

ESMAP Knowledge Exchange Forum: Strengthening Energy Systems in a Time of Technology Disruption

November 29-December 1, 2017
Westminster Conference Center | London, England



1 High level summary

From November 29 to December 1, 2017, the UK Department for International Development (DFID) and the UK Department for Business, Energy & Industrial Strategy (BEIS) hosted the 2017 ESMAP Knowledge Exchange Forum (KEF). The event was organized by the World Bank Energy Sector Management Assistance Program (ESMAP) with assistance from the Consensus Building Institute (CBI).

ESMAP is a global knowledge and technical assistance program administered by the World Bank. ESMAP assists low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

The 2017 ESMAP Knowledge Exchange Forum was a venue for the exchange of knowledge, experiences, lessons and insights among practitioners. The Forum brought together more than 100 participants from World Bank client countries and developed countries, as well as practitioners from international financial organizations, NGOs and private companies.

As technological disruption is spreading from developed to developing countries, the transformation of the power sector is poised to be a key theme for most developing countries in their journey towards achieving Sustainable Development Goal (SDG) 7. In the 2017 London Knowledge Exchange Forum we asked: *What is the future of the energy systems in a time of technology disruption – and how must developing countries seek to adapt?*

Declining costs of renewables and improvements in communications, information and energy technologies present new opportunities for developing countries to increase access to electricity in a sustainable way. These include deploying and integrating variable renewable energy resources and distributed energy resources into the power system, enabling demand side response and energy efficiency, and extending modern electricity services to unserved areas—all of which are key to achieving SDG 7.

With declining costs and surging investments in renewables energy, battery storage, and IT solutions, low-and-medium income countries stand on the threshold of a revolution. Similar developments are already unfolding across the power systems of many developed economies: new business models and services are emerging with the promise of cheaper, greener and smarter electricity, often delivered by new private sector participants. Exploiting the potential benefits brought by new technologies, however, might be at odds with the current business models of the sector. Under this paradigm, transmission, distribution and generation companies must either transform themselves to adapt to a

new reality of rapid technological changes or fight an increasingly difficult battle to preserve their traditional role.

Power systems in developing countries face unique challenges to achieve this transition across the physical system, markets and governance domains. Lack of physical infrastructure to support the integration of new technologies; regulatory frameworks that provide inadequate incentives for utilities to improve their performance and do not open up for private sector participation and market based solutions; and weak institutions incapable of changing the status quo.

The KEF shed light on these issues through 6 sessions spanning over two days:

1. Key Note: Visions of the Evolution of Energy Systems.
2. How will the role of utilities in the future energy system evolve?
3. How innovative off-grid initiatives and improved planning tools are improving access in developing countries?
4. What are the challenges and opportunities of mobilizing commercial capital due to new energy systems?
5. How market-based solutions can unlock power system flexibility through stronger price signals?
6. How can development partners work with national governments to enable the transition to the energy systems of the future? (Closing session)

The sessions involved a mix of presentations and discussion among participants. In addition, on December 1, 2017, participants were invited to join field visits to Thames Water, Europe's largest floating solar photovoltaic (PV) project on the Queen Elizabeth II Reservoir in Greater London and the National Grid Control Center in Berkshire, UK.

Below, we summarize the sessions and the key themes or takeaways that emerged from each of them. All presentations from the event can be found on https://www.esmap.org/esmap_knowledge_exchange_forum2017.

1.1 Opening Addresses

Melinda Bohannon, Head of DFID's Growth & Resilience Department, and Ranjit Lamech, Director of the World Bank Energy and Extractives Global Practice, opened the KEF by providing some initial remarks.

Ms. Bohannon offered four main recommendations for supporting efforts to achieve SDG 7: 1) putting people at the center of our approach; 2) examining issues across the energy system; 3) getting better at early stage grants to small businesses, technical support to governments, and large scale financing; and 4) working more effectively together as donors.

Mr. Lamech emphasized the need to adapt to technological disruptions, and use them to our benefit to deliver on our energy access goals. He suggested that donors need to incorporate innovative approaches for decreasing costs, new business models, and improved data and feedback from consumers into their funding strategies. Mr. Lamech also highlighted the activities and accomplishments of ESMAP in helping to shape the content of the World Bank's energy sector technical advisory work and its \$5-6 billion in lending per year.

1.2 Session 1: Visions of the Evolution of Energy Systems

Rohit Khanna, ESMAP Practice Manager, opened this first session by introducing Dr. Robert Stoner, Deputy Director for Science and Technology of the MIT Energy Initiative. Dr. Stoner then offered a keynote address focused on the following question: *With technology and markets changing rapidly—and longstanding business models with them—what does the future energy system look like and what are the opportunities and challenges for developing countries?*

Dr. Stoner highlighted the impressive strides the world has made towards achieving universal electricity access, especially in the past four years, as well as the significant additional investments that will be needed to achieve universal access by 2030. He emphasized the need to pursue both on- and off-grid solutions, and noted how new planning tools, like the Reference Electrification Model are helping identify least cost solutions at a regional scale. He also suggested that utilities should develop new business models that fully exploit the opportunities offered by new energy technologies) in order to achieve access at the scale needed to accomplish SDG 7.

In the question and answer session, the discussion focused on the need for planning tools to remain flexible and adaptable to changing technologies and market realities, and to allow for innovation. Comments also touched on ideas for further refining the mixed technology utility model, and the importance of improving communication between the public and private sectors to align electrification strategies and efforts.

1.3 Session 2: How will the role of utilities in the future energy system evolve?

Session 2 focused on how the growth of distributed energy resources, the amalgamation of consumers and producers into prosumers, and new remote data acquisition and control possibilities are unlocking innovative ways of providing and charging for energy services.

The session included five speakers, small table discussions in breakout groups, and moderated large-group discussions. The speakers and topics were as follows:

- **Vivien Foster**, Global Lead for Energy Economics, Markets & Institutions at the World Bank, opened the session with an overview of the evolution and future of the utility sector including preliminary insights from ongoing World Bank research.

- **Praveer Sinha**, CEO & Managing Director of Tata Power-DDL, offered a presentation titled “From traditional discom to a smart utility.” It focused on how distributed energy resources are affecting utilities in developing countries and what utilities are doing to transform.
- **Christopher Baker-Brian**, co-founder and Chief Technology Officer of BBOX, presented on the following topic: *How BBOX provides an alternative to grid extensions, how its emerging distance model is adapting lessons drawn from utilities, and the benefits and drawbacks of this approach.*
- **Martin Crouch**, Senior Partner, Improving Regulation, at Ofgem, offered a presentation titled “Adapting regulatory models to drive innovation,” which focused on the UK’s experience in embracing technological change.
- **Pradeep Pursnani**, Chief Operating Officer of the Shell Foundation, made a presentation titled, “The Utility of the Future in Developing Countries,” in which he presented early results from Massachusetts Institute of Technology’s Utility of the Future Phase II study focused on developing countries and sponsored by the Shell Foundation.



Vivien Foster and Sheoli Pargal, ESMAP Lead Energy Economist, served as session moderators.

Following the presentations, participants conversed at their small tables. They were asked to discuss the following questions:

- *What suggestions do you have for taking innovations like the BBOXX distance model and the Tata Power “utility in a box” to scale?*
- *What are the potential benefits and drawbacks to integrating off-grid innovations into the distribution models for utilities in the country or context in which you work?*
- *What barriers and opportunities to implementing the “utility of the future” vision do you see in the country or context in which you work?*
- *What can governments or regulators do to help drive innovative investments in the country or context in which you work?*

During the discussion sessions, participants identified a number of barriers to achieving the vision of a “utility of the future,” including lobbying by incumbents and silos between urban and rural systems. Participants discussed the need for improved planning, but also highlighted the challenges of planning in an unpredictable environment. The conversation touched on the challenge of creating an enabling environment for innovation, while also giving incumbents the confidence they need to invest in existing programs.

1.4 Session 3: How innovative off-grid initiatives and improved planning tools are improving access in developing countries

This session focused on how technological developments, innovative payment schemes, and better data and tools are making off-grid solutions a viable and cost-effective way of reaching the last mile. Global initiatives such as Power for All, Lighting Global, and the roll-out of geospatial planning tools has increased the reach of off-grid solutions, in particular in Africa.

The session included five speakers and a question and answer session. The speakers and topics were as follows:

- **Sophie Johnson**, President of the Renewable Energy Association of Sierra Leone (REASL), made a presentation titled “The challenges of developing an enabling environment for off-grid development.” It focused on how the Sierra Leone Energy Revolution, supported through the Power for All Initiative, is transforming energy services in Sierra Leone.
- **Khant Zaw**, Director General of the Department of Rural Development, Ministry of Agriculture, Livestock and Irrigation, Myanmar, made a presentation titled “Off grid electrification in Myanmar,” which focused on how Myanmar’s National

Electrification Plan is expanding modern solar home systems, mini-grids, and other off-grid approaches to bring electricity to rural and remote communities.

- **Johanna Diecker**, Director of Policy at the Global Off-Grid Lighting Association (GOGLA), offered a presentation titled “The evolution of off-grid business models and how to build environments they can thrive in.” Her remarks addressed the following topic: *Innovative business models allow us to provide energy access to millions of people today. Their impact goes beyond energy access with pay-as-you-go operators providing services beyond electricity. How have these business models evolved? And how can we provide an enabling environment in which they can truly scale and reach hundreds of millions of households?*
- **Yann Tanvez**, Energy Specialist with the World Bank Sustainable Energy Department, Strategy and Operations, offered a presentation titled “The rise of geospatial planning in developing countries.” Mr. Tanvez focused on how new geospatial tools and better data can guide cost-effective investments to improve energy access in developing countries.
- **William Blythe**, Senior Research Fellow at DFID, provided an update to the group on an energy sector roundtable that had been hosted by DFID the day before. Mr. Blythe also served as session moderator.

The discussion session addressed a variety of issues. A number of comments focused on the need for coordination among government actors and across sectors within both Myanmar and Sierra Leone. Others spoke to ESMAP’s role in supporting countries’ planning efforts, and the need for planning to remain flexible and scenario-based. A number of participants asked questions about the ability of market actors to provide access to the poorest consumers, and how governments can use upstream subsidies to support market development rather than inhibit it.

1.5 Session 4: What are the challenges and opportunities of mobilizing commercial capital due to changes in energy systems?

Session 4 focused on how to mobilize commercial investments at unforeseen scale—to leverage billions of dollars of concessional lending with trillions of dollars of private resources – to help power systems across the world meet the Sustainable Development Goal of ensuring access to affordable, reliable, sustainable and modern energy for all.

The session included four speakers, conversations at small tables and a moderated large-group discussion. The speakers and topics were as follows:

- **Alasdair Miller**, Senior Energy Specialist at the IFC, presented on “The Scaling Solar approach towards mobilizing commercial capital for solar investments—the case of Zambia.” His remarks addressed the following topic: *Scaling Solar aims to create viable markets for solar power and make privately funded grid-connected solar projects operational within a short timeframe and at competitive tariffs. How can*

the World Bank and other developing partners collaborate with IFC to build an enabling environment?

- **Vivien Foster**, Global Lead for Energy Economics, Markets and Institutions at the World Bank, offered a presentation titled “The World Bank’s “cascade” approach to mobilizing commercial capital: The Infrastructure Sector Assessment Program (InfraSAP).” The presentation addressed how the World Bank Group and client governments can improve the enabling environment to mobilize commercial capital through a systematic and structured sectoral diagnostic that identifies improvements in sector performance and barriers to investment. The presentation also included a preview of results for the Vietnam Energy INFRASAP.
- **Phil Skinner**, Senior Investment Officer at GuarantCo, presented on the topic “Support for local currency finance for infrastructure projects.” His remarks focused on how the Private Infrastructure Development Group’s GuarantCo scheme support local currency finance in low-income countries, promoting domestic infrastructure financing and capital market development.
- **Cristian Lühr**, Head of Electricity Tenders Unit, Comisión Nacional de Energía, Chile, offered a presentation titled “Chilean experiences leveraging private capital for renewable energy.” Mr. Lühr’s remarks focused on how Chile has leveraged private sector investments in renewable energy generation through its successful renewable energy auctions.



Following the presentations, participants conversed at their small tables. They were asked to discuss the following questions:

- *What strategies do you believe will be effective at taking these financing approaches radically to scale? What are the barriers and how can we overcome them?*
- *What are the key measures countries can take to create an enabling environment for private sector investment, in particular local currency financing?*
- *How can donors and investors best work together to de-risk project financing and attract institutional investments?*

The discussion session focused on a number of topics including the need to increase investments in distribution, not just generation. Participants noted that integrated sector planning can identify whether it will cost less to reduce losses instead of increasing generation. Participants also highlighted lessons learned from experiences in Africa, including the need to be careful about locking in unattractive tariffs, and lessons from Chile around the need to bring multiple stakeholders to the table when designing auctions to understand problems and identify issues.

1.6 Session 5: How market-based solutions can unlock power system flexibility through stronger price signals

This session addressed how market mechanism can be used to mobilize flexible resources to balance the grid, in particular from the demand side, to help integrate variable renewables

The session included three speakers and a question and answer session. The speakers and topics were as follows:

- **Camila Schoti**, Director of Energy at ABRACE (Associação Brasileira de Grandes Consumidores Industriais de Energia e de Consumidores Livres), presented on “Demand-side innovations in Brazil.” Her remarks focused on learning from experience and achievements on demand side response in Brazil.
- **Adam Sims**, SO Flexibility Manager at National Grid, offered a presentation titled “Demand-side management options at the system operator level.” His remarks addressed the growing role of demand response in providing flexibility to help National Grid balance Britain’s electricity system in a cost-effective manner.
- **Yoav Zingher**, CEO at KiWi Power, made a presentation titled “Creating markets to increase demand side flexibility,” which focused on how aggregators can help price signals reach end-consumer and unleash important demand side flexibility.

Debabrata Chattopadhyay, Senior Energy Specialist at ESMAP, served as the session moderator.

The question and answer session focused on messaging to end users about participating in demand response programs, messaging around the inclusion of demand response

capabilities in power system operations, and the benefits of demand response both to program participants and to utilities. There were a number of comments focused on how to build new markets for demand response in countries where it does not exist, but could be very helpful.

