–Private Consortia for Advanced Clean Energy Technology Research

This year's roundtable participants included energy ministers, global business leaders, entrepreneurs, experts from laboratories and academia, and leaders from civil society organizations. In the two-hour small-group discussions, participants clarified barriers to progress and identified potential solutions in each of the topic areas. To prepare all the participants for the discussion, extensive background information on each topic was shared in advance. That information is available online at www.cleanenergyministerial.org/CEM6Roundtables.

The following sections of this report provide highlights from the six roundtable discussions.

1 Accelerating Energy Productivity

This roundtable sought to explore how governments and industry can work together to accelerate energy productivity—getting more economic output from each unit of energy consumed. The discussion identified examples of how energy efficiency policies and programs can foster economic development and create jobs by making better use of energy resources.

Moderator

- **Deborah L. Wince-Smith**, President and Chief Executive Officer, Council on Competitiveness

Government Representatives

- **Helen Bennett**, General Manager, Energy Productivity, Department of Industry and Science, Energy Division, Australia
- **Odón de Buen**, Director General, National Commission for the Efficient Use of Energy (CONUEE), Mexico
- **Toshihiko Fujii**, Deputy Commissioner for International Affairs, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, Japan
- **Thorsten Herdan**, Director General for Energy Policy, Federal Ministry of Economics and Technology (BMWi), Germany
- **Sylvie Lemmet**, Director of International and European Affairs, Ministry of Ecology, Sustainable Development and Energy, France
- **Ajay Mathur**, Director General, Bureau of Energy Efficiency, India
- **Ernest Moniz**, Secretary of Energy, Department of Energy, United States
- **Wang Shancheng**, Director General, National Development and Reform Commission, People's Republic of China
- **Christian Pilgaard Zinglersen**, Deputy Permanent Secretary, Ministry of Climate, Energy and Building, Denmark

Private Sector and Civil Society Representatives

- **Mauro Borges Lemos**, Chief Executive Officer, Companhia Energética de Minas Gerais (CEMIG)
- **Kateri Callahan**, President, Alliance to Save Energy
- **John M. Christensen**, Director of UNEP DTU Partnership, Technical University of Denmark
- **Arturo Echeverria**, Vice President of International Affairs, Asociacion de Empresas para el Ahorro de la Energia en la Edificacion, A.C. (AEAEE), and Calidad y Sustentabilidad en la Edificación, A.C. (CASEDI)
- **Amy Ericson**, President and Chief Executive Officer, Alstom North America
- **Jean-François Gagné**, Head, Energy Technology Policy Division, International Energy Agency
- **Enrique Gonzalez-Haas**, Presidente para México, Schneider Electric
- **Dan Hamza-Goodacre**, Program Director, Energy Efficiency, ClimateWorks Foundation
- **Benoît Lebot**, Executive Director, International Partnership for Energy Efficiency Cooperation (IPEEC)
- **Pablo Moreno Cadena**, President, National Association of Appliance Manufacturers and Corporate Affairs Director, Mabe
- **Clay Nesler**, Vice President, Johnson Controls Inc.
- **Adriana Salazar**, Director of the Energy and Natural Resources Treasury, Grupo Salinas
- **Dr. Raúl Talán Ramiréz**, Director General, Fideicomiso para el Ahorro de Energía Eléctrica (FIDE)
- **Harry Verhaar**, Board Chair, European Alliance to Save Energy; Head of Global Public & Government Affairs, Philips Lighting
- **Robert Weisenmiller**, Chair, California Energy Commission

Operating Agent

- Accelerate Energy 2030 partners: Alliance to Save Energy, U.S. Council on Competitiveness, and U.S. Department of Energy

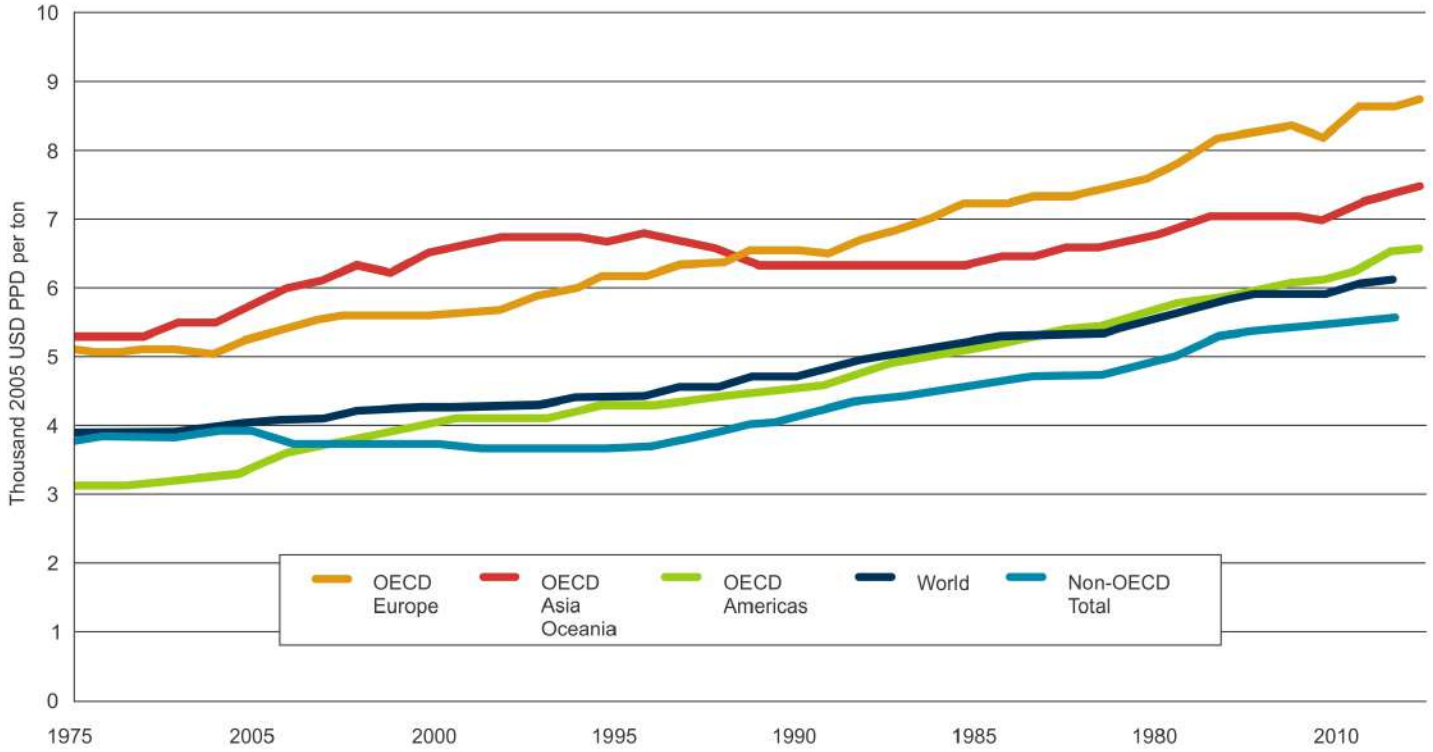


Figure 1: Increase in energy productivity by region, 1975–2012, calculated as gross domestic product at purchasing power parity in 2005 U.S. dollars divided by total primary energy supply in metric tons of oil equivalent. Source: IEA 2014a. Reproduced with permission.

Overview and Background

Energy productivity, the ratio of economic output per unit of energy use, focuses attention on how energy resources can be put to their best use, augmenting scarce energy resources, and how energy efficiency can lift economic growth. The last decade has seen growth in the energy productivity of both Organisation for Economic Co-operation and Development (OECD) member country groups and non-member economies. According to the International Energy Agency's *Energy Efficiency Market Report, 2014*, energy productivity in OECD Americas grew by 22% between 2003 and 2013 (see Figure 1).

While energy productivity is a relatively new concept compared to its inverse, energy intensity, a number of governments and international actors are embracing this framework to set or support the achievement of national and regional goals. In 2013, President Obama set a goal for the United States to double energy productivity from 2010 levels by 2030. The U.S. Department of Energy is partnering with the U.S. Council on Competitiveness and the Alliance to Save Energy on the Accelerate Energy Productivity 2030 effort to draw upon this roundtable discussion and develop a private-sector-driven roadmap to meet President Obama's goal for the United States. According to the Alliance Commission on National Energy Efficiency Policy, achieving this goal would require $166 billion in annualized investments in buildings, transportation, and industrial equipment—but would yield a net annual savings of over $327 billion in 2030. In April 2015, Australia released its Energy White Paper, which calls for the government to improve national energy productivity by up to 40% by 2030. According to the *2015 Energy Productivity and Economic Prosperity Index* study commissioned by Royal Philips, Europe's efforts to double energy productivity by 2030 could cut energy expenditures by one third, improve energy security, and create 1.2 million jobs by 2020.

Achieving these benefits requires identifying and implementing policies and measures that lower energy use while growing the economy, as well as making available financing instruments to translate future savings into liquidity for investments today.

Better Articulating the Case for Energy Productivity

Businesses that have already adopted energy productivity practices find the business case makes itself. Nonetheless, a barrier to scale is lack of awareness, necessitating the engagement and education of all stakeholders on the benefits of energy productivity.

Roundtable participants highlighted examples of government and private sector approaches that have delivered energy savings and economic benefits. In Denmark, the Central Bank has concluded that a focus on energy efficiency and savings has resulted in a roughly 9% gain in wage competitiveness over the last decade. This success is attributed to establishing predictable, long-term efficiency policies such as the National Energy Efficiency Action Plan; targeting both residential and commercial sectors simultaneously; setting standards; and sharing information on best practices. India's energy productivity is increasing by 1.6% annually and is being boosted through policies to align energy pricing, promote business models and new markets, and enhance regulations for efficiency.

Benchmarking, setting goals, and monitoring progress toward those goals were identified as best practices by businesses that have achieved significant productivity gains and energy savings. The practice of continuous improvement was also highlighted, as

was working with supply chains to encourage efficiency along the value chain. The international standard for energy management, ISO 50001, provides a flexible and robust framework for businesses to "Plan–Do–Check–Act" their way to continual improvement in energy savings. In Germany, incentives such as tax rebates or exemptions from surcharges have been effective in fostering the uptake of energy management systems (more than 3,000 ISO 50001 certified systems).

Finally, the discussion highlighted the importance of setting and publicizing goals. According to a study conducted by the Johnson Controls Institute for Building Efficiency (IBD 2013), organizations that made their goals public were almost twice as likely to have made investments in energy efficiency and renewable energy in the previous year, implemented 50% more measures, and were roughly three times more likely to increase investments the following year.

Scaling Up Energy Productivity

A common theme emerged around the importance of partnerships between the public and private sectors—most importantly, the need to agree on common goals and a vision to motivate actions. Coordinated platforms and forums, such as the Clean Energy Ministerial, International Partnership for Energy Efficiency Cooperation, United Nations Sustainable Energy for All Energy Efficiency Accelerator Platform, and the International Energy Agency's Low-Carbon Energy Technology Platform, offer mechanisms for governments and the private sector to work together and avoid duplicating efforts.

