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Vickie Gunderson served as the lead author of this report. Critical insights on all the markets mentioned in the report were provided by in-country Commercial Service energy sector specialists. Lilian Lee provided the primary research and drafting of the energy storage sub-sector snapshot. This report serves as an update to the 2015 report.
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Executive Summary

ITA’s 2016 Smart Grid Top Markets Report ranks 34 international markets in terms of growth potential for the U.S. smart grid industry. It also presents analyses that will help prioritize U.S. Government export promotion efforts target resources toward these markets. The report integrates data and analyses on global markets and trade, including the critical contributions of commercial specialists from U.S. Foreign Commercial Service posts. The results are combined using a weighted scorecard methodology to produce relative rankings of the 34 subject markets.

The rankings highlight the common strengths and weaknesses of the various smart grid export markets. The sub-sector rankings of Smart Grid Information Communication Technology (ICT) and Transmission & Distribution (T&D) equipment are the result of re-weighting the Smart Grid Top Markets scorecard system to focus on differentiated opportunities for exporters of equipment and services across the smart grid technologies continuum, which is described in detail in the report. An additional sub-sector snapshot for the Energy Storage sub-sector is also included, but there are no sub-sector rankings.

The 2016 Smart Grid Top Markets Report is an update of the 2015 report. Since the publication of the 2015 report, there have been a number of key developments that affect the smart grid sector, reflected in the new 2016 rankings, and described in detail in later sections of this report. Three specific global developments, however, are worth highlighting at this juncture: (1) economic downturn, (2) sustained low global oil prices, and (3) the December 2015 agreement reached in Paris under the U.N. Framework Convention on Climate Change.

From the 2015 to 2016 iterations of this report, most markets remained relatively stable among respective overall rankings. Significant increases in rankings were seen for Mexico (+9), India (+13) and Spain (+16), while Singapore (-14), Brazil (-13) and Colombia (-10) saw the largest drops in rankings year-to-year.

Overall, ITA assesses that opportunities to deploy equipment, services, and software to improve energy management on both the supply and demand sides. For example, U.S. T&D equipment exports have performed well in recent years, and total export revenues for the T&D equipment sector reached nearly $2.0 billion in 2015. Exports to Canada and Mexico accounted for almost 45 percent of this total, and exports to the top ten markets make up over two-thirds. On the demand side of management, U.S. smart grid ICT developers continue to be seen as global leaders.

This report considers common regulatory, policy, business and technical challenges to smart grid development, and provides an analysis of their effects on specific markets. These challenges include standards development, improving regulatory models and engaging the consumer.

The Case Studies are not confined to the highest ranking markets. In fact, ten markets from the rankings have been selected in order to provide an in-depth analysis of the issues affecting these smart grid markets.

Brazil: Brazil is currently the largest electricity market in Latin America, and an important global emerging market. Smart grid deployments, however, have been slowed by regulatory and technical hurdles as well as a recent economic downturn. The business environment for U.S. smart grid exporters

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has been challenging as well, since strong local partnerships and longer timelines for investment are usually required of foreign entrants.

**Canada:** Canada ranks first overall. U.S. exporters are highly competitive and face minimal barriers in doing business in Canada, which is by far the top export destination for U.S. T&D equipment manufacturers. In addition, there is still a high potential for growth in this market, as Canada needs to invest in its aging electricity infrastructure. Provinces are planning multi-billion dollar build-outs and upgrades to transmission lines.

**China:** As the world’s largest market for electricity infrastructure development and smart grid technologies, China offers great opportunities for U.S. exporters; in particular, suppliers and service providers who are in the areas of high voltage transmission, synchrophasor technology, and the modernization of transmission operations, and who are in partnerships in Smart City and select smart grid projects.

**India:** India’s Smart Grid Top Market rankings are bolstered by a fast-growing economy and electricity sector. Ambitious government policies for energy access, renewable resources deployment and “smart cities” deployment send positive signals for the smart grid market. Challenges remain, however, especially those relating to access to financing.

**Japan:** Japan ranks third among top markets for smart grid export growth, largely due to electricity sector reforms, energy efficiency objectives, and active technology procurements by utilities. While U.S. suppliers face difficult competition in Japan, important in-roads have been made in recent years, and the market is expected to evolve favorably for innovators and entrants.

**Mexico:** Opportunities for U.S. exporters to Mexico are strong, given the interconnection of U.S. and Mexican electrical grids along the border, longstanding relationship between U.S. and Mexican firms, competitive advantages created by trade agreements, and business potential brought by a single utility company covering a rapidly-expanding customer base of 40 million.

**Nigeria:** The recent transformation of Nigeria’s power sector, combined with sustained economic growth and increasing electricity demand are driving opportunities for T&D equipment suppliers. It also places Nigeria fourth in the Top Markets T&D equipment sub-rankings. Nigeria’s government has thus far been responsive to the need to direct the proceeds from economic growth towards the overhaul and expansion of decrepit T&D infrastructure that currently only reaches 50 percent of the population.

**Saudi Arabia:** Saudi Arabia ranks fourth overall in the Smart Grid Top Market Report. U.S. exporters of T&D equipment find increasing opportunities in the Middle East’s largest market. Understanding Saudi Arabia’s electricity policies start and end largely by focusing on trends in global oil prices. Proven crude oil and natural gas reserves, as well as generous subsidies, have driven energy demand growth over the last several decades, as fossil fuel extraction is highly energy intensive.

**Turkey:** Turkey’s Top Market ranking is bolstered by strong electricity demand growth, public and private sector investment in grid modernization, and steady progress in electricity market reforms. Turkey ranks high among Top Markets in terms of recent electricity demand growth and has received high marks in the local Commercial Service assessment of the business environment for Smart Grid ICT firms.

**United Kingdom:** The United Kingdom has quickly developed into one of the most attractive markets in the world for advanced smart grid technology and applications. Thanks to a highly competitive electricity sector and recent efforts by the government and regulators, the U.K. market offers immense opportunities for innovators in the smart grid ICT segment and is one of the top nations in the world for U.S. firms to do business.
Overview and Key Findings

Introduction

As U.S. Government agencies implement the Renewable Energy and Energy Efficiency Export Initiative (RE4I), policymakers face the complicated challenge of helping U.S. exporters compete abroad while managing considerable uncertainty and restraint in budgeting. Under the RE4I, the U.S. Department of Commerce’s International Trade Administration (ITA) is committed to developing a tool to prioritize U.S. Government export promotion efforts that help target limited resources toward the markets and sectors that are most likely to result in U.S. exports. The following study elaborates on this commitment for the smart grid sector – it is meant to inform decision makers and managers of key trends, areas of opportunity, and important challenges facing U.S. smart grid exporters.

Beginning in 2009, the United States has made unprecedented investments in the modernization of its electricity grid, and has since become a world leader in the development and deployment of smart grid technologies. U.S. companies large and small provide innovative technology solutions to some of the most pressing challenges facing the electricity industry, and investments by utilities and governments around the world are now driving consistent growth in smart grid exports.

Supporting export growth and addressing trade barriers for the U.S. smart grid industry has been a priority for the ITA since the beginning of the President’s National Export Initiative. Among ITA’s major contributions to this effort has been the delivery of research and analysis to U.S. government partners, and valuable market intelligence to the U.S. smart grid industry.

ITA’s 2016 Smart Grid Top Markets Report ranks 34 international markets in terms of U.S. smart grid industry for its export growth and presents analysis that will help prioritize U.S. Government export promotion efforts to target resources toward these markets. The report integrates data and analysis on global markets and trade, including the critical contributions of commercial specialists from U.S. Foreign Commercial Service posts. The results are combined using a weighted scorecard methodology to produce relative rankings of the 34 subject markets.

Each subset of the smart grid sector faces different competitiveness challenges, and each market possesses a set of characteristics that require nuanced and tailored export promotion and policy approaches. This report is designed to identify where U.S. Government activities can be most effective, helping policymakers utilize limited resources more efficiently and strategically.

The rankings highlight the common strengths and weaknesses of the various smart grid export markets.

The sub-sector rankings of Smart Grid ICT and Transmission & Distribution equipment (T&D) are the result of re-weighting the Smart Grid Top Markets scorecard system. The reweighted version focuses on differentiated opportunities for exporters of equipment and services across the smart grid technologies continuum, which is described in detail in the Report.

Figure 2 summarizes the overall rankings. Figure 3 analyzes the rankings into export market clusters. These export clusters describe the common characteristics among top ranking markets.

The 2016 Smart Grid Top Markets Report is an update.

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**Figure 2: Smart Grid Export Market Projections, 2016**

| 5. Australia | 14. Malaysia | 23. Israel |
| 6. United Kingdom | 15. Spain | 24. Denmark |
| 8. India | 17. Philippines | 26. Indonesia |
| 9. Vietnam | 18. Germany | 27. Italy |

28. Thailand  
29. South Africa  
30. Colombia  
31. Poland  
32. Brazil  
33. Portugal  
34. Russia
Since the publication of the 2015 report, there have been a number of key developments that affect the smart grid sector, reflected in the new 2016 rankings and described in detail in later sections of this report. Three specific global developments, however, are worth highlighting at this juncture: (1) economic downturn, (2) sustained low global oil prices and (3) the December 2015 agreement reached in Paris under the U.N. Framework Convention on Climate Change.

**Economic Downturn**

Many economic sectors, including smart grid goods and services, felt the effects as global economic growth slowed in 2015. Decreasing commodity prices, weaker export demand from emerging economies and slowing global trade flows have been reported. Effects of this downturn were the strongest in transitioning and developing economies with the notable exception of India.2
Oil Prices

ITA assesses that although the effects of fuel switching as a result of low oil prices are not perfect, fluctuations in oil prices has impacted the broader electricity market and investment landscape as well, and is a factor contributing to the changes in rankings of key U.S. smart grid export markets. Since mid-2014, oil prices dropped more than 70 percent and the industry is now preparing itself for a "longer for lower" outlook on the price of crude oil. ITA assesses that lower operating costs for major oil exporting countries have affected the outlook for available resources for large capital projects – including electricity grid projects. Additionally, a number of nations have leveraged the drop in oil prices to reduce their fossil fuel subsidies. This affects not only the levelized cost of crude oil feedstocks for electricity generation, but also the cost comparison between electricity generation resources.

Climate Change Agreement

Smart grid technologies play an important role in the effective implementation of policies to reduce greenhouse gas emissions, and as such, ITA assesses that strong climate change policies and regulations enhance the global smart grid outlook. In coming years, ITA expects to see an uptick in new policies directed at fleshing out how nations plan to implement the broad greenhouse gas (GHG) reduction targets and renewable energy deployment targets put forward, and where the financing of said projects will come. During the December 2015 United Nations Framework Convention on Climate Change (UNFCCC) in Paris, nearly 200 countries agreed to a framework for setting country-level targets for GHG emissions that include the submission of so-called “intended nationally determined contributions,” or INDCs. Although not all the INDCs reflected new policy commitments since the last Top Markets publication, inclusion in this agreement strengthens the likelihood of following through on commitments, sending a long term market signal to investors. The International Energy Agency (IEA) predicts that the full implementation of these pledges will require $13.5 trillion in clean energy and energy efficiency technology deployment investments over the next 15 years. Deploying smart grid technologies, especially leveraging ICT software and analytical capabilities in ways to use electricity most efficiently, and better integrating renewable energy sources will be critical in meeting INDC targets. The Paris Agreement also includes a collective goal of keeping the increase of global temperature to well below 2 degrees Celsius – something that cannot be met by even following the initial INDC pledges. As such, under the Paris Agreement, countries will submit new nationally determined contributions at regular, five-year intervals to take stock of progress, and set newer, stronger climate change and adaptation goals. Given these factors, and increased transparency requirements for both developed and developing countries to help make sure each country lives up to its commitments, ITA assesses that this agreement likely will be a strong driver for global smart grid deployment.

Other developments during 2015 are described in the subsequent pages and include examinations of wider trends affecting the development of smart grid technologies; factors in investment, policy, and regulatory factors driving market development, as does the competitiveness of U.S. exporters across the spectrum of smart grid technologies. The report also includes in-depth case studies highlighting smart grid developments and opportunities for U.S. exporters in ten featured markets.

Key Findings: Top Markets and Methodology

The Smart Grid Top Markets Report estimates the relative potential for growth in U.S. smart grid exports in 34 key international markets by integrating analyses of data and information across four categories:

1. **Smart Grid Market Growth Potential**: Industry data and information on policies, regulations, and other local drivers of the smart grid technologies and services market.
2. **Trade Factors and U.S. Competitiveness**: Trade data and other information on exports of U.S. smart grid products and services in a given market.
3. **Key Economic and Energy Sector Investment Indicators**: Broader economic data and power sector trends that impact investment in electricity infrastructure, and the development and growth of the smart grid in a given market.
4. **Strength of Domestic Industry**: Trade data and other information on the extent to which demand for smart grid technology and services will be met by the domestic industry – as opposed to international trade – in a given market.

There are a variety of challenges to obtaining comprehensive and quantifiable information for each of these categories.
The smart grid is an energy sector that experts struggle to define, and in an era of technological convergence, many smart grid technologies are multi-use and purchased outside of the electric utility sector. The challenge is acute when it comes to smart grid trade data. As a result, this assessment draws on both qualitative and quantitative data that may inherently narrow the scope of any one of the four categories and serve as a proxy for wider trends.

This is most significant for category 2 – Trade Factors and U.S. competiveness – where existing global trade data only captures accurate and relevant export revenues for a subset of T&D equipment rather than the entire smart grid market.

The existing Harmonized Tariff System (HTS) includes product codes for the “Transmission & Distribution Equipment”. For the most part, however, HTS product codes for the wide range of hardware, software and networking technology are either non-existent or too broad to discern smart grid applications for these technologies, as opposed to broadband Internet applications, for example. Furthermore, data on international trade in smart grid services, such as consulting, information technology (IT) system integration, and consumer energy efficiency programs, is not collected by government or international institutions.

In order to quantify the global smart grid opportunity, this report utilizes the available U.S. Census trade data for T&D equipment along with smart grid market and investment data – both public and proprietary – to develop a system for comparative market sizing and quantifying opportunities for exporters of smart grid ICT and services.

This report deploys a weighted scorecard system and subsector rankings to better assess industry trends. The weighted scorecard methodology provides a platform for analysis of different technology sub-sectors depending on the weight assigned to the above four factors. Thus, in addition to the overall rankings, the Top Markets analysis also ranks markets for the potential growth of U.S. exports in the T&D Equipment and the Smart Grid ICT sub-sectors. Essentially, these sub-sectors are representative of technologies from the left side and the right side, respectively, of the Smart Grid Technology Continuum, (Figure 4) as presented in detail in the next section.

A detailed explanation of the methodology and key supporting data sets for each of the four categories can be found in Appendix A. This also includes detailed information on the minor modifications to the methodology deployed in the 2016 Smart Grid Top Markets Report relative to the 2015 report.

Figure 2 shows the overall sector rankings for all 34 markets. This builds on an assessment presented in 2015. A full comparison of rankings from 2015 to 2016 is shown in Appendix B, Figure B1.

In 2016, ITA assessments expanded to include two additional markets – Israel and New Zealand – as complete data sets were available for these markets this year. Data sets for all markets were updated for 2016 as described below and in Appendix A.

From the 2015 to 2016 iterations of this report, most markets remained relatively stable among respective overall rankings. Significant increases in rankings were seen for Mexico (+9), India (+13) and Spain (+16), while Singapore (-14), Brazil (-13) and Colombia (-10) saw the largest drops in rankings year-to-year.

Understanding these movements in rankings is best grasped by understanding the market signals as they relate to four of the score areas.

**Smart Grid Market Growth Potential (Category 1)**

The development and deployment of smart grid technologies are affected by a significant number of enabling policy, regulatory, investment and industrial drivers. The experiences of U.S. officials in diplomatic, technical and commercial settings with additional market research are used to quantify the competitiveness of the U.S. smart grid industry in global markets.