1.7 Session 6: How can development partners work with national governments to enable the transition to the energy systems of the future?

Session 6 was a Davos-style session moderated by Ranjit Lamech, Director of the World Bank's Energy and Extractives Global Practice. The session focused on how various donor-led support programs and financing instruments add up to transform power systems and create an enabling environment for new services and on what can be done to increase the efficiency of development partner support to governments and utilities.

The session included the following speakers:

- **Chris Chijiutomi**, Investment Director at CDC Group
- **Peter Hilliges**, Head of Division and Climate Policy Coordinator, Competence Centre Climate and Energy at KfW Development Bank
- **Mi Mi Khaing**, Director General in the Department of Electric Power Planning, Myanmar
- **Camila Schoti**, Director of Energy at ABRACE
- **Steve Beel**, Country Lead, Cities Infrastructure for Growth Programme at DFID Zambia

Each of the speakers offered opening remarks, which focused on different issues. Mr. Chijiutomi noted that CDC Group is currently focused on providing financing for complex grid systems rather than off-grid initiatives, while Mr. Hilliges noted that KfW Bank cannot be as agile as some other development partners due to its role as a bilateral development bank. Mi Mi Khaing provided detailed background on Myanmar's National Electrification Plan and the need for a significant amount of additional investments. Camila Schoti highlighted the need for ESMAP and the World Bank to spread knowledge to various actors about the positive impact of energy sector transitions, to increase buy in. Mr. Beel emphasized the importance of looking at the whole energy system in order to identify the right priorities for government and donor resources.

Following these opening remarks, participants engaged in an open discussion among themselves and with members of the audience. The discussion touched on a number of themes. Using Myanmar as an example, the speakers highlighted the need for national governments to create an enabling environment for private sector investment, so donors expect their investments will be sustainable. They also discussed the need for donors to coordinate their actions and support governments in their negotiations with the private sector.

Members of the audience offered comments noting the challenges that client countries face if donors are not coordinated, for example if they need to have conversations with multiple different donors, all of whom have different priorities.

1.8 Closing Remarks

Steven Hunt, Senior Energy Innovation Advisor at DFIF, and Rohit Khanna, Practice Manager at ESMAP, offered closing remarks. Mr. Hunt reflected on how well the group had done accomplishing the initial goals laid out by Melinda Bohannon in her opening remarks: focusing on people, taking a systemic view, connecting the dots among donors and approaches, and speaking with one voice to maximize impact. He suggested the group had done an admirable job addressing these challenges and expressed gratitude to the event hosts and organizers.

Mr. Khanna focused his remarks on three key takeaways from the conference: 1) the lines between on and off-grid are becoming blurred, 2) the role of utilities in the future is going to evolve, and 3) planning clearly matters, although plans less so. He closed the KEF by thanking all the ESMAP donors, and the teams from DFID, BEIS, CBI and ESMAP.

2 Detailed summary of sessions

The following sections provides a detailed summary of each session of the KEF.

2.1 Opening Addresses

2.1.1 Session Summary



Rohit Khanna, Practice Manager at ESMAP, opened the KEF by thanking DFID and BEIS for hosting the event. He expressed excitement at the program that had been planned, and introduced the opening speakers: Melinda Bohannon, Head of DFID's Growth and Resilience Department, and Ranjit Lamech, Director of the World Bank Energy and Extractives Global Practice.

Remarks by Melinda Bohannon

Ms. Bohannon offered her remarks on behalf of Lord Bates, UK Minister of State for International Development, who had been scheduled to speak but was unable to attend. Ms. Bohannon began by emphasizing the importance of energy within DFID's economic development strategy: Energy is the lifeblood of modern economies. Energy makes businesses large and small more productive and competitive, and it improves social conditions for the poor, especially women and girls. At current rates of growth, however, there will not be universal energy access in sub-Saharan Africa until 2080.

Ms. Bohannon suggested that if we are to be successful in tackling this challenge, all stakeholders will need to work together. There are four main things we need to do.

First, we need to put people at the center of our approach. We need to consider the energy needs of people from all backgrounds, including youth and people with disabilities. Within DFID, we need to demonstrate tangible results and deliver human impact stories to UK taxpayers.

Second, we need to examine issues across the energy system. For example, it may not be good value to promote increased generation capacity if there is old and costly distribution infrastructure, or if the costs of connecting to this capacity make it unaffordable for the poorest consumers. The whole energy sector needs to be on strong footing. Where it is not, that often means heavy subsidies to utilities and public debt.

Third, we need to get better at early stage grants to small businesses, technical support to governments, and large scale financing. DFID recently launched a new strategy through CDC, the UK's Development Finance Institution, to make sure the UK contributes as necessary to scale-up of private finance. The UK is also supporting local currency financing through the Private Infrastructure Development Group. These efforts will only be effective if we work simultaneously with government partners.

Fourth and finally, we need to work more effectively together. DFID needs to work more closely with other UK government departments, especially BEIS. We also need to work more effectively together as a donor community, with the World Bank and ESMAP, to develop a coherent and relevant package of support. DFID acknowledges the critical role of ESMAP and will continue to contribute to ESMAP's business plan.

Ms. Bohannon concluded by reaffirming the UK's commitment to turn billions of dollars of concessional lending into the trillions of dollars of private sector investment needed to achieve Sustainable Development Goals by 2030. She also relayed Lord Bates's hope that the KEF would help strengthen existing partnerships and foster new ones.

Remarks by Ranjit Lamech

Ranjit Lamech began his remarks by expressing gratitude to all the participants, including colleagues from government agencies, client countries, private sector partners, and donor partners, as well as to DFID and BEIS for hosting the KEF. He suggested that the KEF is an excellent opportunity to bring people together to share informal experiences and insights, and help us achieve our goals for clean, sustainable, reliable and universal energy for all.

Mr. Lamech offered reflections on the conference theme of technological disruption, noting that it is everywhere in the energy sector. We need to adapt to these disruptions, and use them to our benefit to deliver on our energy access goals.

There are at least three key aspects to technological disruption: approaches for decreasing costs, innovative business models, and improved access to data and feedback from consumers. Improved access to data and feedback allow us to better understand what consumers want. Each of these approaches needs to be incorporated into donors' strategies.

Mr. Lamech continued by highlighting the activities and accomplishments of ESMAP. ESMAP has been active in this space for many years. ESMAP has shaped the content of the World Bank's energy sector technical advisory work and its \$5-6 billion in lending per year. Conservatively, 80-90 percent of the Bank's energy lending and 90% of its technical advisory work is driven, supported, and incubated by ESMAP. Over the past three years, ESMAP-driven programs, like the Lighting Africa program, have delivered electricity to over 20 million people. ESMAP intends to scale up this work into a "Lighting Global" program.

We still need to do more. In Kenya, for example, the Kenya Power and Lighting Company (KPLC) has been able to increase its rate of providing connections in slums from 5,000 to 100,000 people per year through the last mile grid electrification program. KPLC has also used new approaches with mini-grids. These approaches create transformations in thousands of people's lives. Farmers have new tools, and women do not have to travel back and forth to village wells.

ESMAP's Renewable Energy Resource Mapping Program has also had a dramatic positive impact. Two key outputs, the Global Solar Atlas and the Global Wind Atlas provide quick and easy access to solar and wind resource data globally and continue to help World Bank client countries plan for large-scale solar PV and wind energy developments.

Government ministers can use these tools to understand the renewable energy resources available in their regions, and make informed decisions to pursue new renewable energy projects. Much of the Bank's \$1 billion in annual renewable energy lending is supported by ESMAP seed money, through resource mapping and the design of country level programs in Vietnam, Pakistan and elsewhere.

ESMAP has also provided valuable support around critical issues like energy pricing policies, targeted fiscal support for vulnerable consumers, and building institutional capabilities. In Egypt, for example, the World Bank team, with ESMAP support, decreased the fiscal burden of energy subsidies by 50%. Prices have gone up, and there is now demand for energy efficient investments along with targeted support for vulnerable customers. Because it can be so challenging politically for countries to raise prices, even by a small amount, ESMAP is helping governments design programs to understand who will be impacted by price increases, and how to protect the vulnerable.

ESMAP 's Efficient, Clean Cooking and Heating (ECCH) collaboration is another very successful initiative. It uses a few simple technological tweaks to transform a 20% efficient stove into an 80% efficient stove and has enormous energy efficiency benefits, pollution reduction benefits, and health benefits.

Mr. Lamech concluded by reiterating the critical need to scale up investments in the energy sector, and expressing his eagerness to engage in a productive, participatory, and exciting few days of programming.

2.2 Session 1 Key Note: Visions of the Evolution of Energy Systems

2.2.1 Session Summary

In this session, Dr. Robert Stoner offered a key note presentation addressing the following question: *With technology and markets changing rapidly—and longstanding business models with them—what does the future energy system look like and what are the opportunities and challenges for developing countries?*

Rohit Khanna, Practice Manager at ESMAP, opened the session by introducing Dr. Stoner and the topic. Dr. Stoner then offered his plenary remarks. There was also a question and answer session following Dr. Stoner's presentation.

Remarks by Dr. Robert Stoner

Dr. Stoner focused his remarks on the unique opportunity that has arisen to use low cost, increasingly capable off-grid technologies to provide electricity services to off-grid consumers in developing countries. He suggested that doing so could also provide the many unprofitable utilities in these countries, and notably in sub-Saharan Africa, the space to reorganize and expand rapidly and profitably. Overall, he made the case for rigorous, detailed planning and reform of regulation and ownership to facilitate a concomitant expansion in financing.

Dr. Stoner began his remarks by noting the impressive strides towards achieving universal electricity access globally, especially in the past 4 years. Projections from the International Energy Agency (IEA), suggest we might achieve close to universal access in South Asia by 2030, if governments adopt progressive policies in step with SDG 7, at a cost of \$330 billion in total energy system investment.

The story is quite different in sub-Saharan Africa, where we have effectively hit a wall. By 2030 in sub-Saharan Africa, the number of un-electrified households may in fact be larger than it is now.

IEA projections suggest that a very large fraction of new connections will be made with off-grid technologies, including stand-alone solar home systems and mini-grids. The commercial viability of stand-alone systems, including so called Pay-As-You-Go or PAYGO systems has improved in recent years due to falling costs in PV and battery technology, and the emergence of energy efficient appliances. PAYGO firms grew at a rate of 140% per year from 2012-16. PAYGO firms are also using their remote system connections to collect not just payments, but also significant amounts of customer data, helping them to decide what to sell, to whom, and at what price. They are becoming increasingly like de facto wireless utilities.

Grid connection costs have not fallen in line with those of PAYGO systems, due to their use of materials like wires, poles, and transformers with costs that stay relatively constant over time. In many rural areas, the costs of distribution lines and maintenance make it prohibitively expensive to expand the grid.

In many locations, where it is not economical to expand the grid, mini-grids may be the most cost-effective option. By aggregating small solar panels, generators, batteries, and electronics into centralized facilities, they can reduce operating, maintenance and capital costs as compared to stand-alone systems.

The IEA has offered two different projections for expanded electricity access: the “New Policies Scenario,” in which governments adopt progressive policies in step with SDG7, and the “Energy for All Scenario,” which posits 100% energy access for all by 2030. Under the New Policies Scenario, one third of new connections between now and 2030 are by mini-grid. This figure rises to almost one half of all new connections in the Energy for All Scenario.

Dr. Stoner’s and his colleagues at MIT and IIT-Comillas have developed a tool called the Reference Electrification Model, which looks at very large service areas, such as the state of Bihar in Northern India, or Sokoto in Nigeria, Cajamarca in Peru, or even an entire country such as Rwanda, and informing on what combination of electrification modes provides the least cost service overall. The Reference Electrification Model is highly sensitive to different assumptions. For example, if the model assumes 100% grid reliability in a given area, it may suggest significant grid expansion as the least cost approach overall.

If grid reliability decreases slightly, the balance may shift significantly to mini-grid or off-grid delivery. A change in diesel price from \$2/liter to \$1/liter would have a similar impact, under the model. For this reason, Dr. Stoner recommends planners rerun Reference Electrification Model from time to time as events unfold, adjusting prices and policy incrementally to keep the plan headed along an optimal path.

Despite their cost-savings, mini-grids have been slow to appear for a number of reasons, such as the need for metering, distribution system design and layout, protection of the centralized generation site, and some degree of community cohesion including willingness and ability to pay. Another factor is the difficulty in investing in a technology that may be obsolete if the grid arrives in a few years.

The reality in sub-Saharan Africa and other parts of the developing world is far from optimal. Unprofitable publicly owned utilities with high system losses are under pressure to expand. Stand-alone systems of varying quality proliferate near cities, where distribution and maintenance costs are lowest. For most countries, service costs are too high, subsidies are inefficiently allocated, and progress toward universal electrification is too slow. In places where consumers have limited availability to pay and electrification infrastructure in rural areas needs to be deployed de novo, funding grid expansion through cross subsidies is not a viable option.

None of this has to be this way. The World Bank recently showed that, even at present tariff levels, between a third and half of African utilities could be profitable, or nearly so, if they attained world-class operations. A new utility model could succeed at delivering universal access efficiently and at affordable rates. The model, which has been developed with the Shell Foundation, involves seven elements:

1. The universal service obligation that any utility has within its service district must be preserved.
2. The timeframe for achieving access must be negotiated between the government and utility, motivated by a system of incentives and penalties.
3. The utility should have planning responsibility for all wired service, whether provided by grid extension, or mini-grid.
4. The utility must offer and support a range of approved off-grid systems capable of meeting demand to those without wired service. This does not preclude competitive off-grid services being offered by other firms.
5. The government must determine and provide indirect and direct subsidies that ensure universal access.
6. The utility should decide when to expand wired service under an orderly process that protects investors and consumers.
7. Planning and subsidy allocation should take into account the cross-subsidization opportunities presented by existing productive loads, as well as from future productive loads.

To enable private investors to bring their technical and business skills to this new model, governments should look to the example of Tata Power Delhi District Ltd. (TP-DDL), a public-private partnership in the form of a joint venture with significant minority ownership retained by the New Delhi government, and majority ownership held by a private company. TP-DDL has brought a significant improvement in service to its customers, and incorporated a high level of automation and fault tolerance into its revamped system.