Several specific policy areas were discussed, including regional alignment of energy efficiency test procedures, standards, and codes, as well as providing support for the development of regional testing laboratories. Participants agreed that key ingredients for effective codes and standards are awareness-raising and investment in implementation and compliance support. Participants further identified the challenge of extending successful policies to system-level solutions, recognizing the desire to avoid unintended consequences that can arise, for example, from focusing solely on component-level standards.

Participants also distinguished between policies for *new* versus *existing* facilities and products. While developing policies and standards for new facilities and products is often easier than retrofitting existing facilities, policies focused on the efficiency of industrial processes, especially new processes, must be carefully designed and tested before implementation. This is especially true in the power sector, where robustness and resilience are critical. Significant opportunities exist to improve power system efficiency and resilience through system optimization and controls that enable situational awareness and integration of distributed generation and microgrids, but realizing this potential requires developing robust interoperability standards.

Unlocking finance for efficiency investments is also essential to overcoming first-cost barriers. KfW, the German state bank, served as a trusted "neutral contractor" to successfully accelerating energy-efficient renovations. In France, the use of fee-and-rebate programs, or "feebates," is encouraging the purchase of clean energy products, helping make France's vehicle fleet among the most efficient in the world. In the power sector, there is a need to bridge traditional finance mechanisms for conventional generation that have long-term contracts with newer technologies and business models that attract risk investors.

One outcome of this roundtable is recognition of all participants' importance in the dialogue to promulgate the "Energy Productivity Imperative" across many different policy and business platforms—regionally, in the participants' respective nations, and in partnership with other global and non-governmental organization (NGO) initiatives. The roundtable included a formal commitment to include the "Energy Productivity Imperative" as one of the 2015 "Principles of Competitiveness Strategy" that the Global Federation of Competitiveness Councils (GFCC) will present at its 6th Annual Meeting in Saudi Arabia, November 1–3, 2015. The pivotal role of CEM6 in elevating energy productivity as a core driver of economic growth and industrial competitiveness will also be highlighted at the GFCC's Innovation Summit on 21st Century Infrastructure in October 2015.

Key Recommendations

Roundtable participants identified three overarching means of addressing the needs and challenges discussed herein. Below are their recommendations, along with concrete examples of how they are being successfully enacted.

Raise awareness of energy productivity. Knowledge can be spread through educating stakeholders, sharing experiences, and working with supply chains. Johnson Controls offers an example with its Scaling Energy Efficiency in Corporate Supply Chains, the company's Clinton Global Initiative (CGI) Commitment

to Action. Program results and progress with supplier efficiency efforts will be reported to CGI. The U.S. Department of Energy's Better Buildings Challenge, which publicly recognizes leadership and innovation in energy efficiency, offers another example of how businesses can work with small and medium enterprises in their corporate supply chains to multiply the benefits of energy productivity.

Build and leverage partnerships. Common goals and vision must be established between private and public sectors. Under the United Nations Sustainable Energy for All initiative, the Energy Efficiency Accelerator Platform was launched with a goal of doubling the rate of improvement in energy efficiency worldwide by 2030. In support of this broader goal, additional accelerators have been launched, including the Lighting Accelerator and the Efficient Appliance Accelerator. All bring together public and private sector partners to drive toward large environmental and financial benefits by gaining commitments from national and regional decision makers to take concrete actions on efficiency. Another example is the CEM Global Lighting Challenge, which is teaming up with the United Nations Environment Programme's (UNEP's) en.lighten and the Lighting Accelerator in a global race to deploy 10 billion high-efficiency and high-quality lights across all sectors.

Scale up. This recommendation can be broken down into four objectives: benchmark, set goals, and make plans; facilitate finance; harmonize test protocols and standards where appropriate and feasible; and build regional capacity for testing. Efficiency needs "activators": KfW has created successful building renovation programs in part because KfW and commercial banks have cooperated to create a "sales force" for building renovation projects, resulting in almost 13,000 registered energy experts. Germany is also working on further developing the market for energy service companies.

Economic productivity is a major priority for governments across the world, especially as labor productivity slows. Energy productivity offers one of the most promising productivity solutions, with resultant benefits for competitiveness, wages, living standards, and profit margins.

– Dan Hamza-Goodacre

Program Director, ClimateWorks Foundation

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The Sustainable Urban Energy Transition

The objective of this roundtable was to share perspectives on key urban energy challenges and opportunities and discuss innovative ways to better integrate the clean energy agenda into urban development policies and priorities at the national and local levels.

Moderator

- **Andrew Steer**, President and Chief Executive Officer, World Resources Institute

Government Representatives

- **Suhail Mohammed Al Mazrouei**, Minister, Ministry of Energy, United Arab Emirates
- **Ibrahim Baylan**, Minister, Ministry of the Environment and Energy, Sweden
- **Santiago Crehueras Diaz**, Director General of Energy Efficiency and Sustainability, Ministry of Energy, Mexico
- **Sanjay Garg**, General Manager, Ministry of Power, India
- **Riku Huttunen**, General Director for Energy, Ministry of Employment and the Economy, Finland
- **Anton Inyutsyn**, Deputy Minister, Ministry of Energy, Russia
- **Dominique Ristori**, Director General for Energy, European Commission

Private Sector and Civil Society Representatives

- **Saeed Mohammed Al Tayer**, Managing Director and Chief Executive Officer, Dubai Electricity and Water Authority
- **Katarina Berggren**, Mayor, Botkyrka, Sweden
- **Marcene Broadwater**, Global Head of Climate Strategy and Business Development, International Finance Corporation (IFC) Climate Business Department
- **Adrian Fernandez**, Chief Executive Officer, Latin American Regional Climate Initiative
- **Claudio Ferrari**, President, Federesco
- **Fidel García Granados**, Director General of Environmental Management, City of León, Guanajuato
- **Kate Hampton**, Executive Director, Climate Change, Children's Investment Fund Foundation
- **Maria van der Hoeven**, Executive Director, International Energy Agency
- **Naoko Ishii**, Chief Executive Officer and Chairperson, Global Environmental Facility
- **Lawrence Jones**, North America Vice President for Utility Innovations and Infrastructure Resilience, Alstom Grid
- **Irving Mintzer**, Professor of Energy, Resources, and the Environment, Johns Hopkins University School of Advanced International Studies
- **Mario José Molina-Pasquel Henríquez**, Director, Mario Molina Center for Energy and Environment; Distinguished Professor of Chemistry and Biochemistry, University of California, San Diego
- **Nebojsa Nakicenovic**, Deputy Director General and Deputy Chief Executive Officer, Director of the Global Energy Assessment, International Institute for Applied Systems Analysis
- **Manuel Olivera**, Regional Director for Latin America, C40
- **Carlos Peralta Quintero**, Chairman and Chief Executive Officer, IUSA Group
- **José Luis Romero Morales**, Director of Planning and Projects, City of Puebla, Mexico
- **Josué Tanaka**, Managing Director for Operational Strategy and Planning, Energy Efficiency and Climate Change, European Bank for Reconstruction and Development

Operating Agents

- World Resources Institute
- International Energy Agency

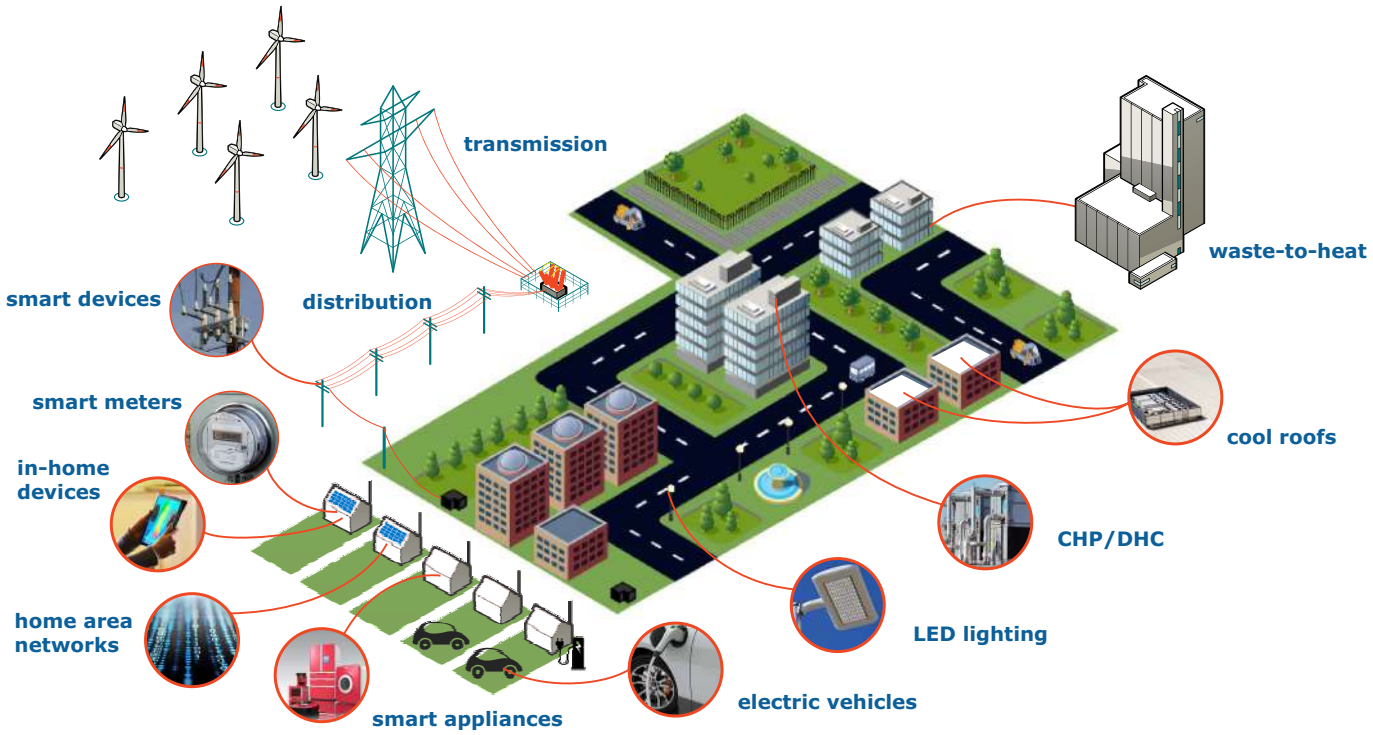


Figure 2. A range of technology solutions can play vital roles in the sustainable urban energy transition. Source: Energetics Incorporated.

Overview and Background

The transition to a global clean energy economy is dependent on the world's cities. Over 50% of the world's population currently lives in cities, accounting for approximately 75% of global energy consumption and greenhouse gas emissions. Over the next 30 years, the urban population is expected to grow significantly, placing pressure on city governments not only to deliver basic services—such as energy access, affordable housing, public health, disaster risk management, economic development, and job opportunities—but to do so in a way that meets local, national, and international clean energy goals.