Drawing on developments over the last year, a handful of markets saw significant movement in their scores for Category 1. Spain, Italy, China and Mexico underwent shifts in their respective markets to increase their scores from 2015. Russia, Portugal and the Philippines underwent the largest drops. Much of these shifts can be explained by macroeconomic trends that inform the local commercial setting as explained in Category 3, and affect U.S. interest and competitiveness in the market. Additionally, the 2016 report takes into account new climate change policy announcements and other policies affecting competitiveness.
For example, major reforms proposed to power sectors in China, Mexico and Japan are being implemented to increase competitiveness and limit the vertical integration of utilities. As competition is expected to be introduced, the ITA assesses that the potential for innovative U.S. firms to supply services – especially ICT and advanced metering infrastructure – will increase as local utilities look to gain a competitive advantage and secure (or retain) market share under a reformed system.

Given the significant weight of this category to the smart grid ICT sub-sector ranking, greater detail on 2016 trends and developments can be found in the sub-sector snapshot.

**Trade Factors and U.S. Competitiveness (Category 2)**

As described above, available trade data for all technologies and services in the smart grid sector limits the scope of Category 2 data. Three data sets form the foundation for scores in this category: U.S. exports of T&D Equipment, trend of U.S. exports over the last two years, and projected electricity consumption growth over the next five years.

Trending for this category is described in detail in Appendix A and the T&D Equipment Sub-Sector Snapshot. Canada and Mexico continued to account for almost half of all U.S. T&D equipment global exports. Year-to-year trends show that Canada, Sweden, Brazil, Russia, Japan and Singapore experienced the biggest absolute drops in T&D equipment exports since 2013, while U.S. exports to Mexico, Korea and Italy increased most significantly over the same period.

Projected increases in electricity consumption over the next five years have been scaled back for Colombia, China and Singapore. Emerging markets such as Vietnam, Nigeria, Indonesia and India are anticipated to see electricity consumption grow most rapidly –
including increased relative growth projections from 2015 among top markets.

**Key Economic and Energy Sector Investment Indicators (Category 3)**

Macroeconomic market signals in the global economy and energy sector are most apparent in category #3 – Key Economic and Energy Sector Investment Indicators. As outlined in Appendix A and highlighted in Figure 4, data in this category informs of the relative risk to reward ratio for investing in the power sector. For example, emerging countries such as India and China have high reward potential, but also relatively high risk. On the other hand, high-income Nordic countries such as Denmark and Sweden have low risk and low reward potential.

In 2016, China, Russia, Brazil and Singapore saw the most substantial decreases to their economic and energy sector investment indicator scores, while India and European markets such as Spain and the Netherlands saw the most significant year-to-year increases. The following regional economic market signals also contribute to score changes captured in categories 1 and 2.

- **Brazil:** Brazil is undergoing a deep economic recession, and there are expectations of record government budget cuts. Recently unfolding scandals have affected the government and state-owned companies, increasing uncertainty and creating a drag on economic growth and infrastructure projects. As a result, stricter compliance rules that could benefit U.S. companies interested in Brazil are being implemented.

- **Colombia:** Sustained low oil prices have decreased demand from Colombia’s trading partners, and have led to a loss of domestic tax revenues. The Colombian peso’s value dropped significantly in 2015.

- **East Asia:** Although still growing, China’s economic growth has begun to slow, reducing investment expectations in domestic infrastructure projects and growth trends in electricity consumption. These effects are being felt regionally as Singapore, Japan, Korea and Thailand all saw reductions in investment power scores. For example, the Singapore Dollar prospects hit a low in 2015 not seen since 1998.

- **Europe:** Economic recessions that plagued parts of Europe – such as Spain and Italy – have been countered by policy reforms in recent years that have begun to make these markets more attractive for investment. This is especially relevant as the continent looks to transition its energy sector to address the changing utility business model and for energy security purposes.

- **India:** India is expected to remain largely sheltered from the economic slowdowns plaguing other large emerging economies, and will benefit from lower commodity prices resulting from low oil prices. Coupled with ambitious policy and regulatory plans, India’s energy sector is expected to be a pillar of the Modi Government’s near-term agenda.

- **Russia:** Recent events in Ukraine have changed the landscape of the bilateral trade and investment relationship between the United States and Russia. For example, the United States has suspended government-to-government economic cooperation with Russia on many fronts, including the bilateral trade and investment working group that sought to expand economic and commercial ties.

**Strength of Domestic Industry (Category 4)**

Data for this category remained consistent between 2015 and 2016, as the data set used for this category is updated on a five-year basis.
Industry Overview & Competitiveness

The smart grid is a modernized electricity transmission and distribution network that includes two-way communication systems and enables the integration of technologies that will further improve grid efficiency, reliability and security. Depending on the market, a wide range of equipment and technology will be required to modernize the grid.

Modernization includes the build-out and upgrade of transmission and distribution (T&D) networks that extend electricity services to new populations and also improve the grid’s efficiency in delivering those services. In many markets, modernization goes beyond these initial T&D investments to include a range of digital technologies and platforms, including the deployment and integration of Internet Protocol (IP) based communications, infrastructure ICT systems to better manage increasingly-complex utility networks and data, and online applications and consumer services that enable energy efficiency programs at the “user-end” of the grid.

This report considers a wide range of utility investments in T&D, communications, data networking, IT infrastructure and energy efficiency services to be part of the worldwide smart grid opportunity for U.S. exporters. The analyses and rankings that are included consider the near-term growth potential for U.S. exporters of the products and services detailed in Figure 5 and discussed in greater technical detail in the T&D Equipment and Smart Grid ICT sub-sector snapshots.

Additionally, U.S. exporters of related energy technologies – including microgrid systems, distributed energy resource technologies, home building management technologies and software, and a wide range of electric utility services – may find this report to be an effective guide to international market growth and potential export gains.

New in 2016, ITA has included a sub-sector snapshot of the energy storage industry to better capture this emerging sub-sector and detail expected applications for electrical grid ancillary services and maintenance deferral globally.

The available data for market-sizing and measuring trade flows varies across the spectrum of technologies detailed in Figure 5. The emergent smart grid industry includes evolving networking and information technologies that are driving the convergence between communication and electricity networks. Defining the industry and identifying data points that capture and distinguish smart grid investment are significant challenges to market analysis, particularly those in emerging and less developed international markets.

Global spending on grid modernization and smart grid technologies has emerged as a major growth segment in the infrastructure sector, and is expected to continue to grow. Various energy market research groups have pegged market values to range from $15 to $500 billion annually, depending on specific technologies that are incorporated into the calculation. Regardless of the absolute estimated market size, the sector has been on a strong growth trajectory over the last decade and will continue to grow.

According to Bloomberg New Energy Finance, worldwide annual smart grid spending grew by 12%...
percent in 2015, reflecting a five-year CAGR just under 13 percent. Other energy market research groups, including GTM Research, Navigant and Transparent Market Research, predict that annual spending on smart grid sub-sectors will grow anywhere from 5-18 percent annually over the next decade. Predictions vary dramatically across sub-categories, but spending in all areas is expected to increase in both established and emerging markets.

The ITA assesses that the current market for all U.S. smart grid exports – including T&D equipment, smart grid ICT goods and services, and energy storage technologies – is valued at $30 billion annually. These exports leverage U.S. investments to upgrade the domestic electric grid and capitalize on the growing global market.

Energy, environmental and security needs for the 21st century have accelerated both public and private sector investments in grid modernization and smart grid technologies across the United States. The Energy Independence and Security Act of 2007 (EISA) made it “the policy of the United States to support the modernization” of the electrical grid. Federal and state governments and private sector stakeholders have since made major investments in the development and deployment of smart grid technologies and programs that are making the electric grid more efficient, reliable, resilient and secure.

The American Recovery and Reinvestment Act of 2009 (ARRA) provided by far the most significant subsidy and stimulus to smart grid spending over the last five years, making the United States the largest smart grid market in the world from 2009 to 2012. The ARRA smart grid investments included $4.5 billion in government funding for electricity delivery and energy reliability activities to modernize the electric grid, with an additional $5.5 billion in matching, and additional funds from private sector stakeholders. Approximately $7.5 billion was invested in smart grid deployments and related utility projects as a result of the ARRA programs.

As outlined in the 2015 release of the Quadrennial Energy Review’s first installment, U.S. transmission and distribution systems are gaining a renewed focus on investment. Reasons for increased investment include reliability enhancement, renewable resources connections, demand shifts, cost increases and market reforms that create more options for independent generators and require new connections to transmission systems. U.S. utilities have a strong interest to address the potential effects of distributed energy resources and understand how utility business models may change as a result of decreased revenues.

Policy and regulatory drivers at the Federal and state levels for demand response, energy storage, net-metering and cybersecurity have also created domestic drivers for innovation in energy efficiency programs, analytical tools, two-way communication systems and consumer engagements that provide a U.S. competitive advantage.

As these smart grid solutions have advanced in the United States, the domestic industry has developed steadily, and a wide range of U.S. technology and service companies now lead the global market for smart grid solutions. Pilot projects and programs by U.S. utilities with U.S. suppliers form the foundational use-case examples to inform U.S. suppliers looking to export. On the other hand, pilot projects abroad with U.S. suppliers offer the potential to also inform deployments in the regulated U.S. market. The ITA assesses that although there is regional variation to priority drivers for grid modernization and smart grid deployment, there is also a pervasive expectation that the global industry is in the middle of a transformation and the door is open to innovative firms to capture market share. With international investment growth and high U.S. competitiveness, the smart grid sector holds great potential for continued and expanded export growth.

Global Industry Landscape

Although the U.S. is amid an active, robust and innovative electricity modernization effort, the global market is also actively engaged. In 2013, China surpassed the United States, becoming the world’s largest market for smart grid spending. Drivers for the deployment and development of grid modernization equipment, technology, and services vary by region and sub-sector. A consistent theme across the world, however, is that utilities are concerned with revenue losses resulting from reduced loads driven by efficiency, increased distributed energy, and/or theft. Global investment decisions are now focused on how to do more with less. This includes looking for ways to increase supply and demand side energy management efficiencies.
For emerging economies in Southeast Asia, India, Africa and South America, the focus is on reducing theft and T&D losses while building new infrastructure to meet increasing demand, and bringing electricity to the 1.2 billion people – 17 percent of the global population – who currently lack access.11

Europe, North America, East Asia, Australia and New Zealand have increased focus on deploying advanced metering infrastructure and big data analytics to better leverage the capabilities resulting from cloud computing advancements. Utilities in these countries are looking to improve systems management as revenues continue to decrease. According to Bloomberg New Energy Finance, many European utilities have lost over 50 percent of their market value since 2010 from deployment of distributed energy resources and other efficiency gains that led to load loss.12

The U.S. is globally competitive for the supply of goods and services to these markets as well as serving as a key test bed for new progressive utilities to experiment with new business models. The U.S. is the third-largest exporter of T&D equipment, behind China and Germany.13 While limited HTS trade data cannot accurately capture global competitiveness in the smart grid ICT sub-sector, U.S. information technology, networking technology, software and technology service firms are widely viewed as ICT industry leaders. European firms serve as the biggest source of competition.

Overall, the growth of the U.S. domestic smart grid over the last five years and increased spending in international markets are now combining to provide expanded opportunities for U.S. innovators in international markets.

Challenges and Barriers

Over the last decade, investment in the smart grid has grown in every major economy; increased export opportunities are anticipated for the wide range of U.S. suppliers and service providers marketing smart grid solutions to electric utilities around the world. However, the development of the smart grid will be unique across – and often within – export markets, and opportunities will vary depending on a nation’s stage of smart grid development and specific market demands for various technology and services. Additionally, there are a number of key issues that could affect smart grid development, challenge the pace of deployment, or hinder U.S. competitiveness in a given export market.

This report considers common regulatory, policy, business, and technical challenges to smart grid development, and provides an analysis of their impact on specific markets. These challenges include:

- **Developing Standards and Achieving Interoperability:** The identification and adoption of international standards for smart grid technologies and the need to ensure their interoperability in order to help drive technology development, deployment and operations.
- **Getting the Regulatory Model Right:** The need for energy sector reforms and the development of a regulatory framework that will sustain smart grid investment and enable sufficient economic returns for the electricity industry.
- **Driving Innovation in the Electricity Industry:** The need for sustainable business models and a coordinated industry approach that ensures investment in new technologies that help achieve the benefits of the smart grid.
- **Enabling the Consumer:** The need for successful consumer protection and engagement in order to help drive demand for smart grid technologies and ensure value for the consumer.

Evolving technologies and policies are driving investments in the smart grid that could translate into export returns for the United States. The rest of this report will examine country-level trends and present an analysis of the top prospective markets for U.S. T&D equipment and smart grid ICT export growth.

Opportunities

In addition to country and sub-sector specific market opportunities highlighted in this report, the following offers a few key opportunities for the smart grid industry to engage in cross-sectorial initiatives and global trends.

**Climate Change:** ITA assesses that the 2015 Paris Agreement under the U.N. Framework Convention on Climate Change likely will be a strong driver for smart grid deployment globally, and that firms positioned to enable nations to deliver on their nationally determined commitments will be best positioned to compete globally. Smart grid technologies that directly
facilitate reductions in greenhouse gas emissions and increase the resilience of critical infrastructure to the effects of climate change are positioned to capitalize on the near-term need of the 195 countries that committed to ambitious actions on climate change in December 2015.

**Smart Cities:** Smart grid is a foundational component of the development of increasing “smartness” of global cities, and informing integrated resource planning at the local level. U.S. suppliers of smart grid technologies will find global opportunities in both greenfield and brownfield city efforts. World urban populations are expected to double by 2050; 80 percent of global goods and services are produced in cities, according to the World Bank.¹⁴

**Internet of Things (IoT):** Similar to the “smart cities” theme, smart grid technologies are included in the suite of technologies included in the IoT. The IoT reflects the digitalization of process and services that leverage cloud computing, data analytics, and other ICT advancements.

**Cybersecurity:** Smart grid firms with a focus on cybersecurity will find interest in export opportunities among both developed and developing nations. As the grid becomes increasingly data driven, the privatization of consumer data and protection of critical infrastructure will be of central importance to policymakers and utilities.

**Regional U.S. Government Initiatives:** Near-term opportunities to deploy smart grid goods and services for U.S. suppliers are not limited to the markets outlined in this report. ITA notes that U.S. suppliers may find success in smaller, less-developed markets, especially in those that are still developing their electricity system. Initiatives such as Power Africa and the Clean Energy Finance Facility for the Caribbean and Central America highlight commercial opportunities supported by development objectives and finance mechanisms provided by multilateral government institutions of lower income nations. These initiatives represent a new approach to development that prioritizes unlocking and accelerating transactions in the energy and infrastructure sector, and building a more investment-friendly enabling environment.
Sector Snapshots
This section contains sector snapshots that summarize U.S. smart grid export opportunities in each subsector. The snapshots provide country rankings, export outlook and challenges for each subsector, along with an overview of the subsector technologies.
Transmission & Distribution (T&D) Equipment

State of the Market

Global trade in transmission and distribution (T&D) equipment exports saw an overall decline of 4 percent reflective of the global downward economic trend over the last year of available global export data (2014). This reflects a return to pre-2011 annual global trade revenues following two years of consecutive year-to-year declines in 2013 and 2014, and reduces the CAGR to 9 percent for the previous decade.

However, according to the International Energy Agency, approximately $5 trillion will be invested in T&D infrastructure globally from 2015-2030. Thus suggesting that despite a downward trend in global T&D equipment trade, opportunities for U.S. exporters will persist.

U.S. Competitiveness

Overall, U.S. T&D equipment exports have performed well in recent years. Total export revenues for the T&D equipment sector reached nearly $2.0 billion in 2015. Exports to Canada and Mexico accounted for almost 45 percent of this total, and the top ten markets makeup over two-thirds. As Figure 7 illustrates, U.S. T&D equipment exports declined 4 percent year-to-year from 2014, but still reflect a long-term growth trend with a 9 percent CAGR over the previous decade. U.S. global market share dropped to approximately 8 percent.

As Figure A4 illustrates, top U.S. T&D export markets do not completely align with those of all goods. Relative to other industries, U.S. T&D equipment manufacturers have captured significant returns in nations like Saudi Arabia and Colombia.

Rankings

The T&D equipment sub-sector rankings focus on markets with high growth in the products and services necessary for the build-out, modernization and automation of T&D networks. For example, trade in T&D equipment receives a higher weight in this ranking, as does electricity demand growth, energy supply investment and other factors driving the build-out of the grid.

The top T&D equipment markets are, therefore, more likely to be less-mature smart grid markets. Investments in these nations are more focused on the foundational grid modernization that is essential to the development of more advanced Smart Grid ICT that is still to come. Countries that have been long-standing markets for U.S. suppliers of the electric grid rank higher in this sub-sector. Additionally, Asian markets, where connecting new populations to the electric grid is a priority, will perform well in the T&D equipment sub-sector.