While off-grid initiatives will be critical, there is also an important role for large-scale, centralized electric power generation in achieving universal energy access. The future likely involves a system in which households, small businesses, schools, factories, generators large and small, storage facilities, and many distributed sources of all sizes will be connected together through a very smart, semi-autonomous grid.

Our focus moving forward should be to use optimal planning tools and well-designed public private partnerships to engage the private sector while providing assurance to governments that universal access will be achieved affordably and faster. At the same time, we should not lose sight of the need to provide the hundreds of gigawatts of grid connected power—centralized and decentralized—necessary to power economic growth. Both are equally important aspects of the same project.

2.2.2 Questions and Answer Session

During the question and answer session, questions and comments from the audience touched on a variety of themes.

Understanding and refining the Reference Electrification Model

A number of questions focused on the nature of the Reference Electrification Model and how it works. For example, one participant asked about how the model accounts for changes in consumers' increasing ability to pay for electricity as improved energy access catalyzes economic growth. Relatedly, another participant suggested that some load estimations and demand profiles do not accurately reflect the reality of what consumers are willing to pay or where they see themselves in five to ten years, and that accounting for these differences is critical for effective planning. This participant noted that a bottom-up modeling exercise from Practical Action has looked more closely at customers' needs, wants, and expectations. Another participant asked about how the model estimates electricity loads and the assumptions it uses.

Dr. Stoner agreed that energy demand will grow and over time this will make certain customers become more attractive to the grid. He also expressed interest in reviewing the study from Practical Action. With respect to the assumptions the model uses for electricity load estimates, Dr. Stoner explained that they obtain information about load in aggregate, develop more specific estimates based on size and other factors, and then

try to “ground truth” these estimates. When it comes to developing individual micro-grids, it is still important to go to the community and conduct a survey.

- *Applying the Reference Electrification Model*

Some participants focused their questions on where and how the Reference Electrification Model can be applied, and the kinds of questions it can help to answer. One question asked whether one could overlay information from the REM with household surveys and use the information to develop market outlooks. Dr. Stoner clarified that model has a number of different uses. It can be used by planning organizations, by regulators to calculate tariffs or determine a fair subsidy, or by entrepreneurs interested in knowing where and what to build. And yes, it will be offered to businesses to use for market analyses as the questioner suggested.

Another question focused on how the Reference Electrification Model might be used to help connect conversations around cooking energy to conversations about planning, by modeling cooking energy access. Dr. Stoner clarified that yes, it is possible to model cooking energy access. They would simply go into an area, find out what applications are in use and their loads, and include them in the model. They could then model the impact, for example, of introducing 30-watt induction stoves to the area.

- *The mixed technology utility model*

Many of the comments and questions touched on Dr. Stoner’s ideas regarding the mixed technology utility model, and how this model might need revision or adjustment. One comment questioned the virtues of handing over planning responsibilities to utilities, given their inefficiency and politicization. Another suggested that centrally planned utilities are part of the problem, not the solution, and that the focus should be on allowing competition among delivery models rather than central planning.

In response to these comments, Dr. Stoner provided some clarity on the mixed technology utility model. He noted that utilities have always had planning responsibilities, but under this new approach they would be relieved of the obligation to provide services via the grid. The model involves letting the utility shed unprofitable customers and allowing other distributors to move in. In addition, the utility might be a joint enterprise, and include private sector actors who can help decide where to offer the grid, where to use micro-grids, and where to use standalone systems. Dr. Stoner further clarified that the Reference Electrification Model is not intended to be a tool for centralized planning. Rather, the idea is to support local planning at the level of the service district instead of centralized planning.

Another participant questioned the idea of seeking technological optimization within defined geographic areas. The participant suggested that this model assumes it is

possible to effectively utilize a regional concessions approach. The participant suggested it would be more effective to provide investor optimized strategic management, and embrace whatever financing proposition and business model is offered by the investor.

Dr. Stoner suggested that regardless of the exact model, the two key ingredients for success are significant amounts of money and a critical mass of skilled actors. The best model for identifying and leveraging those two resources will depend on the country. In some countries, for example, the government will be willing to part with a portion of the national utility, while in others it will not.

Lastly, a participant questioned whether Dr. Stoner's model might involve different consumers paying a different amount for energy access, depending on their income level and ability to pay. Dr. Stoner noted that by virtue of subsidy programs attached to the mixed utility model, there would be some minimum guaranteed access for people who cannot afford to pay. He further noted that urban consumers subsidize rural consumers, for whom accessing the grid is more expensive, even in the developed world. Every society will need to strike its own "deals" around subsidies for the poor.

- *The need for planning*

Another theme that emerged during the discussion was the tension between planning and innovation. A participant noted that while long-term planning seems important to the World Bank and to governments, the private sector only cares about it to a certain degree. The private sector inevitably moves much faster than anyone can do modeling, as reflected in the massive technological innovations in off-grid solar over the past five years. This reality suggests that the focus should be on the level of energy access provided, not the distribution model.

Another participant countered that planning is critical for providing direction to smart public and private sector investments. The lack of effective planning in sub-Saharan Africa has led to decades of failing utilities and unsustainable subsidies. The key is for donors and governments to organize themselves around a single plan, in order to define the space for investment and direct it towards its most impactful use. For example, there is no point in spending billions on IPPs when losses are 50%. Neither the public nor the private sector has all the solutions, and they need to spend more time talking to each other to develop effective plans.

Dr. Stoner replied that the idea behind the Reference Electrification Model and other planning tools is not just to plan once and then implement the plan. Rather, planning tools should be run frequently and updated continuously as technology advances. This means being closely engaged with firms developing new technologies, so the technologies can be built into the model effectively. Nevertheless, he conceded that there might still be technological "game changers" that make long-term planning

almost useless, for example if a large number of standalone PAYGO systems could be strung together into micro-grids, and effective communications system developed to manage them.

- *Improving communication between the public and private sectors*

Some of the conversation focused on the need for improved collaboration between the public and private sectors, including at conferences like the KEF. One participant pointed out that most of the participants in the KEF appeared to be from the public sector. The participant suggested it is not enough to have theoretical conversations among mostly government actors if the private sector is not present to offer insights on what will work in the market, just as it is not effective for private sector actors to have conversations without accounting for what will work from a regulatory or political point of view. A number of participants echoed the refrain that the public and private sectors need to speak more with each other and collaborate more effectively.

- *Other comments*

Some additional comments and questions did not fit easily into any of the categories above. One participant noted that while it is politically difficult to increase electricity tariffs, people in fact pay significant sums of money for small quantities of energy through candles, batteries, and kerosene. This reality, the participant argued, suggests that these consumers' willingness to pay for electricity may be higher than we assume.

Dr. Stoner agreed that people pay more per unit of energy using things like batteries or candles, but he noted that with these purchases they are buying only a very small quantity of energy. Overall, the fundamental challenge of expanding energy access is that the grid is too expensive if consumers do not buy enough units of electricity, because of the high fixed cost.

Another participant asked if Dr. Stoner was aware of good case studies of mini-grid operators being cooped into the grid once it arrives. Dr. Stoner was not aware of such case studies, but noted that in practice there are areas in India where both the grid and a min-grid operate side-by-side, because the grid is so unreliable. This suggests grid operators in those locations need to look at their system and make investments for reliability before extensions.

Rohit Khanna closed this session by thanking Dr. Stoner and the participants for their thoughtful remarks and questions.

2.3 Session 2: How will the role of utilities in the future energy system evolve?

2.3.1 Session Summary

Session 2 focused on how the growth of distributed energy resources, the amalgamation of consumers and producers into prosumers, and new remote data acquisition and control possibilities are unlocking innovative ways of providing and charging for energy services.

The session began with introductory remarks from Vivien Foster, Global Lead for Energy Economics, Markets and Institutions at the World Bank. Participants then divided into two breakout groups. The first breakout session, labeled “Smart delivery on- and of-grid,” focused on specific innovations that utilities and other actors are experimenting with right now. It featured remarks from Praveer Sinha, CEO of TATA Power Delhi Distribution Ltd. (Tata Power DDL), and Christopher Baker-Brian, CTO and co-founder of BBOX. The breakout session was moderated by Sheoli Pargal, Lead Energy Economist at ESMAP.

The second breakout session was labeled “Drivers of evolution for utilities” and focused more on the big picture—what business models might make sense for “the utility of the future” and how regulators can help create an enabling environment to encourage innovation. It included presentations from Martin Crouch, Senior Partner at Ofgem, and Pradeep Pursnani, COO of the Shell Foundation. The breakout session was moderated by Vivien Foster.

Following the speakers’ presentations within each of the breakout sessions, participants were asked to discuss a set of questions at small tables. They then reported out key insights from these small table conversations to the rest of the breakout group, and participated in a moderated discussion with the breakout group speakers. The discussion questions, key insights, and back-and-forth with the speakers are reported below.

Remarks from Vivien Foster

Vivien Foster opened this session with an overview of the evolution and future of the utility sector including preliminary insights from ongoing World Bank research. Slides from her presentation are available on the ESMAP website at http://esmap.org/esmap_knowledge_exchange_forum2017.

Ms. Foster began by displaying a famous set of photos of the Easter Parade on 5th Avenue, New York City. The first photo, from 1900, showed no cars and just horses, while the second photo from 1913 showed only motorized cars and no horses. Within only 13 years, transportation in New York City had completely transformed. Some people argue that we are now in the midst of similar era of disruption in the power sector.

Ms. Foster then asked the audience to raise their hand if they agreed with the following statement: *The time has come to start focusing more on unleashing the transformational power of distributed generation, and less on traditional institutional reforms to fix ailing utilities.* About half the participants agreed with the statement, much like when this question was asked at the World Bank's Energy and Extractives Practice retreat. This suggests there is an emerging cleavage between those who think we should strive into future and those who think we still have a lot to fix in the traditional approach.

New technologies are transforming the energy sector. Consumers are turning into producers. It is possible in most advanced markets for distributed grids to support locally competitive markets. There are improved tools for demand response, and electric vehicles that can store off peak power, allowing us to flatten the load profile, and reduce the sunk capital that's just available to serve peak demand. All of this means huge potential savings.

Despite this first wave of technological improvements, we still need a second wave. In supporting this second wave, we need to remember three lessons. First, we need to radically rethink electricity pricing. Currently we use volumetric charges, but the cost structure is not volumetric. With increasing renewables the cost structure is becoming less volumetric than it ever was. We need prices that vary by time and location.

Second, we need to put in place appropriate regulatory regimes with flexible incentives for innovation, for example through forward-looking multi-year regimes and outcome-based performance incentives. Third, we need to allocate institutional roles to avoid conflicts of interest and abuse of power, for example through unbundling system operator, system planning and market platforms.

The developing world is still struggling to implement the first wave of power sector reforms. This first wave of reforms focused on four areas: 1) the development of an independent regulatory agency, 2) private sector participation in distribution, 3) unbundling of distribution utilities, and 4) the development of power markets. Progress on these reforms in the developing world is lagging. While many countries have a regulatory agency, they often lack capacity and independence. About half of developing countries have tried private sector participation in distribution, but this affects only about a quarter of utilities. Only one in three developing countries have fully unbundled distribution utilities, and only one in five have wholesale or retail power markets. The pace of market reforms has been steadily slowing since 2005, and barely a dozen developing countries score above 80 on the World Bank's Power Sector Reform Index.

In rural areas, the trend towards electrification has been relatively flat since 1990, due to the high cost of grid extension, affordability challenges, and weak incentives for utilities. However, new technologies—such as the falling costs of solar PV, efficient appliances, digital innovation in payment, and improved mini-grid and off-grid models—have the potential to rapidly accelerate access.

New technology will have different impacts in the developed and the developing world. For developed countries, the focus is on improving the efficiency and resilience of established urban networks. In the developing world, the initial focus is instead on off-grid approaches, and the possibility of leap-frogging traditional grid expansion in urban contexts where conventional grids are deficient.

A number of key policy questions remain unanswered, specifically:

- Do developing countries need to complete the first wave of power sector reforms before embarking on the second wave?
- How much of a difference can disruptive technologies make in traditional state-owned monopoly sectors?
- Is the threat of grid defection in developing countries larger (due to poor quality of service) or smaller (due to subsidized tariffs)?
- Is leapfrogging to decentralized generation with storage a real possibility in developing markets? If so, is it desirable?
- How do emerging policy prescription for OECD countries need to be adapted to the developing world context?

2.3.2 Breakout Group 1

As noted above, the first breakout session was labeled “Smart delivery on- and of-grid.” It featured remarks from Praveer Sinha and Christopher Baker-Brian and was moderated by Sheoli Pargal.

Remarks from Praveer Sinha

Praveer Sinha offered a presentation titled “From traditional discom to a smart utility.” It focused on how distributed energy resources are affecting utilities in developing countries and what utilities are doing to transform. Slides from his presentation are available on the ESMAP website at http://esmap.org/esmap_knowledge_exchange_forum2017.

Mr. Sinha began his presentation by providing background on Tata Power DDL, and how it has transformed electricity distribution to 6 million consumers in the North and North-west parts of Delhi. Tata Power DDL is a joint venture between the Government of the National Capital Territory of Delhi and Tata Power Co. Ltd., which holds a 51% majority stake in the venture. Over the past 15 years, it has dramatically improved metering, billing, collection, customer service, system reliability, and reduction of AT&C losses, among other measures. It has brought significant savings to the Indian government as a result of financial prudence, government support, a conducive regulatory environment, effective change management, and implementation of world-class technology and network upgrades.

The second part of Mr. Sinha's presentation focused on macro level questions, including how the India power sector is transforming itself, and what on- and off-grid solutions can be used in rural areas. Indian generation capacity is only 50%, which is far too low. This is the case in part because utilities are greedy. 70 utilities say that they are bankrupt. They have not been able to transform. The question is whether we should push them to change or look at another model.

The Indian government has huge plans to add renewable energy capacity. The plan is to add 175GW of new capacity by 2022. It will be key to ensure all this new capacity reaches the end consumer.