In many cities of the developed world, promoting urban sustainability means proposing solutions that integrate with long-established energy systems, taking into account barriers created by entrenched practices, institutional arrangements and legislation, and legacy infrastructure. In developing and emerging economies, development of infrastructure struggles to keep up with the rapid rate of urbanization, creating perceived and real trade-offs between pressing needs for basic services and well-planned investments that will meet short-term and long-term goals, including sustainability. In particular, the majority of new urban growth is expected to be concentrated in small- to medium-size cities that may be less well-equipped for rapid growth than their larger, better-resourced, and more experienced counterparts.

National government coordination is key for the successful sustainable urban energy transition. Governments are well positioned to consider the big picture, analyzing the forces shaping the national territory and strategizing for the long term. The national government can take the lead in articulating a shared vision for the country that integrates clean energy goals, establishing supportive policies and frameworks for sustainable development that enable cities to realize their greatest promise.

Identified Barriers

Discussion among roundtable participants pointed to several key barriers to sustainable urban energy transition, such as local political realities and incentives that inhibit long-term planning and lack of capacity in integrated urban planning, project management, and finance. Other key barriers are outlined below.

Policy alignment. Better coordination of urban development policies, including energy policies, is necessary to ensure a comprehensive urban clean energy transition. Great untapped potential exists to exploit synergies between clean energy strategies and broader urban development goals and policies promoted at the local and national levels. This horizontal alignment needs to be complemented by greater vertical alignment and coordination among the urban policies of federal/central and state/local governments to ensure incentives are aligned to maximize clean energy investments.

Finance. Most cities have insufficient resources for extensive infrastructure investments, including cleaner energy solutions. In low-to-middle-income economies, significant investments are required for transport, building energy efficiency, telecommunications, water and waste, and other critical infrastructure. According to Boston Consulting Group, the estimated investment shortfall is over US$1 trillion per year (BCG 2013). Only 4% of the 500 largest cities in developing countries are deemed creditworthy in international financial markets (The Global Commission 2014). In addition, the private sector has been reluctant to invest where central government support is lacking.

Potential Solutions

Roundtable participants suggested a number of potential solutions for promoting sustainable urban energy policies, including those presented below.

National urban energy policy. National support can be expanded to other sectors of the urban energy system by formulating a national urban energy plan that is relevant to the challenges and aspirations of cities. National governments can also play a pivotal role in increasing the effectiveness of local sustainability actions by developing or making available urban energy planning tools. These tools can help urban policymakers to set up sustainable urban energy plans that effectively support the advancement of local and national goals.

Integrated planning. Greater alignment of urban policy at the local level calls for a transition to enhanced integrated planning strategies. Such plans would prioritize sustainability and incorporate the latest developments in clean energy technology solutions into future urban development investments.

Capacity building. Improved planning will require training a new army of next-generation urban planners and managers with the required skills and knowledge to implement this new paradigm in existing and new and growing cities. In addition, greater project management capacity is needed at the urban level in order to prepare projects for financing.

Private sector engagement and increased availability of financing. Increased access to and affordability of financing is key to ensuring the sustainable urban energy transition. Policy integration efforts need to be complemented by greater engagement of the private sector to direct investments toward more sustainable solutions for critical infrastructure in cities, such as power, gas, telecommunications, and transport infrastructure. Encouraging dialogue between the private sector and national and local governments is critical to ensure that the private sector is enabled to maximize investments in urban areas that meet clean energy goals.

Key Recommendations

The critical role of cities in meeting national energy goals is increasingly recognized by many international fora. Roundtable participants recommended analysis and international collaboration that the Clean Energy Ministerial could undertake to support sustainable urban policy design and implementation that could complement rather than replicate current efforts in this space.

Create a national urban energy policy design forum. The Clean Energy Ministerial could provide the opportunity for participating governments to form a task force that promotes international cooperation, national action, and formulation of national urban energy policies and plans. International support and cooperation should include knowledge transfer and experience development on national urban energy policies, financing, and related supportive programs, tools, and resources.

Also to be included are expanded dialogue and engagement with cities and city networks, financiers, finance ministries, the private sector, and other urban development and clean energy experts so that stakeholders can understand urban clean energy challenges from international, national, and local perspectives. Future CEM ministerials also offer opportunities to invite the perspective of cities in high-level clean energy policy discussions.

Leverage existing CEM initiatives. The Clean Energy Ministerial is home to a wealth of technical expertise on a range of key energy topics, though work is more narrowly focused on influencing national policy outcomes. The Clean Energy Ministerial should leverage the work of existing CEM initiatives and efforts and adapt available resources and assistance to facilitate the sustainable urban energy transition. Relevant CEM initiatives include but are not limited to:

- CEM Global Lighting Challenge
- Clean Energy Solutions Center
- Energy Management Working Group
- Global LEAP
- Global Sustainable Cities Network
- Super-Efficient Appliance and Equipment Deployment

Support sustainable urban energy analysis. Some critical pieces of analysis are needed to help support action on the above recommendations. The 2016 edition of the International Energy Agency's (IEA's) Energy Technology Perspective (ETP 2016) will focus on sustainable urban energy systems. The IEA and the World Resources Institute are joining forces to produce an analytical framework that will help facilitate dialogue between local and national decision makers to improve alignment between national and local urban energy policies.

The Clean Energy Ministerial can also build upon the work of the Children's Investment Fund Foundation and C40 to conduct a thorough policy-mapping exercise to provide insights on how relevant urban policies interact and how to coordinate policy to improve decision making with regard to clean energy. Policy-mapping facilitates identification of linkages among national urban policies and between local and national policies. It also identifies who owns, operates, and influences the constituents of an urban energy system—key stakeholders for formulating and implementing effective clean energy policy.

In a rapidly urbanizing world, cities must play the lead role in clean energy transition. The sixth Clean Energy Ministerial was able to bring divergent perspectives and responsibilities of stakeholders—governments, the private sector, and development organizations—to the same table in order to formulate a unified and holistic response to global sustainable urban energy needs.

– Naoko Ishii
Chief Executive Officer and Chairperson, Global Environmental Facility

The roundtable was an important discussion about how we as local governments can act together with both national and international stakeholders to ensure a global clean energy transition. The Clean Energy Ministerial plays an important role in accelerating this transition by connecting the key stakeholders, reducing the time to go from devising clean energy strategies to their actual implementation.

– Katarina Berggren
Mayor, Botkyrka, Sweden

3

Achieving a Social Licence for Clean Energy Deployment

Our clean energy future is dependent on the public acceptance of new technologies and the successful and efficient operation of clean energy installations. Technologies that may offer broad societal benefits, such as wind, hydropower, solar, carbon capture and storage, and biofuels, can also have significant impacts—both good and bad—on local communities. In some cases, projects have encountered significant local opposition leading to delays, closures, and loss of value. The objective of this discussion was to explore pragmatic pathways toward the social acceptance of clean energy technologies and processes. Topics of discussion included sharing experiences of social conflict and rejection of technology deployment, strategies for engagement and overcoming barriers to social acceptance, and opportunities for capturing best practice examples and important new initiatives to support clean energy deployment.

Moderator

- **David Sandalow**, Inaugural Fellow, Columbia University's Center on Global Energy Policy

Government Representatives

- **Kåre Fostervold**, Deputy Minister for Energy, Ministry of Petroleum and Energy, Norway
- **Katya Puga**, Deputy General Director, Ministry of Energy, Mexico
- **Katrina Williams**, Director General, International, Science and Resilience, Department of Energy and Climate Change, United Kingdom

Private Sector and Civil Society Representatives

- **Dan Arvizu**, Director and Chief Executive, National Renewable Energy Laboratory
- **Kai Buntrock**, Managing Director and Chief Financial Officer, Sowitec
- **Cao Guangyu**, Vice Director, Shanghai International Automobile City Group Co., Ltd.
- **Christoph Frei**, Secretary General, World Energy Council
- **Alejandro González Cravioto**, International Affairs Director, National Commission for the Development of Indigenous Peoples
- **Alexander Laskey**, President and Founder, Opower
- **Kevin Nassiep**, Chief Executive Officer, South African National Energy Development Institute
- **Ingrid Putkonen**, Managing Director, Agile Sustainability Management
- **Lorenzo J. de Rosenzweig**, Executive Director, Mexican Fund for the Conservation of Nature; Director of the Board of Trustees, International Institute for Environment and Development
- **Stephan Singer**, Director of Global Energy Policy, WWF International
- **Markus Tacke**, Chief Executive Officer, Wind Power and Renewables, Siemens
- **Andreas Villar**, Director, GIZ
- **Rolf Wüstenhagen**, Chair for Management of Renewable Energies, University of St. Gallen

Operating Agent

- Commonwealth Science and Industrial Research Organisation (CSIRO)

Overview and Background

To hold a social licence is to have the *"ongoing acceptance or approval for an operation or industrial activity from the local community …and others that can affect its profitability."* For clean energy deployment, this acceptance needs to be built on a base of mutual trust and a clear understanding of the needs and expectations (and issues) that communities locally, and society more broadly, have around this set of industries. Importantly, the behaviour of deployment agents must be aligned with expectations of these stakeholders.

The social licence concept tells us that acceptance is a product of a three-way set of relationships between governments, industry, and citizens (Figure 3). However, public–private attention and action tend to be economically focused (infrastructure and jobs), which means the integration of these three dimensions, in a certain location for a specific technology, can be neglected. Meaningful dialogue with citizens as an integral part of the decision-making process is the missing dimension in our current mechanisms for building social licence.

There is a range of ways to promote dialogue between stakeholders in clean energy deployment. These include accessing the views of average citizens and local community members through systematic surveys to ensure the voices of these groups are included directly in public and private discussion. Participatory technology assessment methods also provide a structured and formal means for capturing and including citizens' concerns around the design and deployment process. Toolkits and materials for companies can be developed to promote best practices on community engagement. The effectiveness of such efforts is greatly enhanced when clear roles for governments are identified that facilitate an atmosphere of social acceptance for clean energy technology development.

Identified Barriers

Roundtable participants identified a number of social licence-related barriers to the deployment of clean energy technologies. They may be organized under three broad categories, as below.

Communities are often excluded from the discussion/ decision-making process. Social licence speaks to the power of communities to influence development trajectories through creative and novel means. It is problematic when communities are not included more fully in decision-making processes or when community issues and concerns are not heard and incorporated into development plans or technology development itself. Such engagement is important for all groups but is particularly relevant for minority and marginalized groups, such as Indigenous peoples.

The value proposition for deployment is context-specific and poorly articulated. The drivers of acceptance at local levels are very different from those that inform national and global dialogues around clean energy deployment. It is necessary to understand what is important (both positive and negative) among public constituencies at each level and develop propositions that are complementary across scales and tailored to context. For example, communicating the benefits for local communities (e.g., economic opportunity, access to power) is often neglected in favor of an appeal to global benefits regarding the role of clean energy in achieving emissions targets. This issue is particularly problematic in developing contexts in which clean energy deployment must demonstrate its power to support development goals.