Figure 6: T&D Equipment Sub-Sector Rankings (Top 20)

1. Mexico
2. Vietnam
3. India
4. Nigeria
5. Saudi Arabia
6. Malaysia
7. Chile
8. Indonesia
9. Canada
10. Philippines
11. Turkey
12. Korea
13. China
14. Singapore
15. Australia
16. Colombia
17. Thailand
18. Israel
19. Poland
20. United Kingdom
The T&D equipment sub-sector ranking reflects a heavy weight on Category 2, where three data sets form the foundation for the scores in this category. The three data sets are: U.S. exports of T&D equipment, trends of U.S. exports over last two years, and projected electricity consumption growth over next five years. This is described in detail in Appendix A.

Canada and Mexico continue to account for almost half of all U.S. T&D equipment global exports. Year-to-year trends show that Canada, Sweden, Brazil, Russia, Japan and Singapore experienced the largest absolute drops in T&D equipment exports since 2013, while U.S. exports to Mexico, Korea and Italy increased the most significantly over the same time period.

The decline in T&D equipment exports can largely be explained by a drop in exports to Canada that accounted for almost half the global decrease. Other major trade partner markets with decreasing T&D equipment exports since 2013 include Sweden, Brazil, Russia and Japan. This is most obvious in the year-to-year decrease in T&D Equipment Sub-Sector rankings for Brazil (-17), Japan (-13) and Canada (-7), where it heavily influenced the decrease in Brazil’s overall sector ranking.

The projected trend of the electricity sector over the next five years will influence the T&D equipment sub-sector significantly. Projected increases in electricity consumption over the next five years have been scaled back for Colombia, China and Singapore, dropping all three significantly in the T&D equipment sub-sector rankings by 13, 9, and 9 spots, respectively. Factors attributing to exports are consistent with trends in category 3 and are discussed in previous sections. Rationale for this is discussed above, as it also affects the overall investment climate for the energy sector, as included in the Key Economic and Energy Sector Investment Indicators discussion.

Projected increases in electricity consumption over the next five years have been scaled back for Colombia, China and Singapore. On the other hand, the most rapid electricity consumption growth is anticipated to occur in emerging markets such as Vietnam, Nigeria, Indonesia and India; this includes the increased relative growth projections from 2015 among top markets.

Full comparison of year-to-year T&D equipment sub-sector rankings is included in Appendix B.
Technology, Capability, and Application Trends

The ITA predicts there are a number of T&D equipment sub-sector solutions that will be increasingly important as governments and regulators look to implement policies that expand regional grids, especially in Europe and China, while at the same time increasing the resilience and integration of distributed energy resources.

Ultra-high voltage (UHV) Transmission Lines

Co-location of energy resources and electricity load centers is an increasing challenge, especially as nations and regions look to transmit low-cost renewable energy. Coupled with shifts to the urbanization and deregulation of electricity markets, electricity is increasingly being looked to travel longer distances from the generation site to the end-user. UHV transmission lines enable larger amounts of electricity to travel a greater distance, up to three times further than the traditional high voltage transmission lines, with reduced losses and costs. China is currently the global leader in deployment of UHV transmission. Brazil, Africa and Europe all have commissioned lines.

Interconnection

This is the physical linking of electricity systems that allow the transfer of electricity across borders. As nations look to implement their climate change commitments, increase energy security, and reduce costs, ITA assesses that there will be an increased global focus on building infrastructure and creating enabling policies and regulations for grids to interconnect. For example, new interconnections are being built in Poland and Lithuania to complete the synchronization of the electricity grid with the West as European Union countries look to increase energy security and “transition” the energy sector.

Microgrids

A microgrid is a local energy grid with control capabilities to disconnect from the traditional grid and operate autonomously. The ITA assesses that microgrids will be increasingly deployed for critical infrastructure, for example, hospitals, to provide backup for the grid in case of emergencies. These systems can also be used to cut costs or connect to a local resource that is too small or unreliable for traditional grid use. A microgrid allows an energy consumer to be more energy independent and, in some cases, more environmentally friendly. Industrial energy users in locations with unreliable electricity access, such as remote and rural communities, or island nations, and regions without established infrastructure are being evaluated as principal candidates for microgrid deployment.
Smart Grid Information Communications Technologies (ICT)

State of the Market

Turning to the behind-the-meter and emerging ICT space, nations deploying advanced metering infrastructure (AMI), new analytical tools to promote energy efficiency and distributed energy resource aggregation, and developing connected smart grid networks are the focus of the Smart Grid ICT sub-sector rankings.

As demonstrated in Figure 5, there is a diverse array of products and services that comprise the smart grid ICT sub-sector. As highlighted previously, this is expected to grow. For example, smart meter deployment grew by 15 percent in 2015 with over 622 million meters deployed globally. In 2015, Japan surpassed China to become the largest smart metering market. Bloomberg New Energy Finance further predicts that smart meter deployment will continue to grow at 8 percent CAGR over the next three years. The global market of smart grid data analytics – AMI analytics, demand response, grid optimization, asset management, and other analytical tools – was estimated at $1.6 billion in 2014 with an expectation that it would triple to $4.6 billion by 2022, according to Transparency Market Research.

U.S. Competitiveness

As described in previous sections, available trade data for the Smart Grid ICT sub-sector is an acute problem. Understanding U.S. competitiveness in this sub-sector is largely dependent on qualitative data. U.S. developers of smart grid analytical tools for demand response and other applications are widely recognized as global leaders and are partnering with smart meter manufacturers to deploy solutions. The smart meter market is largely dominated by a handful of multinational firms, some with significant U.S.-based manufacturing capacity.

Rankings

The Smart Grid ICT Sub-Sector rankings focus on markets with high growth in the products and services necessary for the digitalization of the electricity grid. For example, Australia and Canada have been widely recognized as first-movers in the deployment of smart meters and advanced metering infrastructure; China is the leading global smart grid investor; the United Kingdom, and other markets in Northern and Western Europe and the Asia Pacific region are catching up quickly. Less-mature smart grid markets, such as Saudi Arabia, Turkey and Mexico, also rank well on account of high U.S. competitiveness and positive signs in the development of smart grid ICT pilots involving U.S. partners.

The 2016 Smart Grid Top Markets Report Smart Grid ICT Sub-Sector saw a handful of markets make significant jumps in the rankings from 2015. Spain (+17)
and China (+11) both rose to crack the top ten rankings as ITA assessed that policy and regulatory announcements by both countries' governments have set the stage for increased near-term deployment of ICT technologies.

On the other hand, Portugal (-10) and the Philippines (-17) saw the biggest rankings drops year-to-year, largely reflective of slowing deployment expectations.

Full comparisons of year-to-year Smart Grid ICT Sub-Sector rankings are included in Appendix B.

**Technology, Capability and Application Trends**

ITA evaluates that there will be a number of Smart Grid ICT Sub-Sector solutions that will be increasingly important as global governments, regulators and utilities look to increase efficiencies, integrate renewable resources effectively, gain market share amid increasing competition, engage consumers, and reduce revenue losses. A selected sub-set of these solutions are highlighted as follows.

**Demand Response**

Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives. Demand response programs are being used by electric systems planners and operators as resource options for balancing supply and demand. Such programs can lower the cost of electricity in wholesale markets, and in turn, lead to lower retail rates. Methods of engaging customers in demand response efforts include offering time-based rates such as time-of-use pricing, critical peak pricing, variable peak pricing, real time pricing and critical peak rebates. It also includes direct load control programs that allow power companies to cycle air conditioners and water heaters on and off during periods of peak demand in exchange for a financial incentive of lower electric bills.

Demand response pilot projects and programs are most active in the United States, but markets, such as Korea, Japan, China and the United Kingdom, have begun to establish programs and policies to foster growth.

**Virtual Power Plants**

This is the grouping of multiple distributed energy resources into one aggregated system through advanced ICT solutions. Smart meters, advanced analytics, demand response programs and generation sources, such as rooftop solar, all can be connected and coordinated together to create a system of energy resources that can bid into energy markets. Navigant predicts that the global virtual power plant market will quadruple by 2023 to $5.3 billion.

**Prepaid Meters with Advanced Meter Reading**

Electricity meters connected via two-way communication platforms for automated meter reading enable customers to monitor their energy usage and manage energy costs while ensuring the electricity provider is paid for the service. The deployment of programs that enable customers to advance pay through cellular applications are increasingly of interest. Additionally, these programs and services help reduce in meter reading costs, better detect electricity theft and reduce outage time. ITA assesses that prepaid electricity meters will grow in interest in emerging nations where theft is high, such as in Africa and South America.
Energy Storage

State of the Market

Improved technology has made storage solutions more efficient, offering both buyers and investors a stronger economic case for investment. Global policymakers are directing funds to storage research and offering subsidies, rebates and other tax incentives. The power industry is increasingly accepting of the fact that storage can play a part in the modern grid, though there may still be questions on how it should be incorporated and regulated. The result is that energy storage is closer to global commercial viability than ever before. In the first three-quarters of 2015, over 1.1 GW of new energy storage projects were announced globally.

The United States is at the forefront of storage technology and market development. Improvements in batteries, in particular, are bringing costs down across the board, leading to increased export opportunities for U.S. firms. According to BCC Research, the global market for grid-scale battery storage technologies is projected to reach nearly $4.0 billion in 2025, up from $716 million in 2015.

ITA anticipates that much of the near-term battery and non-battery storage deployment will be used for frequency regulation.

Finding additional revenue streams and deployment opportunities, however, will be integral to the scale-up of energy storage technologies. Other drivers for energy storage technology deployment include:

- Maintenance deferrals of transmission and distribution investments and upgrades
- Integration of intermittent renewable energy resources

A number of U.S. firms have commercialized products in this sub-sector. American businesses are well-positioned to deliver battery, compressed air and other storage solutions to countries that are implementing more renewable resources in their grid.

Technologies and Capabilities

ITA considers mechanical and electrochemical storage options, such as batteries, as the most commercially promising. These technologies are at varying stages of development, with some at or near maturity while others are still in relatively early stages.

- **Pumped Hydro**: Pumped hydro employs off-peak electricity to pump water from a reservoir up to another reservoir at a higher elevation. When electricity is needed, water is released from the upper reservoir through a hydroelectric turbine into the lower reservoir to generate electricity. This technology has the highest capacity of all the storage technologies assessed because its size is limited only by the size of the available upper and lower reservoirs. Environmental concerns over water and land use, however, have emerged in recent decades. In the United States, the earliest plant was built in the late 1920s, and the last pumped storage plant was commissioned in the 1980s.

- **Compressed Air Energy Storage (CAES)**: CAES systems use off-peak electricity to compress and store air in reservoirs, which are either underground caverns or aboveground pipes or vessels. When electricity is needed, the compressed air is heated, expanded, and directed through an expander or conventional turbine-generator to produce electricity.

- **Flywheel**: Flywheels are mechanical devices that use rotational kinetic energy to both store and discharge power. They can be charged relatively quickly.

- **Lead-Acid Batteries**: Lead-acid batteries are the most commercially mature rechargeable battery technology available. Lead acid batteries, however, are relatively short-lived, with life-spans of about two years. Before the development of valve-regulated lead-acid (VRLA) batteries, lead-acid batteries required frequent maintenance.
They do not offer strong value propositions for utility-scale storage.

- **Lithium-ion Batteries:** Lithium-ion technology is relatively new, but it has become the foundation for many storage projects in recent years. Lithium-ion battery costs have decreased significantly in recent years, which has contributed significantly to new installed-capacity of storage.

- **Sodium-Sulfur (NaS) Batteries:** Sodium-sulfur battery technology holds potential for use in grid services because of its long discharge period of approximately 6 hours. It is capable of prompt, precise response to grid needs, but must be operated at high temperatures, which can be problematic for intermittent uses. Most NaS batteries are currently manufactured by a Japanese company, NGK.

- **Flow Batteries:** Unlike the solid-state batteries described above, flow batteries can store energy in liquid form or in external tanks, and collect or release power by having those liquids exchange ions through a special membrane. The most advanced flow batteries are vanadium redox batteries (VRBs). Vanadium’s advantage is that its ions are stable and can be cycled through the battery over and over without undergoing unwanted side reactions. On the other hand, vanadium is costly, and VRBs have relatively low energy density.

**Applications**

Energy storage plays roles in the generation, transmission and distribution aspects of the electric power system. Although the most obvious application for energy storage may be the balancing of intermittent generation resources, applications for storage are diverse. Firms looking to acquire energy...
storage technologies are not limited to generators and vertically integrated utilities. Developers, utilities, policy-makers and advocates are piloting energy storage to better understand from where in the electricity value chain the greatest economic value will be derived in order to justify the cost.

It is important to consider that deployment of one device may be used for multiple applications, thereby increasing the number of available revenue streams. As outlined in Figure 9, technologies have a few key features that inform their deployment for specific applications. Three components that inform the choice of technology for a specific application include:

- Speed the energy can be deployed, or discharge rate
- Amount of power deployed (e.g. kilowatts)
- Duration power can be sustained (seconds versus hours)

The following represents a selection of applications that ITA identifies as strongly amenable for storage.

- **Arbitrage**: Storing low-priced energy during period of low-demand and selling it during high-priced periods

- **Frequency regulation**: Regulations mandate that the AC frequency of grids be held within certain frames. Storage that can be deployed automatically and quickly (generally with a 1 minute response time) helps grids keep continuously shifting supply and demand within a control area.

- **Load following**: Similar to frequency regulation in that load following manages systems fluctuations, it differs in its longer time frame, which can range from 15 minutes to 24 hours.

- **Voltage support**: The injection of power to maintain voltage levels in the T&D system under normal conditions.

- **T&D congestion relief and T&D infrastructure investment deferral**: Storage is used to increase energy supply by increasing the load-carrying capacity of a T&D system. It relieves congestion points in the T&D grids and can defer the need for an investment in infrastructure.

- **Demand shifts and peak reductions**: Demand for energy peaks dramatically a few days a year, generally during hotter days, leaving the grid to operate at a lower capacity the remainder of the year. Storage reduces the need for additional capacity to serve peak demand and increases the efficiency of a grid’s capacity.

- **Off-grid or low-grid**: Storage increases the reliability of energy supply in off or low-grid communities, especially when paired with renewable resources.

- **Renewable resources integration**: Storage is coupled with solar or wind installations to provide home consumers and utilities a way to use their intermittent sources around the clock and/or year-round.

**Selected Global Storage Market Case Studies**

Currently, the United States, Japan and Korea account for over 50 percent of the global energy storage market. ITA anticipates that opportunities in energy storage will continue to grow in these and other countries from the confluence of decreasing costs, increased understanding of storage’s role in the power grid and a global commitment to cleaner energy.

Demonstration projects and pilot programs are moving forward across the country – including in California, Hawaii and West Virginia – and are being carefully studied and evaluated for market applications. ITA expects an increase in the number of demonstration projects in the near-term.

ITA assesses that near-term economic deployment of storage products will be primarily focused on support for ancillary services, such as frequency regulation. In the long term, creative and flexible deployments of storage will be necessary to capture all of the unique and varying benefits.

In lieu of sub-sector rankings, ITA examines market statuses for a small selection of countries. These evaluations are provided below.

- **Japan**: Japan is the largest residential energy storage market in the world with 277 MWh. This is supported largely by a behind-the-meter storage subsidy program that boosted sales of lithium-ion batteries. Korean producers have...
benefitted from the subsidies, which have not been renewed for 2016. Significant reforms in Japan’s electricity market, which until now has been dominated by the country’s 10 vertically-integrated power companies, are bringing new opportunities for U.S. businesses to tap into the liberalization of a $67 billion Japanese retail market. As the Japanese electricity market is reshaped, there will be opportunities for U.S. energy storage product manufacturers to offer a variety of storage solutions to utilities as well as residential consumers.

- **China:** There are over 50 energy storage demonstration projects in the planning and operating stages in China. The country is already using batteries to smooth wind and solar outputs, and it is expected to introduce other large-scale energy storage technologies to meet growing energy and flexibility needs. Similar to the United States, China is evaluating how to classify, use and regulate energy storage as part of generation, load management, and/or T&D. Despite China’s heavy clean energy investments, it is still behind the U.S. when it comes to energy storage technology. China’s 13th Five Year Plan, to be released in March 2016, has a renewed commitment to clean energy and specifically includes storage.

