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RENEWABLE ENERGY AND SMART GRID SUPPLIERS FORUM: EMERGING OPPORTUNITIES FOR U.S. FIRMS

CLIMATE ECONOMIC ANALYSIS FOR DEVELOPMENT, INVESTMENT, AND RESILIENCE (CEADIR)

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ACRONYMS AND ABBREVIATIONS

BNEF	Bloomberg New Energy Finance
C3E	Clean Energy Education & Empowerment Initiative
CEADIR	Climate Economic Analysis for Development, Investment and Resilience
CEM	Clean Energy Ministerial
DCA	Development Credit Authority
DEC	Development Experience Clearinghouse (USAID)
E3	Bureau for Economic Growth, Education, and Environment (USAID)
ECO	Environmental Communication, Learning and Outreach (USAID)
ECOWAS	Economic Community of West African States
EP	Economic Policy (USAID/E3)
EXIM	Export-Import Bank of the United States
FiT	Feed-in-tariff
GCC	Office of Global Climate Change (USAID/E3)
GDP	Gross domestic product
GE	General Electric
GSGF	Global Smart Grid Federation
ICT	Information and communication technologies
IEA	International Energy Agency
IFI	International financial institution
IPP	Independent Power Producer
ITA	International Trade Agency (U.S. Department of Commerce)
LEDS	Low Emission Development Strategies
MCA	Millennium Challenge Account
MCC	Millennium Challenge Corporation
MITEI	Massachusetts Institute of Technology Energy Initiative
NREL	National Renewable Energy Laboratory (United States)
OPIC	Overseas Private Investment Corporation (United States)
PPA	Power Purchase Agreements
PV	Photovoltaic
RE	Renewable Energy
RES	Renewable Energy Systems
SBA	Small Business Administration

SCADA	Supervisory Control and Data Acquisition
SEL	Schweitzer Engineering Laboratories
SME	Small and Medium Enterprise
STEM	Science Technology Engineering and Math
UNEP	United National Environment Programme
USAID	United States Agency for International Development
USEAC	United States Export Assistance Centers
USG	United States Government
USTDA	United States Trade and Development Agency

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WORKSHOP OVERVIEW

Between 2012 and 2016, developing country markets attracted a total of $623.5 billion in renewable energy (RE) investments, 47 percent of global investments. In 2015 and 2017, RE investments in developing countries exceeded those in developed countries. These significant investments have been driven by the unprecedented transformation of developing countries' energy industries, including in RE generation and in smart grids. Developing country investments in electricity generation from RE sources have increased rapidly as costs have declined rapidly due to technological changes and economies of scale in manufacturing. Reverse auctions for renewable electric power capacity and generation have improved price discovery and competition. Record low bids for new solar and wind power capacity have been obtained in auctions in Chile, India, Mexico, Morocco, Peru, and Zambia (Frankfurt School/UNEP Centre/BNEF 2018; Molina, Scharen-Guivel, and Hyman 2018).

To date, most smart grid investment has occurred in developed countries. By 2017, North America, Western Europe, and East Asia represented more than 75 percent of the market for smart meters and many of the pioneering distribution automation, analytics, home energy management, and other smart grid initiatives. However, developing countries are now positioned to quickly catch up after developing advanced regulatory frameworks and extensive pilot projects in a number of countries in Central and Eastern Europe, Latin America, Middle East and North Africa, and Southeast Asia. In these countries, total investments in distribution automation alone are expected to exceed $51 billion between 2017 and 2027 (Northeast Group 2017).

Gross domestic product (GDP) is expected to grow at annual rates of 4.5-4.7 percent in emerging markets and developing economies between 2018 and 2020, compared to 1.7-2.2 percent in advanced economies (World Bank, 2018). The higher economic growth rates in developing countries will necessitate and allow increased investment to scale up renewable electric power and grid expansion and modernization. This demand will open important opportunities for U.S. firms leading global innovation in electrical equipment, communications networks, grid software, energy management systems, and energy storage (Northeast Group 2017; ITA 2017).

On May 1, 2018, the U.S. Agency for International Development (USAID) hosted the "Renewable Energy and Smart Grid Suppliers Forum" to engage U.S. firms interested in beginning or expanding business in developing country markets. The event had four main objectives:

1. Highlight opportunities for selling equipment, technologies, and services in key emerging markets;
2. Offer guidance on working with partners and potential sources of financing and investment;
3. Discuss competitiveness challenges and export strategies and approaches; and
4. Facilitate networking with partners and investors working in each market.

The forum focused on equipment sales for utility-scale wind and solar power, smart transmission and distribution, related information and communication technologies (ICTs), demand-response tools, and energy storage. It also focused on provision of technical services for utility and grid planning, reverse auctions, grid integration of variable RE, and RE zones.

The forum engaged 71 participants from U.S. companies, trade associations, non-governmental organizations, and USG agencies. It highlighted recommendations and insights from private sector leaders that have successfully expanded sales of RE, smart grids, and energy storage products and services in developing countries. It also identified the types of assistance and support offered by USG agencies to help U.S. firms assess market opportunities and enter or increase sales in developing countries.

The forum was supported by the USAID/Washington GCC office. Bloomberg New Energy Finance (BNEF) was the forum's media partner. The USAID-funded Climate Economic Analysis for Development, Investment and Resilience (CEADIR) and Environmental Communication, Learning and Outreach (ECO) Activities organized the event and prepared the workshop materials, which are available with the presentations on *Climatelinks* at https://www.climatelinks.org/content/renewable-energy-and-smart-grid-suppliers-forum-emerging-market-opportunities-us-firms.

1. PROCEEDINGS

1.1 WELCOME AND OPENING REMARKS

Matthew Ogonowski (USAID Bureau for Economic Growth, Education, and Environment (E3)) welcomed participants and highlighted that USAID's work advances U.S. national security and economic prosperity, demonstrates American generosity, and promotes a path to recipient country self-reliance and resilience. By supporting stability, expanding markets, creating a level playing field for U.S. firms, and strengthening the rule of law, USAID also promotes American prosperity.

Matthew Ogonowski (USAID))

Ogonowski explained that USAID helps countries create policy environments that attract sustained private RE investments through an integrated approach consisting of key building blocks, including competitive procurements, RE zones, strategic energy planning, smart incentives, grid integration, and financing strategies. He noted that USAID provided important technical assistance for RE auctions in Afghanistan, El Salvador, India, Mexico, and Zambia.

USAID has built successful partnerships with the private sector, as illustrated by Power Africa, which had helped 117 projects reach financial close, representing over 9,500 MW of new generation capacity and a combined value of more than $16.5 billion. Power Africa has mobilized nearly $56 billion in commitments from development partners, private financiers, project developers, and technology suppliers. Ogonowski noted that U.S. companies can help developing countries deploy the latest technologies and tools to modernize their power systems and use RE resources more effectively.

Suzanne Leta (SunPower) delivered the keynote address providing insights on opportunities and barriers for U.S. suppliers in developing country markets. SunPower is a 30-year-old U.S. company that has one of the most efficient photovoltaic systems on the market. The company also emphasizes reliability and durability in its products. SunPower has deployed over nine GW of photovoltaics worldwide for commercial, residential, and utility customers.


Suzanne Leta (SunPower)

Leta noted that the solar power market now includes almost 150 countries. Most companies are unable to have a continuous presence in every developing country, especially small markets. In setting country priorities for business development, Leta recommended looking at market fundamentals such as resource availability, rates and rate structures, and market design. However, she also recommended looking at fewer obvious factors, such as extreme weather conditions that may limit how well certain products work, availability of knowledgeable local contractors, the policy and regulatory framework (e.g., import taxes, codes and standards, ease of certifications, and local content requirements), and the political context (including sanctions and corruption risks). Before entering a market, SunPower assesses whether the markets focus on quality (rather than just costs) and considers costs per unit of electricity generated (rather than per unit of capacity).

Ethan Zindler (Bloomberg New Energy Finance [BNEF]) presented trends and projections for RE demand, technology costs, and competitiveness of U.S. suppliers of products and services for utility-scale wind and solar power, smart grids, demand-side management, and energy storage in Africa, Asia, and Latin America. Although the dollar value of new RE investment remained relatively flat between 2011 and 2017, the installed capacity grew rapidly due to decreasing unit costs of wind turbines, utility-scale and residential photovoltaic systems, and lithium-ion batteries.

Ethan Zindler (BNEF)

Zindler also discussed procurement and policy trends, including the increasing number of countries using competitive reverse auctions to scale up utility-scale RE capacity at lower cost instead of using feed-in-tariffs (FiTs).[1] He also presented information on corporate energy procurement. Firms in the Americas have signed the most power purchase agreements (PPAs). However, the number of PPAs has been growing in emerging markets, particularly in Asia as transnational companies press suppliers to buy renewable energy. BNEF has estimated a large capacity growth in developing countries through 2040 as a result of high potential growth in demand, falling costs of RE and smart grid technologies, and innovations in how firms provide energy services. By 2040, solar and wind power will be the main sources of electricity worldwide. Between 2017 and 2040, new investment is expected to total $3.3 trillion for wind power and $2.8 trillion for solar power.

Zindler noted that developing nations have huge potential for RE growth due increasing demand, cost reductions, and the expansion of off-grid, distributed power. This expansion will also require investments in human capital and the availability of financing.

Brandon Owens (General Electric [GE] Energy Consulting) identified four trends disrupting the power sector: decarbonization, digitalization, decentralization, and vehicle electrification. *Decarbonization*, the replacement of fossil-fuel power plants with renewable sources of electricity, has taken its cue from new policies to move alternate energy sources into the marketplace, particularly wind power. Decarbonization is creating challenges for grid stability and congestion volatility on electricity markets, but it is also opening opportunities for new offerings that will take the lion's share of investment and capacity additions. *Digitization*, the increasing use of connected devices and smart sensors, is allowing decision making based on dynamic and nodal prices. Digitization is creating opportunities for more efficient use of assets, increased revenue, and environmental benefits.

Decentralization, the increasing reliance on distributed energy resources, is empowering end users and increasing the complexity of grid expansion decisions. *Vehicle electrification* is increasing the demand for electricity and accelerating the decentralization of power production. The number of electric passenger vehicles is expected to increase from 2 million to 500 million worldwide within the next 25 years. These changes are making it important to increase investment in digital platforms to improve micro-grids, storage, peer-to-peer transactions, and electricity transmission and distribution (General Electric 2017). Despite the projected growth in renewable electric power, GE Energy Consulting expects that fossil fuel sources will remain important for base load power in developing countries.

The above four trends will create significant opportunities for U.S. firms in developing countries. Owens recommended that U.S. companies engage with local partners or establish other types of local representation. He advised companies to be patient and persistent since expanding into new markets is

[1] Feed-in-tariffs have been used by some countries to encourage investment in renewable power capacity by guaranteeing a minimum price for the electricity, in some cases at a premium over the market price. Feed-in tariffs have become less important as the costs of renewable power no longer exceed those of electricity from fossil fuels.

likely to be a multi-year effort with up-front costs. He suggested that companies "play for the long game, not the quick score."

1.2 WIND AND SOLAR TECHNOLOGY OPPORTUNITIES

David Riposo (U.S. Trade Development Authority [USTDA]) moderated a panel discussion on opportunities for selling wind and solar technologies and services in developing countries.

Mark Lyons (Renewable Energy Systems Americas Inc., (RES) Americas) discussed his experience working for South Africa's sole power generation and transmission utility, Eskom. South Africa was one of the first emerging markets to attract RE investment because of a supportive enabling environment for independent power producers (IPPs). The Government of South Africa was motivated by the need to help Eskom meet the power demand during the lengthy and time-consuming process of developing large, coal-fired power plants. The IPPs were initially very successful in attracting developers and investors to expand renewable power capacity at a relatively low cost through PPAs awarded in the first three RE auctions.

David Riposo (USTDA); Emily Puente (First Solar); Suzanne Leta (SunPower); Mark Lyon (RES Americas); and Brandon Owens (GE Energy Consulting)

However, a serious bottleneck emerged after the fourth auction in 2015. The winning bidders could not obtain financing or proceed with development because Eskom refused to sign off-taker agreements despite government pressure. Eskom was in serious financial distress and claimed that the transmission infrastructure was inadequate for the new RE capacity. Eskom did not sign these agreements until early 2018 after receiving external financing and renegotiating the auction prices down. Lyons recommended that U.S. firms obtain information on the commitment of key public and private decision makers before investing in a country.

Emily Puente (First Solar, Inc.) emphasized opportunities for U.S. firms in corporate procurement of on- and off-grid solar power. In Mexico, legal reforms that began in 2013 created and set the stage for public RE auctions that increased investment and reduced the costs of electricity. The reforms also allowed corporate self-supply. New requirements in 2018 mandated "qualified energy users" with an electricity demand of more than 1 MW to obtain a share of their electricity from RE sources. Firms may also benefit from lower prices or greater reliability of supply through self-supply arrangements. Corporate procurement of renewable electricity in Mexico and other countries can create opportunities for U.S. suppliers. However, there are risks associated with financial soundness of some companies, congestion in the transmission and distribution grids, and possible changes in the legal framework for corporate procurement and RE standards after a change in government.

Suzanne Leta (SunPower) discussed opportunities and challenges for corporate power procurement. Many potential buyers are unwilling to sign PPAs for renewable electric power generation that are longer than five to ten years so that they can benefit from continuing cost reductions. However, renewable electric power developers often need 15-20 year PPAs to meet their targets for return on investment. There are also opportunities for U.S. firms in the behind-the-meter market to serve corporate buyers. Behind-the-meter solutions are easy to deploy and can save companies money and meet legal requirements and corporate sustainability principles. SunPower has found it valuable to participate in trade missions organized by USG agencies. Trade missions have allowed the company to: 1) present products to potential buyers in one-to-one interactions; 2) make the case for focusing on value instead of cost in purchasing decisions; and 3) obtain current information on policies and incentives.

Brandon Owens (GE Energy Consulting) highlighted the association between energy use and human development in developing countries. He also discussed the expansion of hybrid energy systems that combine a central grid, distributed generation, and remote microgrids. Electrification offers opportunities to sell equipment and services, while supporting sustainable development. Under its "Access for All" initiative, GE sells small-scale, containerized solutions that can be configured for each site and it is working to reduce the costs to make these solutions more widely feasible.

1.3 SMART GRID, STORAGE, AND DEMAND MANAGEMENT TECHNOLOGY OPPORTUNITIES

Ravi Vora (Transventure Energy LLC) moderated the session on opportunities for sales of smart grid equipment, technologies, and services for transmission and distribution, ICT, energy storage, and demand management.