In India, a village is considered electrified even if only 10% of households have electricity for eight hours a day. Most people in villages do not have reliable electricity and utilities typically do a poor job repairing electricity infrastructure. We need to figure out how to maintain the lights. Micro-grids can be an option. They are expensive but India is working on a model to decrease the cost.

Technological innovation is allowing Tata Power DDL to use the Reference Electrification Model (REM), which was discussed during Dr. Stoner's presentation. The company can use an optimized cost electrification model to help it decide what delivery option (grid extension, micro-grid, or off-grid) will be most cost-effective in which locations.

The future in rural areas will include a mix of solar home systems, hybrid micro-grid systems, off-grid systems with energy storage, and virtual grid extension. The future in urban areas, on the other hand, will include decentralized generation, distributed energy storage, smart meter communication technologies, intelligent substations, and other tools focused on increasing the reliability, sustainability, and efficiency of the grid. Advances like smart metering cannot happen unless we have the right technologies.

Regardless of the exact future we arrive at, Tata Power DDL is moving from a conventional utility to a distributed utility.

Remarks from Christopher Baker-Brian

Christopher Baker-Brian's presentation was titled, "An emerging distance model." It addressed the following topic: *How BBOXX provides an alternative to grid extensions, how its emerging distance model is adapting lessons drawn from utilities, and the benefits and drawbacks of this approach.* Slides from his presentation are available on the ESMAP website at http://esmap.org/esmap_knowledge_exchange_forum2017.

Mr. Baker-Brian began by offering some background on BBOXX. BBOXX is a venture-backed company developing solutions to provide affordable, clean energy to off-grid

communities in the developing world. The company works with communities far away from the grid, where off-grid solar can be an economical solution. BBOXX was founded in 2010 with two university colleagues after two years running a charity. It initially targeted Rwanda, and then East Africa more widely.

When they founded the business, there was very little investment in off-grid solar systems. In last few years, however, there has been a large injection of commercial capital in the off-grid space. BBOXX hopes to combine technology finance and distribution innovation to become a next generation utility that powers the growth of the developing world.

The virtual solar grid is BBOXX's answer to the world's electricity shortage. BBOXX gathers data about customer habits and needs, and reinvests the data into strengthening its products. Its model has been accepted in many countries, including Rwanda and Togo, where it has program to electrify populations through off-grid technology.

The company uses the data it collects on both the customer side and product side to predict customer utilization and use that information to strengthen its business model. It can predict going forward the level of customer service requests, and respond more effectively to demand. BBOXX can be more expensive than the grid, but customers value its quality of service.

In terms of challenges, the off-grid solar space is in need of more financing—roughly \$300 billion is needed in total. They also need a developing world work force. BBOXX's model requires a large team to reach every community. It trains staff and uses technology to help them be more effective.

Mr. Baker-Brian suggested that BBOXX should be seen as a next generation energy business, focused on data collection and the deployment of a virtual solar grid. It is using data and technology to provide quality electricity, de-risk investments, and bring down the cost of capital. The future of the company involves moving up the energy ladder as its customers require access to more products and services.

2.3.3 Discussion

Following the presentations from Mr. Sinha and Mr. Baker-Brian, participants met in small table groups to discuss the following questions:

- *What suggestions do you have for taking innovations like the BBOXX distance model and the Tata Power "utility in a box" to scale?*
- *What are the potential benefits and drawbacks to integrating off-grid innovations into the distribution models for utilities in the country or context in which you work?*

Participants then returned to the larger breakout group to report on key insights from their table conversations and engage in a moderated discussion with the speakers. The discussion touched on the following themes:

- There are key challenges in the off-grid space revolve around connectivity and tracking performance
- There are questions around the profitability of off-grid solar units and how this changes with time as mini-grids start to compete
- In pursuing SDG 7, we should consider how to de-fragment the market and align our various delivery models.
- Energy planning and partnerships have important roles in our pursuit of SDG 7.
- We should model the short, medium, and long-term prospects for utilities. It is not clear whether traditional utilities can exist in the future.

2.3.4 Breakout Group 2

As noted, the second breakout session was labeled “Drivers of evolution for utilities.” It featured remarks from Martin Crouch and Pradeep Pursnani and was moderated by Vivien Foster.

Remarks from Martin Crouch

Martin Crouch’s presentation was titled “Adapting regulatory models to drive innovation” and focused on the UK’s experience in embracing technological change.

Mr. Crouch’s presentation addressed three main topics: the context of the British energy sector, innovations we are seeing, and how regulation should respond.

Although we tend to think of the electricity sector as having four main parts –generation, supply, transmission, and distribution—in practice the boundaries tend to be blurred. In the UK, reforms over the past 27 years have unbundled these services, so that the parts of value the value chain are increasingly separately owned. There is competition in generation, and support contracts for renewables (and new nuclear) and for capacity. There is competition in the retail market through a two-tier market. They are also re-introducing price caps in areas where competition hasn’t worked. There are also revenue caps for monopoly networks.

Over the last 17 years, there has been an increase in gas and renewable generation, and a decrease in coal, oil and other thermal generation. In April 2017, for the first time in over 100 years there was a day with zero coal generation in the UK. Renewable prices have been steadily declining. Prices for offshore wind are now not far above wholesale and less than half what they were a few years ago.

Solar PV generation has exploded in the past few years well above even recent government projections, due to declining costs. Those kinds of surprises will happen again as technology advances.

Last year, Ofgem spent some time considering how the energy sector is changing and why. It concluded that in the future, it expects to see an increasingly flexible system, a more decentralised energy sector, increasing interdependence, a more diverse commercial environment, new innovative services for consumers, and whole systems innovations. These changes are being driven by technical change, new business models, consumer behavior, economic developments, the decarbonisation agenda, and policies and incentives.

Ofgem also considered how it might respond to these changes. It arrived at the following conclusions:

- We need to be less prescriptive in how we regulate, and instead use regulatory principles to design for outcomes
- We need to be flexible and iterative, to accommodate changes while protecting consumers' interests.
- We need to foster safe spaces to try new technologies, using a "sandbox" model.
- We need to be open and available, designating specialist teams to work with new market entrants who are trying to create new ideas. Instead of getting out of the way we need to guide them about how to enter the market.

A number of market innovations, like peer-to-peer trading models, are difficult to achieve within the market rules currently in place. Ofgem is interested in trying to enable these innovations, and doing things differently in order to accelerate the pace of change.

Ofgem has also thought about how it can create incentives to encourage innovations among incumbent utilities, which led it to develop the RIIO framework. The framework stands for a formula: Revenue = Incentives + Innovation + Outputs. The formula suggests that the utilities' job is not just to cut costs but to support outcomes needed for low-carbon future.

All of this high-level thinking has been accompanied by specific regulatory innovations. For example, Ofgem has increased the price control period to 8 years to give utilities more time. It has created pots of money that utilities can bid for to deploy new technologies on on their grids. And it is increasingly trying to focus on the outputs companies need to achieve rather than their costs. A lot of these changes have put companies in less comfortable territory, and have required a change in mindset.

Overall, the accelerating pace of change represents a big opportunity for consumers.

In response, regulators need to change the rules to accommodate new technologies and business models coming in. Regulators need to establish enough predictability so that people are willing to invest, while also making changes as the landscape shifts. The goal should be to create consistent principles within which changes can happen. Rather than setting out how utilities should behave in detail, regulators should leave as much as possible to the market. Regulators need to think carefully about prices that are appropriate and send right signals. And they need to support trials and demonstrations, so they can try out different ways of working and learn from them over time.

Remarks from Pradeep Pursnani

Pradeep Pursnani made a presentation titled, “The Utility of the Future in Developing Countries,” in which he presented early results from Massachusetts Institute of Technology’s Utility of the Future Phase II study focused on developing countries and sponsored by the Shell Foundation. Mr. Pursnani did not use slides.

Mr. Pursnani provided background on the work of the Shell Foundation. The foundation is a leading player co-creating businesses that focus on universal energy access, and supporting industry groups like the Global Off-Grid Lighting Association (GOGLA). Its goals are to accelerate energy access and create viable markets for energy access. It has been doing this work for over 15 years through deep partnerships with DFID, USAID and others.

A little more than a year ago, the Shell Foundation began thinking about the concept of an energy company of the future. Given that almost 700 million people globally are without energy access, the foundation realized that a “business as usual” approach would not suffice for achieving SDG 7 by 2030.

They worked with MIT and the law firm Skadden, Arps, Slate, Meagher & Flom LLP to think about a new business model that could drive accelerated change in the sector. Among other things, they sought to answer the puzzle of why some of the largest private sector energy players in world are not very active in the developing world.

They began by looking at challenges at the customer level around reliability, affordability, and dealing with fragmented and unreliable access options. They looked at current market incumbents, like state owned utilities, and how under-capitalized, inefficient, and poorly managed they are; the low levels of service they provide; their high connection costs; and their inability to attract private investment at scale. They also looked at the impressive growth of off-grid market, including PAYGO models and micro-grids. They noticed that this market is mostly focused in East Africa and faces important limitations, such as its small-scale, its potential decreased relevance as energy demand grows, and the risk of stranded assets.

After nine to ten months of work, they created an advisory board with 20 members, including the African Development Bank, the World Bank, some investors, some of the ESMAP Knowledge Exchange Forum

larger corporate actors, and academics. Their main conclusion is they believe there is a strong opportunity for an independent company that serves urban and rural customers to integrate off-grid models and on-grid services. It will use technology to leapfrog existing limitations of the grid, and build strong customer relationships. Its focus will be on distribution and retailing.

The company will have the following characteristics:

- It will be customer-centric and technology-driven.
- It will build off of the off-grid sector.
- It will partner with government, have flexibility to negotiate concessions, and be part of privatization plans.
- It will have a commitment to operate across the energy system.
- It will focus on improving current operations by reducing technical losses and increasing profitability.
- It will bring in long-term financing across value chain.

They concluded that integrating on- and off-grid approaches will be the most resilient model, and the quickest at expanding energy access. They have already seen this model begin to emerge in small pockets, for example in National Grid's recent acquisition of Fenix.

2.3.5 Discussion

Following the presentations from Mr. Crouch and Mr. Pursnani, participants in this breakout session met in small table groups to discuss the following questions:

- *What barriers and opportunities to implementing the “utility of the future” vision do you see in the country or context in which you work?*
- *What can governments or regulators do to help drive innovative investments in the country or context in which you work?*

Participants returned to the larger breakout group to report on key insights from their table conversations and engage in a moderated discussion with the speakers. The discussion touched on the themes below.

- *Barriers to “the utility of the future”*

A number of participants highlighted barriers to realizing the Shell Foundation's vision of a “utility of the future,” and how to overcome them. One of the small groups noted the importance of countering lobbying from incumbents. In countries where incumbents see innovations coming, they can gang up and challenge regulators in the courts or elsewhere. This group also suggested it is important to make subsidies explicit instead of hiding them in tariffs, and that it will be key to make changes in the distribution system operating principles to allow for bi-directional flow and flexibility.

In response, Mr. Crouch noted that having transparent subsidies would be great but it is hard to get political incumbents to sign up for that.

Another small group focused on the challenge of overcoming silos between urban and rural systems. They emphasized the enormous inefficiencies of utilities in many low-income countries, and their budgetary challenges.

- *Planning*

Some participants discussed the need for improved planning, but also the challenges of planning in an unpredictable environment. One participant suggested that the first wave of utility reform might have inadvertently resulted in a decreased capacity for energy planning, and this capacity now needs to be built back up. Another participant highlighted the difficulties of planning effectively with so many unpredictable variables. For example, in countries like Myanmar, it can be difficult to determine where to bring the grid, and this makes off-grid providers worry about whether their assets will be stranded.

Mr. Crouch acknowledged that it can be difficult to know who is responsible for planning, even in a developed market like the UK. He noted that in the UK, the transmission system operator has most of the responsibility for planning. They set up options and future scenarios rather than developing a single system or plan. It is important to be open to the unexpected and move away from a dogmatic approach to planning, recognizing that planning is not as useful as it was even ten years ago. Mr. Crouch suggested that in today's world, we need markets and other systems that allow people to make their own judgments.

- *Is there a future for utilities?*

One of the tables expressed doubt that there will, in fact, be a long-term future for utilities. They commented on the breakdown of trust between utilities and consumers, and the long-term trends away from utilities. They also suggested that much like having one's own car is a status symbol, consumers might want the status of being an "energy island" in their own house. Nevertheless, because the "energy island" model is highly inefficient, there may be a role for utilities or a different business model in managing economies of scale.

- *Enabling financial innovation*

A participant asked for more information on how Ofgem is managing innovations from the financial sector, like peer-to-peer trading and the block chain, and whether the current market structure in the UK is helping or creating friction with these innovations.

Mr. Crouch suggested that there are problems with the current market structure in its ability to accommodate new models. This is in part because we have given

incumbent utilities a lot of say in changes to market rules. Doing this gives the utilities confidence to invest, but makes it harder for new market entrants to innovate. For utilities, the most important and profitable work they do is often marketing and lobbying. While there's no easy solution to this challenge, it needs to change. At Ofgem, they run workshops where no one comes from the incumbent utility, and instead they include consumer groups and new entrants. They also try to avoid allowing incumbents to be speakers at so many of our events.

2.3.6 Closing Remarks

Mr. Baker-Brian, Mr. Pursnani, and Mr. Sinha each offered some closing reflections. Mr. Baker-Brian highlighted the challenge of connectivity in off-grid systems, and how companies like BBOXX can operate effectively in countries where connectivity is a challenge.

Mr. Pursnani noted the importance of marrying on- and off-grid initiatives in achieving SDG 7, and the potential role of energy planning in accomplishing this goal. He suggested we may need dedicate more resources to planning moving forward.

Mr. Sinha suggested that there is a paradigm shift where electricity on the supply side is moving to the demand side. In the short- and medium-term we need to use technology to reduce the costs for edge-of-the-grid solutions in urban and rural areas. We need to look beyond lack of access to issues of partial access, especially in rural areas. Partial access can mean no access for days at a time. We need good, sustainable solutions for hundreds of thousands of villages, and we need them quickly.