Baseline knowledge within society is poor. Many myths surround clean energy, and there is misinformation regarding the negative impacts of living near clean energy deployments. The

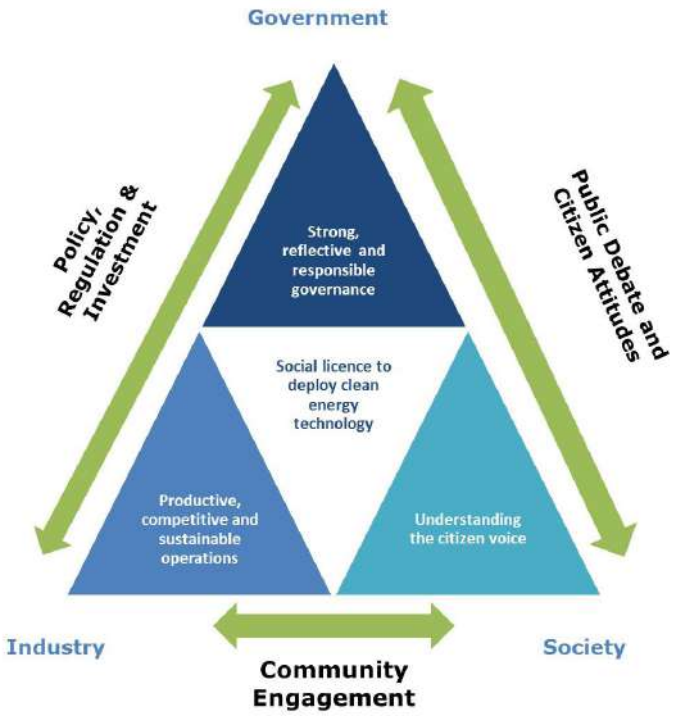


Figure 3. The social licence concept notes that acceptance is the product of a three-way set of relationships between governments, industry, and citizens.

potential benefits at a local scale, as well as how these benefits vary at different scales, are poorly understood. In this context, it is very easy to reject development without deeper consideration of issues, particularly for an industry whose legitimacy is regularly contested. The industry in general has done a poor job of communicating the benefits at different scales and engaging citizens consistently and effectively to redress inaccuracies and address concerns from activist groups. The government role in supporting an atmosphere for acceptance, particularly at the local level, is also unclear, with mixed public signals, inconsistent policy settings, and government's reluctance to position itself actively within the broader discussion.

Potential Solutions

The background material developed for participants and the subsequent roundtable discussion identified some key "solution levers" related to gaining a broader social acceptance of clean energy.

- **Decoupled local, national, and global value propositions**. Achieving a social licence to operate may be a global issue, but it is played out at national and local levels. The global benefits and impacts of a project, national implications, and local value proposition all need to be articulated and targeted to the relevant stakeholders. In developing countries, the challenge is slightly different, with the focus on the need to deliver a service and how that service is linked to electricity.
- **National dialogues on the role and nature of clean energy deployment**. Acceptance requires both education and engagement. Dialogue at a national level can help relay accurate information, set clear expectations, and foster acceptance of clean energy technologies in general. These dialogues should also be informed by systematic understanding of the perspectives of various stakeholders.
- **Emphasis on fairness**. Procedural fairness, the fair distribution of benefits, and faith that government will hold industry accountable are all key drivers of acceptance. Stakeholders have to feel that they are being treated fairly. This includes ensuring not only an equitable distribution of benefits among those affected by deployment but also a sense of agency or control in how deployment takes place. Successful projects create value and then share that value with relevant stakeholders.
- **Clear vision and leadership from governments**. A key role for national governments in building general support for clean energy deployment is to have a long-term vision, effectively communicate that vision, and then be consistent in implementing policy to achieve that vision.
- **Consistently higher standards**. Coordinating approaches among clean energy proponents can help set high standards and principles for community engagement and benefit-sharing and help raise the performance level of all proponents. This might also include independent monitoring and tracking of social performance. The dynamic between the community and clean energy proponents is complex, and it is important to understand both sides of the relationship.
- **Participatory planning processes**. Development is a very local business, and community-integrated development *is* a social licence to operate. Meaningful dialogue with communities, including early input and ongoing consultation, should be an integral part of the planning and decision-making processes. This includes engagement in assessing risks and benefits and debating alternatives to deployment in particular places (rather than outright rejection without consideration of alternatives or consequences). When a community feels heard, its members perceive impacts to be less severe. For industry, engagement requires patience to build acceptance through building consensus (or at least shared understanding) balanced against a need to ensure projects are developed in a reasonable time period.

Key Recommendations

Roundtable participants identified a number of opportunities for action by governments and industry that could facilitate future widespread clean energy deployment:

- Conduct systematic national and local exploration of citizen attitudes toward clean energy deployment. Draw upon the deep body of knowledge and methods on social licence developed by the extractives industries to evaluate and include public perceptions directly in dialogue around current and future development.
- Develop standards and best practices for engagement. Develop toolkits and materials to support more effective engagement of stakeholder groups at different scales and by different actors to support clean energy deployment and social acceptance.

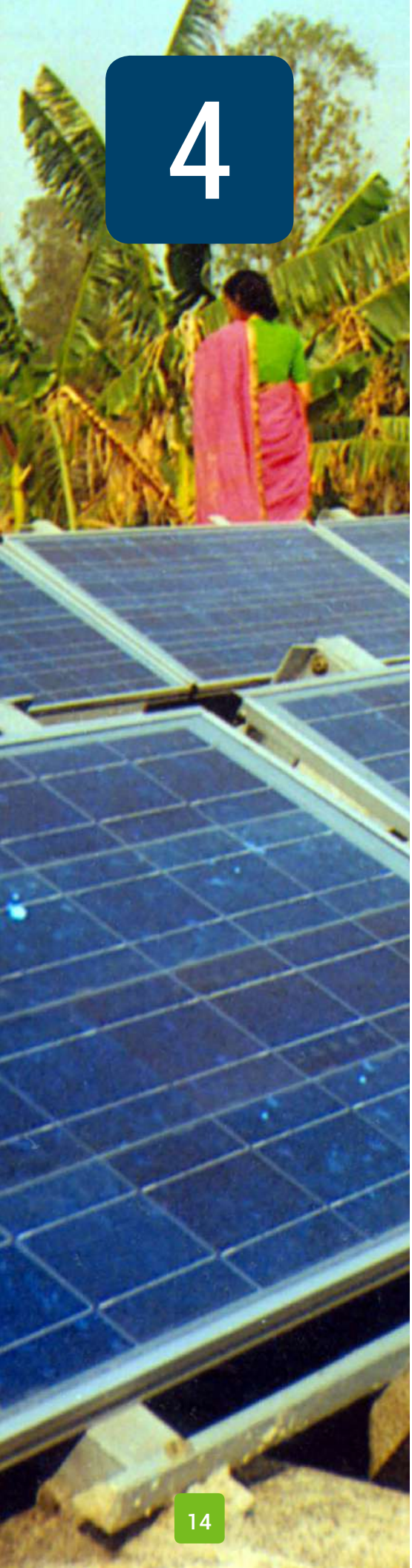
- Encourage and facilitate industry and government cooperation. Develop a clearer understanding of how industry and governments can work together effectively to cultivate an atmosphere for acceptance and create more certainty for investment.
- Explore the role of non-governmental organizations (NGOs) in communicating the benefits of clean energy deployment. Leverage NGO capacity to play a critical role in communicating and celebrating successes.
- Articulate the role of companies in promoting social acceptance through their own internal cultures, norms, and approaches to community engagement. Encourage companies to embed sustainable principles and practices into their businesses.
- Encourage utilizing participatory technology assessment methods for capturing and including citizens' concerns around the design and deployment process.

There is scope to explore an enhanced emphasis on social licence for clean energy deployment through the Clean Energy Ministerial. Much more work and attention is needed in this area if clean energy deployment is to occur at larger scales. Communities and society more broadly will continue to ensure that their voices are heard in development processes. To ensure that this occurs in a constructive manner, these issues must be elevated to a level equivalent to the social risk that rejection represents for clean energy.

We need to change the focus of the conversation—make it less about communities "accepting" or "cooperating with" development, and center the process on people, helping them understand the benefits and consequences. Once this happens, they will come along.

– Lorenzo de Rosenzweig

Executive Director, Mexican Fund for the Conservation of Nature, and Director of the Board of Trustees, International Institute for Environment and Development



4

Finance for Clean Energy Access

Small-scale distributed energy access solutions are central to achieving universal energy access targets. This roundtable brought together practitioners and policymakers to identify barriers to and strategies for unlocking sustainable private capital for these distributed solutions. Drawing from the participants' unique experiences in the energy access field, the discussion synthesized lessons learned in key areas such as innovative finance mechanisms, public–private cooperation, and regulatory policy.

Moderator

- **Rachel Kyte**, Vice President and Special Envoy for Climate Change, World Bank

Government Representatives

- **Toshihiko Fujii**, Deputy Commissioner for International Affairs, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, Japan
- **Robert Ichord, Jr.**, Deputy Assistant Secretary, Bureau of Energy Resources, Department of State, United States
- **Varsha Joshi,** Joint Secretary, Ministry of New and Renewable Energy, India

Private Sector and Civil Society Representatives

- **John M. Christensen**, Director of UNEP DTU Partnership, Technical University of Denmark
- **Fabio De Pascale**, Co-Founder and Chief Energising Officer, Devergy
- **Ingrid Hahn**, Deputy Director, KfW Development Bank
- **Dan Hamza-Goodacre**, Program Director, Energy Efficiency, ClimateWorks Foundation
- **Naoko Ishii**, Chief Executive Officer and Chairperson, Global Environmental Facility
- **Philip Paulwell**, MP, Minister of Science, Technology, Energy & Mining of Jamaica; Chair of the Council of Trade and Economic Development (COTED) on Energy, CARICOM
- **Lorenzo J. de Rosenzweig**, Executive Director, Mexican Fund for the Conservation of Nature; Director of the Board of Trustees, International Institute for Environment and Development
- **Kristina Skierka**, Director, Power for All
- **Josué Tanaka**, Managing Director for Operational Strategy and Planning, Energy Efficiency and Climate Change, European Bank for Reconstruction and Development
- **Simon Trace**, Chief Executive Officer, Practical Action
- **Harry Verhaar**, President, Global Off-Grid Lighting Association; Head of Global Public & Government Affairs, Philips Lighting; Board Chair, European Alliance to Save Energy
- **Manual Wiechers**, Co-Founder and Chief Executive Officer, Iluméxico
- **Paul Winkel,** Co-Founder and General Manager, PowerMundo en el Peru SAC