Ravi Vora (Transventure Energy LLC); Ty Roberts (Itron Networked Solutions); Richard Phillips (Vedanta ESS); and Andre DuPlessis (SEL)

Andre Du Plessis (Schweitzer Engineering Laboratories [SEL]) noted the importance of products that help to increase grid reliability and safety in developing countries. SEL partnered with USAID in two recent activities. The Bosnia Distribution Automation Pilot Activity, provided automation equipment and software for two rural distribution feeders. The Republic of Georgia Emergency Control System Activity helped to prevent unplanned power blackouts by introducing a country-wide, automated emergency load shedding system for the transmission supply operator. USAID's convening power also helped SEL access markets in other developing countries. There are good opportunities for U.S. suppliers in RE grid integration, micro-grids, grid automation and cybersecurity, and new and rehabilitated distribution substations.

Du Plessis also highlighted the advantages of participating in procurements organized by international financial institutions (IFIs), including multilateral development banks (MDBs). IFIs help ensure transparent procurement processes that focus on quality and value, rather than just cost. He advised U.S. suppliers to assess client needs before proposing solutions. SEL's marketing strategies have included presentations for potential clients and pro-bono technical assistance.

Ty Roberts (Itron Networked Solutions) shared perspectives from his company's experiences in Africa, Asia, and Latin America. In Africa, U.S. firms can help improve utility management and service quality. If the quality of electric power service improves, customers will accept gradually increasing tariffs that can cover the utility's costs. U.S. companies can also help developing country utilities improve bill collection and revenue management to increase their financial sustainability and mobilize capital for reinvestment. Sub-Saharan Africa is open to U.S. smart grid technologies since most countries have not yet adopted the standards of other supplier countries. In Asia, there is already a strong influence of technologies and standards from China and Japan. Nevertheless, Itron has identified good market opportunities for smart city network solutions in Asia driven by pressure to reduce energy and water consumption. Australia would be an excellent anchor for U.S. businesses, particularly as its telecommunications standards are similar to those in the U.S.

Central America and southern Africa rely extensively on U.S. technologies and standards, while European Union standards have been adopted in South America and northern Africa. In particular, there are good opportunities for U.S. suppliers of improved grid management software and metering solutions to reduce

technical and nontechnical losses, which currently range from 12-50 percent in Central America. U.S. firms interested in expanding sales in Africa and Latin America can help utilities reduce their costs through software and other services and may be able to achieve large sales volumes. However, some countries have domestic content requirements that will need to be met.

Richard Phillips (Vedanta ESS) has found USTDA and the U.S. Commercial Service support valuable. He noted that energy storage is the wild card that could lead to many changes in future electricity markets, but the rate and types of these changes are still uncertain. There are likely to be various energy storage solutions and U.S. firms will need to identify where their technologies and services fit best. He predicted that the Latin American markets for RE and energy storage solutions are likely to grow rapidly, especially in Brazil. However, some RE auction winners in Brazil have been unable to develop their awarded capacity because the bidders were unqualified or could not get commercial bank financing. Domestic banks had concerns about the risk of the PPAs denominated in domestic currency and over contracting of RE capacity in the 2014 and 2015 auctions. The Government of Brazil had to hold decontracting auctions in 2017 to reduce the penalties for the failure of PPA holders to supply the contracted capacity,

Phillips also discussed the approximately 2,000 diesel electricity generators operating off the grid in the Brazilian Amazon. Distributed generation may become the main driver for scaling up renewable electric power and storage in many Latin American countries. Many commercial and industrial users want to disconnect from the grid because of the poor reliability and high cost of grid electricity. In some countries, regulators have mandated utility investments in RE, energy storage, energy efficiency, and smart grids.

Phillips noted that the world market for long-duration energy storage could exceed $2 billion by 2020 and nearly $7 billion by 2025. He advised U.S. companies to begin expanding in developing country markets with good, effective demand for reliable power and high current costs of electricity. He recommended that U.S. companies perform due diligence before investing in developing country markets and assess the risk of policy distortions and the political environment.

1.4 GENDER CONSIDERATIONS IN EMERGING MARKETS

Nadia Scharen-Guivel (CEADIR) and **Bethany Speer** (National Renewable Energy Laboratory [NREL]) discussed how companies, financial institutions, and donors can address gender inclusion in electric utilities and the large-scale RE industry.

Nadia Scharen-Guivel (CEADIR) and Bethany Speer (NREL)

Scharen-Guivel noted there are many challenges in the gender-energy-poverty-nexus. Approximately 1.06 billion people lack access to electricity and three billion people use wood, charcoal, or other biomass sources for cooking and heating, often at unsustainable harvesting rates (World Bank 2018b). Women earn 10 percent of the world's cash income and only own 20 percent of the world's land (UN Women 2012). Modern RE could increase women's economic and social empowerment. Universal access is more achievable with off-grid solutions. Electricity use is generally correlated with economic opportunity and access to education and health services.

Ernst and Young (2016) reported on a survey of women's representation in boards and leadership positions in the 200 largest utilities in the world. The top 20 utilities in this sample for gender inclusions

had a 1.07 percent higher return on equity than the bottom 20 utilities for gender inclusion.[2] Companies can be motivated to increase women's representation in boards and leadership positions through government regulations, corporate policies, and concerns about business reputation. Scharen-Guivel also underscored the importance of training and other capacity development support and use of performance indicators to create a more level playing field for women as government policy makers, company directors and managers, and workers and suppliers.

Bethany Speer described NREL's activities to advance women's participation in the energy sector. She highlighted the role of mentoring and professional networks in strengthening women's participation in the sector. As the implementing agency for the Clean Energy Ministerial (CEM)'s Clean Energy Solutions Center, NREL helped the Economic Community of West African States (ECOWAS) develop a gender inclusion policy for the energy sector.[3] NREL began by assessing the current representation of women in the energy sectors in Senegal, The Gambia, Guinea-Bissau, Sierra Leone, Guinea, Liberia, Cote d'Ivoire, Ghana, Togo, Benin, Burkina Faso, Mali, Niger, and Nigeria. It then developed a policy and implementation plan to increase gender equity. NREL found occupational barriers and lower salaries for women, who tended to work in firms that were less capital intensive, less profitable, and used less advanced technology. Women also had limited access to finance as a result of lower levels of wealth, income, education, land access, and credit history.

NREL helped private investors and other stakeholders implement the ECOWAS plan, which included assessing the projected gender impacts of projects and use of indicators to monitor the actual impacts. Speer noted that gender and other social considerations can be incorporated in occupational health and safety standards, plans for grid expansion, energy pricing policies, and electric power generation concessions and contracts. The USG and U.S. companies can help lead by example.

CEM launched the Clean Energy Education & Empowerment Initiative (C3E) in 2010 to increase women's involvement in science, technology, engineering, and math (STEM) education and occupations. The International Energy Agency (IEA) took on the coordination role in 2016. The U.S. program for C3E is led by the U.S. Department of Energy in collaboration with the Massachusetts Institute of Technology Energy Initiative (MITEI), Stanford Precourt Institute of Energy, and the Texas A&M Energy Institute. The U.S program includes an annual symposium, annual awards for mid-career women working in clean energy, and outreach activities through advanced professionals (C3E Ambassadors) and a social media community.

1.5 OPPORTUNITIES FOR FINANCIAL AND TECHNICAL SERVICES

Jason Whitney (Overseas Private Investment Corporation [OPIC]) moderated a panel discussion on opportunities for financial and technical services.

Greg Poulos (ArcVera Renewables) described experiences in providing engineering and management services throughout the lifecycles of wind and solar power. He advised U.S. firms to enter markets early and be nimble and steadfast. Business activities in one country can facilitate entry to other countries in the region. Poulos also recommended that companies work with the U.S. Commercial Service to gain introductions to potential business partners and buyers. U.S. suppliers should carry out due diligence to reduce risks from competition, insufficient market volume, and customer failure to pay for products and

[2] However, a causal link between gender inclusion and returns on equity cannot be determined from this survey. The most profitable or largest firms or those located in certain countries may have more willing or able to promote gender inclusion.

[3] The CEM is a consortium of 24 countries and the European Commission.

services.

Nadia Scharen-Guivel (CEADIR) discussed the types of political and macroeconomic risks that U.S. firms need to assess before investing in new markets. In large and relatively open markets, U.S. firms may encounter more competition. In small and less open markets, U.S. firms may face other risks that may need to be offset by higher expected returns on investment or country diversification.

Jason Whitney (OPIC); Nadia Scharen-Guivel (CEADIR); Ignacio Rodriguez (Tetra Tech); Greg Poulos (ArcVera Renewables); and David Spira (Deloitte)

The Government of Argentina reduced the risks for investors by establishing a trust fund to guarantee its financial obligations for RE investments contracted through competitive auctions. Winning bidders paid a fee for the government guarantee. The World Bank offered a separate guarantee for an additional fee. Companies could choose whether to obtain the World Bank guarantee in addition to the government guarantee. The dual guarantees helped attract private investors, illustrating the catalytic role of governments and IFIs. As RE markets develop further, commercial banks may be willing to increase their financing without external de-risking and credit enhancement.

David Spira (Deloitte) noted that U.S. manufacturers and suppliers can generally be competitive in developing country markets if they follow best value approaches in their products, services, and selection of partners. The U.S. has distinct state and regional markets for electric power with different policy and regulatory environments and contexts. The diversity of these markets encouraged the development of many alternative solutions for power generation, transmission, and distribution. As a result, U.S. consultants have expertise on many alternatives that maybe relevant for different developing country markets.

Power transmission and distribution infrastructure has a high capital cost and consulting services on siting and design this infrastructure are critical and only a small fraction of the total cost. IFIs require countries to select reputable service providers through transparent procurement processes. Export promotion agencies and some bilateral donors tie their financing and other support to providers from their countries.

Ignacio Rodriguez (Tetra Tech) discussed opportunities for U.S. firms to provide policy and regulatory advisory services. He described the critical role of USAID support in advising on institutional reforms in electric power generation, transmission, and distribution and designing the RE auctions in Mexico. The Government of Mexico was keenly interested in learning from the experiences in the U.S. and other countries.

Rodriguez also mentioned the importance of understanding the local context and building trust with key stakeholders. Although elections can create uncertainty about the policy and regulatory environment and priorities, he noted that there is usually momentum for continuing power sector reforms after they have been implemented, although risks remain, particularly in Mexico and Brazil.

1.6 TECHNOLOGY AND REGIONAL BREAKOUT DISCUSSIONS

Participants self-selected into two sets of breakout groups focusing on types of technologies and geographic regions. Lead discussants in each breakout group facilitated the dialogues with the participants. Following the breakout groups, Victoria Gunderson (U.S. International Trade Administration) moderated the plenary session where each group shared their top insights.

Solar Power Breakout Group

Moderator: Bethany Speer (NREL); Lead discussants: Rebecca Cantwell (Colorado Solar Energy Industries Association), Emily Puente (First Solar), and David Renne (International Solar Energy Society)

Participants in the solar group highlighted the importance of assessing the specific characteristics of different market segments, considering a broad range of technical solutions, and emphasizing product quality (e,g., efficiency, reliability, and durability).

Wind Power Breakout Group

Moderator: Ravi Vora (Transventure Energy LLC); Lead discussants: Pramod Jain (Innovative Wind Energy), Christopher Moné (Senvion USA), Mark Lyons (RES), and John Rezaiyan (Tuatara Group)

Although the main focus of the forum was on utility-scale electricity, most of the discussion in the wind power group focused on applications for microgrids and minigrids. Systems with a capacity below 10 kW are usually called microgrids while those between 10 kW and 10 MW are minigrids. Microgrids that serve a small cluster of homes or firms might not require a distribution network. Microgrids and minigrids can be used in areas where the cost of extending the main grid is high. They can also be less costly than diesel generators in areas with grid access but unreliable electricity service.

Most minigrids in developing countries have been established with grants or subsidies. Even if the capital costs are covered by donors or governments, a market assessment should be prepared in advance to help them operate sustainably. For example, some minigrids set up on remote Indonesian islands provided customers with free electricity from minigrids until the systems failed due to lack of revenue for operating, maintenance, and replacement costs. Turnkey operations that include construction and operation and maintenance may be desirable for minigrids. Participants discussed various business models and competitiveness strategies for U.S. firms in wind power for utilities and minigrids.

Smart Grids and Energy Storage Breakout Group

Moderator: Santiago Enriquez (CEADIR). Lead discussants: Andre Du Plessis (Schweitzer Engineering Laboratories), Steve Hauser (Gridwise Alliance), Peter Lilienthal (HOMER Energy), and William Pott (POWER Engineers)

Participants debated whether developing countries should follow the historical, developed country approach based on large centralized grids or leapfrog to decentralized networks. POWER Engineers works with clients to help them decide which model would be best for them. Small grids generally have storage and can be connected to other grids for greater resilience. However, microgrids have a relatively high energy loss, 5-7 percent, in converting direct current to alternating current. There are innovative technologies for microgrids that only use direct current, but only donors and multilateral development banks are likely to accept the additional technology risks.

Government and donors have a large influence on the electrification models promoted in developing countries. In some countries where utility charges and taxes on electricity are a major source of government revenues, regulatory agencies may be reluctant to support microgrids or distributed RE systems that could reduce their revenues. However, governments in some of these countries recognize that they cannot afford the capital costs of extending the grid to serve all citizens and welcome alternatives. In other developing countries where electric utility tariffs are subsidized or below costs or it is difficult to provide reliable services, governments may welcome movement of customers off the grid.

U.S. companies should be aware that developing country governments may have different definitions of grid access. For example, the Government of India announced that all villages were connected to the grid, but their definition only required 10 percent of the village to have access to the grid.

The Gridwise Alliance is a U.S. organization that champions the principle concepts, policies, and investments needed to transform the electricity grid by understanding the diverse perspectives and priorities of all stakeholders; crafting action plans and strategies that articulate the benefits of the changes required in the United States. Steve Hauser mentioned that the Gridwise Alliance helped to establish the Global Smart Grid Federation (GSGF).

The GSGF is an association of national smart grid organizations from 15 countries and the European Union. The head office is in Washington, DC. The GSGF collaborates with governmental and national and international nongovernmental organizations to: 1) conduct and foster research; 2) provide expertise to support rapid implementation; 3) foster information exchanges and shares good practices; and 4) support dialogues between the public and private sectors.

Andre Du Plessis reported that Schweitzer Engineering Laboratories does not do local sourcing of technologies. As a result, it does not work in markets with domestic content requirements. SEL does work with importers and local engineering, procurement, and construction firms. All of SEL's technologies meet U.S. Department of Defense security requirements. Customs can be an issue, but their local partners bear this risk for the customers. SEL does consider customs delays and other factors that might affect its own work. Du Plessis also noted that supervisory control and data acquisition (SCADA) systems cannot currently stabilize the grid in most of Africa.

Some developing countries have held RE auctions that imposed domestic content requirements through bid rules or the power purchase agreements awarded to winning bidders. Victoria Gunderson commented that U.S. companies should be aware that the World Trade Organization prohibits domestic content requirements.

Smart grid and hybrid grid software can increase integration of variable RE sources. However, in developing countries, it is often necessary to duplicate grid modeling work for different clients due to the lack of central repositories for this information.