Ms. Foster thanked the participants and speakers for their remarks and drew the session to a close.

2.4 Session 3: How innovative off-grid initiatives and improved planning tools are improving access in developing countries

2.4.1 Session Summary

This session focused on how technological developments, innovative payment schemes, and better data and tools are making off-grid solutions a viable and cost-effective way of reaching the last mile. Global initiatives such as Power for All, Lighting Global, and the roll-out of geospatial planning tools has increased the reach of off-grid solutions, in particular in Africa.

William Blythe, Senior Research Fellow at DFID, served as session moderator. He opened the proceedings by summarizing the topic and introducing the speakers: Sophie Johnson, President of the Renewable Energy Association of Sierra Leone (REASL); Khant Zaw, Director General of the Department of Rural Development, Ministry of Agriculture, Livestock and Irrigation, Myanmar; Johanna Diecker, Director of Policy at the Global Off-Grid Lighting Association (GOGLA); and Yann Tanvez, Energy Specialist with the World Bank Sustainable Energy Department, Strategy and Operations. Mr. Blythe also offered some prepared remarks of his own, presenting off-grid related conclusions from the DFID energy planning roundtable, which had taken place the day prior. There was a question and answer session following the speakers' remarks.

Remarks from Sophie Johnson

Sophie Johnson made a presentation titled “The challenges of developing an enabling environment for off-grid development.” It focused on how the Sierra Leone Energy Revolution, supported through the Power for All Initiative, is transforming energy services in Sierra Leone.

Ms. Johnson provided background on Sierra Leone and its energy sector. The country has a population of 7 million but generates only 100 megawatts of electricity. There is constant load shedding in large cities, which are completely dark for most of the year. At the same time, the country has a stable political environment, good political will, natural resources and religious tolerance.

Sierra Leone was the first country to the Energy Africa Compact, and it launched the Sierra Leone Energy Revolution commitment in May 2016 with a goal of reaching 250,000 households with modern solar solutions by 2018 and achieving universal energy access by 2030. The President is committed to ensuring that all 149 chieftains have access to energy by 2025, and has established a multi-stakeholder energy task force in collaboration with key partners including government agencies, donor agencies and the private sector.

The country has already made significant progress on rooftop solar since May 2016. It has:

- Established the Renewable Energy Association of Sierra Leone (REASL)
- Attracted major international companies to the country, including d.light, Azuri, Barefoot Power, TOTAL, Azimuth, BBox and Ignite Power
- Established a VAT and tariff waiver that is linked to qualified certified solar products
- United sector stakeholders through DFID support from the Power for All campaign
- Launched a household solar consumer financing pilot
- Launched a nationwide renewable campaign to concertize the market and create champions from every district
- Committed to a 2016 Renewable Energy Policy 2016 to ensure renewables become a significant part of the energy portfolio

REASL is serving an important role in promoting this agenda. In March 2016 the Association had just six members. It now has 30. It is coordinating the efforts of private sector companies, engaging in advocacy and lobbying on behalf of its members, supporting Ministry of Energy efforts to implement the waiver for high quality solar and energy efficiency products through rigorously screening its members, negotiating facilitated access to foreign currency with the Central Bank of Sierra Leone, facilitating events and demonstrations to raise awareness of DRE, and working to attract investors and industrial partners to Sierra Leone

The biggest existing challenge in Sierra Leone is unlocking finance. Investors face interest rates of up to 20%. Local currency needs to be used, so there needs to be lower rates and more flexible payment terms. There is a lack of awareness among the public, and a hesitance to move to renewables. There are difficulties keeping pricing down so that products are affordable for consumers, and a lack of capacity within the Ministry to fully implement the government's policy. There is also a need for financial and technical support, to help private investors understand the available grants, loans and other programs, and to help public officials navigate the complex system.

But there is also progress. For example, a group called "Barefoot Women" has trained female technicians from 59 out of 149 districts. Soon, every chieftain will have a qualified champion trained by local women. There is hope that moving forward, improving energy efficiency and development of more low power consumption devices will save even more costs. One of largest mini-grid installations in West Africa has begun construction, which will result in PV mini-grids installed in 50 villages by the end of 2017 and benefit 500,000 people over the next four years.

Currently, Sierra Leone has 13% energy access. There is a need to focus on strengthening the supply chain and creating demand to unlock finance. There will be an Energy Africa

Compact refresh, with a goal of updating and widening its scope to enable more donor support and participation in off-grid solar

Ms. Johnson concluded her presentation by reading a call to action by Sierra Leone Minister of Energy Henry Macauley:

Since the Sierra Leone Energy Revolution in May 2016, much has been done to lay the foundations for universal energy access—from VAT and tariff exemptions for off-grid solar, to the creation of a Renewable Energy Association and the launch of one of the largest PV mini grid projects in West Africa. However, a lot more work is needed to end energy poverty for 7 million people in Sierra Leone. We call on the international community to join us in our bid to achieve energy for all by 2025.

Remarks from Khant Zaw

Khant Zaw's presentation was titled "Off grid electrification in Myanmar" and focused on how Myanmar's National Electrification Plan is expanding modern solar home systems, mini-grids, and other off-grid approaches to bring electricity to rural and remote communities.

Mr. Khant Zaw noted that there is only 15% electricity access in Myanmar's rural areas, and 35 million people nationwide cannot access electricity. In 2014, they used geospatial least cost planning technology to help develop an off-grid electrification plan and a plan for grid extension. If the grid extension cannot reach an area within 10 years, it is considered an off-grid area. They have geospatial data from the whole country, as well as socioeconomic data.

For the first five years they plan to implement solar systems in 8,751 villages, with a mix of solar home systems and mini-grid systems. From 2012-2015, the government subsidized 100% of the investments. This is not sustainable. The subsidy policy changed starting in the 2016-17 fiscal year. The public now contributes 10-15% for solar systems. They are working with multiple development banks to support their investments.

Electrification is already having a positive impact on local communities. It is supporting education and health through public facilities, schools, health centers, religious buildings, and streetlights. People are using more electrical appliances and using electricity instead of wood for cooking.

Challenges include a lack of rules and regulations for mini-grid systems. They also need more data to help provide better guidance to organizations or developers on which kind of system is best.

Myanmar has learned a number of lessons through its experience. First, they need a communication program with communities, installers, and other stakeholders. Many challenges are not technical in nature. Second, they need a plan for providing electricity to poor people, who do not have the means to pay for even a 10-20% share of the cost. Third, they need to develop the capacity of agency staff, the private sector, and communities.

Key next steps for the government include developing rules and regulations for mini-grids, promoting private sector participation, providing more incentives for developers, implementing mini-grid projects with international development partners, and linking with other development partners to promote economic development in mini-grid project areas.

Remarks from Johanna Diecker

Johanna Diecker offered a presentation titled “The evolution of off-grid business models and how to build environments they can thrive in.” Her remarks addressed the following topic: *Innovative business models allow us to provide energy access to millions of people today. Their impact goes beyond energy access with pay-as-you-go operators providing services beyond electricity. How have these business models evolved? And how can we provide an enabling environment in which they can truly scale and reach hundreds of millions of households?*

Ms. Diecker provided background on GOGLA and its mission. GOGLA is the industry association for the off-grid lighting and electrification sector. Its mission is to help our members build sustainable markets, made up of profitable companies, delivering quality, affordable off-grid electricity products and services to as many customers as possible across the developing world.

GOGLA has more than 100 members around the world, with a focus on solar lanterns, solar home systems, community and street lighting, and off-grid productive use appliances. Its members offer solutions that can be deployed immediately, that are high quality, affordable and scalable. They sold over 3.5 million products globally in the first half of 2017, and have met the Tier 1 energy needs of close to 40 million people and the Tier 2 needs of close to 2 million people.

GOGLA’s members use a diverse set of business models from pay-as-you-go models such as rental, perpetual lease, or lease-to-own, to other models such as upfront sales with a financing partner or direct cash sales. Many companies employing the pay-as-you-go model are vertically integrated. They provide everything from the product design to the financing in house. There are also partnership models where the company focuses on distribution and financing.

Pay-as-you-go has significant benefits in terms of affordability, since consumers do not need to pay up front for an extensive system. Even people who may never get credit from a bank but can still get a pay-as-you-go solar home system, and if the service is bad they can simply stop paying. The model also allows companies to leverage long-term value for the customer, allowing the customer to buy into larger systems and appliances, or other technologies like cook stoves or bicycles. The companies capture a wealth of data on their customers that is very useful for providing targeted services, which can extend beyond energy. Most sales in the sector are still cash, but pay-as-you-go now represents about 18% of sales and is growing. There is also a trend towards more Tier 2 and 3 products.

To sustain growth, significant market challenges need to be addressed including limited access to finance, inadequate policy environments, poor quality products swamping nascent markets, and last mile distribution costs. We need new thinking on how to support this market with an understanding that our traditional energy sector interventions will not work. GOGLA has developed guidance not on how to help off-grid markets while minimizing the risk of market distortion.

First, public funding should be used to help expand the commercial market more quickly. While there might be a noncommercial market left subsequent to this expansion, we will only know that once the market fully scaled. This means we should promote the commercial market first and then see if there is market where private sector solutions are not adequate.

Second, support should be in the form of low risk interventions, such as fiscal incentives, awareness raising, and working with the industry on standards. There should also be efforts to expand commercial markets to get access to finance. While there is a risk of picking winners, results based financing will push companies to go further. For non-commercial markets, retail subsidies may be appropriate but should not be deployed too early, for risk of distorting the market.

Third and finally, there should never be free distribution. Free distribution is not sustainable and would drive out commercial players. It should only be used in situations like a refugee camp or a natural disaster.

Remarks from Yann Tanvez

The presentation by Yann Tanvez was titled “The rise of geospatial planning in developing countries.” Mr. Tanvez focused on how new geospatial tools and better data can guide cost-effective investments to improve energy access in developing countries.

Mr. Tanvez began by noting what will be needed to achieve universal access in Africa by 2030, according to the International Energy Agency (IEA). 69% of connections will be via the grid, 20% will be solar home systems, and 11% will be via mini-grids. Achieving these

connections will require a change in the “software” we deploy to promote energy access. Specifically, we need to look at off-grid more seriously.

To understand how we need to change our electricity paradigm, we can use the example of a toothbrush. If you live alone, you have just one toothbrush. You can place it anywhere and use it any time. If you have a partner then there are two toothbrushes, and if you have a family you have many toothbrushes. Overall, it is better to be in a family because you can share your costs, but it also has challenges. You need to know which toothbrush to take and when you can use the bathroom. You may have toothbrushes of different colors so you don't mistakenly use your wife's. Some families will have stricter rules than others, but in all cases managing your toothbrushes requires some planning. It is this planning that allows you to be greater together.

The same principles apply to grid and off-grid connections. Geospatial electrification can help in the following ways:

- It is inclusive of both grid and off-grid solutions;
- It uses a bottom-up approach to planning based on electricity demand;
- It is dynamic, with an ability to adjust parameters and sequencing of roll-outs;
- It can inform access policies and investments with increased precision;
- It can foster transparency and rationality in government planning;
- It allows for donors' coordination and investments syndication; and
- It can reduce risks for off-grid private investments through predictability and data availability.

Within this framework, the goal is not planning for its own sake, but planning towards investments. When geospatial plans are done right they include a roll-out plan. Governments can phase their approach using a planning roadmap.

ESMAP has pioneered geospatial planning under the ESMAP SE4All Technical Assistance Program. The program supports 11 countries, focusing on electricity and cooking. Lessons from Phase I of the program include the following:

- Geospatial plans get outdated quickly, and need to be updated to reflect changed realities.
- Scenarios and visualizations are most useful for informing strategies and policies. It is better to provide scenarios based on the desired level of access rather than providing a fixed plan.
- There is a need for refining off-grid services as well as including productive and social uses.
- The appropriate selection of resolution is key.
- In-country capacity development requires long-term sustained support.
- There are high costs of data collection and limited data publishing.

Key opportunities moving forward include the exponential availability of data, and our improving ability to crunch more data much faster.

Phase II of the program includes three pillars towards mainstreaming. First, they will create a global geospatial planning platform and publication. All countries with less than 90% access will be provided with a “strategy level” updatable electrification plan. Second, they will provide at least seven new countries with detailed “investment grade” geospatial planning. Third, they will complement country-level efforts with longer-term regional and global capacity building activities.

A 2017 pilot of the program was deployed in three countries. To turn it into a global planning platform, they are working with best in class research and IT partners, including the University of Cambridge, Google and others. The new platform will provide users with the ability to customize plans and incorporate new data as it becomes available. The platform will be 100% open source, with no IP issues or fees associated with it. It should be available by the summer of 2018.

Mr. Tanvez concluded by noting that geospatial electrification planning has become a key to help designing electrification strategies inclusive of both grid and off-grid solutions. In the future, data innovations and economies of scale will help mainstream in forthcoming years while models will continue improving. It is critical to focus on building countries’ capacity to develop and update plans. We cannot send someone to do the planning for them every year. The private sector can benefit from these efforts through a focus on transparency and open data, while partnerships and coordination can speed up results.

Remarks from William Blythe

William Blythe provided an update to the group on an energy sector roundtable hosted by DFID the day before. One conclusion from the roundtable was that there is no single decision-maker in the sector. Rather, there is an ecosystem of decision-making that includes individual households, private firms, investors, international finance institutions, and governments making political and strategic decisions. This suggests that there should also be an ecosystem of planning tools.

While it is unrealistic to expect decision-makers to fully converge around a single plan, and while we want diversity in order to drive innovation, donors could still do more to contribute to coherence in the system. Donors should work to improve how they coordinate our support, and improve access to models and tools to improve decision-making.

The roundtable identified five principles for donors:

1. Give ownership of strategy and objective-setting to countries.

2. Give countries tools and access to data to manage this work.
3. Develop transparent and robust planning tools.
4. Develop open source tools when possible and relevant.
5. Coordinate at the country level.

The group will produce a white paper outlining these conclusions, and likely meet again in six months.

2.4.2 Question and Answer Session

There was a question and answer session following the speakers' presentations. It touched on the themes below.