- **Germany:** Battery-makers such as Tesla have benefitted from Germany’s rebates for solar-plus-battery household systems. The rebate program has returned 30 percent of the cost of the system, an average of $4000, to households, and was coupled with low-interest loans for other various renewable energy storage systems. When the subsidies expired in November 2015, Germany announced that this was because the goal of encouraging more solar-plus-storage systems had been met. The decision, however, was reversed only a month later. Lawmakers are now pushing for another three-year extension for the subsidies.

- **Australia:** Australia is emerging as a ripe market for energy storage. The country leads the world in residential solar penetration (15 percent), which presents an opportunity for large-scale household deployment of storage. BNEF reported that the average residential storage system cost fell from $2700/kWh in 2014 to $1000/kWh in 2015. With high electricity costs, Australia is particularly suitable for storage systems that offer good value propositions for households. Storage can also be applied to help defer T&D investments and service Australia’s micro, low and off-grid communities.

- **Korea:** KEPCO plans to deploy 500 MW of energy storage for frequency regulation by 2017. This includes three projects in Kokam, Korea that have already been deployed: two lithium nickel-manganese cobalt (NMC) oxide energy storage systems (ESS) at 24 MW (9 MWH) and 16 MW (6 MWH) and a 16 MW (5 MWH) lithium titanate-oxide (LTO) ESS. These projects are the largest frequency regulation NMC ESS and LTO ESS globally and, together, are estimated to save KEPCO $13 million annually by reducing the amount of fuel purchased.27 Lithium-ion batteries are driving the project, which is no coincidence as Korea has become a dominant player in this sector. ITA projects that Korea, along with Japan, will continue to innovate and drive down the costs of lithium-ion batteries.
Country Case Studies

The following pages include country case studies that summarize U.S. smart grid opportunities in selected markets. The overviews outline ITA’s analysis of the U.S. export potential in each market and offer recommendations to exporters that can improve their competitiveness. The markets represent a range of countries to illustrate a variety of points – and not the top markets overall.
Brazil

Brazil’s top markets ranking is affected by the nation’s economic and electricity demand growth, as well as by a policy and regulatory environment that may constrain investment and exporter opportunities in the energy sector. Brazil is currently the largest electricity market in Latin America and is an important global emerging market, but smart grid deployments have been slowed by regulatory and technical hurdles. The business environment for U.S. smart grid exporters, where strong local partnerships and longer timelines for investment are usually required of foreign entrants, has been challenging as well.

U.S. exports of transmission & distribution (T&D) equipment have grown in recent years and investments in Brazil’s power infrastructure will need to continue in order to meet growing electricity demand, particularly in urban centers that are distanced from traditional hydropower sources. Brazil’s leadership has intensified its efforts to meet electricity supply challenges, often at the expense of utilities. The utility finance environment has suffered as a result and smart grid ICT investments have been delayed. The unfolding scandal connected to energy giant Petrobras poses another challenge to government and business, increasing uncertainty and creating a drag on growth.

Sustained opportunities for U.S. suppliers of T&D infrastructure are expected in Brazil, along with limited opportunities for technology and solution providers in the Advanced Metering Infrastructure sub-sector. However, given the economic recession, this market will be more difficult for U.S. suppliers in the near term. Continued engagement with key stakeholders on regulatory and commercial issues affecting Brazil’s smart grid market will be required.

Market Overview

Brazil’s electricity market is heavily dependent on hydroelectric power plants with approximately 80 percent of its electricity generated through hydropower in an average year. Droughts, however, can severely restrict the country’s electricity generation. Increased volatility of supply and rising wholesale electricity costs have been the headline-making trends of recent years for Brazil’s power sector. Public officials have focused on short-term funding solutions to these problems, financed mostly through public and utility industry debt, keeping consumer electricity prices relatively low.

Privatization and competition have been limited in Brazil’s power supply and services markets, with the state-owned Centrais Elétricas Brasileiras (Eletrobrás) controlling about one-third of total installed capacity and a handful of state-owned companies generating most of the rest. Transmission lines in Brazil are largely state-owned as well, and the Operador Nacional do Sistema Elétrico (ONS) is a nationwide operator. Privatization and competition have gone much further in the distribution segment, where there are more than 60 providers across the country. While state governments are allowed monopolies over their electricity markets, many have been privatized. Approximately 70 percent of distribution companies rely to some degree on private capital. A number of distribution company concession contracts have been renewed.

Growth in Brazil’s electricity consumption decreased in 2015 and is expected to be slow to resume its growth. It is predicted to increase at an average of 1.3 percent annually between 2015 and 2020, driving a need for further investment in infrastructure. Beginning in 2012, Brazil’s government set out on an ambitious plan to increase and diversify its energy mix, with goals to invest approximately $235 billion and install 36 Gigawatts (GW) of hydropower, 12 GW of biomass and 11 GW of wind over the course of 10 years.

Although Brazil has supported renewable energy projects, particularly wind, transmission infrastructure has been inadequate, delaying a number of projects.
Brazil now requires that projects involved in energy auctions prove that they have transmission lines secured prior to participating in the auctions. This will reduce the problems of delays associated with insufficient transmission infrastructure while helping drive the market for T&D equipment.

Poor energy efficiency and average electricity losses in excess of 15 percent are also pressing issues impacting Brazil’s market. Aging transmission lines delivering power over long distances combined with rampant electricity theft in segments of the distribution network are largely to blame.

The need to upgrade infrastructure is a common refrain in Brazil, but meeting the need has proved difficult. In 2012, Eletrobrás announced plans to invest heavily across generation, transmission and distribution over the following two years, but it failed to reach its targets. The company subsequently cut its workforce and cited an imbalance between high generation costs and electricity tariffs that have been largely suppressed by national and state governments.

Policy and Regulatory Environment

Brazil’s electricity market is regulated by the National Electricity Agency (ANEEL), and the Ministry of Mines and Energy (MME) leads energy policy developments.

ANEEL regulates public tenders for electricity sold to distribution utilities, sets tariffs for residential consumers in the regulated market, and is responsible for maintaining an economic balance that enables distributors to cover operating costs and recover an adequate return on investment. Meanwhile, a liberalized and unregulated system governs electricity trading between independent energy suppliers, and industrial consumers have the option of purchasing from the unregulated market.

In 2011, Brazil released its “Ten Year Energy Plan” and set a goal of adding 18 GW of renewable resource capacity by 2020. The expanded renewable supply is intended to diversify the energy supply mix and help Brazil meet its goals to reduce greenhouse gases, with a reduction of emissions of 37 percent by 2025 and 43 percent by 2030, compared to 2005 levels as part of its 2015 UNFCCC INDC. Renewable energy projects in Brazil – particularly locally sourced projects – receive favorable financing in Brazil, and electricity produced from renewable sources with capacity less than or equal to 30 megawatts (MW) receives a 50 percent reduction in T&D tariffs.

In December 2015, Minister of Mines and Energy, Eduardo Braga, launched a multi-agency distributed generation initiative (Pro-GD) that hopes to attract $25 billion in investment by 2030. This included the announcement to install 2.7 million solar units to increase Brazil’s non-hydropower renewable resources share from 13 percent to 23 percent, where less than 1 percent is currently derived from solar energy. The initiative is also expected to lower CO2 emissions by 29 million tons to contribute to Brazil’s goals of cutting greenhouse gas emissions.

In late 2013, Brazil’s first “solar only” energy auction attracted bids among the lowest in the world, bringing Brazil closer to achieving the world’s cheapest solar contract prices – without subsidies. Renewable resources auctions have continued to do well throughout 2015 with almost all projects awarded.

ANEEL further predicts that revisions to its net-metering policies instituted of the last year will
increase opportunities for aggregation of sources and increase the number of small customer units installed to 1.2 million by 2024, amounting to 4.5 GW of installed capacity. For example, this new rule also enables “shared generation,” where interested parties are allowed to create a consortium, or cooperative, to install a micro or mini-distributed generation unit, up to 75 kilowatts or up to 5 megawatts, respectively, to reduce the electric bill of the parties.

Despite the long-standing goal of nationwide deployment, Brazil’s smart meter market has experienced a number of false starts and the regulatory environment has not developed favorably to drive deployment. In 2012, ANEEL approved a long-awaited resolution establishing requirements for smart meters, but the regulator limited the classes of consumers for the roll-out. The smart grid market is still eagerly awaiting additional technical regulations from both ANEEL and Brazil’s lead standards body, INMETRO, that will finally kick-off deployment.

Brazil’s Energy Efficiency Program (EEP) mandates distribution utility spending in energy efficiency, requiring about $250 million to be invested annually. Restrictive program requirements, however, have limited the effectiveness of spending, and the wider energy efficiency market in Brazil has been stifled by a high cost of capital for financing deals.

Market Analysis

Brazil’s electricity needs and investment in large infrastructure projects through the 2013 period of economic growth have been important growth drivers for U.S. suppliers of grid modernization equipment and services. In 2013, U.S. T&D equipment exports to Brazil more than doubled to over $94 million in revenue. Imports, however, dropped to resume modest growth in 2014 and decreased to $40.9 million in 2015. Coupled with the increased economic downturn Brazil dropped in the Smart Grid Top Market rankings to #32.

Beginning with the Lula administration, Brazil set ambitious goals for its national smart grid deployment, but the market has been slow to develop. The smart grid regulatory and business environment has fallen short of expectations. Once the technical hurdles are overcome, the market expects significant investment in smart distribution solutions that can solve the problem of electricity theft. While the smart meter market is likely to be limited to an estimated $500 million in the near-term, some of the larger, urban utilities with higher-income consumer footprints will require advanced smart grid solutions to a range of power management challenges.

Opportunities and Challenges for U.S. Companies

U.S. suppliers continue to find export success in Brazil’s T&D sector, where projects are continuing apace though economic and political issues that pose a threat to future growth. Opportunities for transmission to connect areas of energy supply growth, in particular, wind, to growing demand should be a focus. As the integration of new power sources moves forward, many Brazilian utilities will require more advanced power management solutions. Brazil continues to be a challenging market for U.S. firms to do business, and a great deal of upfront work to overcome both cultural and technical issues is required of technology firms in particular.

Opportunities

- Transmission build-outs and solutions to ensure supply/demand balance
- Distributed generation management as sector grows
- Electricity delivery and demand side management solutions as smart grid deployments advance in 2015

Challenges

- Utilities have been forced to shoulder the financial burden of meeting recent electricity demand growth, and an improved regulatory and financial environment will be required to drive future investments.

Know Your Buyer

Brazilian purchasers of U.S. smart grid goods and services include generation, transmission and distribution companies. For example, according to the Brazilian Electric Power Utility Association (ABRADEE), there are 64 electric power utilities in Brazil, with 74.1 million consumer and 2 million new connections every year.

Summary of Resources

- Brazilian Ministry of Mines and Energy (MME): www.mme.gov.br
• Brazilian National Electrical Energy Agency (ANEEL): www.aneel.gov.br
• Brazilian Electrical and Electronics Industry Association: www.abinee.org.br
• Eletrobrás: www.eletrobras.com.br
• Empresa de Pesquisas Energéticas (EPE): www.epe.gov.br
Canada

As the United States’ top trading partner and a world leader in advanced smart grid deployment, Canada ranks first overall in the Top Markets Report. U.S. exporters are highly competitive and face minimal barriers to doing business in Canada, which is far and away the top export destination for U.S. T&D equipment manufacturers. There is still a high potential for growth in this market as Canada needs to invest in its aging electricity infrastructure, and certain provinces, such as Alberta and Ontario, are currently planning multi-billion dollar build-outs and upgrades to transmission lines.

In the Smart Grid ICT market, energy policy drivers and regulatory frameworks are in place to help sustain growth and incentivize utility investment in new applications, including demand response and consumer energy efficiency programs.

It is important to note that provincial policies and regulations play a dominant role in Canada’s energy sector, where power sector regulation authority resides with the provincial governments. Therefore, smart grid opportunities will vary across provinces accordingly. Still, Canada has been a global leader in areas like smart meter deployment with rollout across all provinces near completion. Ontario was one of the first provinces to complete smart meter deployment. Further major investments are anticipated in British Columbia’s energy efficiency market, Quebec’s advanced metering infrastructure, and Ontario’s market for non-generation regulation resources and services.

Market Overview

Canada’s large territory is endowed with a rich and varied set of natural resources, enabling the country to rank among the five largest energy producers globally. Canada is the largest foreign supplier of energy to the United States, having supplied 62 billion kilowatt hours of electricity in 2013 alone. Canada currently has an estimated 133 GW of installed electricity generation capacity, dominated by hydropower (approximately 77 GW), but with a growing share for wind energy due in part to highly supportive federal and provincial policies. Canada’s ongoing efforts to transition its power supply and upgrade its electricity infrastructure should be a major driver of T&D and smart grid investment for years to come. Eighty percent of power-generation facilities in Canada are scheduled to be replaced in the next 10-15 years and Natural Resources Canada’s 2011 Clean Technology Report estimated that the smart grid industry in Canada will grow between $520 million and $2.1 billion by 2020.

Each province is planning further T&D infrastructure upgrades and modernizations, including new transmission line deployment.

Today, the majority of Canadian households have “smart” or “advanced” meters installed. Although annual deployments of smart meters nationwide slowed in 2013 as the deployment was near completion, Bloomberg New Energy Finance predicts deployments to remain at approximately 1 million units per year through 2018.

While all provinces have deployed smart meters to varying degrees, Ontario is by far the largest market and the nation’s leader in terms of smart grid applications, including the utilization of time-of-use (ToU) pricing. Importantly, other cities and provinces appear to be following Ontario’s lead. Montreal has embarked on a new round of smart meter deployment and is moving toward ToU pricing. While Alberta and British Columbia are not planning to switch to ToU in the near-term, both provinces continue to invest in energy efficiency programs.

Policy and Regulatory Environment

Canada’s 10 provinces and three territories each govern their own natural resources, and each
province has developed an electricity grid and market that is largely independent, though border provinces are well-integrated with the U.S. grid to facilitate north-south trade. The North American Electric Reliability Corporation (NERC) oversees electricity trade and reliability in Canada, similarly to its role in the United States, including in the development of standards for most provinces.

Due to its large hydropower endowment, electricity prices in Canada have traditionally been among the lowest in the world. Anticipated investment in aging electric power infrastructure and the shift towards non-hydro renewable and low-carbon sources will likely increase prices over the next decade.

At the national level, Canada’s energy policy is increasingly driven by climate change targets. In 2010, the Canadian Government announced its target of 90 percent emission-free electricity by 2020. Federal regulations require that plants reduce GHG emissions to no more than 420 metric tons on average of CO2 per gigawatt hour of electricity produced, though most provincial policies are actually accelerating the transition from coal in their jurisdictions, with Ontario being the first to eliminate coal based generation in 2015. A new Canadian Prime Minister, Justin Trudeau, was elected in October 2015 and has since pledged his commitment to prioritize renewable energy policies, which should have positive effects on smart grid deployment as well.

Canada and the provinces have taken important steps to help finance investment in the clean energy sector, and private and public stakeholders alike are cooperating on research and development and other projects that are open to international suppliers and partners.

Overview of ITA’s Analysis: CANADA

Strengths
- Top trading partner
- Policy drivers and facilitative regulations in place
- Market access and high U.S. competitiveness

Key Trends
- Continued leadership in transition to renewable resources
- Mature smart meter market with moderate growth
- Opportunities for time of use, demand response, and other advanced applications

Risks
- Provincial-level regulations are key
- Privacy and cyber security issues currently being addressed

Top Markets Analysis

Canada is one of the most advanced countries in the world in terms of its smart grid development. According to a 2012 report, Canadian awareness levels of smart meters are higher than those of the United States, and the potential for consumer energy efficiency programs to drive additional savings for both households and utilities were shown to be positive. Due to the fact that parts of Canada are at an advanced stage of smart grid deployment, opportunities for highly competitive U.S ICT firms will be ripe. With a shared transmission network and a history of cooperation on standards, issues of interoperability for U.S. smart grid exporters to Canada will be minimized.