Peter Lilienthal discussed HOMER Energy Ltd.'s software products for on- and off-grid electricity management. The HOMER name stands for Hybrid Optimization of Multiple Energy Resources. HOMER Pro is the global standard software for optimizing microgrids and distributed energy resources, ranging from village power systems to island utilities, and grid-connected campuses and military bases. HOMER Grid optimizes behind-the-meter distributed energy resources to minimize demand charges, model complex tariffs and time-of-use rates, and take advantage of self-consumption, energy arbitrage, and incentives. HOMER Quick Start is free software for off-grid hybrid power systems. HOMER Quick Grid is a free web tool for understanding potential savings from demand charge reduction in behind-the-meter systems. HOMER SaaS Application Programming Interface allows users to develop their own web-based application with access to the components of HOMER Pro or HOMER Grid. A controller manages a microgrid's components to provide power in the most economical way. HOMER's products include a choice of controller algorithms and the flexibility to use an existing controller.

Africa Breakout Group

Moderator: Jason Nagy (Mainspring Innovation). Lead discussants: Paul Bergman (U.S. Department of Commerce) Ty Roberts (Itron), Raul Flores (Power Africa), Ryan Tramonte (Power Africa)

The Africa breakout group focused on resources and tools that the USG offers to support U.S. firms interested in doing business in Africa. Raul Flores and Ryan Tramonte of USAID discussed Power Africa's support for technical assistance, financing, and leveraging of financing from other sources. The Power Africa website offers valuable resources for U.S. firms interested in exporting energy technologies and services. The U.S. Secretary of Commerce usually travels to four African countries for two weeks each year.

Asia Breakout Group

Moderator: Mikell O'Mealy (CEADIR). Lead discussants: Victoria Gunderson (U.S. International Trade Administration), Rachel Posner Ross (Allotrope Partners), and Douglas Shuster (Tuatara Group)

Douglas Schuster noted that investments listed in China's five-year plans usually happen on time. The most recent five-year plan calls for 250 GW of wind power, but a lot of existing wind power generation has been curtailed in China due to transmission and market constraints. He added that the technical capacity of Chinese firms is spotty, for example capacity in combined heat and power technologies are not very advanced. However, when government gets out of the way, businesses often do well.

Allotrope Partners is an advisory, investment, and project development firm that specializes in clean energy in developing countries. The firm works on corporate procurement of RE in Indonesia, the Philippines, and Vietnam. It also aggregates the demand of different RE buyers for distribution utilities and promotes policy and regulatory reforms.

Participants discussed similarities and differences among countries in the region, including China, India, Central Asia, and Southeast Asia. For example, China and India have protectionist policies. To work in China, foreign firms have to be on the central government's approved procurement list. China's New Silk Road Economic Belt may be unlikely to create opportunities for U.S. firms since promotion of Chinese exports is a key motivation for the program. India has localization requirements. Indonesia does not have a centralized grid. The Philippines is developing a renewable portfolio standard. Some countries in Central Asia are dominated by fossil-fuel generation of electricity that is often located near cities that have serious air pollution problems, which may motivate RE development. However, some Central Asian countries have low electricity prices and rigid grid balancing contracts with Russia.

The group also discussed the importance of utilities as clients and challenges in grid integration. Although utilities can contract for a project, the regulatory agency may still have to approve it. The Asia Low Emission Development Strategies (LEDS) Forum has communities of practice on the private sector and financing.

Latin America Breakout Group

Moderator: Santiago Enriquez (CEADIR). Lead discussants: Greg Poulos (ArcVera Renewables), Richard Phillips (ESS Inc.), and Ulises Odio (POWER Engineers)

Participants noted the comparative advantage of U.S. firms, but European and Chinese competitors are already operating in the region. Many of the Chinese firms have cheaper, but lower quality products. They also recommended gaining a good understanding of the local context and culture, by getting to know potential new clients and building relationships. Spanish language is useful, but it is a secondary factor since English is also widespread. Some participants have identified business opportunities in the region by marketing their goods and services through the U.S. head offices of transnational firms.

Greg Poulos mentioned that his company provides technical services ranging from wind and solar resource prospecting to the design, financing, construction, inspection, monitoring, and evaluation of

wind and solar power investments in Central and South America. He emphasized the importance of trustworthy introductions to local companies in developing new business.

Richard Phillips brought up logistical challenges due to the rural conditions, lack of roads to deploy equipment, and climate in some Latin American countries. His main advice was, "Don't let anybody be between you and the customer." He suggested that companies be present in the room in addition to having in-country partners and to understand that cultures vary greatly across countries in the region.

Emily Puente (First Solar) observed that many large companies in Mexico are owned or managed by wealthy families. As a result, it is essential to begin discussions with the chief executive officer of the company to open the doors to engaging with the technical and managerial staff. She concurred that relying on intermediaries to manage these relationships can lead to reputational risks if something goes wrong.

Ignacio Rodrigues (Tetra Tech) commented that, "U.S. companies have to invest in understanding the local context and do their homework to be successful." He added that some European companies are more protected by their governments and can take more risks. China's Belt and Road Initiative is unlikely to create opportunities for U.S. firms since promotion of Chinese exports is a key motivation for the program.

1.7 USG SUPPORT FOR U.S. EXPORTERS OF GOODS AND SERVICES

USAID supports many RE collaborations between the private sector in the U.S. and assisted countries that range from small-scale to utility-scale. USAID technical support and financing has opened doors for U.S. suppliers of goods and services in many developing countries. Some USAID country missions and some USAID regional missions have supported utility-scale RE and smart grids in their geographic areas of coverage. Various USAID/Washington operating units have provided relevant support, particularly the Energy and Infrastructure (E&I) Office, the GCC Office, Global Development Lab, Development Credit Authority (DCA), Private Capital and Microenterprise Office (PCM), and Power Africa.

For example, USAID has partnerships with NREL, the U.S. Energy Association, and energy regulators and utilities in developing countries to promote sector reforms and utility commercialization. Regional activities include the Clean Power Asia Program, Clean Energy Finance Facility for the Caribbean and Central America, the South Asia Regional Initiative for Energy Integration, and the Private Financing Advisory Network (PFAN). Information on these and other ongoing global, regional, and country activities of USAID in the energy sector can be found at https://www.usaid.gov/energy/programs. USAID has worked with SparkMeter, a U.S. company that produces plug-and-play smart meters for utilities in developing countries that allow prepaid billing, customer communications, and remote monitoring and control.

USAID develops and promotes various toolkits and information resources. Examples include ClimateScope, the Renewable Energy Data Explorer, and toolkits for Clean Energy Lending Toolkit for banks, electric sector reform, greening the grid, grid-connected renewable energy generation, mini-grids support, and energy efficiency (https://www.usaid.gov/energy/toolkits).

USAID's Global Development Lab implements the Development Innovation Ventures (DIV), an open innovation program that tests and scales creative solutions to any global development challenge. Proposals are accepted year-round across three stages from any type of organization in countries where USAID operates.

Stage 1: Proof of Concept (Up to $200,000 - up to three years);
Stage 2: Testing and Positioning for Scale ($200,000 to $1,500,000 - up to three years); and
Stage 3: Scaling ($1,500,000 to $5,000,000 - up to five years)

The DIV also provides evidence grants (up to $1,500,000) to support research and evaluations that generate rigorous evidence of an innovation's impact per dollar and potential for expansion. These applications are evaluated separately from proposals for tiered funding. Information on applying for the DIV is available at https://www.usaid.gov/div/apply.

The USAID Global Development Lab and the Shell Foundation are collaborating in the Partnering to Accelerate Entrepreneurship (PACE) Program to catalyze private sector investment in early-stage enterprises by testing innovative approaches. USAID and Shell jointly supported early-stage clean energy technology start-ups through Factor(e) Ventures, an incubator based in Colorado, and Sangam Ventures, an investment firm in India.

In 2018, the USAID Global Development Lab announced some new support for RE financing. The Distributed Energy for Social Housing Fund will support solar power for low-income tenants in Brazil. Green Aggregation Tech Enterprise (GATE) will be the first guarantee mechanism for clean energy minigrids in Sub-Saharan Africa. The Residential Rooftop Solar Accelerator will offer financing for a standardized, home photovoltaic system in India.

Power Africa is a whole-of-government initiative led by USAID with 11 other USG entities. Power Africa also partners with over 140 private companies and other bilateral and multilateral development assistance institutions.[4] The initiative's goal is to add more than 30,000 MW of cleaner, electricity generation capacity and 60 million new home and business connections in Sub-Saharan Africa. Power Africa has a transaction focus. It provides on-the-ground support, helps to bridge the financing gap, and promotes African-led reforms. Power Africa focuses on generation, transmission, and distribution of on-grid electricity as well as beyond-the-grid electricity. Power Africa plans to increase its focus on U.S. suppliers and will work more closely with the Foreign Commercial Service, TDA, and Overseas Private Investment Corporation (OPIC).

The Power Africa Toolbox mobilizes 160 different tools to unlock obstacles facing private sector power deals in sub-Saharan Africa. It includes resources from 12 U.S. government agencies and 16 international development partners. These tools fall into six major categories:

1. Transaction assistance;
2. Finance;
3. Policy/regulatory design and reform;
4. Capacity building;
5. Legal assistance; and
6. Information resources.

Power Africa has helped 117 projects reach financial close, representing over 9,500 MW of new generation capacity and a combined value of more than $16.5 billion. Power Africa has mobilized nearly $56 billion in commitments from development partners, private financiers, project developers, and technology suppliers to invest in Africa.

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[4] Power Africa partners include the World Bank Group, the African Development Bank,, African Trade Insurance Agency, the European Union, the Development Bank of Southern Africa, the African Union's New Partnership for Africa's Development, the United Nations' Sustainable Energy for All initiative, the International Renewable Energy Agency, the Industrial Development Corporation of South Africa, the Government of Japan, the Government of Sweden, the Government of Norway, the Government of Canada, the U.K. Department for International Development, the Government of France, and the Government of Israel.

The USAID Development Credit Authority (DCA) provides partial portfolio guarantees to reduce risks to generate additional lending to underserved market and sectors and demonstrate the long-term commercial viability of lending in developing markets. Its standard products include loan guarantees, portfolio guarantees, portable guarantees, and bond guarantees. DCA charges origination and portfolio fees to cover the risks. The guarantees are backed by the U.S. Treasury. Information on the general features and standard terms of the DCA can be found at https://www.usaid.gov/sites/default/files/documents/1865/DCA_One-Pager_Financial_Partner.pdf.

The Export-Import Bank of the United States (EXIM) is a self-sustaining, export credit agency that fills gaps for American businesses when private lenders are unwilling to provide financing for foreign sales. EXIM offers export credit insurance, working capital guarantees, and performance and bid bonds. It allows U.S. companies to borrow against export assets and can finance foreign purchases of U.S. exporters, It can provide direct loans, loan guarantees, finance lease guarantees, and protection against buyer nonpayment (https://www.exim.gov/what-we-do).

The Millennium Challenge Corporation (MCC) is an independent, U.S. foreign aid agency with a mission to reduce poverty. It delivers foreign assistance through large, five-year grants to governments that have met competitive selection criteria that include good policies, country ownership, and results (compact countries). The grants promote economic growth, poverty reduction, and the strengthening of institutions. MCC also offers smaller grants for threshold programs in countries that come close to passing its eligibility criteria and show a firm commitment to improving their policy performance. MCC emphasizes country-led solutions and implementation. Partner countries set up local Millennium Challenge Accounts (MCA), accountable entities responsible for compact implementation overseen by MCC. The MCAs offer open procurements without U.S .preferences, but MCC encourages US companies to participate.

The OPIC is a self-sustaining USG agency that helps American businesses invest in emerging markets. It provides U.S. companies with financing, political risk insurance, advocacy, and partnering with private equity fund managers.

OPIC had a $23 billion portfolio, approximately one third in the power sector. Over the last decade, 80 percent of the power projects supported by OPIC have involved RE, mostly on-grid utility-scale, but also some off-grid.

The U.S. Small Business Administration (SBA) helps Americans start, build and grow businesses. It has a network of field offices and partnerships with public and private organizations to deliver services to people throughout the United States, Puerto Rico, the U.S. Virgin Islands and Guam. The SBA matches companies with approved lenders and provides loan guarantees. It also licenses and regulates Small Business Investment Centers (SBICs) – privately owned investment companies that provide debt and equity capital for small businesses, typically for a three-year period. The SBA provides some matching funds to qualified SBICs with expertise in specific industries or sectors that they can use along with their own capital. The SBA provides low-interest loans for disaster recovery. The SBA guarantees bid, performance, and payment surety bonds issued by certain surety companies. The SBA does not give grants to start or expand most businesses, but has limited grants available for exporting and research and development. It also offers information resources to help companies plan, launch, manage, and grow small businesses.

The SBA's Office of International Trade has a competitive State Trade Expansion Program (STEP) that provides grants to state government agencies. STEP awards allow states to assist small businesses with information and tools and participation in foreign trade missions, foreign market sales trips, services provided by the U.S. Department of Commerce, international marketing campaigns, export trade show exhibits, and training workshops.

The U.S. Department of Commerce has many operating units that assist exporters, including the U.S. Commercial Service, International Trade Administration. The www.export.gov website is a guide to

various resources from the Department of Commerce and other USG entities. It has a Renewable Energy and Energy Efficiency Exporter Portal with sector-specific resources (https://2016.export.gov/REEE/) as well as a newsletter.

The U.S. Commercial Service (USCS) has 77 commercial offices in U.S. embassies and consulates plus 106 offices in the United States (U.S. Export Assistance Centers [USEACs]). USEACs can help U.S. companies with initial market checks, customized market analyses, preliminary or in-depth profiles of foreign companies, and lists of U.S. and foreign business service providers. They can help companies with international partner searches and virtual introductions and virtual fairs. They can also identify, vet, and arrange meetings with interested parties in foreign countries; organize product launches, technical seminars, and promotional events for individual companies. The USEACs can also promote and support trade shows for multiple companies or industries.

The Featured U.S. Exporter (FUSE) directory lists U.S. products on USCS websites around the world and accepts advertising. Fees are charged for many USCS services.

The International Trade Administration (ITA) provides U.S. firms with country-specific export promotion services and market access advocacy. It also develops and implements trade and investment policies and enforces U.S. trade laws and trade agreements. The ITA administers the International Buyers Program, which brings foreign buyers to the country for matchmaking with U.S. companies exhibiting at major industry trade shows. Participants apply and are charged a fee if selected (https://2016.export.gov/ibp/). International buyers receive travel assistance from the U.S. embassy in their countries; free or discount admissions to trade shows; customized pre-arranged briefings and meetings, technical tours, translation assistance, and other business services. The International Buyers Program Select Service is similar, but focuses on smaller trade shows.

The ITA's Advocacy Center coordinates USG efforts on behalf of U.S. companies bidding on foreign government procurements. It helps to resolve U.S. company complaints about foreign public sector bidding processes that are not transparent, open, and fair. The Advocacy Center also has liaison staff at five multilateral development banks (World Bank, Inter-American Development Bank, African Development Bank, European Bank for Reconstruction and Development, and Asian Development Bank). The liaisons advise U.S. companies on how to work with the multilateral development banks and advocate on procurement and contracting issues. The ITA's Advocacy Center services are free for companies with products that have at least 51 percent U.S. export content.