- *Country-level coordination*

A number of questions focused on the level of coordination happening among various country-level actors in Myanmar and Sierra Leone. One participant noted the important role that ESMAP played in supporting Myanmar's National Electrification Plan after the government indicated its commitment to electrification by endorsing SDG 7. When ESMAP began its work in Myanmar, there was a coordinating committee chaired by Myanmar's Vice-President, which included all the necessary ministries. The participant was interested in knowing the status of this committee, and how Myanmar intends to sustain its commitment to national electrification.

Mr. Khant Zaw conceded that Myanmar faces a challenge in sustaining its policies and priorities every five years during the government transition period. Nevertheless, the energy sector remains the government's first priority, and they will be sure to continue coordination among government ministries.

Another participant was curious to hear about the role of REASL in Sierra Leone's electricity planning. Ms. Johnson noted that the Government of Sierra Leone has made conscious efforts to inform and involve the private sector in the Energy Revolution. For example, the Ministry of Energy invited private sector representatives to join the board of the Standards Bureau, and sends minutes from its meetings to REASL so it can review the standards being discussed.

- *The role of planning*

Participants asked a series of questions about how best to engage in planning, and ESMAP's role in supporting countries' planning efforts. One participant asked whether ESMAP's planning tools can be turned into an open platform where information can be updated and made available to all actors, including the private sector. Another participant offered a quote from Dwight Eisenhower, stating that "Plans are useless, but planning is indispensable." The participant asked about the role ESMAP should play in supporting countries in getting value from their modeling and data.

Mr. Tanvez replied that yes, ESMAP wants all of its planning support to be totally open whenever the information is not sensitive. It is critical for all actors to be able to explore plans. ESMAP is also seeking to bring some minimum level of standardization to its planning platform, so that private sector actors can use it and visualize it. Mr. Tanvez noted that ESMAP provides services related to geospatial planning by supporting countries' use of planning to develop electrification strategies, and by using this information to support bank policy dialogue regarding access. For example, insights from ESMAP helped inform the Bank's access program in Zambia, directing it towards more off-grid solutions.

Another participant asked about what happens when plans do not come to pass as expected, for example if the grid is planned for a given location but does not end up going there, and in the meantime the plan has discouraged other actors from investing in that area.

Mr. Tanvez noted that it is the nature of planning for plans not to materialize. This is why it is so important to develop multiple scenarios, and update plans frequently as circumstances change. Ms. Diecker added that the private sector loves it when the government has a solid plan, so long as it is not overly rigid. Even if in the end the market never actually develops according to the plan, the planning process can still provide useful data to the private sector.

- *Providing access to the poorest*

A number of participants questioned the ability of the private sector to reach the very poorest consumers through off-grid solutions, and asked if and when the state might step to support the market through smart capital subsidies. Ms. Diecker suggested that it is still too early to determine whether the market will be able to deliver solutions to very poor rural consumers, so we should be careful about jumping to subsidies too quickly. It is not realistic to expect the private sector can deliver in three years what the public sector has been unable to deliver for decades.

Ms. Diecker further emphasized that we do not have the public money available to reach all consumers. If subsidies are too generous, they run the risk of crowding out commercial players. At the same time, subsidies in the form of import duty exemptions, VAT incentives, consumer awareness campaigns, or quality standards are all ways to help expand the market. The key is to avoid downstream subsidies facing the end user. If one person gets a free or highly subsidized system, others will expect it, they will not want to pay the full price, and then we will not get universal energy access.

Following these questions and answers, Mr. Blythe drew the session to a close by thanking the speakers for their thoughtful remarks and the members of the audience for their helpful questions and comments.

2.5 Session 4: What are the challenges and opportunities of mobilizing commercial capital due to changes in energy systems?

2.5.1 Session Summary

Session 4 focused on how to mobilize commercial investments at unforeseen scale—to leverage billions of dollars of concessional lending with trillions of dollars of private resources – to help power systems across the world meet the Sustainable Development Goal of ensuring access to affordable, reliable, sustainable and modern energy for all.

The session included remarks from four speakers: Alasdair Miller, Senior Energy Specialist at the IFC; Vivien Foster, Global Lead for Energy Economics, Markets and Institutions at the World Bank; Phil Skinner, Senior Investment Officer at GuarantCo; and Cristian Lühr, Head of Electricity Tenders Unit, Comisión Nacional de Energía, Chile.

Following the speakers' presentations, participants were asked to discuss a set of questions at small tables. They then reported out key insights from these small table conversations to the large group, and participated in a moderated discussion with the speakers.

The session began with introductory remarks from the moderator Phil Stevens, head of DFID's Private Sector Investment Team. He noted that achieving SDG 7 will require massive investments. The World Bank estimates between \$3-4 billion per year will be needed for transmission and distribution networks in Africa alone. The donor community needs to identify new approaches to get billions of dollars of concessional finance to stimulate trillions of dollars of private capital investment.

Remarks from Alasdair Miller

Alasdair Miller offered a presentation titled “The Scaling Solar approach towards mobilizing commercial capital for solar investments—the case of Zambia.” The presentation focused on the following topic: *Scaling Solar aims to create viable markets for solar power and make privately funded grid-connected solar projects operational within a short timeframe and at competitive tariffs. How can the World Bank and other developing partners collaborate with IFC to build an enabling environment?*

Scaling Solar is a World Bank Group solution to accelerate private investment in utility-scale solar PV. Solar has a number benefits in emerging markets. The economics of solar have changed massively in past few years, with prices dropping dramatically. Many emerging markets have some of the best irradiation levels on the planet, and large solar PV projects have relatively short construction period of 3-6 months. Solar can also help countries diversify their generation capacity.

However, for a number of reasons progress so far with respect to large-scale solar investments in sub-Saharan Africa has been very poor. Many governments and utilities simply lack knowledge of solar or an understanding of its potential. There is also a lack of market scale in many sub-Saharan countries. Because solar projects are modular and scalable, developers will focus on higher wattage projects in larger, more familiar markets. The up-front investments needed for solar projects are another disincentive, in that they make solar projects extremely sensitive to the cost of capital. In addition, most deals in Africa are negotiated bilaterally, negotiations can drag on for years, and there are high project attrition rates. All of these factors in combination lead to lack of competition, projects from second tier developers, and high tariffs in African markets.

Despite these challenges, South Africa was able to develop a large-scale solar project with relatively low tariffs, in part because the South African market is large enough to attract major developers. As it became clear that the solar deals in South Africa were bankable, more and more companies entered the tender process and further reduced the tariffs. The Scaling Solar program looked at the South Africa example and decided they wanted to try to replicate elements of it elsewhere in the continent.

Scaling Solar is the World Bank Group's standardize approach to procurement and structuring of solar IPPs in developing countries. It consists of a suite of World Bank Group products and services. The approach involves a number of steps. First, in the project preparation phase, IFC advisory helps with siting as well as technical, economic, regulatory and legal analyses.

Once there is a project ready to take to market, IFC investment helps with bid preparation by providing template tender and project documents, and agreeing to provide financing to the winning bidder. This eliminates the need for drawn out negotiations after a bid award, which can drive up tariffs significantly. If necessary, the World Bank Group can also agree to provide political risk insurance and payment guarantees. All of this means that by the time the project is ready to take to market, all the documents are truly non-negotiable and ready to go. This attracts competition from good bidders. Next there is a tender process and award, a financial close, and eventually construction and operation.

The World Bank has five Scaling Solar mandates in four countries: Zambia, Senegal, Ethiopia, and Madagascar. Zambia is the farthest along. There was a commercial close some time ago, which resulted in the lowest tariff for large-scale solar ever achieved in Africa. The approach has attracted top tier, leading players in the industry. While the timeline in Zambia was not as quick as they hoped, it was pretty good and they expect to be quicker elsewhere as they learn more. The standardized approach lets them improve as they go along.

Standardization has a number of other benefits as well. First, it means the approval process for IFC financing, guarantees, and political risk insurance can all take place on an expedited basis. In addition, and more importantly, standardization creates a single

margin market. Even though Scaling Solar is doing multiple rounds in different African countries, investors see something similar in each round. This helps them gain increasing confidence in the process over time, which in turn increases competition. As the number of bidders in these processes continues to increase, there are signs that this theory is in fact working in practice.

Despite these successes, there have been important challenges and lessons learned. Institutional capacity is still a challenge, as client countries struggle with the expedited timeline and demands of the program. In addition, it can be difficult to secure land reliably and responsibly in line with demanding environmental and social standards. Scaling Solar has experienced everything from mine fields to unexpected military bases, and civil strife, all of which requires a significant level of effort to overcome. These challenges have implications for how they can take the program to scale.

There are multiple benefits to Scaling Solar to government, utilities, project developers, investors, international donors and development partners. It represents an effort by various parts of the World Bank Group to work together to try to change the status quo on a significant scale. There have been good early results from Zambia and Ethiopia, but the program remains a work in progress.

Remarks from Vivien Foster

Vivien Foster's presentation was titled "The World Bank's 'cascade' approach to mobilizing commercial capital: The Infrastructure Sector Assessment Program (InfraSAP)." It focused on how the WBG and client governments can improve the enabling environment to mobilize commercial capital through a systematic and structured sectoral diagnostic that identifies improvements in sector performance and barriers to investment. It also offered a preview of results for the Vietnam Energy InfraSAP.

The World Bank has embarked on an effort to help countries maximize finance for development, using a "cascade algorithm" at the project level. The algorithm is a set of questions they task teams to ask at the early stage of development, which put the onus on private solutions first and public solutions only when they're the only viable option. They ask the following questions:

- Is there a sustainable private sector solution that limits public debt & contingent liabilities? *If yes than promote such private solutions.*
- If no, is it because of policy, regulatory gaps? *If so, provide WBG support for policy and regulatory reform.*
- Or is it because of risks? *If so, assess the risks and see whether WBG instruments can address them.*

- Does the project require public funding? *If you conclude the project requires public funding, pursue that option.*

In Kenya, the World Bank has been working for twenty years to try to revitalize private sector investment through reforming the energy sector. The country has required them to use a wide, systemic approach over a long period of time to open the gates to private investment. Short-term, program-by-program approaches have not been sufficient.

To help develop more systemic, long-term approaches, the World Bank has developed Infra-SAPs, which are analytical tools that look at how to optimize scarce public resources at the country level. A number of countries currently have Infra-SAPs ongoing, but the Vietnam Infra-SAP is particularly relevant because it is focused on energy and is fairly advanced.

Vietnam has rapidly rising electricity demand, and significant and increasing investment needs. There is a call for significant expansion in their generation capacity, which will require proportional investments in transmission and the distribution network.

Historically, Vietnam funded most generation and all network investments through EVN, the state-owned power company, with state guarantees. This model is not sustainable, as the country is on the verge of a fiscal crisis and will soon graduate to middle income status and become ineligible for concessional finance.

The Infra-SAP has identified a number of possible options for addressing these challenges. First, Vietnam could try to raise unguaranteed corporate finance through the SOE balance sheet. Its ability to do this, however, is constrained by the country's credit rating, low tariffs, and EVN's overall weak financial performance.

A second option is to raise additional international capital through PPPs. The country currently has 30% generation by PPPs and could aim for more. However, there are challenges here, too. While Vietnam has a good legal framework for PPPs on paper, in practice it is being ignored. This means each project is negotiated on a bilateral basis, and few projects have moved forward in recent years. A frequent sticking point in negotiations is FOREX convertibility, as the government is only willing to guarantee 30% convertibility and there are no hedging instruments in the market.

The third option is to raise more domestic capital through local capital markets. Challenges with this option include the fact that commercial banks lack long-term deposits, the stock exchange lacks liquidity and is dominated by SOEs, the bond market is still nascent, and institutional investors have limited capital.

The conclusion emerging from this exercise is that the biggest constraints to private solutions often lie outside the energy sector. These include challenges at the macro-fiscal

level, the domestic capital market level, the PPP/infrastructure level, as well as at the energy sector policy levels (e.g. low tariffs).

Overall, Infra-SAPs are reenergizing World Bank efforts. They are a useful policy tool, they integrate multiple perspectives across the World Bank Group, and they can help determine programmatic engagements.

Remarks from Phil Skinner

Phil Skinner made a presentation titled “Support for local currency finance for infrastructure projects,” which addressed how Private Infrastructure Development Group’s GuarantCo scheme supports local currency finance in low-income countries, promoting domestic infrastructure financing and capital market development.

GuarantCo is part of the Private Infrastructure Development Group (PIDG), a group that mobilizes private sector investment to assist developing countries in providing infrastructure. GuarantCo was established in 2005 and has supported over 40 projects through \$700 million in written guarantees. Its current portfolio is \$457 million. With support from five G12 governments, GuarantCo provide a guarantee product to support lending into development projects in developing countries, in particular projects with positive social and environmental impacts. It focuses on local capital markets and local currency. It has a AAA rating, and a \$1 GuarantCo commitment supports \$5.48 in private sector investment.

Renewables are changing the way we think about our financing models for energy infrastructure. With traditional fossil fuel power products, the argument is that all costs are in dollars so the financing should also be in dollars. This is significant because it puts risk inside the financing structure. Local consumers are paying local currency, but the cost structure and financing introduces foreign exchange risk. Consumers are asked to pay for this risk.

Renewable energy projects do not have ongoing fuel costs, so it is an open question as to what currency the projects should be written in. However, adopting a PPA in the local currency can often be challenging. There may not be sufficient debt available in the local capital market to provide the capital needed. In many countries, the capital may be available but is just not being deployed towards infrastructure. In Nigeria, for example, there is a \$20 billion pension fund industry, but very little of it is invested in corporate bonds and none of it is focused on infrastructure.

Local currency financing can also have benefits in terms of pricing. While local borrowing costs are usually much higher than USD borrowing costs, the true cost of hard currency needs to account for depreciation and convertibility issues

Another challenge is the lack of local capacity, but Mr. Skinner suggested that this will only be a challenge as long as we allow it to be. International capital needs to mobilise and not crowd out local funding sources.

In Nepal, GuarantCo has provided a 90% guarantee for an 82MW run-of-river hydro project. It is a split PPA, with part in local currency and part in USD. The idea behind the 90% guarantee is to give local lenders some “skin in the game.”