Operating Agent

- National Renewable Energy Laboratory

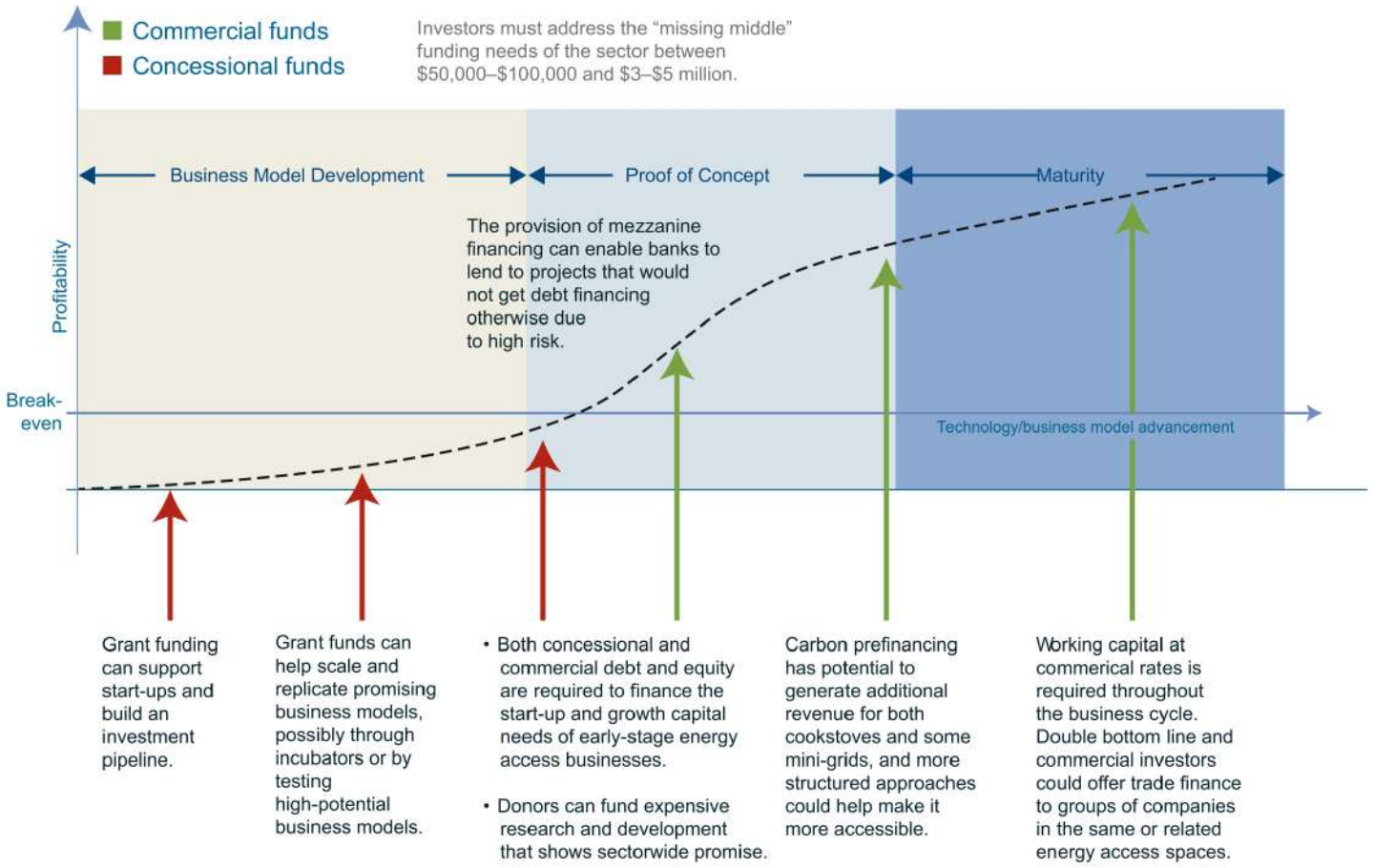


Figure 4. Financing is needed in three areas: to support companies in their early stages (start-up and growth capital), to support operations (working capital or trade finance), and to strengthen revenue streams. Source: IFC 2012.

Overview and Background

Over one billion people globally lack access to electricity. Providing clean and affordable energy services to these unelectrified populations will be a critical driver for poverty reduction, job creation, and improved health and social outcomes. According to the International Energy Agency, achieving universal energy access targets within the next two decades will require an unprecedented level of public- and private-sector investment—an estimated $640 billion. Over 60% of this investment will be directed toward distributed generation solutions, such as mini-grids and off-grid standalone systems. Expanding energy access will also involve a dramatic increase in new energy service providers, particularly small and medium enterprises (SMEs), to better reach rural and base-of-the-pyramid consumers who account for the majority of unserved populations.

Global momentum to mobilize finance for energy access is on the rise. However, current financing efforts are heavily skewed toward conventional grid-extension approaches. While grid extension will continue to play a central role in electrification efforts, universal grid access will require significant capital investment over long time frames. Decentralized solutions provide a complementary pathway to accelerate entry-level electrification in the short term and will also be the most viable long-term solution for some remote populations.

One major obstacle for the delivery of decentralized energy services through SMEs is the lack of affordable financing well-tailored to the needs of this emerging and higher-risk sector. Currently, many energy access businesses rely on early-stage funding in the form of grants and other concessional sources. However, businesses need to tap into the larger reserves of private capital to overcome the "missing middle" pioneer gap and achieve the required scale of investment (Figure 4).

Identified Barriers

Despite the importance of small-scale, decentralized solutions, there are many barriers to investment in this area. Roundtable participants highlighted the following major challenges.

- **Risks.** This sector is unattractive to traditional investors because of the high levels of real and perceived risk. Investment risk in energy access markets is multi-faceted, arising from a range of sources including political instability, regulatory uncertainty, currency risk, low investor returns, unproven business models, and unreliable cash flows.
- **Investment size.** The most pressing funding need for many energy access SMEs is for modest-sized deals ranging between a few hundred thousand and a few million dollars. Traditional public- and private-sector investors typically provide funding at much larger scales.

- **Business models.** Many energy access SMEs are early-stage companies, with scale-up of successful models challenging and occurring over relatively long time horizons. This lack of maturity in the sector reduces investor confidence in the viability, scalability, and replicability of energy access businesses.
- **Policy and regulatory frameworks.** In many developing countries, policy and regulatory frameworks for decentralized energy solutions are often unfavorable or confusing. Lack of clarity on grid-extension plans creates a high level of uncertainty in the sector, while ambiguous or burdensome regulatory procedures can stifle innovation and create high bureaucratic barriers for entrepreneurs. Tax and subsidy policies may undermine the sector by favoring large-scale projects and grid extensions over energy access technologies.
- **Perceptions and branding.** Both public- and private-sector actors may perceive small-scale, decentralized energy access technologies and businesses as poor or low-priority investments.

Potential Solutions and Recommendations

The following solutions and proposed actions to address the identified barriers emerged from the roundtable discussion.

- **Strengthen policy and regulatory frameworks.** Several participants emphasized that enabling policy and regulatory frameworks provide a foundation for de-risking business models and investment. As a starting point, governments should prioritize distributed energy options in energy sector planning, streamline procedures, and provide well-designed incentive structures to promote and level the playing field for small-scale energy access solutions and ensure stability and transparency.
- **Leverage public–private partnerships.** The scale of investment required to achieve universal energy access far exceeds available public funding sources. However, public funds play a crucial role in catalyzing private capital, particularly in the area of credit enhancements and risk sharing. Smarter deployment of grants and subsidies is also essential to sustain and not undermine energy access markets. Donors and multilateral development banks should evaluate their lending practices to more effectively serve the energy access market.
- **Address the affordability challenge.** Affordability is a major issue, particularly among bottom-of-the-pyramid consumers who form a significant portion of the customer base in typical energy access markets. Multiple factors affect the cost of energy service provision and consumers' ability to pay. A range of approaches should be pursued to tackle the challenge. Roundtable participants highlighted the following:

- Increase the public-sector role for very low-income populations.
- Increase access to affordable finance.
- Promote super-efficient appliances and equipment.
- Promote productive uses and economic growth.
- Support development of flexible payment mechanisms.
- Support end-user finance mechanisms.

- **Promote tailored, flexible, and innovative finance instruments.** Energy access businesses need patient and flexible financing sources. This requires investors with higher risk tolerance such as impact investors and philanthropies, as well as public–private partnerships, to share risk with commercial lenders. Equally important is the creation of new flexible finance mechanisms, as well as innovative deal and fund structures to better reach energy access SMEs, including through local finance institutions. Examples cited include convertible grants, working capital funds, blended capital products, concessional loans, cash flow financing, and local currency lending.
- **Increase involvement of large corporations.** Long-term viability of the sector requires increased involvement of larger corporations. Utilities may offer a potential exit pathway for energy access SMEs by facilitating access to "pre-packaged" and de-risked expansion markets. Energy access markets may become attractive to non-utility players by providing access to consumers for a wide range of services.
- **Support capacity-building and knowledge-sharing.** Providing technical assistance and facilitating knowledge-sharing among energy access entrepreneurs is important for fostering growth of the sector. Public-sector actors are well-suited to provide market-supportive activities such as finance facilitation, project preparation assistance, knowledge-sharing platforms, business-to-business networking opportunities, investor education, market intelligence support, and business incubation services.
- **Change perceptions and market successes.** Changing negative perceptions about the risk and viability in energy access markets will require strategic and sustained outreach to both public and private sectors. This may include the following:
  - Reframe off-grid as the "first mile" rather than the "last mile," and cultivate widespread support for decentralized technologies as legitimate energy access solutions.
  - Highlight successes in sectors such as off-grid lighting to increase investor confidence.
  - Leverage the credibility and independence of philanthropies to advocate on behalf of the sector.

We need to have access to debt financing and working capital to move forward, and look at off-grid solutions, which are the first mile, not the last mile, for rural communities. We are talking about basic services to get people on the energy ladder.

– Rachel Kyte

Vice President and Special Envoy for Climate Change, World Bank

5 Power System Transformation and the Smart Utility of the Future

Innovation and change in the electric power sector are placing 20th century models of electricity delivery under pressure. This roundtable examined trends in wholesale and retail power system evolution, threats and opportunities for current utility business and operational models, the role of technology and finance innovation, and lessons learned for policy and regulatory frameworks that can guide power system transformation.