The U.S. Trade and Development Agency (USTDA) has three mechanisms to support U.S.-based infrastructure developers in emerging markets. It can provide grants and U.S. technical experts to help developers prepare feasibility studies and prepare scopes of work for a project lifecycle from conception through financing. USTDA sponsors trade delegations from emerging markets for travel to meet with U.S. developers and visit factories. USTDA can also help develop the capacity of partner governments, including training procurement officials on best value selection. It organizes sector- and project-specific workshops. It provides grants to overseas sponsors to conduct feasibility studies and pilot projects, and technical assistance and training for legal and regulatory reforms and to increase understanding of U.S. capabilities.

2. CONCLUSIONS

Developing country emerging markets offer important business opportunities for U.S. firms to expand sales of renewable energy and smart grid equipment, technologies, and services. USG agencies, independent market analysts, and the experience of U.S. companies agree on the growing demand for U.S. products and services for utility-scale RE and smart grids in Africa, Asia, and Latin America. Developing countries are keenly interested in technologies, institutional structures, and business models that have been used in the United States and other countries served by U.S. suppliers.

There are challenges in accessing new markets in developing countries. Although there are important differences across and even within countries, common challenges include the regulatory and legal framework (import taxes, administrative procedures, domestic content requirements); the political commitment to implement reforms; competition from firms in other countries that may have an advantage due to a common language or use of similar technologies and standards; and ability of potential customers to obtain financing on suitable terms.

U.S. companies have adopted various successful strategies to expand business in developing countries. These strategies have included: 1) hiring local representatives; 2) joining with local partners; 3) focusing on selected markets or projects and gradually expanding to others; 4) participating in trade missions; 5) providing pro-bono technical assistance; 5) implementing pilot projects; and 6) prudent selection of customers. Flexibility, responsiveness, and persistence have often been important success factors.

USG agencies offer many valuable services to help U.S. companies. Many U.S. companies are not aware of the breadth of these services. Some of the services are free while others require payment.

Procurements organized by IFIs offer opportunities for U.S. suppliers. IFIs fill financing gaps that commercial banks are not yet ready to undertake and reduce risks for participating commercial banks and suppliers of goods and services. IFIs require transparent procurement processes and generally focus on value, rather than just cost, which can be advantageous for U.S suppliers. They also promote new technologies and help ensure that environmental and social impacts are assessed in analyzing alternatives.

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ANNEX A: FORUM AGENDA

TUESDAY, MAY 1

AGENDA	
8:00	**REGISTRATION** CRIPPLE CREEK FOYER
8:30	**WELCOME AND OPENING REMARKS** CRIPPLE CREEK SALON 2 **Forum Moderator:** Mikell O'Mealy, *CEADIR* **Opening Remarks:** Matthew Ogonowski, *USAID* **Keynote Address:** Suzanne Leta, *SunPower*
9:05	**WELCOME AND OPENING REMARKS** CRIPPLE CREEK SALON 2 **Trends and Projections by Technology and Region:** Ethan Zindler, *Bloomberg New Energy Finance (BNEF)* Trends and projections in Latin America, Asia, and Africa for demand, technology costs, and competitiveness of U.S. suppliers of products and services for utility-scale wind and solar power, smart grids, demand-side management, and energy storage. **Industry Insights on Global Power Systems:** Brandon Owens, *GE Energy Consulting* Key drivers creating opportunities for new business models and markets in developing countries.
10:15	**NETWORKING AND COFFEE BREAK** CRIPPLE CREEK FOYER
10:30	**Panel discussion on WIND AND SOLAR TECHNOLOGY OPPORTUNITIES** CRIPPLE CREEK SALON 2 Opportunities for selling wind and solar equipment, technologies, and services in developing country markets, and insights for firms interested in initiating or expanding business in emerging markets. **Moderator:** David Riposo, *U.S.Trade and Development Agency (USTDA)* **Speakers:** Emily Puente, *First Solar*; Mark Lyons, *RES;* Suzanne Leta, *SunPower;* and Brandon Owens, *GE Energy Consulting*
11:30	**Panel discussion on SMART GRID, STORAGE, AND DEMAND MANAGEMENT TECHNOLOGY OPPORTUNITIES** CRIPPLE CREEK SALON 2 Opportunities for sales of smart grid equipment, technologies, and services, including for transmission and distribution (T&D), information communication technologies (ICT), energy storage, and demand management, with first-hand insights on the needs of electric utilities in developing country emerging markets. **Moderator:** Ravi Vora, *Transventure Energy LLC* **Speakers**: Andre Du Plessis, *Schweitzer Engineering Laboratories;* Ty Roberts, *Itron;* and Richard Phillips, Vedanta *ESS Inc.*

1:00	**LUNCH BREAK** On your own (Purchase of a portable lunch is recommended to allow participation in the lunch session)
	LUNCH SESSION: GENDER CONSIDERATIONS IN EMERGING MARKETS CRIPPLE CREEK SALON 2 An overview and case studies on how companies, financial institutions, and donors are addressing gender and inclusion in the energy sector in developing country markets. Participants are invited to share their perspectives and experiences. **Speakers**: Nadia Scharen-Guivel, *CEADIR;* and Bethany Speer, *National Renewable Energy Laboratory (NREL)*
2:00	**Panel discussion on OPPORTUNITIES FOR FINANCIAL AND TECHNICAL SERVICES** CRIPPLE CREEK SALON 2 Prospects to support large-scale wind and solar power development, utility and grid planning, renewable energy zones, reverse power auctions, and variable renewable energy integration in developing countries. **Moderator:** Jason Whitney, *Overseas Private Investment Corporation (OPIC)* **Speakers**: Greg Poulos, *ArcVera Renewables;* David Spira, *Deloitte;* Nadia Scharen-Guivel, *CEADIR;* and Ignacio Rodriguez, *Tetra Tech*
3:00	**TECHNOLOGY-SPECIFIC BREAKOUT GROUPS** CRIPPLE CREEK SALON 2 Breakout groups focusing on technology-specific opportunities. Following initial remarks by the lead discussants, session moderators will invite all group participants to share their perspectives, experiences, and insights. **A. WIND** • **Lead Discussants:** Pramod Jain, *Innovative Wind Energy*; Christopher Moné, *Senvion USA*; Mark Lyons, *RES*; and John Rezaiyan, *Tuatara Group* • **Moderator:** Ravi Vora, *Transventure Energy LLC* **B. SOLAR** • **Lead Discussants:** Emily Puente, *First Solar*; David Renne, *International Solar Energy Society*; and Rebecca Cantwell, *Colorado Solar Energy Industries Association* • **Moderator:** Bethany Speer, *NREL* **C. SMART GRID AND ENERGY STORAGE** • **Lead Discussants:** Andre DuPlessis, *Schweitzer Engineering Laboratories*; Peter Lilienthal, *HOMER Energy*; William Pott, *POWER Engineers*; and Steve Hauser, *Gridwise Alliance* • **Moderator:** Santiago Enriquez, *CEADIR*
3:45	**NETWORKING AND COFFEE BREAK** CRIPPLE CREEK FOYER

4:00	**REGIONAL MARKET BREAKOUT GROUPS** CRIPPLE CREEK SALON 2 Breakout groups focusing on regional market opportunities. Following initial remarks by the lead discussants, session moderators will invite all group participants to share their perspectives, experiences, and insights. **A. AFRICA** • **Lead Discussants:** Ty Roberts, *Itron*; Raul Flores, *Power Africa*; Ryan Tramonte, *Power Africa;* and Paul Bergman, *U.S. Export Assistance Center* • **Moderator:** Jason Nagy, *Mainspring Innovation* **B. ASIA** • **Lead Discussants:** Victoria Gunderson, *U.S. International Trade Administration*; Rachel Posner Ross, *Allotrope Partners;* and Douglas Shuster, *Tuatara Group* • **Moderator:** Mikell O'Mealy, *CEADIR* **C. LATIN AMERICA** • **Lead Discussants:** Hugh McDermott, *ESS Inc.*; Greg Poulos, *ArcVera Renewables*; and Ulises Odio, *POWER Engineers* • **Moderator:** Santiago Enriquez, *CEADIR*
4:45	**HIGHLIGHTS FROM REGIONAL AND TECHNOLOGY-SPECIFIC BREAKOUT GROUPS** CRIPPLE CREEK SALON 2 Lead discussants from each breakout group will share themes from their discussions and new insights gained. **Moderator:** Victoria Gunderson, *U.S. International Trade Administration*
5:15	**KEY TAKEAWAYS AND CLOSING REMARKS** CRIPPLE CREEK SALON 2 Ethan Zindler, *BNEF*

ANNEX B: BRIEFER ON INFORMATION RESOURCES ON

INFORMATION RESOURCES ON

UTILITY-SCALE RENEWABLE ENERGY AND SMART GRID MARKETS IN DEVELOPING COUNTRIES

This briefer identifies major information sources on the markets for utility-scale renewable energy (primarily, solar and wind power) and smart grid technologies in developing countries. It includes world market outlooks with country data, regional market outlooks, technology-specific outlooks, and databases. A link is included for each report or web resource. The icon in front of each item indicates whether it is free or for sale.

WORLD MARKET OUTLOOKS AND GLOBAL RESOURCES

SALE

ADS Reports published market research reports on wind and solar energy and smart grids. These reports addressed industry analyses, technology trends and developments, and descriptions of key players and their market shares.

FREE

Bloomberg New Energy Finance's (BNEF) ***Climatescope*** (2017) was an assessment of renewable energy market conditions and opportunities in more than 70 emerging market countries. Climatescope contained detailed country profiles. It also ranked the renewable energy development potential of each country, based on 43 indicators and 179 sub-indicators.

SALE

BNEF's ***New Energy Outlook*** (2017) contained detailed annual forecasts of electric power production by type of energy through 2040. The report discussed changes in technologies, markets, and business models. The near-term market projections were based on an analysis of policies and other drivers and BNEF's database of planned installations, retrofits, and facility retirements by country and types of technology. The seven reports consisted of a Global Synthesis, regional reports; and energy resource reports.

In addition, ***BNEF*** provided other services, such as research, long-term forecasts, and in-depth analyses of energy technologies and sectors. It also offered a comprehensive database of projects, policies, companies, and investments; a suite of interactive analytical tools and proprietary models; a daily news feed; and briefings and webinars.

SALE

BMI Research offered a range of global, regional, and country-specific outlooks for renewable energy and developed forecasts for specific technologies. It provided daily viewpoints and insights and an online platform for data and forecasting tools.

FREE

The BP ***Energy Outlook*** (2018) explored projected demand and supply changes for renewable and nonrenewable energy that will shape the global energy transition through 2040 and key uncertainties. BP also published ***insight factsheets*** on various regions and countries with large energy markets.

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INFORMATION RESOURCES ON

UTILITY-SCALE RENEWABLE ENERGY AND SMART GRID MARKETS IN DEVELOPING COUNTRIES

WORLD MARKET OUTLOOKS AND GLOBAL RESOURCES

The ***Energy Sector Management Assistance Program*** (ESMAP) had several databases and tools, including the ***Global Solar Atlas*** and the ***Global Wind Atlas***. It also provided free, web-based applications developed to help policymakers and investors identify potential high resource areas for wind and solar power generation worldwide, and perform preliminary calculations. Its Regulatory Indicators for Sustainable Energy (RISE) scores summarized the policy and regulatory environment of countries for energy access, energy efficiency, and renewable energy.

ExxonMobil's 2018 ***Outlook for Energy: A View to 2040*** (2018) contained energy demand and supply projections through 2040, including regional projections of solar and wind energy.

Greentech Media was a market analysis and advisory firm that focused on technologies, financing, and institutional analyses for electric power and associated industries worldwide.

The International Energy Agency's (IEA) Market Report Series, ***Renewables 2017***, contained five-year forecasts of hydropower, bioenergy, onshore wind, offshore wind, solar photovoltaics (PV), concentrated solar power (CSP), geothermal, and ocean power. The report contained country-specific data and forecasts for major markets, including investment pipelines, economic growth projections, policy frameworks, economic feasibility, and power system integration.

IEA's ***World Energy Outlook*** (2017) analyzed the effects of policy and investment decisions on long-term energy by regions and sectors (residential, services, agriculture, industry, transport, and non-energy use). It also modeled electric power and heat generation, fossil fuel production and processing, and bioenergy. The model projected energy flows by type of fuel, investment costs, greenhouse gas emissions, and end-user prices.

IEA's website ***statistics*** page contained data on world energy markets, including monthly prices for oil, gas, and electricity.

The International Renewable Energy Agency's (IRENA) ***Renewable Energy Roadmap*** (REmap) (2016) assessed the potential for countries and regions to scale up renewable energy use in electric power, heating and cooling, and transport. REmap also presented costs, investment requirements, impacts on air pollution and greenhouse gas emissions, and economic growth and employment. IRENA also produced country reports on Renewable Energy Outlooks and Renewable Energy Prospects that estimated the potential contributions of countries to achieving a 36 percent share for renewables energy worldwide by 2030, and Renewables Readiness Assessments that identified actions specific countries can take to scale up renewable energy use faster.

IRENA's ***website data and statistics*** page contained data on renewable energy capacity and generation, renewable energy balances, finance, renewable energy auctions and targets by country, and technology costs.

McKinsey's ***Global Energy Perspective: Reference Case 2018*** presented the results of macro- and microeconomic modeling of 55 types of energy demand in 145 countries and 28 sectors.

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INFORMATION RESOURCES ON

UTILITY-SCALE RENEWABLE ENERGY AND SMART GRID MARKETS IN DEVELOPING COUNTRIES

WORLD MARKET OUTLOOKS AND GLOBAL RESOURCES

The Renewable Energy Policy Network for the 21st Century (REN21) issued a ***Renewables Status Report*** (2017) that addressed world energy markets, industries, policy and regulatory frameworks, and investments. REN21 has also issued regional reports.

Shell's ***World Energy Model*** (2017) projected the world demand and supply for energy services and discussed resource constraints, build rates, and prices. The model produced regional and country forecasts of the demand for electricity and the projected installed capacity by technology. Shell's ***Renewable Energy Resources Database*** provided regional and country-specific information.

The U.S. Energy Information Administration's (EIA) ***International Energy Outlook 2017*** provided long-term regional energy projections, including a reference case based on current policies and other scenarios reflecting different economic growth rates and world oil prices.

The U.S. International Trade Administration's (ITA) ***Top Markets Series*** provided information on market opportunities for U.S. exporters in specific industries, by country. The series described export opportunities, the competitive landscape, and challenges and included detailed case studies. Examples included the ***Renewable Energies Report*** (2016) and ***Smart Grid Report*** (2017).