GuarantCo is limited in the amount of guarantees it can write while maintaining its credit rating, but a more important limit is simply its human resources. It covers 88 countries and needs significant human capital to manage all those projects.

One next step representing an effort to expand GuarantCo’s impact is taking place in Nigeria. GuarantCo will provide contingent capital support to InfraCredit Nigeria, a joint venture where the government is providing contingent capital in the form of a guarantee. By combining 3x leverage at GuarantCo and 5x leverage InfraCredit, donor equity will be leveraged up to 60x. GuarantCo is also working with local partners to enhance origination channels, increase market insight and add to local credibility.

In addition to financing tools, it is important for donors to engage in direct efforts to enhance capacity and create market solutions. In Nigeria, the fact that many investors have never invested in a corporate bond or in infrastructure is as much a behavior challenge as a financial one. There is a need to educate investors about the sector you are trying to get them to invest in. Along these lines, GuarantCo has been running workshops with pension fund managers to help them understand infrastructure investments and ways of managing risks.

There are three key takeaways from this work: 1) local capital markets and local currency can’t be ignored, 2) solutions will be market specific, and 3) direct capacity enhancement is needed to help local currency markets realise their full potential.

Remarks from Cristian Lühr

Cristian Lühr offered a presentation titled “Chilean experiences leveraging private capital for renewable energy.” It looked at how Chile has leveraged private sector investments in renewable energy generation through its successful renewable energy auctions.

Chile amended its tenders law in 2015 to give responsibility for the tenders process to the National Energy Commission (CNE) and to require an annual tenders’ report with a demand forecast. The new law also articulates three types of tenders in Chile: long term, short term and exceptionally short term, for emergencies.

The new law and related regulatory changes have been a huge success. While average energy prices had been increasing up until 2013, they subsequently dropped by 75% due

to increased competition spurred by the changes. There were 84 participants in the 2016 tender.

The tender now includes the following main features, all designed to reduce investor risks and make PPAs more bankable:

- 20-year contract between generator and distributors (instead of 10 years)
- 5 years until beginning of supply (instead of 3 years)
- Supply includes all distribution companies of Chile
- Technology neutral
- Innovative design for energy blocks (hourly or quarterly)
- Maximum price is hidden
- Bids are assessed not just by their nominal amount, but according to their indexation formula
- Possibility of modifying the contract price based on regulatory changes
- Option to postpone or terminate the contract early
- Option to cede the contract to a third party

The use of hourly and quarterly blocks was a unique innovation. It allows renewable companies to bid for a specific segment of the day or quarter of the year. For example, solar projects may only want to bid for daylight hours, and hydro projects might bid only for certain seasons of the year. All of this helps them make the most efficient offer

In the 2017 tender, the total energy offered was ten times larger than the energy auctioned. Solar/wind and pure solar were the most successful technologies. Mixed solar/wind projects represented only 3% of the bids but were awarded 25% of the energy tendered. Solar bid 6% of the total and took away 16%. The average awarded prices was \$32.5/MWh.

In deciding on the awards, the government does not simply go with the cheapest individual offers. Rather, they consider the combination of offers and look at the overall mix of energy.

There will be more tenders in the coming years, including a very large tender in 2019. They believe the 2019 tender will be even more attractive than this year's.

2.5.2 Discussion

Following the speaker presentations, participants met in small table groups to discuss the following questions:

- *What strategies do you believe will be effective at taking these financing approaches radically to scale? What are the barriers and how can we overcome them?*

- *What are the key measures countries can take to create an enabling environment for private sector investment, in particular local currency financing?*
- *How can donors and investors best work together to de-risk project financing and attract institutional investments?*

Participants then returned to the larger group to report on key insights from their table conversations and engage in a moderated discussion with the speakers. Highlights from the large-group discussion are recounted below, organized by theme.

- *Investing in distribution and reducing losses*

A number of participants emphasized the need to look beyond just investments in generation, and recognize that there are huge investment needs in distribution. There is not enough thinking about how to invest in the distribution sector, which is where the cash to pay for generation comes from in the first place.

A participant noted that in countries where distribution losses are 30% or 50%, it can be much less expensive to reduce losses rather than increase generating capacity. The World Bank can and should help countries conduct these kinds of value chain analyses.

- *Capacity building for local currency lending*

A number of participants emphasized the importance of local currency debt funding, and suggested that it is growing too slowly. One participant noted that improving local currency lending requires government support as well as capacity building. Banker-to-banker training on these types of transactions can be an effective tool, and there is room for more of them. For example, maybe we need all the Chilean bankers to meet with bankers from other countries. Donors could do more to support those kinds of meetings. Another participant noted the importance of local currency lending for off-grid initiatives, and the need to educate banks on the perceived risks, business models, and KPIs for measuring company performance.

- *Lessons from Africa and Chile*

There was a back-and-forth on lessons learned from the growth of IPPs in Africa. One participant suggested that African governments may refuse to sign more PPAs because of continued liability issues on their books and guarantees to private sector actors from previous bad deals.

Ms. Foster reinforced these observations. She noted that direct negotiations with IPPs and rigid PPAs can lock in unattractive pricing, and risk free arrangements can exacerbate these issues. She suggested that many of these challenges originate due to weakness in the distribution sector, which is a problem given donors' limited success in fixing distribution issues.

Participants expressed admiration for the accomplishments of the Chilean government in reducing the overall generation costs, and asked for more details on the model, including Chile's use of credit enhancement guarantees. Mr. Lühr responded that Chile believes in establishing a healthy balance between the financial health of generation companies and reasonable prices for final consumers. It is trying to achieve a healthy equilibrium. The contract pricing is binding, and they have a number of guarantees including a big bond guarantee. However, they still allow for some flexibility to change the project, modify technical details, or adjust the schedule during the five-year construction period, or even to sell the project if the developer can properly justify it.

Mr. Lühr also noted that these finely tuned rules and regulations did not emerge by accident in Chile. They occurred because the government modified the law only after a long series of meetings with industry, banking, government agencies, and other stakeholders to identify all the possible problems and issues. It was long exhausting process but now they are experiencing the payoff.

- *Comments on Scaling Solar*

A number of participants offered reflections or advice on the Scaling Solar program. One question focused on the potential for Scaling Solar to create unrealistic expectations around tariffs in countries like Sierra Leone. The participant suggested that such expectations might be dangerous if there is no realistic planning and messaging within less-developed countries. Mr. Miller agreed with the premise that unrealistic tariff expectations are a risk. However, he further noted that these risks should not mean that countries in Africa should just accept paying exorbitant costs for solar.

Another participant asked whether the World Bank Group might consider applying the Scaling Solar model to other renewable energy sources, such as wind. The participant further suggested that it might be problematic to scale up solar too much, given the benefits of having a sensible technological mix within countries.

Mr. Miller explained that the World Bank Group decided to start with solar because it is the simplest, most standardized form of power generation, but they are interested in looking at other technologies. They are just starting to look at wind and energy storage.

Following these comments, Phil Stevens thanked participants and drew the session to a close.

2.6 Session 5: How market-based solutions can unlock power system flexibility through stronger price signals

2.6.1 Session Summary

This session addressed how market mechanism can be used to mobilize flexible resources to balance the grid, in particular from the demand side, to help integrate variable renewables.

Debabrata Chattopadhyay, Senior Energy Specialist at ESMAP, served as session moderator. He opened the proceedings by summarizing the topic and introducing the speakers: Camila Schoti, Director of Energy at ABRACE (Associação Brasileira de Grandes Consumidores Industriais de Energia e de Consumidores Livres); Yoav Zingher, CEO of KiWi Power; and Adam Sims, SO Flexibility Manager at National Grid. There was a question and answer session following the speakers' remarks.

Mr. Chattopadhyay noted that it is very difficult for demand response to materialize, and it requires a lot of negotiations especially with large industrial customers. Nevertheless, demand response remains one of cheapest options for systems operators to get frequency control response, and can help dramatically reduce prices. When renewables enter the picture, demand response becomes obligatory.

Remarks from Camila Schoti

Camila Schoti offered a presentation titled "Demand-side innovations in Brazil," which focused on lessons from experience and achievements on demand side response in Brazil. Ms. Schoti explained that she represents large industrial consumers in Brazil, for whom energy is a matter of competitiveness. Her organization's members utilize 45% of the industrial energy consumption in Brazil, which is bigger than all electricity consumption in Chile.

Currently, Brazil is migrating from hydro generation to more wind and thermal plants, as its reservoir capacity decreases over time. Politically, the country is changing from a government with direct intervention in the economy to a more liberal oriented regime.

Brazil's electricity regulator recently approved a program for demand response. There had been efforts to allow demand response in Brazil since 2002, but they had all failed. The current effort succeeded due to a number of factors. First, Brazil's power system is highly dependent on rain, and changing climate conditions have had a severe impact on prices in the past two years. Second, the increasing participation of wind in the northeast energy matrix has also meant that the complexity of operating the system has increased, so the system operator needed more resources to deal with the challenge.

There were also political factors. From 2002-2015 the dominant political party in Brazil had an interventionist view of the economy and an aversion to high individual profits. But then, electricity rationing caused the president to not be reelected. In 2015, with a new government in place and a decrease in rain in the northeast, the political climate was more amenable to change and industrial consumers realized it was necessary to restart a dialogue on demand response. They started a dialogue in 2016 with system operators and people with experience from other countries. ABRACE served as the facilitator, trying to connect the system operator with consumers and other stakeholders.

ABRACE had to engage and manage multiple stakeholders with different objectives. For example, ABRACE needed federal government approval for demand response, so it needed to consider the government's interests. Clearly, it also needed the system operator to see the value of demand response, along with the regulator, consumers, the media, the system planner, the Chamber of Trade and Energy, and others. Engaging required listening to everyone, understanding their worries, acknowledging their perceived risks, and designing solutions

After six months of one-on-one conversations, ABRACE organized a larger consultation with all the stakeholders. They spent eight hours discussing how to overcome the challenges together. For example, they discussed how the system operator needs to trust that the consumer will respond, so they decided to run a pilot where the system operator could impose a penalty for failure to respond. Similarly, the regulator needs to understand that the outcome will be cost competitive and fair to every agent, so they proposed an auction. For consumers, it was important to make the program voluntary, and to make clear to non-participating consumers that their costs would go down over time as a result of the program.

After a year and half of dialogue, the regulator approved a pilot program on demand response. Challenges remain—for example, Brazil's spot market has huge challenges—but they have made progress.

ABRACE did not do this work alone. It had help from its associates, who helped build trust among the agents. Overall, the cost of the work was very low but it is having a very high impact. It cost about \$1500 to host the multi-stakeholder meeting, and they are moving forward with a 200MW demand side initiative.

The success of the project has depended on them getting every player on board and aligning their goals. It has depended on their ability to listen, and to include all the stakeholders from the beginning. Ms. Schoti suggested that it wasn't about one brain designing a solution, it was about using the opportunity to bring many brains together.

Remarks from Adam Sims

Adam Sims's presentation was titled "Demand-side management options at the system operator level" and focused on the growing role of demand response in providing flexibility to help National Grid balance Britain's electricity system in a cost-effective manner.

Mr. Sims began by explaining National Grid's responsibilities as system operator in Great Britain. They work to make sure the transmission system is developed in an economic and efficient way, and they serve as the residual energy balancer. Their job is to maintain quality and security of supply.

When National Grid talks about flexibility they mean the ability of any asset to change its behavior from its baseline in response to a market signal. For example, they need more flexible plants as generation becomes more distributed, as generation becomes situated closer to areas of demand, as their generation mix shifts from thermal to more renewables, and as consumers become more proactive.

Power Responsive, National Grid's industry initiative, was launched in 2015 to support growth in participation of demand side flexibility into Great Britain's electricity markets. It supports companies in accessing the market and works to attract more company interest. Its objectives for year 3 include continued customer engagement (including with additional types of technologies such as battery storage), increasing confidence in flexibility, and supporting the evolution of flexibility markets by simplifying balancing services.

Recently, National Grid published a System Needs & Product Strategy consultation. They got 128 responses from across ten industries. 98% of the respondents agreed with National Grid's approach.

Overall, the goal of the Power Responsive initiative is promote demand side participation to such an extent that the initiative becomes obsolete. That is how it defines success.

Remarks from Yoav Zingher

Yoav Zingher made a presentation titled "Creating markets to increase demand side flexibility," which addressed how aggregators can help price signals reach end-consumer and unleash important demand side flexibility.

Mr. Zingher started his presentation by describing KiWi Power. The company is a leading energy technology innovator and the UK's leading demand response aggregator. Its vision is to be the global leader in innovative energy technology through innovative smart grid technology, sustainably and cost effectively. It was founded in 2009 and operates in seven countries at over 800 sites.

Mr. Zingher offered his own description of what demand response is. Essentially, demand response means that instead of keeping around dedicated polluting power stations, or making sure our power stations so have enough headroom to cover peak demand, we adjust demand and give money to consumers.

National Grid in the UK was the first to initiate a demand response program. Their ambition was to get to 50% of all balancing to come from demand side. In 2015 alone, their balancing costs were 400 million pounds. There could be £8 billion of annual savings to UK consumers from deploying demand response.

KiWi Power believes getting customers to participate in demand response requires making it a simple and attractive choice. Technology is a key piece of the puzzle. KiWi Power's technology includes three pieces: a smart meter control system, a communications system, and a battery control.

They have achieved big cost savings by fitting their system into a single circuit board. The system costs only around £100 to make. There is also a software component, which gives consumers full access to information, their response to demand response events, and how much money they're making. The software will also alert them if things are not working properly. The company also has back-end operations doing aggregation work. Currently, they serve only industrial and commercial customers, and they target medium to large or extra-large consumers.

One of the big challenges they face is the complexity of the market. For example, the capacity market—which is only one of 23 markets in which demand response can operate—has legislation that runs to more than 500 pages. The legislation is very hard to simplify.

The markets also lack stability. Recently, there were three auctions over a period of a few weeks, and the prices varied dramatically from £6,500 to £45,000. The result of all this complexity and unpredictability is more limited access to the market compared to what it could be.

2.6.2 Question and Answer Session

There was a question and answer session following the speakers' presentations. It touched on the themes below.