Moderator

- **Christoph Frei**, Secretary General, World Energy Council

Government Representatives

- **Wolsey Barnard**, Acting Director General, Department of Energy, South Africa
- **Ibrahim Baylan**, Minister, Ministry of Environment and Energy, Sweden
- **Helen Bennett**, General Manager, Energy Productivity, Department of Industry and Science, Energy Division, Australia
- **Federica Cattoi**, Second Secretary, Office of Energy, Climate Change and Sustainable Development, Ministry of Foreign Affairs and International Cooperation, Italy
- **Sanjay Garg**, General Manager – International Coordination, Ministry of Power, India
- **Thorsten Herdan**, Director General for Energy Policy, Federal Ministry of Economics and Technology (BMWi), Germany
- **Cesar Emiliano Hernández Ochoa**, Undersecretary of Electricity, Ministry of Energy, Mexico
- **Riku Huttunen**, Head of the Energy Department, Ministry of Employment and the Economy, Finland
- **Moon Jae-do**, Vice Minister, Ministry of Trade, Industry and Energy (MOTIE), South Korea
- **Sylvie Lemmet**, Director of European and International Affairs, Ministry of Ecology, Sustainable Development and Energy, France
- **Ernest Moniz**, Secretary of Energy, Department of Energy, United States
- **Dominique Ristori**, Director General for Energy, European Commission
- **Christian Zinglersen**, Deputy Permanent Secretary, Ministry of Climate, Energy and Building, Denmark

Private Sector and Civil Society Representatives

- **Carlos Barrera**, Vice President and Managing Director – Latin America, SunEdison
- **Stephen Berberich**, President and Chief Executive Officer, California Independent System Operator
- **Marcene Broadwater**, Global Head of Climate Strategy and Business Development, IFC Climate Business Department
- **Charles Feinstein**, Director – Energy and Extractives Global Practice, Global Practice Vice-Presidency, World Bank
- **Kate Hampton**, Executive Director – Climate Change, Children's Investment Fund Foundation
- **Maria van der Hoeven**, Executive Director, International Energy Agency
- **Lawrence Jones**, North America Vice President for Utility Innovations and Infrastructure Resilience, Alstom Grid
- **Alexander Laskey**, President and Founder, OPower
- **Pedro Luna**, Deputy Director of Programming, Comisión Federal de Electricidad (Federal Electricity Commission)
- **Nicola Melchiotti**, Head of Mexico and Central America, Enel Green Power
- **Carlos Peralta Quintero**, Chairman and Chief Executive Officer, IUSA Group
- **Jose Ignacio Pérez-Arriaga**, Professor of Engineering, Economics and Regulation of the Electric Power Sector, Universidad Pontifica de Comillas
- **Jaime de la Rosa Montes**, President, Mexican Energy Association (AME)
- **Swami Venkataraman**, Vice President – Senior Credit Officer, Global Project and Infrastructure Finance, Moody's Investors Service
- **ZHANG Qiping**, Chief Engineer, State Grid Corporation of China

Operating Agent

- National Renewable Energy Laboratory

Overview and Background

Today, custodians of the power sector face an unprecedented number of challenges—not only to uphold the core principles of universal access, reliable service, and affordability but also to simultaneously meet new expectations for grids to be resilient, flexible, environmentally friendly, and customer-controlled. Perhaps one of the most significant trends in power system transformation is the growing democratization and diversification of supply. Enabled by technological, policy, and business model innovations, power systems are moving from being purely centralized systems to more decentralized ecosystems, in which consumers not only gain more ability to choose but become themselves an integral part of the electricity supply.

These innovations are fueling the growth of energy entrepreneurship, disrupting traditional energy business models and enabling new models for achieving secure, affordable, and clean power systems. In turn, this evolution has implications for the regulatory compact, in which regulated monopolies are increasingly subjected to competition not only to promote cost reductions but also to introduce more innovation, improved reliability, and greater environmental sustainability.

According to the International Energy Agency, roughly $16–$19 trillion in cumulative investment will be needed in the next two decades to meet the policy targets for new grid and power plant infrastructure (IEA 2014). The fundamental challenge for policymakers is how to direct these investments to take advantage of new innovations to build power systems that are accessible, affordable, reliable, resilient, and low-carbon.

What is power system transformation?

Power system transformation is the active process of creating the policy environments, and the planning and operating practices, that accelerate investment and innovation in power systems that maximize the use of sustainable energy and delivered energy productivity, while also fostering the integration of power systems with transportation, heating and cooling, and broader resource management (21CPP 2015).

Identified Innovation Domains

The participants of the roundtable represented over a dozen countries and a diverse range of power system architectures—from vertically integrated state-owned enterprises to competitive deregulated markets and systems in the midst of wide sectoral reform. While these differences in ownership model and market structure have important bearing on the pace and direction in which each system will transform, participants were able to identify a number of areas in which innovation is presenting common policy challenges and opportunities.

Representatives of countries that have been early adopters of renewable energy, such as Denmark and Germany, noted how the addition of wind and solar has reinforced the value of larger balancing areas, bringing new methods of transmission system operation and new "smart transmission" infrastructure. Meanwhile, other participants noted how the distribution system is moving toward managing two-way power flows from distributed generation and storage, necessitating new forms of interaction and control for consumers and power system operators. Distribution companies are also experimenting with new business models that focus on delivered energy services. Connecting the two, the transmission–distribution boundary is becoming less physically distinct but more important as a juncture of economic value.

Innovation is also occurring at the boundary between the electricity and thermal systems (e.g., combined heat and power, district heating and cooling) and in integration of the power and transport sectors through the expanded deployment of hybrid and electric vehicles, and potentially also hydrogen fuel cell vehicles. Planning processes and policies are increasingly emphasizing integration to increase system efficiency, achieve emissions reduction targets, reduce water use, and meet environmental policy goals and regulations.

To unlock greater investment, technical and market innovations are catalyzing the development of new mechanisms for power

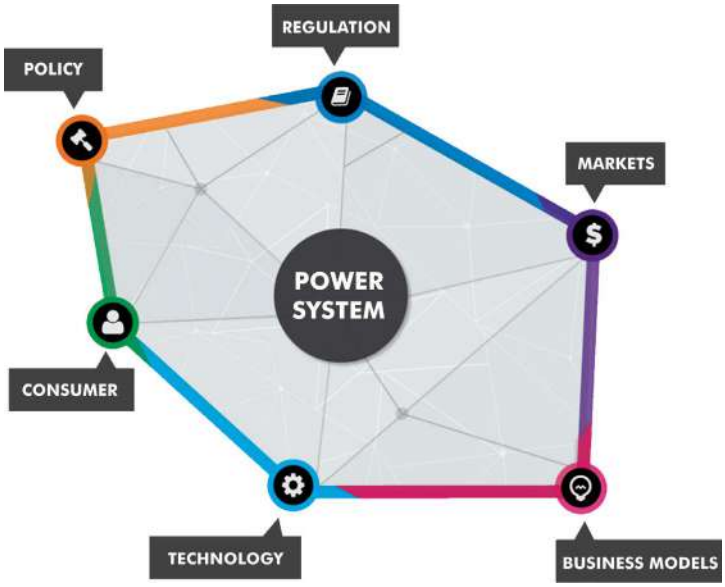


Figure 5. Cross-sectoral power system jurisdictions are depicted in this schematic representation.

sector finance (e.g., renewable energy auctions, green bonds), development of new pricing strategies (e.g., time-of-use pricing, tiered rate structures), and market reform to accommodate new grid services (e.g., intra-hour market scheduling, demand response bidding). The need for new capacity is also reviving a debate over the value of "energy-only" versus "capacity" markets. A need for new market mechanisms is particularly important for developing economies in which the majority of new clean energy investment will occur. To grow these markets, financial institutions are looking to tools such as risk-sharing instruments and standardized contracts to remove project risk and accelerate foreign investment.

Innovation was also highlighted in response to a need for greater power system flexibility from a more diverse set of sources—from flexible generation to flexible transmission and demand-side resources. A key policy question is how to incentivize investments in system flexibility. Energy efficiency, demand response, and energy storage at the transmission, distribution, and end-user levels are all beginning to provide clear economic and reliability value to transmission and distribution utilities and end users, particularly with new innovations in business models.

Key Recommendations

Roundtable participants discussed several recommendations for greater international collaboration that can enable power system transformation and the diffusion of best practices in power system planning and operation.

New ways of measuring progress. A key challenge is developing meaningful metrics that capture the effectiveness of actions taken to transform power systems. One solution proposed was to evaluate measures by the degree to which they facilitate increases in "delivered energy productivity" by raising the economic output of every kilowatt-hour generated and reducing the pollution of every kilowatt-hour generated. Furthermore, progress in implementation could be approximated by the degree of emergence, mainstreaming, and effective impact of innovations in a particular power system jurisdiction.

Regional market design. Many countries, such as in the European Union, are moving to create larger energy markets, integrated across national boundaries as well as between electricity, gas, transport, and heat systems. More efforts to create integrated markets were called for as an important opportunity to increase the overall flexibility of power systems.

Evolving regulatory compacts. A fundamental challenge for retail electricity delivery is to redefine the regulatory compact in a way that incentivizes utilities to value efficiency, reliability, resilience, and innovation. New solutions are being tested in many markets, creating opportunities for peer learning and collaboration.

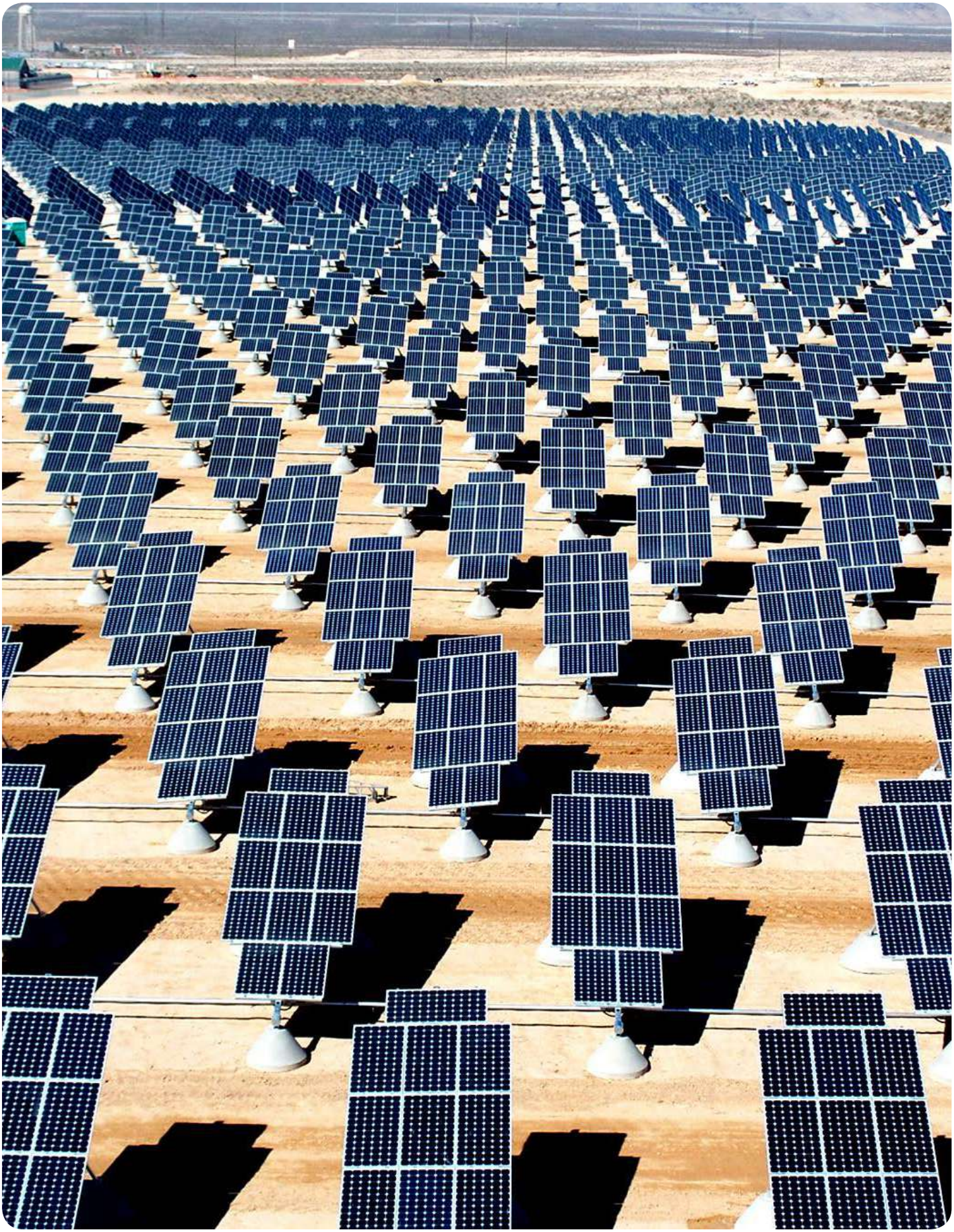
No one-size-fits-all solution. While innovation is driving change across the globe, participants agreed that "smart" solutions will be mindful of local contexts.