Electricity sector regulations throughout Canada continue to facilitate smart grid deployments and support energy efficiency as a tool to meet climate and energy policy goals for the country. Ontario has been a world-leader in smart grid deployment and is helping to drive developments in the rest of Canada as well. Over 2.6 million customers in Ontario can now access their smart metering data through a “Green Button” format that enables energy monitoring and opens the market to a variety of consumer energy efficiency applications.

Ontario is also at the forefront in addressing issues arising at the leading edge of smart grid technology deployment. Led by its Information & Privacy Commissioner, the province is working to address consumer privacy concerns and reach out to the smart grid business community with the Privacy by Design international standard. These efforts, combined with commitments by both utilities and the public to improve energy efficiency, will help drive opportunities in Canada’s smart grid ICT market that are matched by few other international markets.
Opportunities and Challenges for U.S. Companies

In 2015, Canada was the top ranked market for U.S. T&D exports, with $556 million in export revenue. The need to upgrade and extend Canada’s aging electricity infrastructure to meet household, commercial and industrial demands will be a major driver of investment and opportunity for U.S. T&D equipment manufacturers. Recent investments include a $3 billion project to construct two 500-KV transmission lines in Alberta, and a $1 billion Lake Erie Clean Power Connector connecting the province to Pennsylvania through underwater transmission lines.

In the Smart Grid ICT realm, the relatively wide spread deployment of AMI in parts of Canada is now driving additional investment in utility IT systems and analytic software platforms and applications. Opportunities also exist for energy efficiency programs and systems marketed directly to consumers. There are a number of smart grid segments that continue to develop in Canada, with higher growth expected in certain provinces that are developing emerging markets for the following technologies and applications:

- Advanced Metering Infrastructure (Alberta; Quebec)
- Household ToU Rates (Quebec)
- Demand Response (BC; Alberta)
- Outage Management (Ontario; Quebec; BC)
- Reactive Power Control Systems (Alberta; Manitoba; BC; Quebec; Ontario)
- Microgrids (Ontario; Quebec)
- Energy Storage (Ontario; Quebec)

Canada is also advancing the development of its electric vehicle (EV) market. Quebec and Ontario now offer electric vehicle rebates and have implemented other incentives. British Columbia Hydro is currently developing guidelines for the underlying smart grid infrastructure needed to support additional EV adoption.

Know Your Buyer

Canadian purchasers of U.S. smart grid goods and services include generation, transmission and distribution companies.

Summary of Resources

China

As the world's largest market for electricity infrastructure development and smart grid technologies, China offers great opportunities for U.S. exporters, particularly suppliers and service providers in the areas of high voltage transmission, synchrophasor technology and modernization of transmission operations, and partnerships in Smart City and select smart grid projects.

U.S. T&D equipment export revenues to China exceeded $54 million in 2015, reflecting a two year decrease and the lowest export levels since 2006. After a period of very high electricity consumption growth, China is shifting its economy, and growth is expected to slow. ITA, however, expects continued investment in electricity infrastructure and opportunities for U.S. suppliers of T&D equipment and an increase in opportunities for smart grid ICT solution providers to increase.

With smart meter procurements underway, the government is showing a commitment to diversifying its energy mix, reducing carbon emissions, and increasing energy efficiency. China leads the world in new investment in the full suite of smart grid technologies. While the bulk of smart grid technologies for China's distribution network will be provided by local suppliers in the near term, opportunities will grow for firms providing solutions to operational and network efficiency, renewable integration and management, demand side management, and end-user energy efficiency challenges.

Market Overview

China's electricity market is dominated by coal, but this has been dropping in share over the last two years, as the government is now primarily interested in improving urban air quality. Investments in renewable resources and nuclear energy have grown and are expected to contribute the most to an expanding electricity supply that will be necessary to meet anticipated average demand growth rates of 4 percent per year over the next five years.

China’s government has made significant, recent statements regarding its intent to reduce carbon emissions, including bans on new coal-fired power plants in certain regions and the creation of a national carbon trading system by 2017. Such measures will apply major pressure to the power sector and likely accelerate the market for non-coal-fired generation, as well as for smart grid and energy efficiency technologies and services. Currently, overall growth of China's power sector is estimated at 2 percent, but the markets for renewable energy development, energy efficiency investment and smart grid technologies grew at approximately 16 percent, 25 percent and 34 percent, respectively, in 2013.

Investment in the modernization of China's electricity infrastructure and the development of a "unified strong and smart grid" have been a focus for the country’s power sector since 2010. China’s largest vertically-integrated T&D company, State Grid Corporation of China (SGCC), has largely kept pace with goals outlined in the country’s 12th Five Year Plan (FYP) for 2011 through 2015 to boost grid investment by 68 percent over the period, particularly in ultra-high-voltage transmission lines. This trend is expected to continue with SGCC tapped to invest $243.2 billion (CNY 1.6 trillion) as outlined in the 13th FYP (2016 through 2020). The challenge of connecting major hydro and wind resources to distant population centers continues to be a major driver of China’s growing T&D market.

China also has commitments to massively expand its use of smart meters. Through 2015, tenders for 425.8 million smart meters have been contracted. Annual investment in smart metering was estimated to be $1.4 billion in 2015 and was predicted to reach $2.9 billion in 2016. In 2020, China is expected to account...
Overview of ITA's Analysis

Strengths
- China’s government is making a push to reduce the carbon intensity and use of coal in its economy, largely through improving energy efficiency
- China is planning to install smart meters in every household by 2017, and then institute country-wide time-of-use electricity pricing

Key Trends
- Electricity consumption in China is continuing to rise as China’s economy continues to expand rapidly, though the nature of economic growth is expected to have more growth in the less-energy-intensive service industry
- China’s electricity mix will begin shifting away from coal and towards cleaner energy sources, necessitating the build-out and modernization of grid infrastructure

Risks
- Chinese firms have substantial market shares in the smart grid sector, supplying most of the smart meters currently produced at prices below U.S. products
- More favorable labor markets give Chinese manufacturers an advantage over U.S. manufacturers in commoditized products, so as these products mature, the U.S. advantage on these technologies will diminish

for over 24 percent of the global smart grid market at around $96 billion, according to GTM.

Policy and Regulatory Environment

The electricity market in China is heavily regulated, with power prices at the both generation and consumption levels being set by the government. Although China has begun liberalizing the generation sector, it is dominated by five state-owned utilities that control almost half of total capacity, and the transmission and distribution grid is entirely controlled by three state-owned operators.

The National Development and Reform Commission (NDRC) plays a critical role in China’s electricity market as the primary price-setter and regulator. It also develops and implements major policies that affect the wider economy and energy sector, including energy policy planning primarily falls to the National Energy Administration, a sub-agency within NDRC. The NDRC currently dictates the pace of privatization and liberalization of China’s energy markets, including the involvement of foreign competitors.

As part of China’s stated effort to open up the electricity sector, the NDRC allows limited foreign investment in the construction and operation of the power grid. Other market reform objectives for China’s energy sector include the unbundling and separation of owners, operators and various business units across the electricity supply chain and the creation of an open wholesale electricity market. Progress has been slow: the separation of some of the power grid operators from generation companies is all that has been achieved to date.

Electricity prices are currently separated into residential, agricultural, and commercial & industrial (C&I) tiers, with additional levels of granularity – including peak and trough pricing – offered to C&I customers. The NDRC determines the profit margins of generators, and can determine prices and incentives according to supply-type.

In order to balance electricity supply and demand, China is increasingly focused on energy efficiency opportunities, including the implementation of demand side management (DSM) programs. Beginning in 2011, NDRC mandated peak load reductions for grid companies of 0.3 percent annually, and has since endorsed Suzhou, Beijing, Foshan and Tangshan as DSM pilot cities. Energy Service Companies (ESCOs) and technology solution providers work with end-users and utilities in these cities to achieve energy savings through Direct Load Control technologies, interruptible tariff programs, smart metering solutions, and time-of-use (ToU) pricing options. ToU pricing is available to roughly 66 percent of commercial and industrial consumers.\(^{31}\)

As the electricity provider for over 1 billion customers and 88 percent of the Chinese Market, SGCC has an investment portfolio and operating policies that all have a major impact on the power market. Beginning in 2010, the grid operator earmarked over $40 billion for smart grid technologies. Although SGCC has delayed its deployment goals, combined with China
Southern Grid the firms are set to install of another 280 million smart meters is expected over the next five years. Additionally, SGCC has updated its grid connection policies to enable the expanded installation of distributed energy resources. In order to better integrate and manage these resources, the utilities are expected to invest almost $7 billion in distributed automation technologies over the next five years.\footnote{32}

Top Markets Analysis

Spending on electricity infrastructure and the smart grid in China is expected to far outpace that of any other international market for at least the next five years. Success over the period for foreign suppliers, however, will be limited because of the focus on developing basic infrastructure and larger business issues that constrain exporters’ commercial opportunities in China’s energy sector.

China’s Smart Grid Top Markets ranking remained unchanged in 2016. Though it had a slower economy and lower T&D equipment imports, China countered this with significant overall power sector investments, government policies and a commitment to grid modernization. A reliance on local suppliers, the lack of opportunity for foreign suppliers of advanced smart grid technologies, and a poor competitive environment for U.S. firms, however, all have negative effects on China’s ranking.

Opportunities and Challenges for U.S. Companies

Despite the huge investments being made in grid modernization and smart metering, the market for U.S. firms in China is significantly limited by the challenge of incumbent local supply chains and technical interoperability issues, particularly in the distribution network. The market for demand DSM technologies that help reduce peak load and overall power consumption by end-users, however, is an area of potential growth for U.S. exporters that have already deployed and proven these technologies at home. China fell short of its goal to reduce energy consumption per unit of GDP, or “energy intensity,” by 16 percent from 2010 to 2015 and has since scaled this back to 15 percent with a total energy consumption cap of 5 billion tons of coal equivalent by 2020.

Opportunities

- Continued, though declining, opportunities in T&D infrastructure, particularly high voltage transmission.
- Increasing demand for network management technologies and applications following modernization of China’s substations.
- Energy efficiency programs and projects with industrial and municipal partners, particularly green data center segment.
- Microgrids, as China accelerates their construction and distribution of other energy resources.

Challenges

- The Chinese electricity market is opaque: incumbent suppliers are favored, and government intervention to support local firms and production is common.
- Local partnerships are key to success. A coordinated effort to support U.S. industry involvement in major projects, like smart cities, will be required.

Know Your Buyer

Chinese purchasers of U.S. smart grid goods and services include generation, transmission and distribution companies. SGCC and China Southern Grid remain the primary purchasers of smart grid technologies.

Summary of Resources

India

India’s Smart Grid Top Market rankings are bolstered by a fast-growing economy and electricity sector. Ambitious government policies for energy access, renewable resources deployment and development of “smart cities” send positive signals for the smart grid market. Challenges remain, especially in relation to access to financing.

U.S. T&D Equipment sales to India were valued at $12.8 million in 2015 and reflect only a 2 percent CAGR over the last five years. Despite market challenges, the Indian market remains attractive as U.S. exporters look to tap into an electricity sector that is expected to grow at one of the fastest global rates among all major economies.

Market Overview

For the administration of Indian Prime Minister Narendra Modi, the largest and most perplexing challenge is arguably addressing India’s significant need for power. India currently is home to 18 percent of the global population, but only accounted for 5.7 percent of the global energy demand in 2013. India runs at an average energy deficit of 5 percent with values as high as 25 percent in some regions, leading to daily rolling brownouts, hampering economic growth and limiting foreign investment in the country. The July 2012 blackout that affected 620 million people was, for example, seen as a global embarrassment and remains a politically contentious topic to this day.33

As a result, the administration’s flagship power sector initiative has been the pledge to ensure continuous, 24 hours a day/seven days a week (24/7), power for all Indians. This will require bringing electricity to the over 300 million people who currently lack any access and substantially improving electricity access to the additional 250 million people whose intermittent electricity access may be limited to only three to four hours a day.34 Bloomberg New Energy Finance estimates that to realize its electricity access targets, generation capacity will need to increase fourfold, and $750 billion in new investment will be required by 2030.

Electricity theft continues to run rampant, and hurdles to rural and urban Indians paying for power remain, thus affecting availability of capital by Indian transmission, distribution and generation providers to invest in grid modernization and expansion.

T&D remains dominated by the government, with the overall private sector role limited to 1 percent in transmission and 5 percent in distribution. One of the biggest challenges facing these entities is T&D losses, which on average are very high – 8 percent at transmission level and 26 percent at distribution level, nationally. Several large states even report more than 40 percent distribution losses.

The Power Grid Corporation is the owner, operator (under its subsidiary the Power System Operator Corporation Limited) and developer of the national interstate power transmission grid. In 2009, the National Load Dispatch Center began supervising regional load dispatch centers, scheduling and dispatching electricity, and monitoring operations of the national grid. In 2013, five regional grids were ultimately united into one synchronous national system, but interconnections are largely thought to remain inadequate with control technologies still out of date. Power Grid Corporation has stated that it anticipates spending $18 billion in the next five years to extend and upgrade the Indian power grid to include smart technology. This, however, is only a small fraction of the $50 billion that the Ministry of Power has indicated is necessary over the next decade to modernize the grid.

The power distribution companies (DISCOMs) handle electricity sales and retail to commercial and residential customers, but industrial customers also have the opportunity to buy directly from the generators and wholesale market. The distribution,
sales, and retail markets are largely handled by the regional governments in Delhi and Odisha states and the City of Mumbai, with Kolkata, Ahmedabad, and Surat municipalities having private companies engaged in electricity distribution. India’s DISCOMs are largely not profitable. The government continues to direct cash to the DISCOMs to bail them out of debt, while still exploring policy and regulatory reforms to find permanent solutions to the problem. ITA expects the solution will likely need to include increasing regional competition to drive sector innovation and reduce overall losses. As seen in other global markets, ITA expects new smart grid export opportunities for U.S. firms to increase if sectoral competition also increases, as DISCOMs seek new innovations to capture and/or retain market share.

ITA notes this will also spur smart grid investments to effectively integrate the resource, including technologies to improve load shedding when the sun goes down. India announced a renewable energy deployment target of 175 GW of renewable resources by 2022. Solar is expected to play the largest role in India’s power mix going forward with goals of increasing capacity to 100 GW by 2022. While ITA does not expect India to meet these targets, the ambitious nature of its announcement sends a positive signal to the market of India’s willingness to use its policy tools to drive development of the generation source.

ITA expects India to raise capital to fund new major infrastructure projects while keeping energy prices affordable. A balanced budget will remain an ongoing challenge for India. The July 2014 budget proposed by the Modi administration included a doubling of the tax on coal, which will fund several important clean energy subsidies under the umbrella of the National Clean Environment Fund (NCEF). This includes helping to finance the estimated $6 billion Green Energy Corridor that will deploy high voltage transmission lines and other infrastructure (e.g., substations) to facilitate the transfer of electricity generated from renewable energy in rural locations to load centers throughout the country. In 2014 to 2015, India reported that $2.7 billion was raised, and the NCEF used this to fund 46 clean energy projects. The effectiveness of the NCEF in directing funds to new projects, rather than paying off debt from previous clean technology infrastructure projects, has come under question.

Following the budget declaration, India’s finance minister announced that Indian banks would be allowed to raise long-term funds for lending to the infrastructure sector through the easing of constraints on liquidity, cash reserves and priority lending. This should support additional investment in the grid infrastructure needed to move renewable electricity produced in rural areas to load centers around the country.

The Asian Development Bank has announced plans to lend $1 billion to Power Grid Corporation for the Green Energy Corridor. India further emphasized in its Intended Nationally Determined Contribution to the U.N. climate change negotiations that it will seek low cost international financing for climate change mitigation efforts from institutions such as the Green Climate Fund. ITA anticipates that the ability to secure project financing will continue to be an important key to success for U.S. exporters.

Policy and Regulatory Environment

India’s energy policy is overseen by its Ministry of Power (MOP), and tariffs are regulated by the Central Electricity Regulatory Commission (CERC) and its state-level counterparts.

In 2014, MOP initiated the Integrated Power Development Scheme to guide the development of transmission and distribution systems updates and fill gaps in funding for sub-transmission, distribution and metering to support a more efficient grid.
Focused on efficient and reliable distribution, MOP issued a Smart Grid Vision and Roadmap for India with the vision of a nationwide smart grid. In order to achieve the targets envisioned in the smart grid roadmap, a National Smart Grid Mission (NSGM) was proposed, which was approved by the government with an outlay of approximately $155 million in the 12th Five Year Plan, including $72 million in allocated funds in 2015. The NSGM serves as an institutional mechanism for planning, monitoring and implementing policies and programs related to the smart grid. MOP announced that grants up to 30 percent of the project cost will be available from the NSGM budget, and for selected components, such as training and capacity building, and consumer engagement, grants of 100 percent of costs will be available.