The World Energy Council's (WEC) ***Energy Trilemma Index*** (2017) ranked over 120 countries on energy security, energy equity (accessibility and affordability), and environmental sustainability.

The WEC's ***World Energy Resources 2016*** contained data on energy use in more than 180 countries. It also included briefs on the energy mix in various countries and analyses of the economic and environmental impacts of energy technologies.

The WEC's ***World Energy Scenarios 2016 - The Grand Transition*** presented three scenarios for energy production and use worldwide. The WEC also prepared regional reports for example on ***Latin America & the Caribbean Energy Scenarios*** (2017) and the ***Regional Perspective for Sub-Saharan Africa*** (2018).

The WEC website offered several ***datasets***, graphs, and charts, including on world energy ***resources***, ***issues*** shaping global and regional energy markets, and the ***sustainability of national energy policies***.

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INFORMATION RESOURCES ON

UTILITY-SCALE RENEWABLE ENERGY AND SMART GRID MARKETS IN DEVELOPING COUNTRIES

TECHNOLOGY-SPECIFIC OUTLOOKS

Allied Market Research's ***Solar Energy Market*** (2015) report provided detailed regional and country projections for solar power through 2022.

Frost & Sullivan Research's ***Global Wind Power Market: Forecast to 2025*** (2017) contained wind power projections from 2017 to 2025 and discussed factors affecting the world and regional markets. It also projected annual growth in installed wind power capacity for the world, regions, and selected countries.

The Global Wind Energy Council's (GWEC) ***2016 Global Wind Energy Outlook*** contained wind power projections for 2020, 2030, and 2050. It also estimated the associated employment gains, greenhouse gas emission reductions, cost savings, and capital investment requirements. GWEC has also issued ***country reports***.

MarketsandMarkets ***Smart Grid Market – Global Forecast to 2022*** (2017) projected smart grid software, hardware, and service sales through 2022 by region. It also analyzed their business strategies, products and services, partnerships and collaborations, planned expansion of major companies, and the competitive landscape for smart grid products and services.

Mordor Intelligence was a market research and consulting firm with expertise in country-specific analyses of energy industry segments, including power storage, renewables, generation, transmission, and distribution. Their 2017 ***Global Smart Grid Network Market - Segmented by Application and Geography - Growth, Trends and Forecasts (2018-2023)*** provided market size and demand forecasts for various smart grid technologies through 2023. It analyzed market segments for transmission upgrades, demand response, and advanced metering by region and for selected countries and companies.

Navigant Research offered custom market research on energy technologies and utility restructuring. It had a proprietary platform to create customized views and sort data by product or service, region or country, price, and manufacturer. It also conducted market assessments and provided advisory sessions.

Navigant Research's ***Market Data: Smart Grid IT Systems*** (2017) analyzed the world and regional markets for smart grid information technology (IT) systems and analytic solutions through 2026. It projected sales revenues for implementation and upgrade services, maintenance, and cloud support. This market assessment addressed 12 major smart grid IT systems: advanced distribution management systems, asset management systems, customer information systems, demand response management systems, distributed energy resource management systems, energy management systems, geographic information systems, meter data management systems, mobile workforce management systems, outage management systems, supervisory control and data acquisition, and analytics.

Northeast Group was a market intelligence firm with expertise in smart infrastructure and smart grids. It analyzes and forecasts how smart infrastructure and the Internet of Things will be deployed at utilities and in smart cities. It also publishes market research studies and data and offers custom research services. Their ***Emerging Markets Smart Grid: Outlook 2018*** identified the 50 emerging market countries with the largest expected investments in smart grids through 2022. These technologies included smart metering, distribution automation, and battery storage. This report profiles and trends in smart grid tenders and deployment in 50 countries. The Northeast Group also issued in-depth reports on smart grid infrastructure in specific regions and countries.

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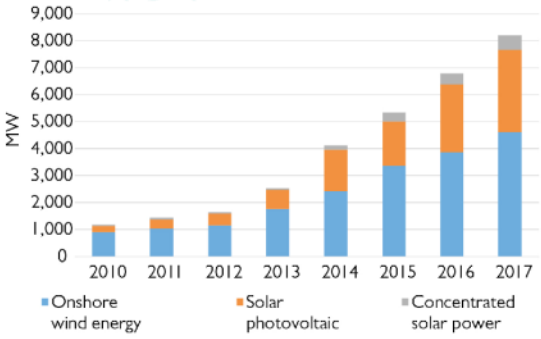
ANNEX C: BRIEFER ON OPPORTUNITIES IN AFRICA

OPPORTUNITIES FOR US SUPPLIERS
OF UTILITY-SCALE WIND AND SOLAR POWER AND SMART GRID PRODUCTS AND SERVICES IN AFRICA

The installed capacity of wind and solar power in Africa increased by 600 percent between 2010 and 2017 (Figure 1). Investment in both technologies is expected to continue expanding as countries broaden access to grid electricity and meet increasing demand while reducing dependence on fossil fuels (IEA 2016).

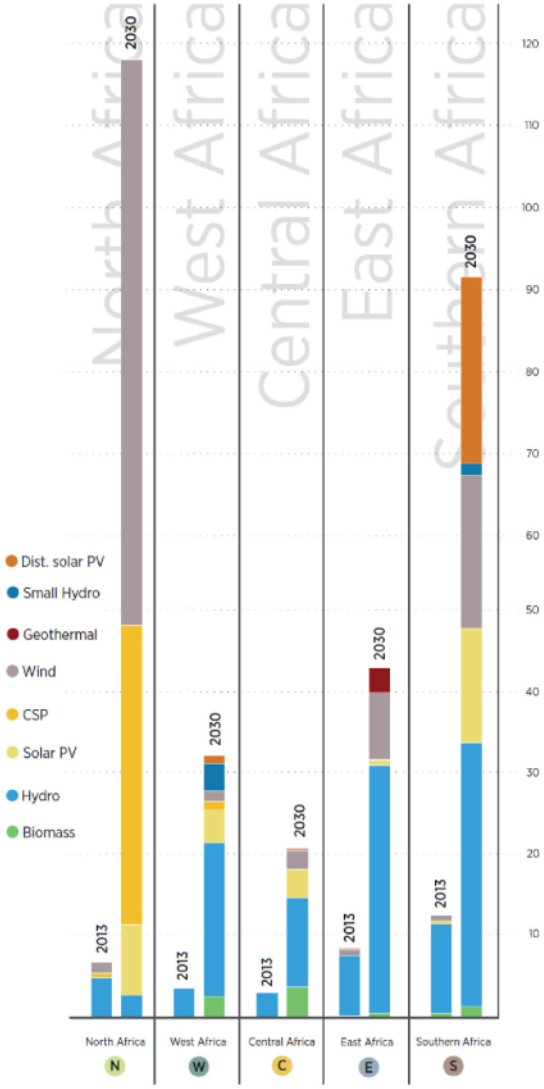
IRENA (2016a) projected that Africa will require electric power capacity of 610 gigawatts (GW) by 2030, up from 185 GW in 2014. IRENA estimated that renewable energy sources could account for 310 GW of the total, including 100 GW from wind, 38 GW from concentrating solar power (CSP), and 30 GW from photovoltaics (PV), as shown in Figure 2.

Figure 1. Solar and Wind Power Installed Capacity in Africa, 2010-2017



Source: IRENA 2018a.

Figure 2. Projected Electric Power Capacity in Africa, by Source, 2013 and 2030



Source: IRENA 2016a.

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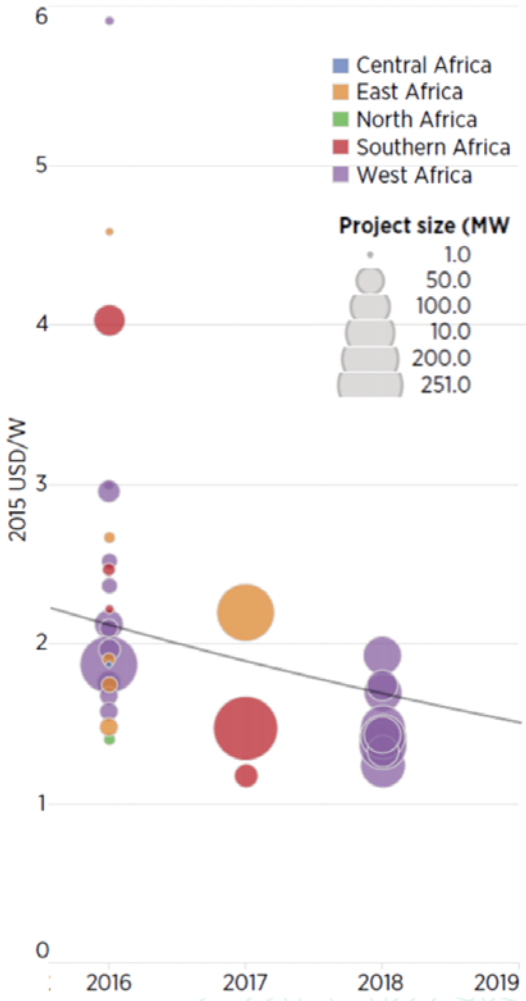
POLICY AND REGULATORY ENVIRONMENT

South Africa switched from feed-in-tariffs (FITs) for renewable energy to auctions in 2011 (Baker 2017). Between 2012 and 2016, South Africa attracted more than $17 billion in clean energy investments (BNEF and UK Aid 2017). Ghana and Uganda have also switched from FITs to auctions. Kenya plans to switch from FITs to auctions by 2020. Botswana, Burkina Faso, Cameroon, Ethiopia, Madagascar, Mauritius, Namibia, Senegal, and Zambia have also implemented renewable energy auctions (Lucas et al. 2017).

The World Bank's Scaling Solar Program combines auctions with financing and insurance for bidders and risk management and credit enhancement products. Scaling Solar aims to develop more than 1,400 megawatts (MW) of solar power by 2020 through active engagements in Ethiopia, Madagascar, Senegal, and Zambia (Scaling Solar 2018). The governments of Germany, Norway, and the United Kingdom, as well as the European Union and the World Bank have provided technical assistance, financial incentives, funds to build interconnection infrastructure, and financial guarantees to complement auctions in Ghana and Uganda (Lucas et al. 2017).

Utility-scale solar PV investments in Africa in 2015 and 2016 had estimated costs of $1.3 to $4.1 per watt (W), compared with a worldwide weighted average of $1.8/W in 2015 (Figure 3). The Levelized Cost of Energy (LCOE) from onshore wind in Africa in 2016-2017 was $0.09/kWh, compared with $0.08/kWh in Europe and $0.10/kWh in Central America and the Caribbean (IRENA 2018b). Egypt and Morocco have both attracted investments for solar electric installations larger than 180 MW, requiring significant debt by bringing together a group of diverse public and private investors (BNEF and UK Aid 2017).

Figure 3. Actual and Projected Installed Costs for Operating and Proposed Utility-Scale Photovoltaics in Africa by Region, 2016-2018



Source: IRENA 2016b.

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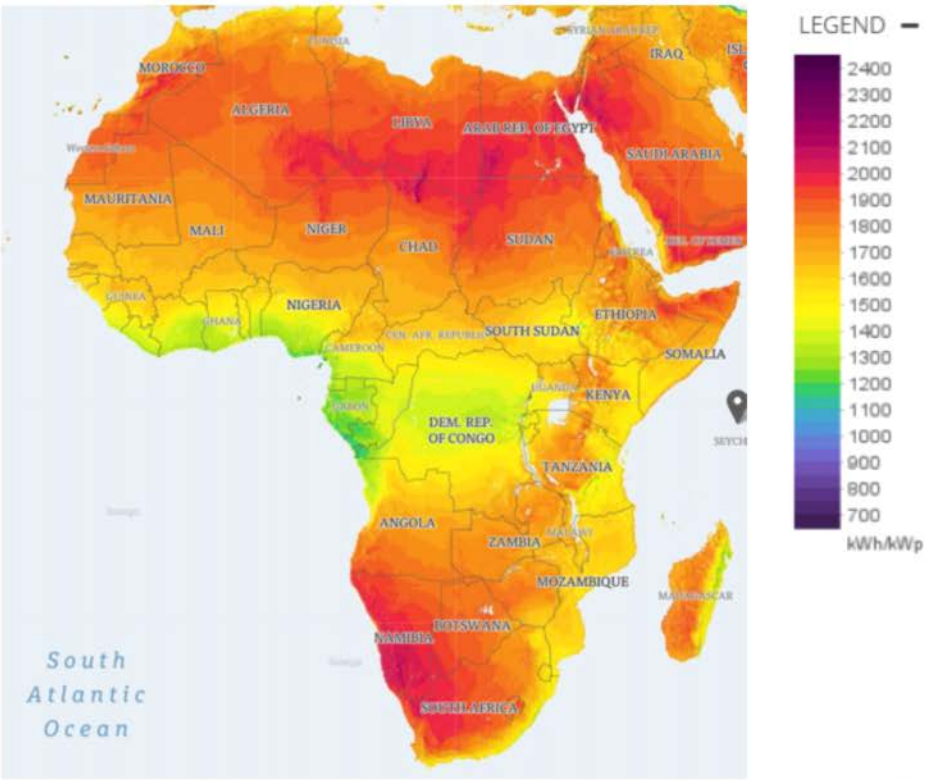
SOLAR POWER

Figure 4 shows that Africa has tremendous solar potential, distributed across multiple countries. African capital cities receive an amount of solar power ranging between 1,750 and 2,500 kWh/m²/year (IRENA 2016b).

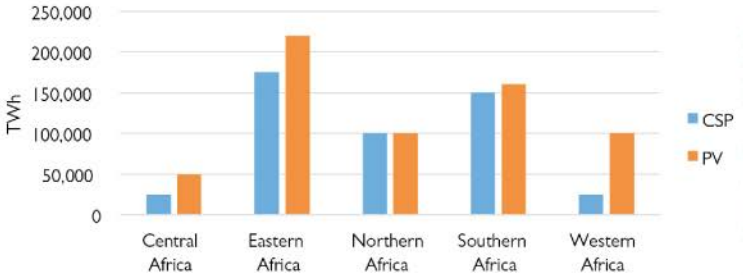
Figure 4. Average Electric Power Potential Per Peak Kilowatt of Grid-Connected Photovoltaics in Africa, 1994-2015



Source: World Bank 2017.

Africa has a theoretical potential of 470,000 terawatt hours (TWh) for CSP and 660,000 TWh for photovoltaics. East and Southern Africa have the highest potential (Figure 5).

Figure 5. Theoretical Potential for Concentrated Solar and Photovoltaic Power in Africa, by Region (TWh)



Source: Based on data from IRENA 2014.