Greater cross-sectoral collaboration. At CEM6, fourteen countries plus the Directorate-General for Energy of the European Commission signed a joint statement articulating a vision for power system transformation focused on eight "core principles." Many roundtable participants contributed to the drafting of the statement, which calls for greater international efforts to facilitate power system transformation in each country. Achieving the goals of the statement will require new linkages between CEM initiatives, the private sector, other international organizations, and the national or subnational entities with jurisdiction over power system regulation and policy reform.

A highlight of the 2015 Clean Energy Ministerial was the debate on market challenges for electricity looking at new market design initiatives and early learning. Going forward, the vision for CEM 2.0 shows the commitment to delivering real impact and making clean energy a reality.

– Christoph Frei

Secretary General, World Energy Council



6

Public–Private Consortia for Advanced Clean Energy Technology Research

Centers for clean energy technology innovation provide opportunities for stakeholders in the scientific community performing cutting-edge research and development (R&D) to work together in unique ecosystems and accelerate the pace of advanced energy technology innovation. Several innovation-based scientific consortium models have been implemented worldwide with a wide array of outcomes. This roundtable allowed interested CEM governments, private-sector executives, and academic institutions to discuss this integrated research consortium model, share best practices, learn from international experiences, and consider options for applying this research model globally.

Moderator

- **Ramamoorthy Ramesh**, Associate Laboratory Director for Energy Technologies, Lawrence Berkeley National Laboratory; Professor of Physics and Materials Science, University of California, Berkeley

Government Representatives

- **Kåre Fostervold**, Deputy Minister for Energy, Ministry of Petroleum and Energy, Norway
- **Ajay Mathur**, Director General, Bureau of Energy Efficiency, India
- **Carlos Roberto Ortiz Gómez**, Director General for Research and Talent Development, Ministry of Energy, Mexico
- **Wan Gang**, Minister of Science and Technology, People's Republic of China

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- **Dan Arvizu**, Director and Chief Executive, National Renewable Energy Laboratory
- **Bert De Colvenaer**, Executive Director, Fuel Cells and Hydrogen Joint Undertaking
- **Jean-François Gagné**, Head, Energy Technology Policy Division, International Energy Agency
- **Dolf Gielen**, Director of the Innovation and Technology Center, International Renewable Energy Agency
- **Mario Molina**, Director, Mario Molina Center for Energy and Environment; Distinguished Professor of Chemistry and Biochemistry, University of California, San Diego
- **Pablo Mulás del Pozo**, Member of the National Council of Climate Change, Mexico
- **Nebojsa Nakicenovic**, Deputy Director, International Institute for Applied Systems Analysis; Professor for Energy Economics, Technical University of Vienna
- **Clay Nesler**, Vice President, Johnson Controls Inc.
- **Antonio del Río**, Director, Universidad Nacional Autónoma de México (UNAM), Renewable Energy Institute
- **Song Denyang**, Chief Technology Officer, Yingli Group Co. Ltd.
- **Markus Tacke**, Chief Executive Officer, Wind Power and Renewables, Siemens
- **Robert Weisenmiller**, Chair, California Energy Commission
- **James Wood**, Director, U.S.–China Clean Energy Research Center – Advanced Coal Technology Consortium, West Virginia University
- **You Yuxian**, President of Hongbo Group, Fujian Hongbo Opto-Electronics Technology Co., Ltd., and Fujian Hongbo Real Estate Development Co., Ltd.; Vice President of Fujian Hongbo Printing Co., Ltd.

Operating Agents

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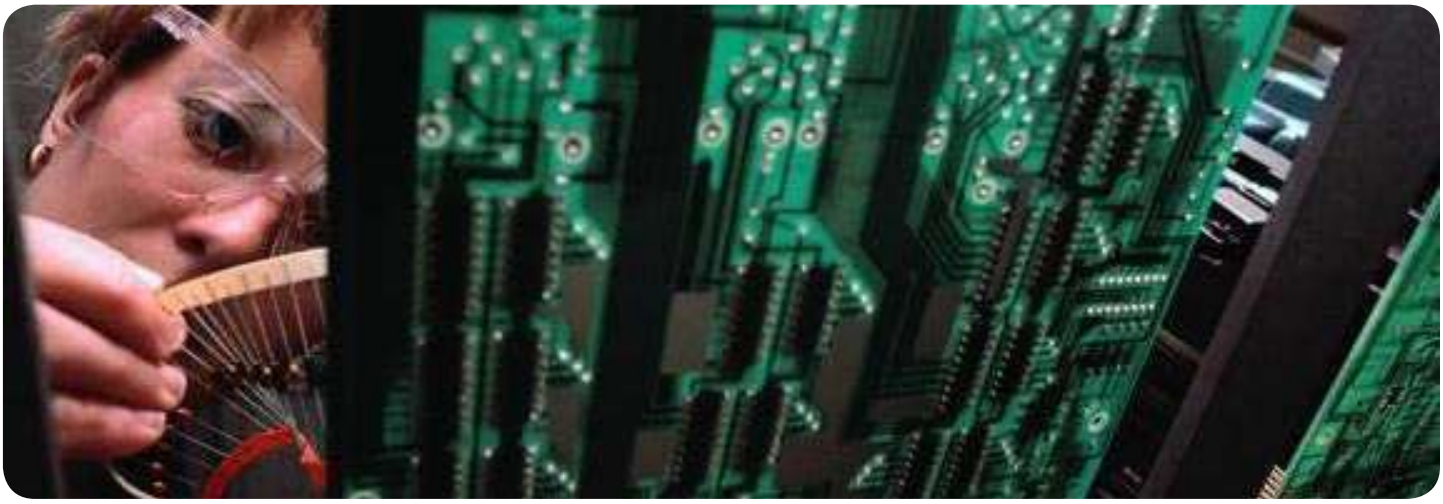


Overview and Background

Many governments around the world have invested substantial resources in scientific research and technology development, resulting in disruptive technologies (e.g., the Internet, GPS, nanotechnology) that have driven economic growth and improved quality of life. Government-supported basic scientific research provides a crucial foundation for innovative technologies and later-stage research. Broader social benefits from publicly funded research can also be enhanced by focusing attention on the three crucial pillars of the research system: a talented and interconnected workforce, adequate and dependable resources, and world-class basic research in all major areas of science.

Addressing the global challenges posed by the expected growth in energy consumption and climate change may require a new paradigm in terms of how to approach R&D efforts. Finding viable solutions to these challenges at the speed necessary will require the collaboration of the best minds, worldwide, in search of scientific and technology breakthroughs to reduce greenhouse gas emissions while helping to meet growing energy demand. Thus, the world may need to transition from a national to a global innovation paradigm.

Clean energy technology-focused innovation consortia can bring various stakeholders together—governments, academia, research institutions, foundations, and the private sector—and leverage their expertise, perspectives, and resources to accelerate breakthrough discoveries, reduce costs, and accelerate deployment and adoption in the marketplace.

However, certain issues consistently arise when different R&D stakeholders are brought together, e.g., funding mechanisms, intellectual property (IP) issues, and differing agendas and approaches. As new technologies are developed, another challenge is the availability of financing mechanisms to overcome the "valley of death" and bring the new technologies to market. All of these issues and challenges become more complex in multilateral collaborations.

Given the context above, the following questions guided the roundtable discussion:

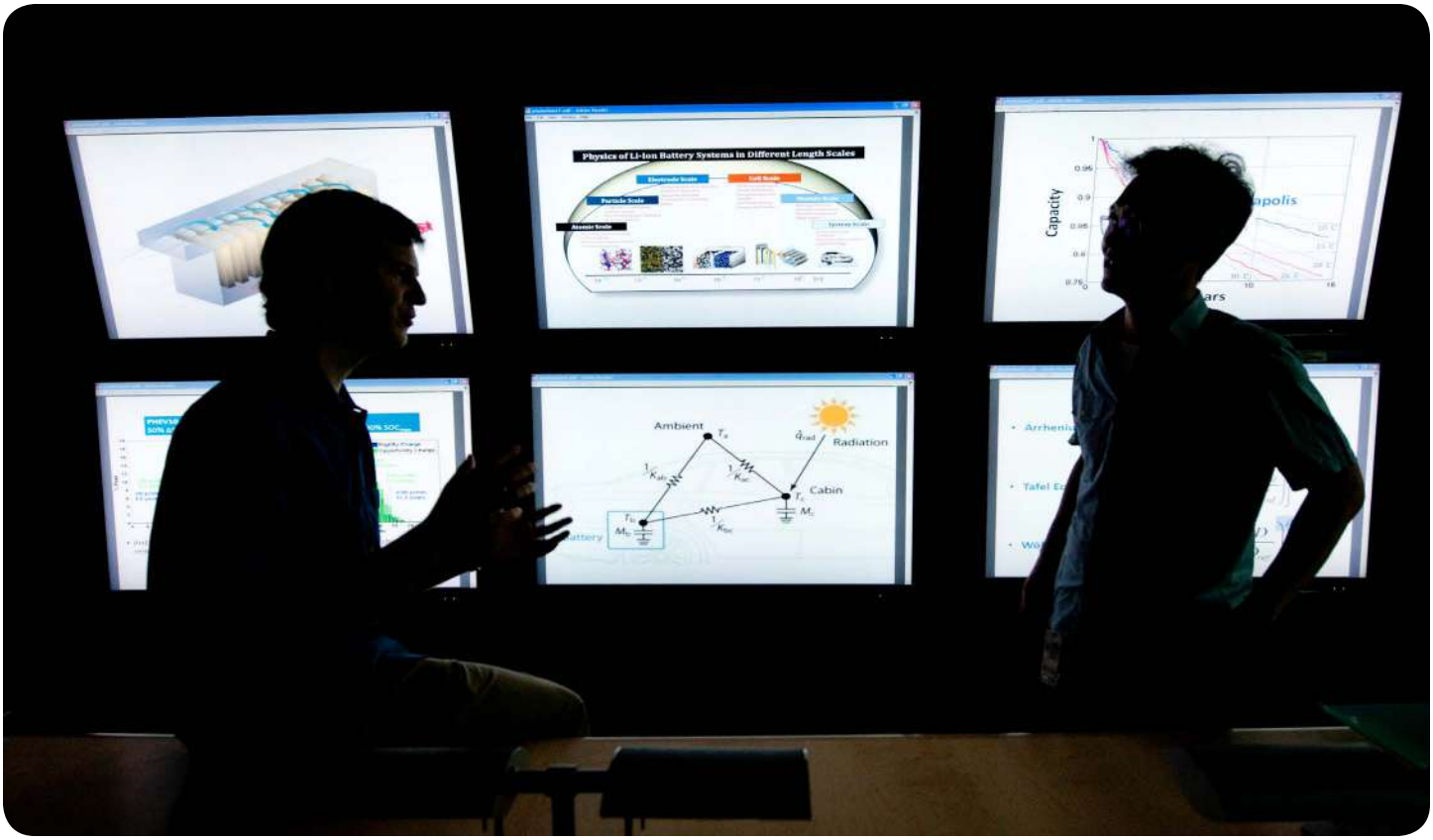
- Can R&D and innovation scale from national efforts to a global platform?
- How can global R&D strategies be put into practice?
- How can global efforts be funded?
- How do we overcome IP issues?