The NSGM is also charged with overseeing state-specific policy efforts, where some regions have already begun to implement smart grid enabling policies on their own. Net metering policies have been adopted in locations such as Andhra Pradesh, Maharashtra and Punjab. Tata Power Delhi has begun to bundle other services and institute a series of social programs that are targeted to finding a business model that drives customers to pay for power instead of stealing it.

Additionally, the National Telecom Machine-to-Machine (M2M) Roadmap, a reference document for deployment of devices at the intersection of physical and digital worlds, incorporates efforts related to the smart grids ICT sub-sector. This is the world’s first national strategy for the “internet of things” (IoT). It further highlights the Smart Grid Pilot Program to prove the application of the IoT that will provide $60 million for 14 pilot projects, each with at least 20,000 customers. Largely the projects are focused on deploying smart meters and increasing meter readings to address theft issues, support reliability, support dynamic tariff structures and renewable resources integration. Four of the projects are underway, and six are in the contracting phase.

These efforts are informed by the India Smart Grid Forum (ISGF), the public-private partnership initiative of MOP. ISGF performs research, organizes conferences, develops standards, performs training and provides recommendations to policymakers and regulators.

Policy efforts related to so-called “smart cities” offer another mechanism for smart grid policy and regulation development. India’s cities account for approximately 60 percent of the country’s gross domestic product (GDP). By 2030, that share is expected to reach 75 percent, and the urban labor force is expected to increase by nearly 200 million workers. The new government has proposed a dramatic nationwide program to build 100 smart cities with 20 cities annually being selected to receive financing to kick-start development. Additionally, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched with the smart cities project and is focused on providing basic services, such as electricity, to households in 500 cities.

Market Analysis

India continues to be a difficult market for U.S. exporters. However, bolstered by growing electricity consumption, ambitious government policies, and a growing economy, India saw significant increases to its Smart Grid Top Markets rankings in 2016. Interestingly, despite concerns over the difficulty of doing business in India, which ranks 130 of 189 by the World Bank,³⁸ it had the highest Key Economic and Energy Sector Investment Indicator value (Category 3). On the other hand, India’s GTAP score remains one of the lowest among evaluated countries. U.S. firms have had some success to date in India through broader partnership efforts, but securing project financing is a primary challenge.

Opportunities and Challenges for U.S. Companies

Opportunities

- Growing electricity demand and an emphasis on smart technologies
- U.S. companies are advised to monitor multinational development bank postings and publications for international soft loan and grant funded project announcements. These projects offer significant front-end consulting opportunities and the possibility to supply power generation equipment during the project implementation phase.

Challenges

- Exporters must engage with a slow, often overly bureaucratic, regulatory system that includes highly regulated electricity prices
and inefficient state-owned distribution companies.

- U.S. firms looking to pursue opportunities in India are likely to need to bring their own financing options, thus providing an additional layer of difficulty to doing business in country.

Know Your Buyer

The primary buyers of smart grid technologies in India are the transmission and distribution companies. An emerging buyer community, however, is large commercial and industrial energy consumers. Due to rolling brownouts, these consumers are installing their own distributed energy resources and microgrid infrastructure to enable off-grid capabilities to maintain their operations.

Central and local government authorities continue to be active players in securing deals in-country as the electricity sector is not completely privatized. Similar to other large markets, exporters and policy-makers are well-served to consider distinct regions or states as different opportunities. Exporters to India should be prepared to face varied political and economic conditions across India’s 29 states and seven union territories.

Summary of Resources

- Indian Ministry of Power: www.powermin.gov.in
- Indian Ministry of New and Renewable Energy: www.mnre.gov.in
- Central Electricity Authority: http://www.cea.nic.in/
- Indian Renewable Energy Development Agency - www.ireda.gov.in
- India Smart Grid Task Forum: http://indiasmartgrid.org
- Confederation of Indian Industry: http://www.cii.in/
- Federation of Indian Chambers of Commerce and Industry: http://www.ficci.com/
Japan

Japan ranks third among Top Markets for near-term smart grid export growth, due in large part to electricity sector reforms, energy efficiency objectives and active technology procurements by utilities. While U.S. suppliers face difficult competition in Japan, important in-roads have been made in recent years, and the market is expected to evolve favorably for innovators and entrants to a strong market.

U.S. T&D equipment exports to Japan have increased dramatically over the last decade, peaking in 2012 and seeing a decline in recent years. This corresponds with the nation’s efforts to rebuild and strengthen its electricity infrastructure following the Tōhoku earthquake. A high level of investment is expected to continue, but it has begun shift to the distribution network, including smart grid applications and energy efficiency services.

The break-up of vertically-integrated utilities, creation of a nationwide grid operator, incentives for distributed generation and demand response are among the major overhauls to Japan’s electricity market. Sustained reforms will drive the pace and scope of new opportunities for U.S. suppliers, and strong relationships with Japanese partners will continue to be a requirement in this market.

Market Overview

The Japanese electricity market has been dramatically impacted by both the 2011 Tōhoku earthquake and the policy response that followed. The damage resulting from the earthquake and tsunami, including the public concerns over nuclear energy safety, forced Japan to shut down all of its nuclear reactors, which accounted for 30 percent of its electricity supplies at the time. The Government of Japan also shifted its focus to demand side management and an increased emphasis on energy security and resiliency through smart grid and energy efficiency technologies. This created a spark for technology markets that had long been suppressed and lacked innovation.

Japan’s electricity market is dominated by 10 regional utilities that have historically controlled generation, transmission, distribution and retail. Compared to other mature markets, electricity prices in Japan are high and consumption levels are low. Following the Fukushima disaster and energy crisis, household rates rose as much as 40 percent in some regions, and rate hikes are expected to continue, despite the re-activation of nuclear power, in order to fund continued upgrades to the system and provide relief to debt-laden utilities.

Although Japan has begun to re-activate its nuclear supplies, major reforms of the energy sector have continued, culminating in the April 2014 approval of the fourth Basic Energy Plan, which focuses on the policy objectives of energy security, reliability, efficiency, affordability, reduced emissions and increased consumer choice. The full implementation of this plan, including the break-up of many traditional energy sector monopolies and further liberalization of electricity markets, is expected to result in dramatic changes in the technologies and services incorporated in Japan’s energy infrastructure.
Overview of ITA’s Analysis: JAPAN

Strengths
- The Government of Japan is providing strong support for the development of the energy efficiency, smart grid and microgrids sectors
- Increased amount of renewable resources in Japan’s energy matrix will continue to support the development of smart grids into the future

Key Trends
- The 2011 Tōhoku earthquake and the continued transition of Japan’s energy supply mix require electricity management and efficiency solutions
- Electricity sector reforms will incentivize utility investment in smart grids and open various segments of the electricity services market to entrants

Risks
- Japanese conglomerates and local suppliers already hold strong positions in Japan’s smart grids sector
- Long project timelines and burdensome technical requirements
- Pace and strength of implementation of electricity sector reforms remain to be seen

Policy and Regulatory Environment

Japan’s energy market is overseen by the Ministry of Economy, Trade, and Industry (METI), which is responsible for policy planning, stable supply of electricity and rule-making through the Agency for Natural Resources and Energy. The Japan Fair Trade Commission monitors the state of competition and has been increasingly active in the electricity market since reforms began in the 1990s. By 2011, roughly 60% of the electricity market, including sales to large industrial and commercial customers, had been deregulated.

The 2014 Basic Energy Plan represents a complete overhaul of Japan’s energy policy, utility industry and electricity markets. While more nuclear reactors will come back online over the next few years, natural gas, coal and renewable resources will make up a greater share of the nation’s energy supply mix in the future. The plan did not set specific targets but did state that the share of renewable resources would exceed the previous policy objective of 20 percent by 2030. The Plan, however, will likely ease emissions restrictions as it aims to cut emissions by just 3.8 percent by 2020, a lower bar compared to previous policies.

Additional reforms called for by the Japanese government include the establishment of a national grid and the liberalization of retail power markets. The Basic Energy Plan and related regulatory changes will effectively break-up the regional utility monopolies in Japan, opening up the $67 billion household and small shop retail electricity market to competition in 2016. Japan has awarded over 150 applicants retail licenses. Many of these entities are small firms, but new non-electricity entrants have also applied, suggesting potential for the future bundling of electricity with gas, communications or other services.

In 2015, METI established two regulatory bodies. The first, the Organization for Cross-Regional Coordination of Transmission Operators (OCCTO), was established in April 2015 and is charged with overseeing the construction of cross-regional transmission lines, reviewing utility power supply and demand plans, and prescribing utilities to increase power generation and interchange as necessary.

The second, the Electricity Market Surveillance Committee (EMSC), was established in September 2015. METI has delegated the authority to the five EMSC members to monitor the electricity market, ensure its neutrality and make recommendations to the Minister.

Market Analysis

In addition to power sector investment in new energy supply technologies, enhanced T&D infrastructure and energy efficiency services, Japan’s government is also funding the integration of clean energy technologies and helping drive the development of the market for smart grid applications. METI’s 2014 budget allocated $3.8 billion for energy improvements, a 29 percent increase on the previous year, specifically targeting energy efficiency and demand-side response.

While subsidies targeting energy efficiency grew by 29 percent in 2014, the key program supporting the roll-out of home and building energy management systems has faded out, and the focus of both the public and private sector in Japan is expected to strengthen and remain – on smart grid applications
that help integrate renewable resources and manage demand, including demand response and microgrids.

In addition to monitoring the electricity system, EMSC is charged with overseeing the rollout of smart meters. Meter deployments ramped-up in 2015, and Bloomberg New Energy Finance predicts 6 to 10 million installations per year through 2022. As Japan’s utilities deploy AMI, investments in meter data management and additional smart grid applications and services are anticipated. By the end of 2016, electricity retail deregulation will come into effect, and most Japanese consumers will have access to live pricing and the choice to select ToU-based tariffs. If this timeline for technology deployments and market reforms is met, Japan will be the largest foreign market for residential smart grid and energy efficiency service providers.

Opportunities and Challenges for U.S. Companies

While Japanese conglomerates and traditional local suppliers have been largely successful in winning smart metering bids thus far, as Japan’s electricity market reform takes shape and its smart grid develops, additional opportunities for entrants are anticipated beyond the market for hardware. As Japan’s electricity sector moves to a more customer-oriented and competitive structure, energy efficiency service providers and smart grid innovators with experience in mature markets, such as North America, will be highly competitive.

Opportunities

➢ Integration of renewable resources into Japan’s grid will require investment in distributed energy management.
➢ Meeting energy efficiency goals will require increased consumer engagement and improved data management.

➢ Meeting grid reliability goals will require further investment in outage systems and microgrids.

Challenges

➢ The smart grid market remains saturated with major Japanese conglomerates, such as Toshiba, Hitachi and Mitsubishi.
➢ Projects often have a long approval process, spanning two or more years.
➢ Japan still employs a burdensome project and technology certification process.

In addition to utility-driven smart grid deployments, Japan’s Ministry of Environment has a budget of approximately $7 million per year for the next three years to initiate programs to develop microgrids that will improve overall system reliability, enhance renewable resources and energy storage integration, and incorporate EVs.

Know Your Buyer

Smart grid procurers in Japan include the established 10 utilities, but as market liberalization comes into effect, U.S. firms will potentially find new partners among the newly awarded market entrants.

Summary of Resources

• Japan Ministry of Economy, Trade, and Industry: http://www.meti.go.jp/english/
• Japan External Trade Organization: https://www.jetro.go.jp/en/
Mexico

Opportunities for U.S. exporters to Mexico are strong given the interconnection of the Mexican and U.S. electrical grids along the border, longstanding relationship between U.S. and Mexican firms, competitive advantages created by NAFTA, collaboration at a government level between both countries on energy issues, and the business potential brought about by a single utility company covering a rapidly-expanding customer base of 40 million clients.

Mexico is the United States’ third largest trading partner and second largest export market for U.S. products. U.S. T&D equipment exports to Mexico increased by 47 percent in 2015 with revenues rising to $327 million. This marked one of the few U.S. export destination locations for T&D equipment to see year-to-year increases over the last two years.

Market Overview

Mexico is considered one of the top emerging global markets for U.S. smart grid technology exports. Mexico’s 2014 energy reforms have significantly improved the outlook for the Mexican smart grid market. These reforms are designed to liberalize the electricity generation market, open future development to private firms and create competition between energy producers.

Mexico’s state-owned Comisión Federal de Electricidad (CFE) previously owned and operated nearly 100 percent of the country’s national electric transmission and distribution grid. The utility will now be broken into 10 discrete companies. The reform also created an independent grid operator, CENACE, which controls a new, wholesale market and enables customers to purchase power directly from producers, creating an independent power producer market for the first time in Mexico.

CFE’s smart grid vision must now also be understood in view of the changes produced by the energy reform. This is to assist CFE in its transition from a state monopoly serving nearly 40 million customers to a productive and competitive company in the new open market. CFE has undergone grid modernization efforts during the last five years through smart metering pilots, control and automation systems, and grid monitoring solutions, such as phasor measurement units (PMU) among several other technologies.

Some recent projects include the installation of 700,000 smart meters in 2015, with a total of 2 million meters to be deployed during 2016, through an eight-phase distribution loss reduction metering program and a new energy management system (EMS) to be procured by CENACE. The timeline for this last project is still under discussion. U.S. smart metering and communications companies have already been awarded several contracts within this set of projects. ITA anticipates that international suppliers, including U.S. firms, will continue to capitalize on these tenders for so-called “smart technologies.”

In August 2015, Mexico announced that it would invest $330 million in the development of smart grids over the next three years, with expectations that investments in power transmission and distribution would surpass $17 billion over the next 15 years.

The country has forecast as much as $62.5 billion in private investment in the energy industry by 2018. This includes significant investment in renewable energy deployment.

ITA further assesses that opportunities for smart grid ICT technologies will increase as its deployment of renewable energy increases. Mexico announced in September 2015 that it’s first-ever energy auction will award contracts priced in U.S. Dollars, an effort to make the newly opened power industry more attractive to developers.

Policy and Regulatory Environment
### Overview of ITA’s Analysis: MEXICO

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The Comision Reguladora de Energia (CRE) has the main regulatory role in the power sector, with the Energy Secretariat (SENER) taking on the policy role with less guidance from CFE. In June 2015, SENER released the first-of-its-kind 15-year plan for generation, transmission and distribution. This plan called for additional investments to reduce grid losses, modernize the grid, install smart meters and gradually deploy additional smart meter technologies.

Smart grid implementation is specifically mentioned in the Constitutional Energy Reform as a means to reduce power losses, increase quality and reliability, and enable the integration of energy generated from intermittent renewable sources. CRE received a grant from the U.S. Trade and Development Agency to develop a smart grid and renewable energy integration regulatory roadmap in 2012. The roadmap was published in February 2015.

### Market Analysis

Rising electricity demand and strong investment in electric power infrastructure are expected to support increased opportunities for electric grid equipment and smart grid exporters to Mexico. International investors, including U.S. firms, are expected to bid on related projects.

Furthermore, in 2015, the U.S. and Mexican governments established a new U.S.-Mexico Energy Business Council under the auspice of the U.S.-Mexico High Level Economic Dialogue. This council will be stood up in 2016, and power sector reform will be an area of focus, thus strengthening opportunities for U.S. exports and enhancing cross-border electricity coordination, including smart grid development.

The 2016 *Smart Grid Top Markets Report* reflected these trends with Mexico jumping in the 2016 rankings to second overall, first in the T&D Equipment sub-sector, and seventh in the Smart Grid ICT sub-sector.

### Opportunities and Challenges for U.S. Companies

#### Opportunities

- The CFE has identified five priority projects in its rollout of the smart grid. Opportunities are available to U.S. firms offering technologies in the following areas: reduction of technical and non-technical losses, enterprise IT and communications architecture, strengthening of the billing system, management of assets, and implementation of GIS.