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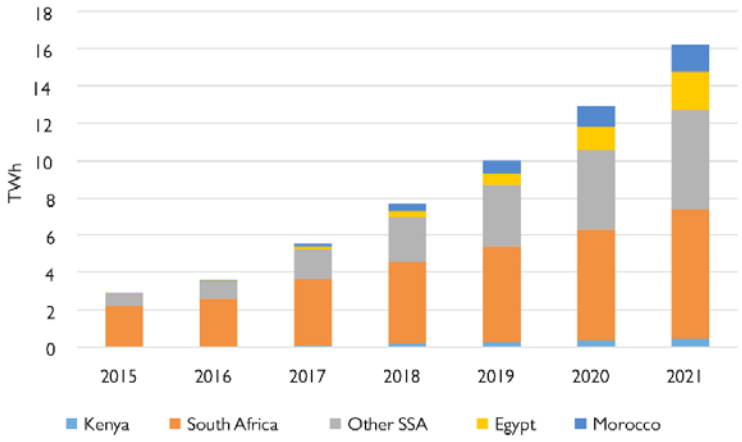
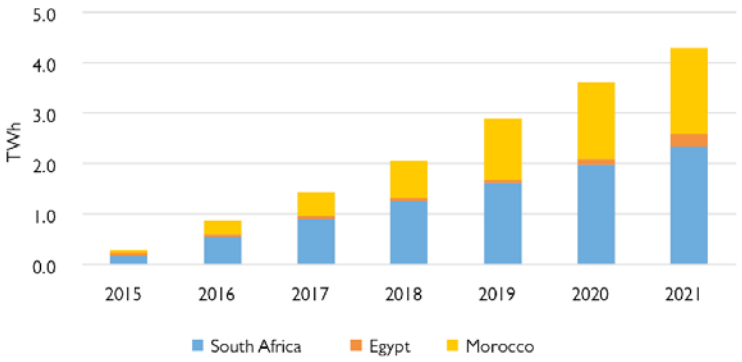
IEA (2016) estimated that electric power generation from PV in Africa will increase from 2.9 TWh in 2015 to 16.2 TWh in 2021 (Figure 6). It also estimated that electric power generation from CSP will increase from 0.3 TWh to 4.3 TWh over the same period (Figure 7). South Africa, Morocco, and Egypt are expected to have the largest share of electric power generation from PV and CSP technologies.

Figure 6. Projected Electricity Generation from Photovoltaics in Africa, 2015-2021 (TWh)



Source: Based on data from IEA 2016.

Figure 7. Projected Electric Power Generation from Concentrating Solar in Egypt, Morocco, and South Africa, 2015-2021 (TWh)



Source: Based on data from IEA 2016.

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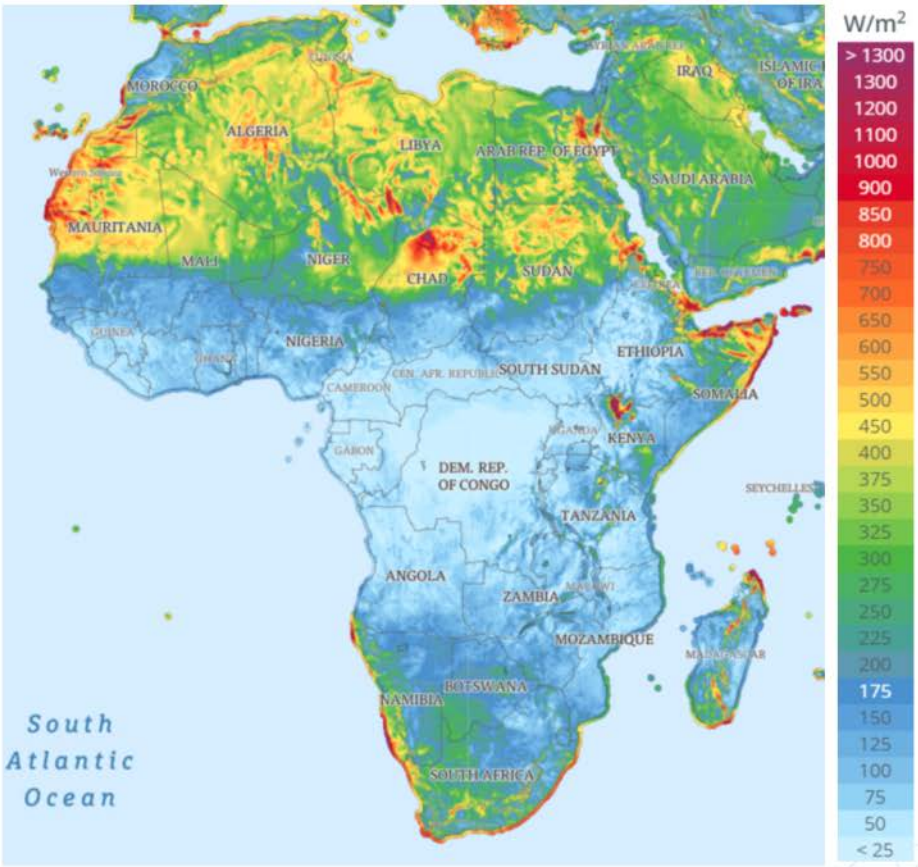
WIND POWER

Figure 8 shows wind power densities in Africa. Algeria, Chad, Egypt, Madagascar, Namibia, Somalia, South Africa, and Sudan have high wind power density areas.

Figure 8. Wind Power Density in Africa



Source: Technical University of Denmark 2017.
Note: Power density at 100m height.

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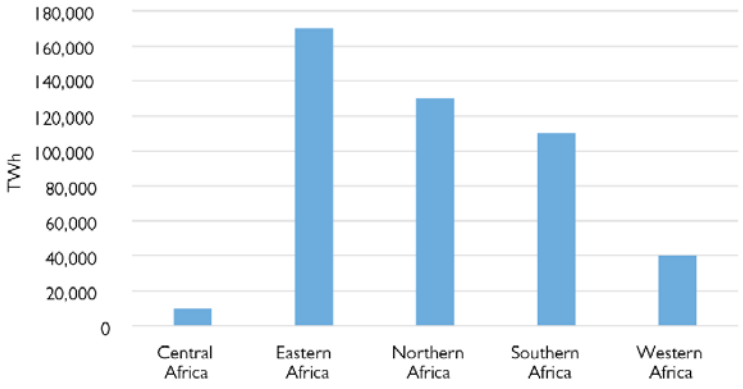
IRENA (2014) estimated Africa's theoretical wind potential at 460,000 TWh in 2014. Algeria, Egypt, Somalia, South Africa, and Sudan are among the countries with the highest wind energy potential (Figure 9).

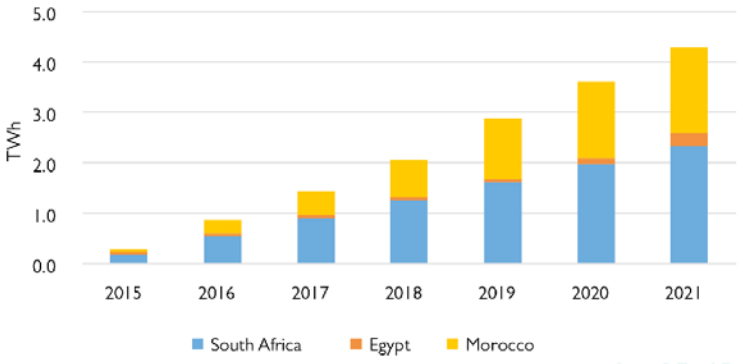
Figure 9. Theoretical Potential for Wind Power in Africa, by Region (TWh)



Source: Based on data from IRENA 2014.

IEA (2016) estimated that onshore wind power generation in Africa would increase from 8.4 TWh in 2015 to 29.1 TWh in 2021. South Africa, Egypt, and Morocco are expected to have the largest share of this power (Figure 10).

Figure 10. Projected Electricity Generation from Onshore Wind Power in Africa, 2015-2021 (TWh)



Source: Based on data from IEA 2016.

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SMART GRIDS

African utilities are looking at the potential of smart grid technologies to reduce losses from theft and transmission and distribution (T&D) while building new infrastructure to meet increasing demand (ITA 2017).

T&D products and services will be increasingly important as governments and regulators look to implement policies that expand regional grids, while increasing the resilience and integration of distributed energy resources. Four regional power pools aim to integrate the electricity markets in Africa, covering Central, Northern, Southern, and Western Africa (Deloitte 2015). These regional projects are slowly developing, but interest in integrating geographically disperse, variable renewable energy sources could spur regional cooperation.

Egypt started talks with Burundi, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda to build the T&D infrastructure to connect these countries' grids. These discussions took place in the context of the Nile Basin Initiative, which has already supported power projects connecting the grids of Ethiopia and Sudan, and of Zambia, Tanzania, and Kenya. Ethiopia has allocated 30 percent of its power infrastructure investment to regional T&D interconnections, including a 1,045-km voltage line under the Ethiopia-Kenya Power Interconnection Project. When completed in 2019, this new transmission line, with a capacity of 2 MW, will allow Ethiopia to expand domestic distribution of electricity and export surplus energy to Kenya (ITA 2017).

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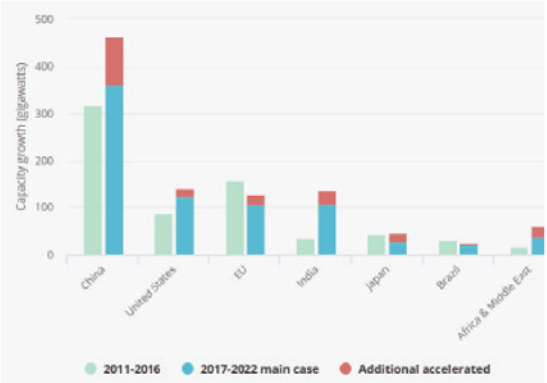
ANNEX D: BRIEFERON OPPORTUNITIES IN ASIA

OPPORTUNITIES FOR US SUPPLIERS
OF UTILITY-SCALE WIND AND SOLAR POWER AND SMART GRID PRODUCTS AND SERVICES IN ASIA

In 2016 and 2017, Asia saw the largest deployment of solar and wind power worldwide (IRENA 2018a). China and India have led the development of these technologies and have mobilized the largest amount of clean energy asset finance since 2010. These trends will continue in the future, as both countries aim to meet their ambitious renewable energy targets.

China's targets include an installed capacity of at least 110 gigawatt (GW) of solar power and 210 GW of wind power by 2020. China will account for 40 percent of global renewable expansion between 2017 and 2022 (Figure 1).

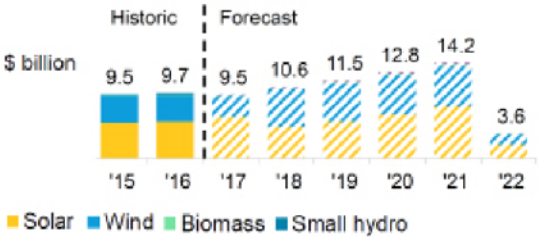
Figure 1. Renewable Electric Power Capacity Growth by Country or Region 2017-2022 ("Main Case" Scenario Based on Current Policies)



Source: IEA 2017.

India's ambitious renewable energy targets are second only to China's and include the development of 135 GW of utility-scale power. Utility-scale photovoltaic (PV) and wind power were significantly cheaper than fossil-fuel based alternatives in India by the end of 2017 and were expected to constitute most of the capacity that will be added between 2018 and 2022. Utility-scale renewables in India will provide investment opportunities of $53 billion during this period (Figure 2). In the past, debt from domestic and international banks and private and corporate equity provided most project finance in India. In 2018, the launching of several public offers by Independent Power Producers will open up the market to a broader group of investors (BNEF 2017). India's renewable energy market has become increasingly attractive for investors due to factors that include low risk, medium to high growth, and high cash-flow stability (Jena et al. 2018).

Figure 2. Historical Renewable Energy Investments in India and Estimated Future Financing Requirements ($ Billion)



Source: BNEF 2017.

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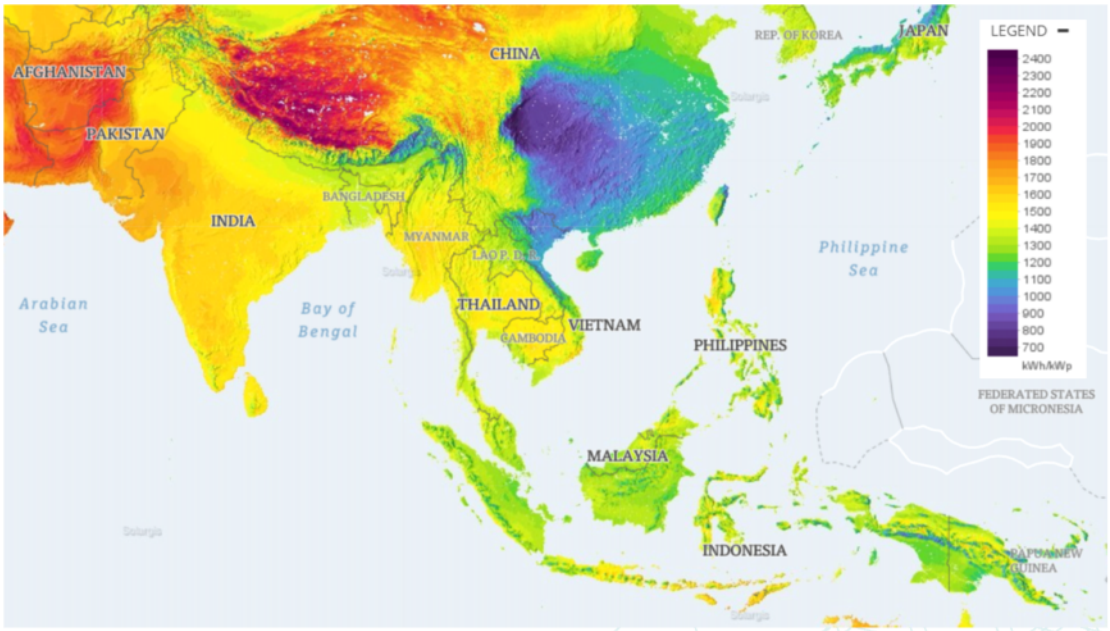
Thailand was the leading generator of solar power in Southeast Asia with an installed capacity of 2,700 megawatts (MW) in 2017. The Government of Thailand has mainly used FITs to encourage PV investments. Thailand has set a cumulative capacity target of 6,000 MW of PV by 2036. The Philippines also used FITs to help increase PV capacity from 22 MW in 2014 to 885 MW in 2017. The Philippines has a target of 3,000 MW of utility-scale solar power by 2022. Indonesia, Malaysia and Vietnam also offer FITs and have set PV capacity targets of 5,000 MW, 1,356 MW and 850 MW, respectively, by 2020 (IRENA 2018; AsianPower 2018; Tan and Asmarini 2016). In December 2017, Malaysia awarded 563 MW of solar power in its second large-scale solar auction (Kenning 2017). In March 2018, Malaysian utility Tenaga Nasional Berhad (TNB) signed 21-year power purchase agreements (PPA) for eight PV projects with a cumulative capacity of 240 MW awarded through the tender (Kenning 2018a).