Future collaborations can look to models of national public–private research consortia that have been implemented around the globe, such as the Energy Innovation Hubs, Sunshot, and ARPA-E in the United States; the Fraunhofer Institutes in Germany; the public innovation fund in Finland; and development banks in Germany, China, and other countries. There are also examples of bilateral public–private consortia for energy research, including the U.S.–China Clean Energy Research Center (CERC).

Identified Barriers

Roundtable participants identified three significant barriers to the implementation of public–private research consortia addressing global energy and climate change challenges. Although these barriers were discussed in the context of bilateral and multilateral research consortia, they are also generally applicable to domestic consortia.

- **Missing sense of urgency.** The high capital costs required to implement robust research programs for clean energy technology can obscure the significant risks of inaction and long-term research benefits.
- **Unclear roles for the various stakeholders.** Different stakeholders may have vastly different goals and objectives—private-sector agendas are typically guided by profit and short payback periods, while government agendas may seek to address broader and longer-term societal challenges. Disparate and sometimes conflicting national priorities can make it difficult to coalesce around a global vision. Addressing IP issues is also important for increased private-sector participation.



- **Overall lack of investment.** Investment in clean energy technology R&D is far too low, according to the International Energy Agency (IEA). The IEA notes in its *Energy Technology Perspectives 2015* that energy-related public expenditures as a share of research, development, and demonstration have fallen "from a peak of 11% in 1981 and [have] remained flat between 3% and 4% since 2000."

Potential Solutions

Roundtable participants discussed potential solutions to the barriers identified above. Generally, the successful implementation of research consortia depends on properly understanding and defining the who, what, why, and how for all those involved.

- **Create a sense of urgency.** More should be done to help pivot the narrative to the global and national benefits of clean energy technologies as well as to the potential costs and risks of inaction. Investing in measures to address and fight climate change should be described and communicated as an insurance policy against these extreme risks. The risks should be illustrated with clear examples and parallels that laymen can fully appreciate.
- **Clearly define government and private-sector roles and goals.** Roundtable participants were able to identify some common principles that can be used to define different consortia's goals. Global research programs were agreed to be most effective when governments fund basic research and the private sector—ideally along with governments and other stakeholders such as foundations—funds advanced research, product development, and product deployment.

One participant noted that "the closer to market you get, the more private funding you seek." Market-oriented systemic thinking should be embraced, as should cooperation on R&D for non-competitive technologies common across industries.

Governments should contribute significantly at the onset of research programs to set objectives, provide initial funds, and support the requisite partnerships. It is useful for governments to establish clearly defined research areas and put performance measurement and metrics in place; however, governments should not pick "winning" technologies. Governments should also develop eligibility criteria for establishing appropriate partnerships with industry.

Private-sector participants usually provide funding with the goal of product development and commercial deployment, although private-sector stakeholders may also have compelling reasons for participating in early-stage research (e.g., desire to increase knowledge capacity and fear of exclusion).

Consortia should implement business standards and quality controls from project initiation through deployment. As needed, capacity building in developing countries should also be a goal of multilateral research consortia. A management culture should be promoted that incorporates business practices, has well-defined rules for IP and appropriations of profits, and fosters an unrestricted innovation environment.

- **Increase funding opportunities.** The ultimate goal of increased funding for global research consortia is directly related to the two barriers addressed above. Working to create a sense of urgency and clearly defining consortia's roles and goals will help lower the investment barrier.

Key Recommendations

Roundtable participants recommended that all stakeholders emphasize a risk management approach, develop a clear message (using layman terms and concrete examples) that conveys the sense of urgency, and communicate the large economic and social benefits of developing clean energy technologies. Acceptance and understanding are key to increasing and mobilizing the resources needed to accelerate the scientific and technology breakthroughs to address global energy and climate challenges.

There was agreement among participants on the need to accelerate R&D and technology development to reduce greenhouse gas emissions, with a key recommendation to consider an effort to accelerate carbon capture use and sequestration (CCUS).

Participants agreed to continue the conversation on public–private research consortia with the goal of preparing specific proposals to promote clean energy research and technology development and to further engage countries in and outside of the Clean Energy Ministerial.

Given the size of the climate change challenge, we are not investing enough in research and development of new technologies; governments should be investing two or three times more. There is a significant risk—about one in five—that business-as-usual emissions will eventually cause a 5-degree or greater global temperature increase, which would lead to enormous financial and other costs, while the cost of reducing emissions to minimize the risk is only 1%–2% of GDP.

– Dr. Mario Molina

Director, Mario Molina Center for Energy and Environment; Distinguished Professor of Chemistry and Biochemistry, University of California, San Diego; and Nobel Laureate

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II Annex II: Clean Energy Ministerial Initiatives

The wide-ranging initiatives that have been launched through the CEM are categorized under four thematic areas: energy efficiency, clean energy supply, integration, and human capacity. The low-cost, high-impact policy and technical work taking place through these initiatives facilitates international coordination and amplifies each government's clean energy deployment efforts. These initiatives are helping nations reduce carbon emissions, improve energy security, provide energy access, and sustain economic growth.

Energy Efficiency
The **Super-efficient Equipment and Appliance Deployment (SEAD)** initiative promotes energy-efficient appliances and equipment.
The **Energy Management Working Group** seeks to improve energy efficiency in the industrial and commercial sectors worldwide by accelerating broad use of energy management systems.
The **Sectoral Working Group** aims to accelerate the sharing and adoption of efficiency-enhancing and emissions-reducing best practices and technologies within energy-intensive industrial sectors, including power and steel.
Clean Energy Supply
The **Multilateral Solar and Wind Working Group** works to lower the costs of solar and wind energy in regions around the world.
The **Hydropower** initiative promotes the development of sustainable, cost-effective hydropower.
The **Bioenergy Working Group** focuses on bolstering the deployment of bioenergy.
Integration
The **International Smart Grid Action Network (ISGAN)** works to accelerate the development and deployment of smarter electricity grids worldwide.
The **21st Century Power Partnership (21CPP)** works to transform the electricity sector through the integration of smart grids, clean energy, and energy efficiency.
The **Global Sustainable Cities Network (GSCN)** provides a platform for sustainable city initiatives throughout the world.
The **Electric Vehicles Initiative (EVI)** works to accelerate the global scale-up of electric drive vehicles.
Human Capacity
The **Clean Energy Solutions Center** is a first-stop resource for clean energy policy, best practices, data, analysis tools, and expert assistance.
The **Clean Energy Education and Empowerment (C3E)** initiative strives to close the gender gap and help advance women's careers and leadership in clean energy.
The **Global Lighting and Energy Access Partnership (Global LEAP)** works to facilitate access to affordable, clean, and quality-assured off-grid energy solutions.

Annex III: Acknowledgments

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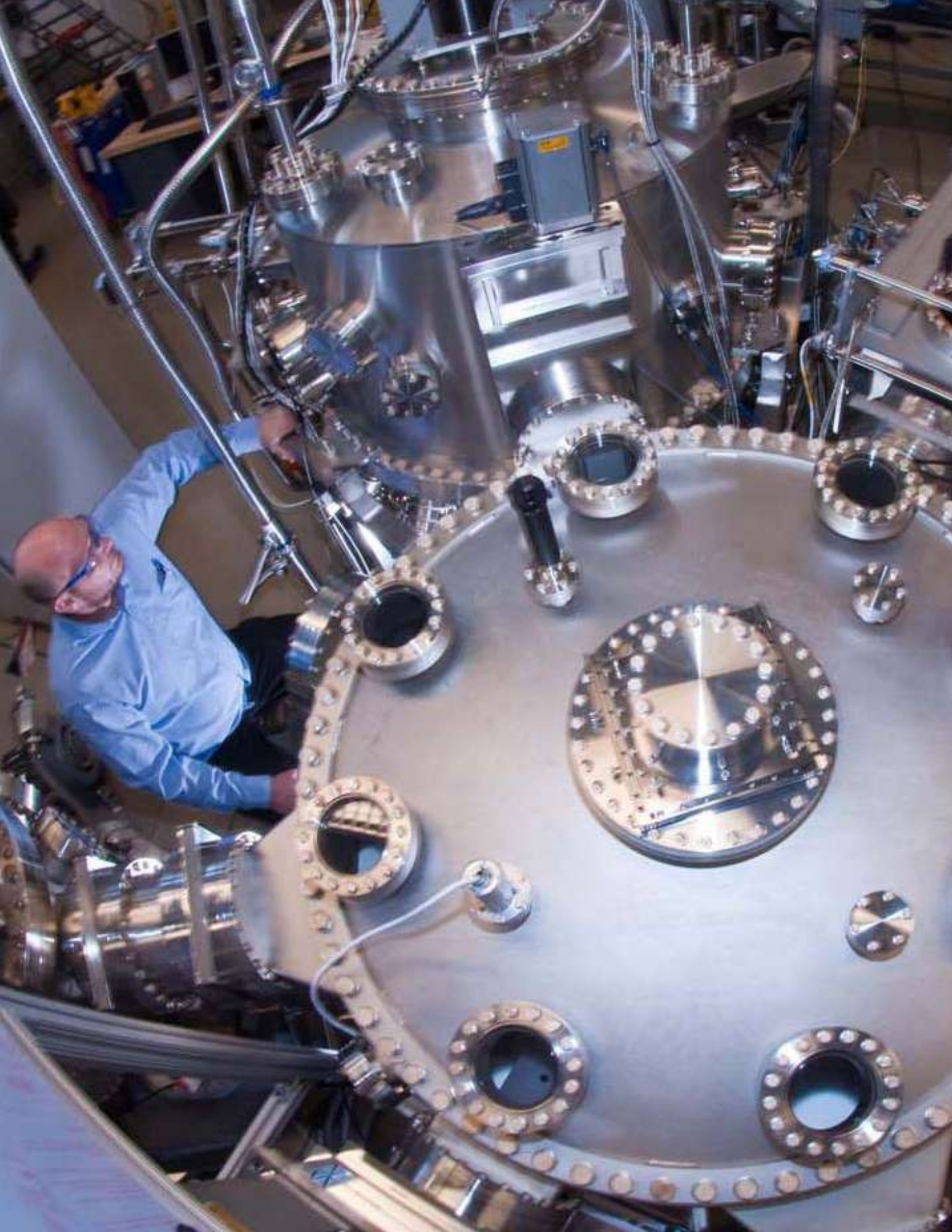

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