- An outline of the CFE’s smart grid roadmap has been made available to government entities and industry stakeholders. It creates short and mid-term opportunities for:
  - Smart meters and AMI
  - Demand response
  - Energy storage
  - Microgrids
  - EV pilots
  - SCADA systems
  - Data management
  - Cybersecurity
  - IT services
  - Business Process Management
  - Customer based solutions

#### Challenges

- Standards are a crucial smart grid topic and one that the CFE has not yet addressed. The CFE is currently part of the Smart Grid Interoperability Panel, and numerous efforts are being made by the U.S. Department of Commerce, including the U.S. Commercial Service in Mexico, and U.S. trade associations, such as the National Electrical Manufacturers Association (NEMA), to generate increased awareness. The energy regulator, CRE,
will also be involved in standards development for the smart grid.

➢ In particular, small and medium-sized enterprises (SMEs) find it difficult to obtain financing at reasonable rates despite the Mexican Government’s efforts to increase capital for SMEs.

Know Your Buyer

In order to do business in Mexico, it is crucial to develop and maintain close relationships with clients and partners. Mexicans prefer direct communication, such as telephone calls or face-to-face meetings. U.S. companies should engage CFE early in order to promote the inclusion of their products or services in the utility’s specifications. This can be a lengthy process, as can be the tender process. Companies should be patient and make sure they have sufficient resources to dedicate to these efforts or engage Mexican partners that have experience working with the CFE.

In its new, post-reform role as a productive and competitive state company, CFE’s procurement process has been modified to facilitate direct purchases, less cumbersome tender processes and partnerships with the private sector. The company is open to new technologies and welcomes commercial presentations, which may lead to invitations or specific technology recommendations in tenders.

Mexico’s size and diversity are often under-appreciated by U.S. exporters. It can be difficult to find a single distributor or agent to cover this vast market. A local distributor or partner is recommended to track tender announcements and complete bids. Foreign companies often form consortiums with Mexican vendors to compete in the CFE tenders, benefitting from their partners’ local expertise.

Summary of Resources

• U.S. Department of Commerce Mexico Country Commercial Guide:
  http://www.export.gov/ccg/mexico090857.asp
• Mexico Secretariat of Energy (SENER):
  http://www.energia.gob.mx
• Federal Electricity Commission (CFE):
  http://www.cfe.gob.mx
• Energy Regulatory Commission (CRE):
  http://www.cre.gob.mx
Nigeria

The recent transformation of Nigeria’s power sector, combined with sustained economic growth and increasing electricity demand, is driving opportunities for T&D suppliers to Africa’s most populous nation and places Nigeria fourth in the Top Markets T&D Equipment sub-rankings. Nigeria’s government has thus far been responsive to the need to direct the proceeds from economic growth towards the overhaul of decrepit T&D infrastructure that currently only reaches 50 percent of the population.

The country’s newly-privatized distribution companies are under pressure to modernize their infrastructure and quickly expand power supplies. Financing these projects will be a challenge, but efforts, such as the Power Africa Initiative, have already helped to catalyze international investment in power and grid modernization projects. Significant opportunities in Nigeria’s Smart Grid ICT segment are not anticipated in the near-term, and utility finance and business sector risks limit the potential for many U.S. exporters, keeping Nigeria’s Top Markets ranking at a modest 21st.

Market Overview

Nigeria’s traditionally under-developed power sector is changing rapidly, in terms of structure as efforts to privatize the industry take shape and in terms of the levels of investment supporting the development of new energy supplies and improvements to infrastructure used to meet surging electricity demand and support economic growth. Thermal power supplies dominate Nigeria’s electricity supply mix is dominated by natural gas, which comprises almost 90 percent. Supply disruptions and shortages often result in power outages in a nation where electricity demand growth has averaged 8.5 percent annually over the last three years. Expanding the power supply, modernizing the electricity infrastructure and ensuring that the energy sector is foundational to the nation’s continued economic growth are top priorities for the Federal Government of Nigeria (FGN).

Nigeria has the largest economy in Africa, but well-rounded economic growth is hampered by a low electrification rate (approximately 50 percent of the country), and frequent power outages that cause work stoppages at industrial centers and add uncertainty to the market. The FGN estimates that an additional 26.6 GW of supply will be required to meet electricity demand by 2020.

Additionally, the Government plans to pool $2.6 billion in institutional funding for near-term investment in transmission infrastructure; the projected annual capital expenditure in the distribution sector is set at $370 million. In order to achieve its ambitious goals, the FGN will also have to ensure that investors in the newly privatized electricity sector are able to recover adequate returns and continue to fuel growth.

The structural transformation of Nigeria’s power sector began in 2004 with the National Integrated Power Plan (NIPP), a government-funded initiative to boost and stabilize electricity supplies, followed by the Electric Power Sector Reform Act (EPSRA) of 2005. EPSRA has thus far led to the unbundling of state-owned Power Holding Company of Nigeria (PHCN), a process that officially ended in late 2013 with the establishment of 15 private successor companies (five generation firms and 10 distribution utilities). While transmission remains government-owned, it is estimated that up to $4 billion in funding will be required to upgrade and expand assets in the newly privatized generation and distributions sectors.

The privatization of PHCN has spurred optimism for growth in Nigeria’s power sector. Investors are hoping immediate returns can be reaped from innovations and efficiencies driven by the successor companies. Growth through the transitional phase will depend on access to finance and successful upgrades to ageing infrastructure. Thus, a healthy power sector in Nigeria
will mean robust opportunities for T&D suppliers and service providers in particular.

Policy and Regulatory Environment

The FGN has made the expansion of the power supply and upgrades to T&D infrastructure policy priorities, but the country has many challenges to overcome on the regulatory and finance fronts in order to ensure necessary strong investment growth in the sector. In 2006, the Nigerian Rural Electrification Agency (RER) was set up in order to increase rural and peri-urban access to electricity from the estimated level of 35 percent to 75 percent by 2020. Beginning in 2010, privatization of the power sector became a focus, and recent progress in this effort has led to the allocation of approximately $3.5 billion for transmission investments and the mobilization of public pension funds to support investments across the power sector.

Amid the electricity sector reforms that began in 2005, the Nigerian Electricity Regulatory Commission (NERC) was established as an independent regulator. NERC monitors and regulates the electricity industry, including licensing and compliance for market participants. Over the last few years, NERC has worked to expand gas-fired supplies and issued power generation licenses to 29 independent power producers since 2011.

In 2012, NERC implemented a new Multi-Year Tariff Structure (MYTO) intended to increase electricity rates and help attract further investment to the power sector. The MYTO has gone some ways to correcting policies that severely underpriced electricity in Nigeria at a high-cost to the government and to the detriment of investment in the power network. Today, the agency is focused on establishing a regulatory framework for the development of the renewable resources sector and for the improvement of the efficiency of the grid, including through energy efficiency and demand-side management programs.

Meanwhile, the privatization of generation and distribution has begun to take shape in Nigeria. Since 2013, five generation and 10 distribution companies have been privatized, and 10 newly built plants by Niger Delta Power Holding Company are all privately operated. Contractual obligations in the private generation sector are designed to boost capacity by over 13,000 MW over the next five years. To help achieve these goals, the FGN is focused on sustaining a stable investment climate for private sector participation, expanding T&D networks, maintaining creditworthy off-takers, establishing cost-reflective tariffs and reducing inefficiency of networks.

A major pillar of Nigeria’s efforts to improve the transmission network is the government’s $23.7 million management contract with Manitoba Hydro International Limited (MHI), a Canadian electric utility company. Under MHI’s management, the Transmission Company of Nigeria (TCN) is expected to effectively and reliably transport power from generation companies to distribution companies and eligible customers connected to the national grid. The contract also has the goal to establish local capacity in this area. System collapses and transmission losses have been a frequent issue faced by TCN, and the hope is that this arrangement will reduce this issue.

Market Analysis

Thus far, investor interest in Nigeria’s transformed power sector has been positive, including the U.S.-supported Power Africa Initiative. The initiative,
announced by President Barack Obama in 2013, aims to expand access to power across Sub-Saharan Africa by 2030 through the addition of 60 million new electricity connections and 30,000 megawatts of new and cleaner power generation. Nigeria has been a country of focus since the inception of the Initiative, which provides technical assistance, credit enhancement, financing for independent power producers and other forms of transaction facilitation to support an additional 14,000 MWs of additional capacity in Nigeria alone. The effort also includes a $100 million investment in Nigeria’s gas and power transmission infrastructure through the World Bank’s Nigeria Electricity and Natural Gas Improvement Project. Through the work of Power Africa, over $1 billion has also been mobilized for the newly privatized generation and distribution companies to reduce energy losses, improve operational efficiencies, and expand generation and grid capacity.

A May 2014 U.S. Department of Commerce trade mission to Nigeria, led by Secretary Penny Pritzker with a focus on energy infrastructure, resulted in a number of key power sector deals and has helped to establish a foothold for U.S. T&D and smart grid companies in Nigeria. The Mission concluded with a grant signing by the U.S. Trade and Development Agency for two power generation projects and an electricity distribution modernization plan, all of which have the potential to catalyze nearly half a billion dollars of investment in Nigeria’s energy sector.

Opportunities and Challenges for U.S. Companies

In order to be sustainable, the proceeds from Nigeria’s recent economic growth will need to be directed to grid modernization, and Nigeria’s decision makers have so far proved responsive to this notion. Additionally, major consumers of electricity are also proving willing to invest in distributed energy sources to overcome grid inadequacies. While the health of the financial sector and the wider economy will be major factors, it appears that the massive demand for electricity and upgrades to power infrastructure are currently providing a healthy market for utility equipment suppliers and service providers.

Opportunities

➢ T&D network upgrades and expansion of backbone infrastructure.

➢ Metering, billing and collection software, systems, and solutions, including theft prevention.

➢ Global Information System (GIS) software and platforms, Supervisory Control and Data Acquisition (SCADA) systems, network monitoring and control systems.

➢ Outage management and emergency response solutions.

➢ Smart grid road mapping and strategy services.

Challenges

➢ The cost of lending is high in Nigeria, and recently privatized distribution utilities are under pressure from local investors to provide immediate returns.

➢ Continued economic growth will be required to fund infrastructure projects in Nigeria’s energy sector, and the government will have to remain committed to increasing electricity tariff rates.

➢ Nigeria’s government has begun to push for more protectionist legislation in recent years. Local content requirements and other protectionist policies could limit opportunities to export to Nigeria.

Know Your Buyer

Nigerian purchasers of U.S. smart grid goods and services include generation, transmission and distribution companies. For example, there are 11 distribution companies in Nigeria that maintain a monopoly status within each of their geographical areas.

Summary of Resources


• Power Africa Portal: https://www.usaid.gov/powerafrica

• Power Africa Nigeria: https://www.usaid.gov/powerafrica/nigeria
Saudi Arabia

Saudi Arabia ranks fourth overall in the Smart Grid Top Market Report. U.S. exporters of T&D equipment find increased opportunities in the Middle East’s largest market. An understanding of Saudi Arabia’s electricity policies starts and ends largely by focusing on trends in global oil prices. Proven crude oil and natural gas reserves, as well as generous subsidies, have driven energy demand growth over the last several decades.

Over the last year global oil prices have hit decade lows, creating uncertainty in the electricity market, and affecting investment, policy, and regulatory decisions. Opportunities for U.S. smart grid exporters, however, remain high in Saudi Arabia, with its ranking largely driven by high T&D equipment exports. ITA expects that as regional interconnections and renewable energy deployment plans move forward, interest in implementing smart grid ICT solutions will characterize the market.

Market Overview

The electricity market in Saudi Arabia has grown rapidly for over 20 years – virtually doubling in size since 2000 – with expectations that electricity generation will continue to grow at just over 5 percent annually over the next few years. An additional generation capacity of 2 to 4 GW needs to come on line each year to meet the country’s growing electricity demand. ITA assesses that Saudi Arabia’s aggressive infrastructure expansion program to increase electricity generation, efficient distribution, fuel diversification, and energy conservation will be restrained as oil prices remain low.

That being said, Saudi Arabia remains the biggest power market in the Gulf Cooperation Council (GCC), and spending on infrastructure will need to continue. Opportunities for private sector investment will likely increase as the Saudi Government cannot fund infrastructure projects at the rate it once did. The electricity market is dominated by one firm, Saudi Electricity Company (SEC), with Saudi Government maintaining a majority stake in the firm. The utility generates almost 75 percent of the country’s power, while other producers include the Saline Water Conversion Corporation (SWCC) and Saudi Aramco. The SWCC operates 32 plants that desalinate water and supply electricity, with total annual output of around 2.5 GW of power.

Downstream SEC maintains virtual monopoly status to operate the grid and transmit under the subsidiary National Grid, distribute and sell electricity. The SEC has launched a series of projects to overhaul outdated segments of the power grid and lay the groundwork for a modern transmission and distribution system. There are plans to spend nearly $14.7 billion for the transmission of electricity and $13.7 billion for the distribution of electric power over the next 10 years.

SEC has expanded its transmission network by over 50 percent since 2000. SEC has stated that it expects investments in transmission to reach $80 billion through 2020. The SEC has focused much of its longer-term investment on interconnecting the Kingdom’s transmission network both internally, between the western, central, and southern provinces, and internationally.

The Gulf Cooperation Council Interconnection Authority’s (GCCIA) Interconnection Project includes three phases that connects Saudi Arabia, Bahrain, Kuwait and Qatar via overhead and submarine lines in order to help provide improved aggregate demand and supply over a wider area and meet peak loads in the summer. The project was funded by a handful of sources, where SEC provided almost half the total to connect the GCC states.
Overview of ITA’s Analysis: SAUDI ARABIA

Strengths
- Electricity demand and grid investment growth
- High competitiveness for T&D equipment exports

Key Trends
- Building out of regional interconnections
- Support to modernize the grid to integrate new, anticipated renewable energy deployments

Risks
- Political and economic issues could derail electricity market reform and/or investment

The SEC has also carried out a feasibility study to build a 3 GW underwater interconnection with Egypt to balance daily and seasonal peak loads. There are plans to eventually expand the connection to Europe as to better utilize existing generation capacity during non-peak operating seasons.

Experts estimate that power losses along the distribution system are approximately 9 percent of total output and will slowly drop over the next decade as grid modernization moves forward.12

SEC plans to accelerate its investments in the smart grid, including a significant smart meter roll out across the country. One component of the Kingdom’s smart grid and energy efficiency program was put into place in 2010 when electricity tariffs for industrial and large commercial customers were increased and variable tariffs were introduced to encourage conservation during peak demand hours.

Tariffs increased again in January 2016 for all users as the decline in oil exports has led the Saudi Government to begin reducing subsidies.

In order to implement the new tariff system in the private consumer sector, SEC sees smart meters as a necessary tool for its customers. With a number of pilot projects completed in Riyadh, SEC is now looking to roll out smart meters to the rest of the country. Investment in the distribution system in Saudi Arabia, including smart grid systems, is predicted to reach $24 billion over the next decade.

Policy and Regulatory Environment
The development of Saudi Arabia’s electricity market is overseen by three major government entities: the Electricity and Co-Generation Regulatory Agency (ECRA), King Abdullah City for Atomic and Renewable Energy (KACARE), and the Ministry of Water and Electricity.

ECRA is the independent watchdog and standard setter for the Kingdom’s electricity industry. ECRA assesses tariffs, issues licenses, monitors service providers, investigates complaints, establishes quality of service standards and promotes fair competition among providers and suppliers.

Meanwhile, KACARE drives the integration of clean energy sources in Saudi Arabia and the development of energy efficiency programs and directives.

The Ministry of Water and Electricity (MOWE) is responsible for setting and long-term energy plans and policies for the electricity sector. MOWE also oversees private investment in the water and electricity sectors.

ECRA is in the midst of a comprehensive long-term plan to privatize and deregulate the electricity market, starting with the structural separation of the vertically-integrated electric supplier monopoly, SEC. ECRA has stated its intent to separate and introduce private competition to SEC’s generation, transmission and distribution networks, where there are expectations that the market will be reformed to increase competition in distribution and retail sales. Today, however, competition exists only in the form of Independent Water and Power Plants (IWPP) that compete with SEC in the generation market and that are integrated with its grid.

More broadly, the Saudi government has set a number of goals for the wider energy sector that will likely act as key drivers for investment in the country’s electricity infrastructure and services; these include:
- reductions in the amount of crude and natural gas-fired electricity generation;
• establishment and development of nuclear power;
• integration of solar energy supplies for electricity;
• interconnection of the regional electric grid;
• increased reliability and efficiency of electricity transmission and distribution; and
• the achievement of significant energy efficiency gains among residential, commercial, industrial and government consumers.