- *New technologies*

A participant inquired about building demand response flexibility into new technologies, rather than adding them in after the system is built. Mr. Sims noted that such technologies are attractive, but the issue is public perception. For example, people are worried about the system operator taking over their appliances, like their refrigerators.

- *Comparing demand response and energy efficiency*

A participant asked for clarity around why, if it is possible to cut demand from a consumer, this should be pursued through demand response as opposed to encouraging more lasting energy efficiency. Mr. Zingher and Ms. Schoti clarified that demand response is a short-term, temporary measure designed to help with balancing services and/or peak demand issues. Energy efficiency is more long-term. Both approaches can save consumers money.

- *Building new markets*

There was an extended conversation on how to build markets for demand response in countries where they might be beneficial but don't currently exist. One participant asked what KiwiPower looks for when deciding whether to enter a market. Mr. Zingher noted that the company has a list of countries that it keeps internally. They look at macro-economic requirements and commercial attractiveness. The key question is whether they will be able to sell their capacity if they enter the market. This will depend on factors like how the peaks are being managed and whether they can compete. Both Mr. Zingher and Mr. Sims added that it can be helpful to run trials in a country first, to gain the trust of the system operator.

Other participants asked about where to start in promoting demand response in countries that do not even have a power market, and how to help countries think about the prospects of ancillary services in their planning. Mr. Sims suggested that in places without a market, you could just give a price or make a bid for demand response, and split this charge among consumers. While you should continue to try to build a spot market, it is not necessary at the outset. Mr. Zingher added that when rolling out new markets, it is important to consider the makeup of the contracts you want. There are important tradeoffs involved in building short-term markets vs. longer-term markets.

- *The value of demand response*

Other participants emphasized the value of and need for demand response overall. One cited a series of IEA studies that underscored the value of demand response in particular during extreme demand conditions. Another participant suggested that demand side management is a "no brainer," in that it can help improve the efficiency of utilities and allow them to provide better service. Mr. Zingher noted that KiWi Power's customers can save anywhere from a couple of percent off their energy costs to upwards of 10% (although 10% savings is rare). This can amount to anywhere from tens of thousands of pounds to millions of pounds per year.

- *Energy charges vs. capacity charges*

Praveer Sinha, CEO of Tata Power DDL, recounted his company's experience with demand response, which was approved four years ago as a pilot in Delhi. Eventually,

Tata Power DDL was permitted to provide consumers with a financial incentive, and this allowed them to get better leverage in meeting peak demand. However, the Tata Power DDL demand response system is managed by the distribution company, not the aggregator, which means they are using energy charges only and not capacity charges. Mr. Sinha asked if the speakers believed it would be possible to develop a market without capacity charges.

Mr. Zingher and Mr. Sims both suggested it would be difficult to develop a market without capacity charges. Capacity charges create confidence in the consumer that they will get a certain amount of revenue regardless of how much they are used. Mr. Zingher suggested energy charges alone might work in a totally free energy market with high peak prices, but Mr. Sims noted that there had been a program in the UK with high prices for periods of peak demand, but it failed because customers did not sign up for it.

2.7 Session 6: How can development partners work with national governments to enable the transition to the energy systems of the future?

2.7.1 Session Summary

Session 6 was a Davos-style session moderated by Ranjit Lamech, Director of the World Bank's Energy and Extractives Global Practice. The session focused on how various donor-led support programs and financing instruments add up to transform power systems and create an enabling environment for new services and on what can be done to increase the efficiency of development partner support to governments and utilities.

The speakers included Chris Chijiutomi, Investment Director, CDC Group; Peter Hilliges, Head of Division and Climate Policy Coordinator, Competence Centre Climate and Energy, KfW Development Bank; Daw Mi Mi Khaing, Director General, Department of Electric Power Planning, Myanmar; Camila Schoti, Director of Energy, ABRACE; and Steve Beel, Country Lead, Cities Infrastructure for Growth Programme, DFID Zambia.

Mr. Lamech opened the session by suggesting that the participants use the discussion to try to connect the dots between the various sessions from the previous day and a half, and identify how diverse stakeholders can collaborate more effectively. He then introduced the speakers, who each offered brief opening remarks prior to the moderated discussion.

2.7.2 Opening Remarks

Mr. Chijiutomi provided some background on CDC, noting that the institution sees energy as critical to improving people's lives. He further noted that he recently set up a fund for early stage power development. They will be making investments over the next twelve

months in transmission and distribution. He also commented that CDC Group is currently focused on providing financing for complex grid systems rather than off-grid initiatives.

Mr. Hilliges commented that KfW Bank is pursuing multiple agendas, including the climate agenda and the access agendas. He noted that KfW Bank cannot be as agile as some other development partners due to its role as a bilateral development bank, and suggested that it is critical for donors to learn to cooperate more efficiently with champions at the national level.

Mi Mi Khaing provided detailed background on Myanmar's National Electrification Plan and the need for a significant amount of additional investments for the plan to be realized. She highlighted a number of challenges Myanmar faces, including the lack of generated power, seasonal variations of hydropower, increasing residential electricity consumption and, most importantly, 6 million people who still need access to electricity. The country needs billions of dollars of investments in generation, transmission, and distribution, and they hope for more help from development partners through concessional loans.

Ms. Schoti highlighted the need for ESMAP and the World Bank to spread knowledge to various actors about the positive impact of energy sector transitions, in order to increase buy in. She pointed out that disruptions in the energy sector will cause some actors to gain and some actors to lose. By aggregating knowledge and facilitating knowledge-exchange, ESMAP and the World Bank have a critical role in helping people understand the larger global gains amidst all the change.

Mr. Beel suggested that in many countries, reforms are blocked because of the presence of an unbankable utility at the center of the system. However, in places where innovation has been unleashed, like in the UK, the pace of technological change is astronomical. This pace of change means we need to be more flexible and faster in implementing reforms and responding to changes. In addition, because power systems are so complex and becoming more so, we cannot look at specific elements of the system in isolation. Instead, we need to support governments in thinking about the whole energy system so they can identify the right priorities for government and donor resources.

2.7.3 Discussion

Following these opening remarks, participants engaged in an open discussion among themselves and with members of the audience, moderated by Mr. Lamech. Specific comments are recounted below, organized by theme.

- *The need for an enabling environment*

Using Myanmar as an example, the speakers highlighted the need for national governments to create an enabling environment for private sector investment. Mr. Chijiutomi suggested that donors' goal should be to create a self-sustaining system such that the capital they put in drives sustainability. The first things they should look

at are the policy around legal and technical regulations, tariffs, and how they will get end users to pay for electricity. The goal is to convince the private sector that this is a country where they can earn a return, so they should invest.

Mr. Beel commented on the political difficulties of tariff reforms. He suggested that donors' goal should be to help governments implement reforms quickly and combine them with other projects that provide immediate benefits, in order to mitigate the political fallout.

Ms. Schoti encouraged donors to think about delegating execution of projects to the private sector through competitive processes.

- *The need for donor coordination and support to governments*

The speakers also discussed the need for donors to coordinate their actions and support governments in their negotiations with the private sector. Mr. Beel commented on the need for donors to work as closely together as possible, particularly around financing. Client countries face challenges identifying who to speak to in order to find the right financing product for them.

Mi Mi Khaing commented that it often seems like development banks take the side of private developers by requesting bankable documents and agreements to implement projects. She encouraged them to stand more on the government side.

Members of the audience offered comments as well, noting the challenges that client countries face if donors are not coordinated, for example if they need to have conversations with multiple different donors, all of whom have different agendas and views. Coordination should start with the development of a strategy in cooperation with the client country, using local country resources including the private sector and NGOs.

Another member of the audience offered reflections on how conflicting donor objectives can delay progress. Donors should focus on what they do best without being overly philosophical. For example, some donors will not finance coal or gas while other will, so it will be critical for these donors to discuss their priorities and roles before they enter a country where thermal generation might be an important part of the electrification plan.

2.7.4 Closing reflections

Each of the speakers offered brief closing reflections. Mi Mi Khaing expressed hope that Myanmar's development assistance and donor coordination committees will help bring donors together to operate more effectively.

Mr. Chijiutomi suggested that donors should try to get better at standardizing their documents, so they are easier for client countries to work with and deals can get done more quickly. Donors should also think about conducting collective due diligence, to avoid duplication of effort.

Ms. Schoti stressed the importance of aligning interests within and among stakeholders, to help shape the political economy in a direction conducive to reform.

Mr. Beel suggested that in the best-case scenarios there will be a strong government lead, but where there is not, donors need to coordinate better among themselves. The more donors can align with the government strategy the better, but that may not be possible in some cases, for example when the strategy prioritizes coal, nuclear, and large hydro.

Following these concluding remarks, Mr. Lamech offered his thanks to the speakers and closed the session.

2.8 Closing Remarks

2.8.1 Session Summary

Closing remarks were offered by Steven Hunt, Senior Energy Innovation Advisor at DFID (on behalf of UK Minister of State for International Development Lord Bates, who was unable to attend), and Rohit Khanna, Program Manager at ESMAP.

Remarks from Steven Hunt

Mr. Hunt reflected on the initial goals laid out by Melinda Bohannon in her opening remarks. First, there was the goal of focusing on people and demand. Mr. Hunt observed with approval that the KEF did, in fact, have this focus. The new technologies under discussion are ultimately customer oriented.

Second, there was the goal of taking a systemic view. Mr. Hunt suggested that the group accomplished this through its discussions on blending on- and off-grid technologies, the utility of the future, and geospatial modeling.

Ms. Bohannon's third goal was to connect the dots among donors and the kinds of support they provide. Financing innovations from GuarantCo, CDC approaches using loans and equity, and grant funding around innovation are all examples of this kind of thinking. Scaling Solar Zambia is a prime example of combining multiple approaches in the service of lower cost power.

The fourth goal was to speak with one voice to maximize impact. Mr. Hunt noted that this goal is extraordinarily challenging, and donors still have not figured out all the answers. For example, the room was split on whether to keep trying to deliver with problematic

utilities, or to go wholesale to new approaches. There was similar division around the question of whether and how to do planning.

Mr. Hunt concluded by thanking BEIS for hosting the event, the World Bank for pulling the group together, and participants for attending. He expressed hope that despite the messiness of technological change, those countries that embrace it will reap benefits down the road.

Remarks from Rohit Khanna

Mr. Khanna noted that the KEF had been an important opportunity for the ESMAP team to hear experiences and share knowledge from partners.

He suggested that there were three key takeaways from the conference sticking out in his mind. First, the lines between on and off-grid are becoming blurred. Second, the role of utilities in the future is going to evolve, which means donor prescriptions will also need to change. Third, planning clearly matters, although plans themselves perhaps less so. Lastly, he noted that it is critical to facilitate conversations among different stakeholders including governments, the private sector, development partners and others, to achieve clarity on strategy and alignment on goals.

Mr. Khanna closed the KEF by thanking all the ESMAP donors and the teams from DFID, BEIS, CBI and ESMAP.

2.9 Site visit to National Grid



20 participants visited the National Grid control center in Wokingham, west of London, to understand how demand side response and other measures such as generation forecasting can help National Grid manage the variability of renewable energy sources such as solar and wind.

National Grid is one of the world's largest investor-owned utilities, focused on transmission activities in electricity and gas. The company owns and operates the electricity transmission system in England and Wales and the gas transmission system in Great Britain. The electricity system consists of approximately 7,200 kilometres (4,474 miles) of overhead line, 1,500 kilometres (932 miles) of underground cable and 342 substations.

National Grid has seen an impressive growth in renewables over the past 5 years. In the summer of 2017, almost 52% percent of electricity generation was provided by low carbon sources compared to around 35% four years ago. On sunny and windy days, solar panels panels produce around 7.6GW of electricity while wind farms generate 9.5GW of power, meeting a typical demand of around 40GW. National Grid, as the operator of the UK grid, has developed a number of tools and market products to help integrate such a large penetration of variable renewables in a cost efficient manner.

Demand side response (DSR) is an important tool to help ensure a secure, sustainable and affordable electricity system. It involves businesses increasing, decreasing, or shifting their electricity use – in response to a signal – to help balance Britain's electricity system. In return they receive strong financial incentives, lower their bills, reduce their carbon footprint and play an important role in the transition to a low carbon energy system. For National Grid, DSR helps soften peaks in demand and fill in the troughs, especially at times when power is more abundant, affordable and clean, thus reducing the need for stand-by power plants. National Grid also uses advanced forecasting systems to predict

fluctuations in solar and wind generation. This allows National Grid to ramp other resources up or down in response to an expected shortfall or surplus of generation.

2.10 Site visit to Thames Water Queen Elizabeth II Reservoir Floating Solar PV Plant

25 participants visited Thames Water to see their Queen Elizabeth II Reservoir Floating Solar PV Plant west of London.

Thames Water is the UK's largest water and wastewater services provider. The privately owned utility supply around 2,600 million liters of tap water to 9 million customers across London and the Thames Valley and provide sewage services to 15 million customers. Thames Water generate renewable energy from Combined Heat and Power (CHP), sewage sludge incineration, solar power, wind power and hydropower and aim to self-generate a third of its own energy consumption by 2020.

Outside London, Thames Water has developed Europe's largest floating solar PV plant on the normally unusable suburban space on the surface of the reservoir. During the visit, Thames Water presented the key technical and commercial aspects of the floating solar PV plant and how the plant contributes to the company's ambitious energy strategy. With total installed peak capacity of 6.3 megawatts, the innovative floating solar PV installation generates around 5.8 million kilowatt hours of electricity annually - enough to cover the consumption of around 1,800 British homes - and will help power Thames Water's nearby water treatment works. With more than 23,000 floating solar photovoltaic (PV) panels mounted on 61,720 individual floats, the floating solar PV plant takes up approximately 9% of the reservoir - equivalent to the size of eight large soccer pitches.

The plant is operating close to the expected performance and the team expects performance to improve slightly in the future. The main performance challenge is a large amount of bird droppings covering the panel surface that have shown to be difficult and expensive to cleanse. The reservoir is located on a major bird migration path and bird droppings will continue to affect operations despite attempts to mitigate the issue.

Pictures from Thames Water Floating Solar PV Plant