Most ASEAN countries also exempted renewable energy investments from corporate income and import taxes, and Indonesia, Malaysia, and Thailand offered soft loans for developers. Countries that provided a combination of FITs with other incentives experienced the highest growth in renewable power between 2006 and 2016 (Tongsopit et al. 2017). Cambodia, Indonesia, Malaysia, and Thailand have started using competitive auctions and most countries in the region will likely implement auctions in the coming years (IRENA 2018b). In Vietnam, provinces have started developing PV plans and regulation for projects up to 50MW, offering better terms and options for investors than the national government (Kenning 2018b).

SOLAR POWER

Photovoltaic power potential is particularly high in Afghanistan, Pakistan, and southwestern China, all of which have areas with a yearly potential of more than 1,900 kilowatt hour/kilowatt peak (kWh/kWp) (Figure 3).

Figure 3. Solar Energy Resources in Asia and the Pacific (Photovoltaic Electricity Output)



Source: World Bank 2018.

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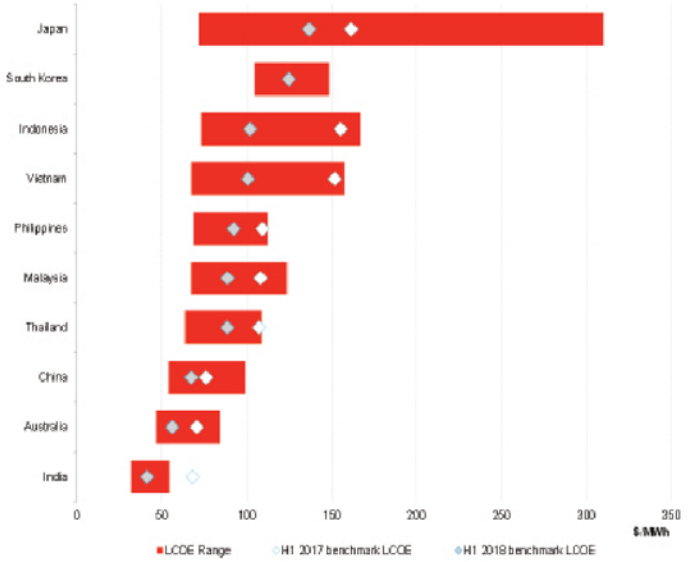
The Levelized Cost of Energy (LCOE) for PV power in China and India were among the most competitive in the world in 2017. Japan's LCOE for PV was more than double the cost of India's (Figure 4).

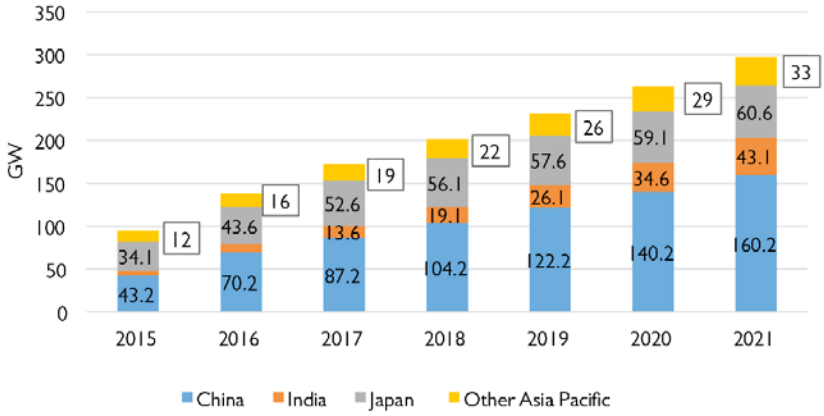
Figure 4. Solar Photovoltaic Levelized Cost of Energy in Asia Pacific Region in 2018 ($/MWh)



Source: Bloomberg New Energy Finance

The International Energy Agency (2016) projected that China and India would account for almost 70 percent of PV expansion in Asia between 2015 and 2021 (Figure 5). In 2018, China will install up to 60 GW of PV, potentially representing more than half of a global estimate of 113 GW. Installations were expected to peak around the FIT deadlines planned for the second and fourth quarters of 2018. India is poised to overtake the U.S. as the second largest PV market in the world (Osborne 2018). In other parts of Asia and the Pacific, deployment of solar power could accelerate as the Asian Development Bank signed in March 2018 a cooperation agreement with the International Solar Association and committed to provide $3 billion per year by 2020 for clean energy, including solar energy projects, in the region (Economic Times 2018b).

Figure 5. Projected Photovoltaic Electric Power Capacity in Asia, 2015-2021



Source: IEA 2016.

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WIND POWER

Indonesia, Lao PDR, Myanmar, the Philippines, Thailand and Vietnam have set national targets for wind power (Table 2).

Table 2. National Wind Power Targets in Selected Countries

Country	National Target by 2025
Indonesia	1.5 GW
Lao People's Democratic Republic	73 MW
Vietnam	2 GW

Source: IRENA 2018b.

FITs and priority grid connections have encouraged wind project development in the Philippines, Thailand, and Vietnam, resulting in nearly 1 GW of collective installed capacity as of 2017 (IRENA 2018b). Afghanistan, China, India, and Pakistan also have significant wind resources (Figure 6).

Figure 6. Wind Power Density in Asia at 100 Meters

Source: Technical University of Denmark 2017.

As in the case of PV, the average LCOE for onshore wind in China and India was among the most competitive in 2017. Japan, Thailand, and Indonesia had the highest LCOE in the region (Figure 7). By 2021, almost 94 percent of Asia's onshore wind installed capacity will be located in China and India (Figure 8). Offshore wind will likely increase in the coming years. India has a target of 5GW by 2022, up from zero in 2018. In April 2018, the government invited private firms to participate in a process to shortlist prospective developers for a 1 GW offshore wind energy project in the Gulf of Khambat, off the coast of Gujarat (Saluja 2018). China had 2,641 MW of offshore wind by 2017 and will have an estimated 6,800 MW by 2021 (IRENA 2018a; IEA 2016).

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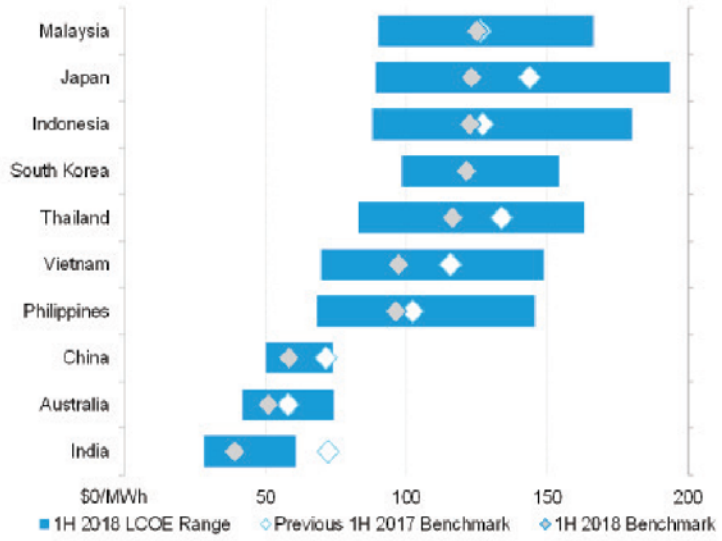
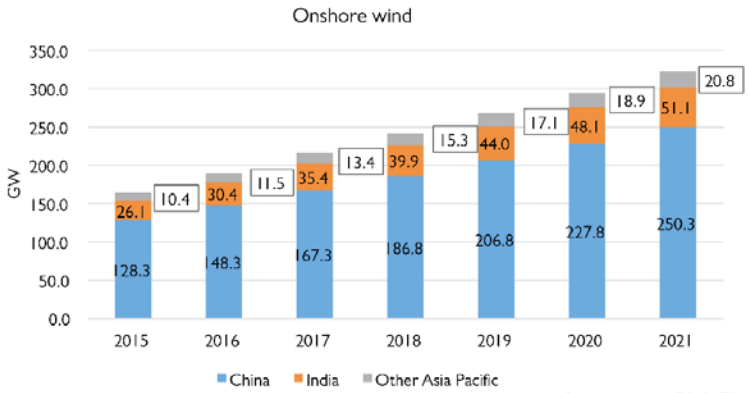
Figure 7. Onshore Wind Levelized Cost of Energy in Asia Pacific Region in 2018 ($/MWh)



Source: Bloomberg New Energy Finance

Figure 8. Projected Installed Capacity of Onshore Wind Power in Asia, 2015 -2021



Source: IEA 2016.

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SMART GRIDS

In 2017, high transmission and distribution (T&D) losses ranging from 15 and 50 percent in Indian states jeopardized the financial position of many utility companies, which include firms owned by the central government, state governments, and the private sector. Smart-grid technologies could reduce these losses. According to a 2017 survey, two-thirds of Indian power utilities cited digitization of manual processes as one of the biggest drivers or growth and indicated interest in investing in technology to increase their organizational flexibility and agility. Among Indian utilities, cloud platforms for data management, Internet of Things, and utilization of data within 3D visualizations were particular priorities for organizations looking at new areas of technology investment (Economic Times 2017). India's electricity market had the second largest customer base in the world in 2017 and is generally open to international vendors (Northeast Group 2017).

China plans to invest $270 billion to improve T&D through 2020, including construction of 144 GW of long-distance, high-voltage lines (BNEF and UK Aid 2017). Northeast Group (2016) identified wide area measurement (which combines the functions of metering devices and the abilities of communications systems) and automation of data collection and analysis as market segments in China where international suppliers were competitive.

Energy storage will offer increasing business opportunities in Asia. China will become the second largest energy storage market in the world in 2019 and will remain in this position through 2022, with cumulative deployments of around 10,000 MWh between 2013 and 2022. India will be the second largest emerging economy in the energy storage market segment and will rank seventh among all countries (Manghani and McCarthy 2018).

The Government of the Philippines is committed to making the electricity grid fully interconnected by 2020. ITA (2017) identified good opportunities for U.S. firms offering software and hardware to integrate variable renewable energy into the grid, smart metering, consumer interface technologies, Supervisory Control and Data Acquisition systems (SCADA) to improve grid automation, and microgrids for remote islands. Malaysia is an upper-middle income country that needs to expand electric power capacity and generation in the near future. ITA (2017) identified T&D as an area with large opportunities for U.S. firms in Vietnam.

The expansion of ASEAN's regional grid will offer additional opportunities for T&D services and products. The ASEAN Power Grid (APG) will increase its capacity by 3,300 MW between 2018 and 2021 to a cumulative 8,512 MW. The APG could reach a capacity of more than 20,000 MW if multi-country projects are implemented. The first of these projects, the Lao PDR-Thailand-Malaysia (LTM project) Power Grid connection, was in construction in 2017. The ASEAN Plan of Action for Energy Cooperation 2016-25 aims to initiate multilateral electricity trade through the APG in at least one sub-region by 2018 (OECD 2017).

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ANNEX E: BRIEFER ON OPPORTUNITIES IN LATIN AMERICA

OPPORTUNITIES FOR US SUPPLIERS
OF UTILITY-SCALE WIND AND SOLAR POWER AND SMART GRID PRODUCTS AND SERVICES IN LATIN AMERICA

Latin America attracted over $130 billion in renewable energy investments between 2007 and 2016. The macroeconomic outlook is favorable in most Latin American countries, and many governments in the region have set ambitious targets for increasing renewable energy use. For example, Brazil announced plans to increase clean energy capacity by 19 gigawatts (GW) by 2026. Brazil, Chile, Colombia, and Uruguay have announced substantial smart grid investment plans (Northeast Group2018). U.S. companies have a comparative advantage in Latin America because of their geographic proximity and reputation for high-quality goods and services (ITA 2016).

POLICY AND REGULATORY ENVIRONMENT

Figure 1. Wind Power Auctions in Latin America

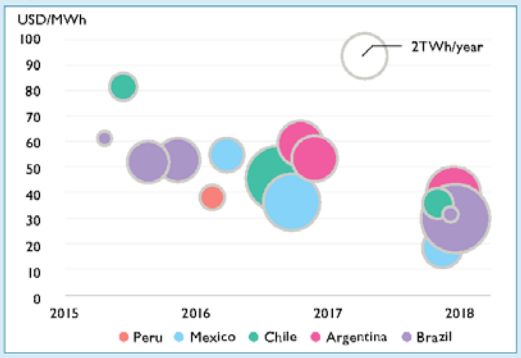
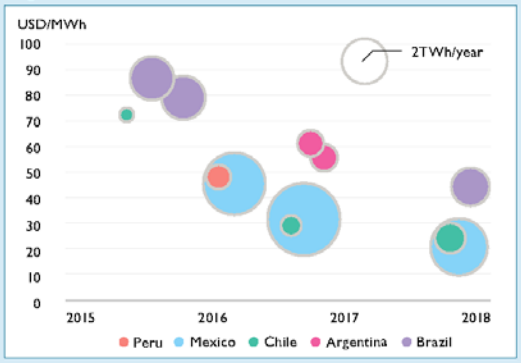


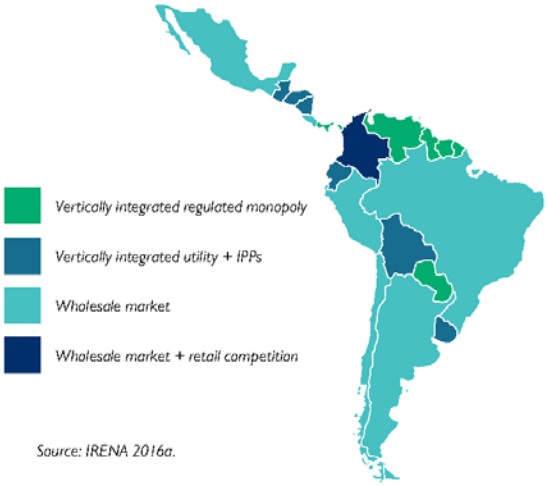
Figure 2. Solar Power Auctions in Latin America



Source: BNEF 2018a.

Many countries in Latin America have been early adopters of public auctions and power purchase agreements (PPAs) to encourage private investment in renewable electric power generation and the transmission and distribution grid (**Figures 1 and 2**). In late 2017, Brazil awarded contracts for $8.2 billion of energy investments over the next six years, including 4.5 GW of power generation and 3,100 miles of power lines. Many countries have established competitive wholesale power markets (**Figure 3**).

Figure 3. Electricity Market Structures in Latin America



Source: IRENA 2016a.

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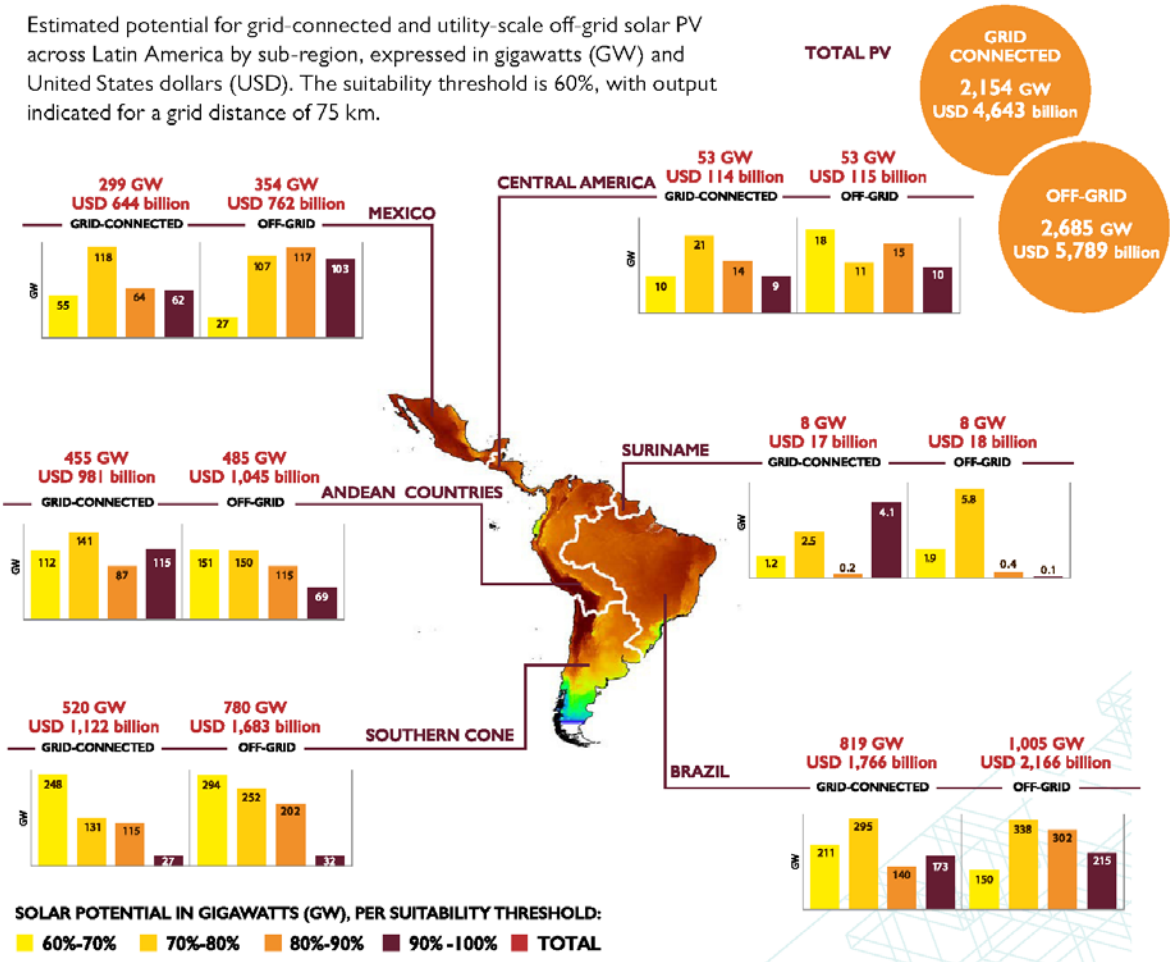
PHOTOVOLTAIC POWER

Latin America has the technical potential for 4,839 GW of photovoltaic (PV) power, on and off grid (Figure 4).

Figure 4. Technical Potential for Photovoltaics in Latin America

Estimated potential for grid-connected and utility-scale off-grid solar PV across Latin America by sub-region, expressed in gigawatts (GW) and United States dollars (USD). The suitability threshold is 60%, with output indicated for a grid distance of 75 km.



Source: IRENA 2016b.

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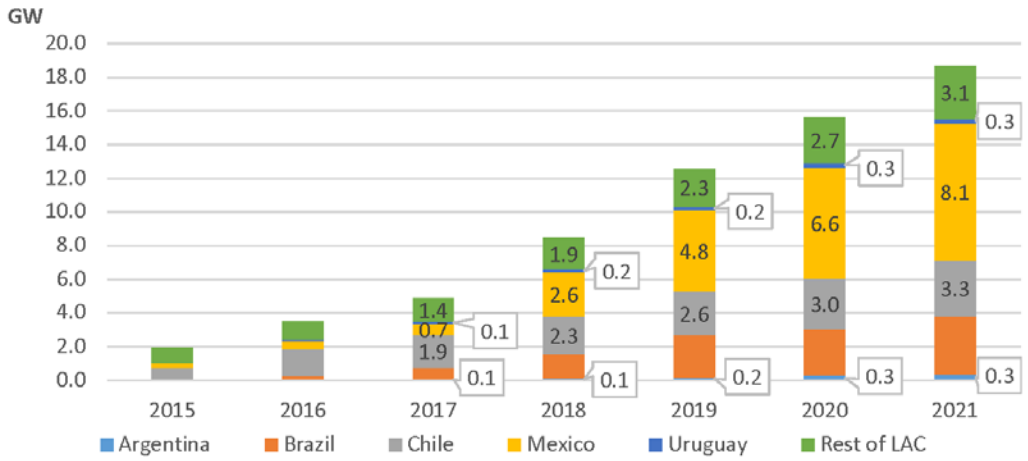
The International Energy Agency (IEA) estimated that the installed capacity of PV will grow from about 2 GW in 2015 to more than 18 GW in 2021 (**Figure 5**). Mexico, Brazil, and Chile were expected to have the largest share of this installed capacity.

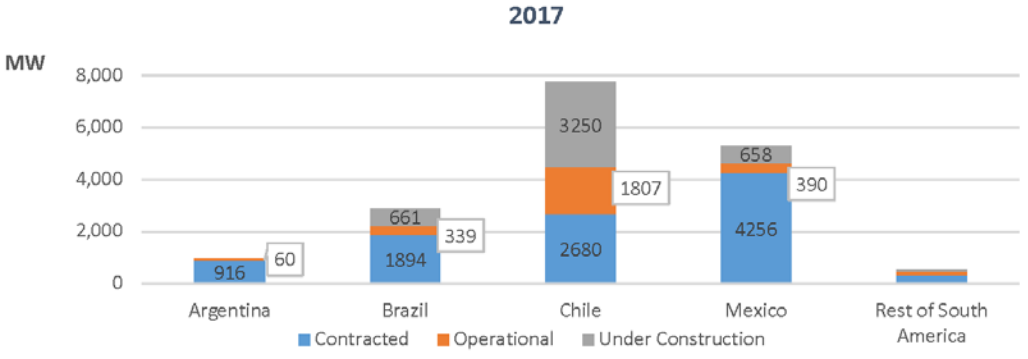
Figure 5. Installed Capacity of Photovoltaics in Latin America, 2015–2021



Source: Based on data from IEA 2016.

In March 2017, the largest markets in the Latin America region had 2,725 megawatts (MW) of PV capacity in operation and over 4,500 MW was under construction (**Figure 6**).

Figure 6. Photovoltaic Power Capacity in Latin America, Operating or Under Construction in 2017



Source: Based on data from Sushma 2017.

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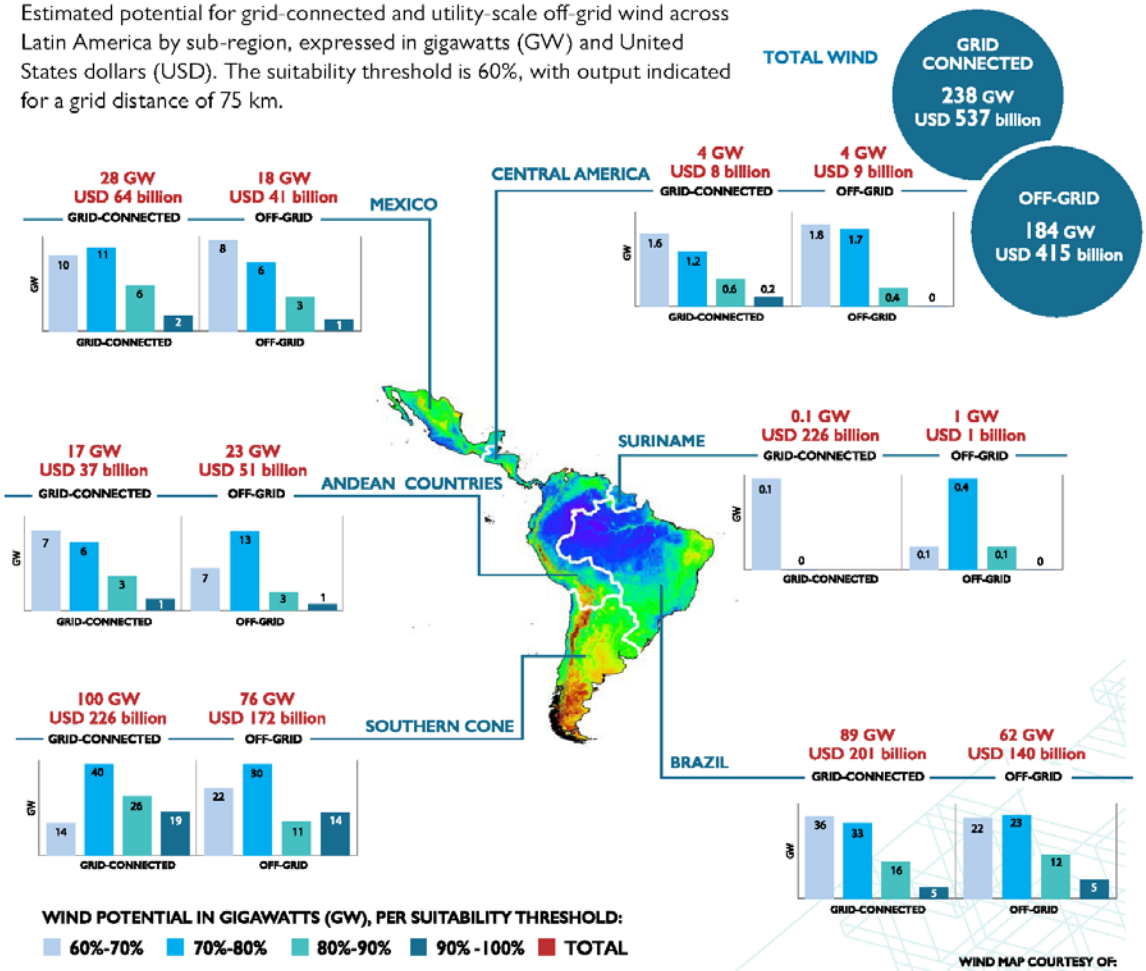
WIND POWER

Latin America has the technical capacity for 422 GW of wind power, on and off the grid (Figure 7).

Figure 7. Technical Potential for Wind Power in Latin America

Estimated potential for grid-connected and utility-scale off-grid wind across Latin America by sub-region, expressed in gigawatts (GW) and United States dollars (USD). The suitability threshold is 60%, with output indicated for a grid distance of 75 km.



Source: IRENA 2016b.

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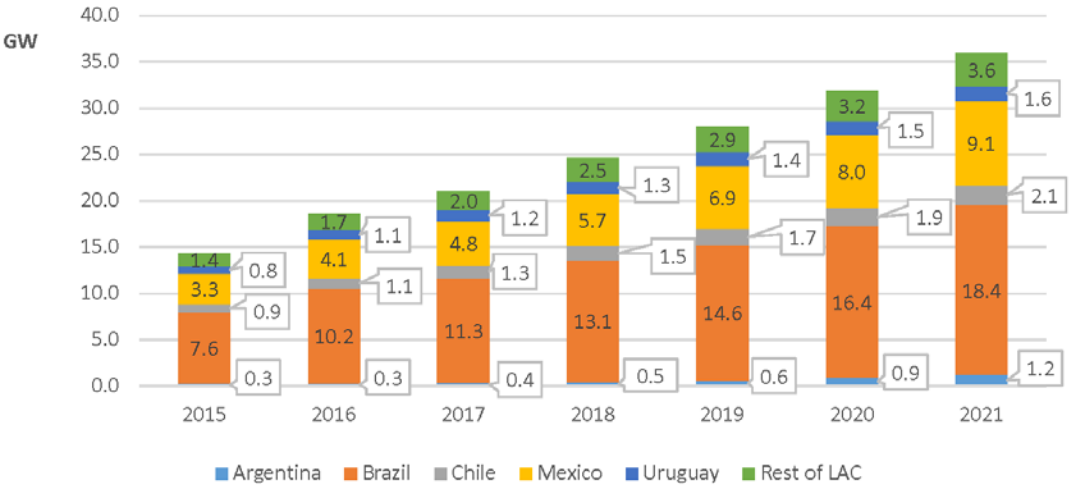
OPPORTUNITIES FOR US SUPPLIERS

OF UTILITY-SCALE WIND AND SOLAR POWER AND SMART GRID PRODUCTS AND SERVICES IN LATIN AMERICA

The IEA estimated that the installed capacity for on-shore wind electricity would more than double from 14.4 GW in 2015 to 36 GW in 2021 (Figure 8). Brazil, Mexico, and Chile are expected to have the largest shares of the on-shore wind power capacity.

Figure 8. Projected Installed Capacity of Wind Power in Latin America, 2015-2021



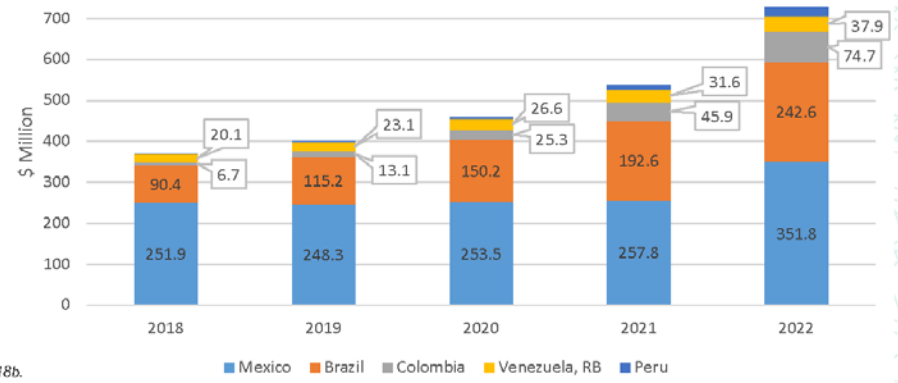
Source: Based on IEA 2016.

SMART GRIDS

New smart grid investments in Latin America are expected to increase steadily through 2030. Argentina, Brazil, Chile, Colombia, Ecuador, and Mexico have targets for smart meter implementation. Uruguay has announced investment plans for smart grids. In 2018, Mexico will be a primary market for exporters of transmission and distribution end products. Chile and Colombia also offer significant opportunities to U.S. exporters of smart grid technologies and are perceived as high reward, low risk markets, based on projected electricity capacity and generation growth in the near-term, coupled with stable economic and political environments (ITA 2017).

Annual investments in smart electricity metering in Latin America's top five markets will nearly double from $370 million in 2018 to $728 million in 2022. Most of these investments will occur in Mexico and Brazil (Figure 9).

Figure 9. Investments in Smart Electricity Metering in Top Latin American Countries, 2018-2022



Source: BNEF 2018b.

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