The Saudi Government has sought to reduce its dependence on fossil fuels, not out of a need to address climate change but so that it can export more fossil fuels. In 2012, the King Abdullah City for Atomic and Renewable Energy (KACARE) released Saudi Arabia’s National Energy Plan, which noted that the Kingdom would meet its 54 GW goal by developing 16 GW of solar PV, 25 GW of solar thermal and 9 GW of new wind power by 2032. Delays in projects and market uncertainty, however, caused the Saudi Government to push back this target to 2040 as part of its INDC submission to the UNFCCC negotiations in late 2015, which also included goals to reduce its energy intensity between 2005 and 2030 by 30 percent.

MOWE released a new power sector strategy white paper for the Kingdom that forecasted its needs and requirements through 2040. The plan focuses heavily on sustainability, conservation, and planning in order to reduce the energy use, as Saudi Arabia has one of the world’s highest levels of energy and electricity intensity. Its consumption per capita is twice as high as that of Western Europe, and almost double of the United States.

Since Spring 2015, the tanking of global oil prices has led to the government moving forward on unprecedented cuts to gasoline subsidies, and there are indications the government may sell off some of its stake in SEC in order to raise capital. According to the IMF, fossil fuel revenues account for 55 percent of the Saudi Government budget, so the changing oil prices are debilitating the national budget.

Market Analysis

T&D equipment sales to Saudi Arabia outperform U.S. exports in all goods. U.S. T&D equipment exports to Saudi Arabia peaked in 2012 but, since a drop in 2013, have continued to grow year-to-year to $79 million in revenues in 2015. This reflects a five-year CAGR of just over 12 percent.

As the country’s transmission and distribution infrastructure is modernized, commercial and industrial scale consumers will also seek to capitalize on potential energy efficiency gains through investments in smart grid and smart building technologies and services. The market potential for residential and industrial energy efficiency products and services is projected to grow rapidly as a result, and a wide range of opportunities for U.S. companies in the green building and energy efficiency subsectors are expected to open up.

Opportunities and Challenges for U.S. Companies

SEC has become more open to public-private partnerships and private investment in recent years.

Opportunities

 Some of the needed smart grid solutions that have been identified in Saudi Arabia include: system monitoring, outage management, substation automation, synchrophasor technology, wide area network management and distribution automation.
 Working to curb energy demand and preserve domestic fossil fuel resources makes demand response and other energy efficiency programs attractive.
 The goal to achieve a reliable and interconnected transmission network will drive expanded short and medium-term opportunities for high voltage transmission systems and related equipment.

Challenges

 Reduced loss of capital for purchases resulting from a sustained period of low oil prices

Know Your Buyer

Although American exporters are not required to appoint a local Saudi agent or distributor to sell to Saudi companies, ITA strongly recommends that all new-to-market U.S. companies consider partnering with a local company for the purposes of monitoring business opportunities, navigating import and standards testing regulations, and identifying public sector sales opportunities.

Summary of Resources
• U.S. Department of Commerce Saudi Arabia Country Commercial Guide: 
  http://www.export.gov/ccg/saudiarabia090959.asp
• Ministry of Water and Electricity: 
  www.mowe.gov.sa
• Saline Water Conversion Corporation: 
  www.swcc.gov.sa
• Water and Electricity Company (WEC): 
  www.wec.com.sa
• Power and Water Utility Company for Jubail and Yanbu: www.marafiq.com.sa
• Electricity and Cogeneration Regulatory Authority: 
  www.ecra.gov.sa
Turkey's Top Market ranking is bolstered by strong electricity demand growth, public and private sector investment in grid modernization, and steady progress in electricity market reforms. Turkey ranks high among Top Markets in terms of recent electricity demand growth, and it received high marks in the local Commercial Service assessment of the business environment for Smart Grid ICT firms.

U.S. T&D equipment exports to Turkey have continued to grow at a 5 percent CAGR over the last five years peaking in 2015 at over $6 million in revenue. This growth has been largely driven by state divestment of its distribution utilities, which raised $13 billion over three years.

Select utilities in Turkey are investing heavily in smart grid technologies, and a number of U.S. firms have already found success in the market. A major challenge for distribution companies, however, is raising revenue to support new investment, where tariffs are strictly controlled by the government regulator. As a result, maintaining and upgrading the grid, rather than digitalization, remains the priority.

Market Overview

The Turkish power sector is a mix of both public and private entities. A majority of its electricity generation – approximately 65 percent – is provided by independent power producers (IPPs) and other privately owned companies. State-owned Elektrik Uretim AS (EUAS) operates some thermal and large hydroelectric plants and provides the remaining 35 percent of the power generation.

Investment is expected to continue to focus on electricity supply growth, particularly indigenous thermal sources such as coal, nuclear energy, solar, wind and geothermal power. Non-hydro renewable resources currently account for just over 6 percent of generation, but Turkey’s Energy Market Regulatory Authority (EMRA) awarded licenses for 600 MW of solar power and plans to open up the market for another 3,000 MW.

Transmission system operations and maintenance is controlled by the Turkish Electricity Transmission Company (TEIAS), a wholly state-owned company.

Distribution Grids in Turkey are owned by the government but are operated by the private sector on the government’s behalf. There are 21 regional electricity distribution utilities that have been privately owned since 2013.

The Turkish Government privatized all distribution utilities, and Turkey has 21 Electricity Distribution Service Operators (DSOs). Turkish Energy Regulator, EMRA, gives importance to the quality of electricity delivered and approves five year investment plans of DSOs to improve grid infrastructure and introduce smart systems for the purpose of decreasing technical and non-technical losses and black outs. This is particularly relevant to smart grid investment. Given the U.S. quality of innovative solutions, deployment of U.S. technologies in Turkey is expected to be a growing trend. Cyber security will be one of most important areas for DSOs and the national Turkish Electric Transmission Company, TEIAS.

Turkey's strategy for the electricity sector is mainly driven by the objectives of increasing energy security and domestic supplies in order to meet electricity demand growth that is predicted to exceed 5 percent per year over the near and medium-terms.

Grid modernization and distribution efficiency will also be key objectives as Turkey seeks to capitalize on the recent divestments and reduce distribution losses. Nationwide, T&D losses are at an average of 17 percent. While a majority of the utilities have losses less than 10 percent, utilities in eastern and
southeastern Turkey have non-technical losses of 60 percent.

Policy and Regulatory Environment

Beginning in 2011 with the Electricity Market Law, Turkey has remained on a steady course to reform the electricity sector and strengthen the role of the private sector and market forces. As a candidate for the European Union – although already in the European Customs Union – Turkey has liberalized its electricity market. Electricity is now traded by the management of EPIAS on a day-ahead basis.

The Ministry of Energy and Natural Resources (MENR) is responsible for Turkey’s overarching energy policy. The 2015 to 2019 Strategic Plan set important policy objectives for the sector, including a goal of having 30 percent renewable resources by 2023, which includes hydropower. Feed-in tariffs have been in place in Turkey since 2011 and were reformed in order to improve the incentives for renewable resources. Turkey’s tariffs, however, remain low in comparison to many European nations.

Established in 2007, The Energy Efficiency Co-ordination Board (EECB) is responsible for preparing national energy efficiency strategies, plans and programs; monitoring implementation; and assessing effectiveness. The EECB has sought to align Turkey’s energy efficiency policies with those of the European Union’s and has set legally-binding goals to reduce energy intensity by 15 percent by 2020, with a focus on energy-intensive sectors, such as manufacturing, transport and power generation.

Turkey is also launching energy efficiency programs that are being supported by the IFC, World Bank and the ERBD. Privatization of state-owned power plants, mainly gas and coal, has started, and a majority of the major ones completed. EUAS keeps large hydroelectric power plants and will be the PPP partner for nuclear power plants to be built.

Top Markets Analysis

Despite the current economic slowdown in Turkey and around the world, electricity demand has continued its steady growth at 5 percent CAGR and is expected to continue growing in the next decade. As a result, Turkey will need to double its power generation capacity by 2023. ITA expects that smart grid and energy efficiency technologies will likely be important solutions to the country’s electricity infrastructure challenges.

The demand for smart grid technologies among utilities in Turkey is driven largely by the need to decrease electricity distribution losses, increase power quality and reliability, and solve problems encountered in forecasting and balancing markets.

Smart grid and smart meter deployment is developing in Turkey. As such, growth in the Smart Grid ICT Sub-Sector is expected and bolsters Turkey’s ranking to 13th for the sub-sector.

Opportunities and Challenges for U.S. Companies:

Turkey is hoping to achieve investments of over $5 billion a year in the electricity sector through 2020 to support its primary goals of increasing capacity, extending and upgrading grids, increasing network...
efficiency, and integrating and managing new supply sources. Turkish utilities are expected to invest $9.3 billion in grid upgrades and other smart grid investments during the next five years.

Additional prospects are services and products in the following areas:

- Automated meter reading systems
- Renewable resources integration and monitoring systems
- Demand management and reactive power control systems
- Utility IT and communication system upgrades

Although European suppliers have a major presence in Turkey’s electricity sector, U.S. smart grid firms have proved highly competitive in the early stages of market development. The U.S. Commercial Service, in cooperation with U.S. Trade and Development Agency, is extremely active in supporting smart grid exporters in Turkey, including technical and regulatory workshops, feasibility studies and pilot projects.

The smart-grid sector in Turkey often faces some of the following challenges:

- Limited budget allowed by EMRA
- Lack of standards
- Ownership of meters belongs to customers thus limiting the activities of distribution companies

Know Your Buyer
Turkish purchasers of U.S. smart grid goods and services include generation, transmission and distribution companies.

Summary of Resources

- Turkish Energy Market Regulatory Authority (EMRA): http://www.emra.org.tr/
United Kingdom

The United Kingdom has quickly developed into one of the most attractive markets in the world for advanced smart grid technology and applications. Thanks to a highly competitive electricity sector and recent efforts by the government and regulators, the U.K. market offers immense opportunities for innovators in the smart grid ICT segment and is one of the top nations in the world for U.S. firms to do business.

The British Government’s commitment to a nationwide smart meter roll-out by 2020 is a key driver for its Smart Grid ICT Top Markets ranking of third. Additionally, the regulatory framework in the U.K. is well developed to fund smart grid deployments, and a highly competitive market for retail electricity and consumer energy efficiency services exists. With the implementation of electricity market reforms underway, there is now the potential for the U.K. to develop a robust market for demand response and further opportunities for smart grid solutions at the distribution and consumer levels.

Market Overview

Since the mid-80s, the U.K. has been a global trendsetter when it comes to competition and innovation in electricity markets. For the better part of two decades, competition drove down electricity prices and helped to ensure robust energy supplies. Prices, however, have been on the rise for the last ten years. Government pressure on industry to contain costs and improve consumer services has culminated in the launch of a review of the domestic energy market by the U.K. regulator, with results being delayed but expected to be released in mid-2016.

The U.K. electricity sector is dominated by the “Big Six” energy companies – E.ON, RWE npower, Centrica, Scottish and Southern Energy, Scottish Power, and EDF Energy – that generate two thirds of the energy and control 95 percent of the retail market. Electricity prices in the U.K. are solely market-based and remain below those of EU peers, such as Germany and Spain, after taxes. Transmission is unbundled in the U.K., where maintenance, ownership and operations of the high voltage system falls to National Grid in England and Wales, SP Transmission in the South of Scotland, and Scottish Hydro-electric transmission in the North of Scotland.

The U.K. is becoming increasingly concerned over energy security, as existing generation capacity depletes, electricity imports rise, and energy sector investments slow amid political and regulatory uncertainty. The U.K. Government is faced with the challenge of facilitating investment in the electricity sector and achieving carbon reduction goals, all the while containing the rising consumer electricity prices that have become a hot-button political issue. ITA assesses that, as is the case with other European countries, interconnections will play an increasingly more significant role in the near-term.

The U.K. Energy Bill, including the Electricity Market Reform (EMR) bill, passed into law in December 2013 and represents the government’s flagship response to electricity sector challenges. Britain’s electricity market now enters a transitional phase with the potential for major commercial opportunities for energy efficiency, smart grid, and various electricity service providers.

Policy and Regulatory Environment

After more than a year of compromises and revisions from its first reading in November 2012, the U.K. Energy Bill was signed into law in August 2014 and followed by a series of legislative changes focused on improving the implementation. The key objectives affecting the electricity sector include:

- Implementation of EMR to attract GBP 110 billion investment in generation and grid upgrades by 2020;
Overview of ITA’s Analysis: UNITED KINGDOM

Strengths
- Existing regulatory framework facilitates strong funding and returns for smart grid
- Government roadmap in place, and commitment and support remain strong
- U.S. exporters have already proved highly competitive in U.K. electricity sector

Key Trends
- Smart meter procurements have begun, and major roll-out to begin in 2016.
- Electricity market reforms could drive demand response and energy efficiency opportunities

Risks
- Politics continue to threaten policy and investment in broader energy sector
- Potential under-achievement of capacity markets and renewable resources development.
- Consumer smart grid adoption and energy efficiency programs could under-perform

- Safety and security regulations for the nuclear sector to be implemented by the Office for Nuclear Regulation;
- Consumer protections, including limits on energy tariffs, improved transparency of electricity bills, and expansion of third-party consumer electricity services; and
- Increased coordination and strategic alignment between the electricity regulator, the Office of Gas and Electricity Markets (Ofgem), and the U.K. Government, including the Department of Energy & Climate Change (DECC).

Existing regulations in the U.K. already provide healthy support for the smart grid and energy efficiency markets, compared to other European nations. The DECC has set a deployment goal for smart meters at more than 50 million devices (30 million for electric), with regulated roll-out from 2016 moving toward 80 percent of homes having a smart meter by 2020.

Ofgem regulations enable utilities to include smart meters, renewable integration, and consumer energy efficiency program costs in electric bills. Ofgem’s new performance-based RIIO framework (Revenue = Incentives + Innovation + Outputs) will involve setting eight-year price controls, offering incentives to encourage the growth of smart grids.

Taken at face value, the objectives of the Energy Bill should help drive further opportunities for these technologies and services. For example, the government has stated its intent to nearly triple the funding available for low-carbon sources of power, but during 2015, the outlook for additional deployment of onshore wind and solar has diminished as subsidies were cut and regulatory uncertainty increases.43 New provisions for capacity markets in the U.K. are intended to facilitate the development of demand response programs and may stimulate increased investment in interconnections as regional neighbors with excess capacity seek to bid into the U.K. system.

The government’s push for improved billing and energy efficiency services to consumers should open doors for various solutions providers.

In September 2013, DECC established through contract the smart metering Data Communications Company (DCC), an independent entity, which will be responsible for linking all smart electricity and gas meters in homes and small businesses with the systems of energy suppliers, network operators and energy service companies. The DCC is expected to be up and running in 2016. The government has created the Central Delivery Body, which contracts with media companies, consultants and electricity sector experts to support the “brand identity” of the smart metering program and ensure consumer engagement during smart grid roll-out and operations.

DECC and Ofgem created the public-private Smart Grid Forum to develop a roadmap and vision for the nation’s smart grid. The U.K. smart grid program is the most well-publicized and transparent project of its kind in any market. A wealth of information is available through DECC’s Website, and the annual reports on the Smart Metering Implementation Programme are highly informative.

In March 2016 the National Infrastructure Commission has published its report on balancing energy demand and supply. The key finding was that the U.K. smart power system should be achieved through three innovations: interconnection, storage and demand
flexibility. The recommendations of the reports have been accepted within the HMG 2016 Budget.

Top Markets Analysis

The recent follow-through on government commitments to deploy smart grid technologies in the U.K. supports the market’s ranking for near-term smart grid ICT export opportunities.

U.S. manufacturers have already garnered success in the United Kingdom. In October 2012, U.S. Commercial Service representatives held a Smart Grid Trade Mission in the U.K. that resulted in over $40 million in export success for U.S. companies.

U.S. T&D equipment exports to the United Kingdom have grown at a 15 percent CAGR over the last five years to $66 million in revenues in 2015. This makes it the fourth biggest global market for U.S. manufacturers in the sector.

Opportunities and Challenges for U.S. Companies

Despite a delay to the national smart meter roll-out and lingering uncertainties over the implementation of the EMR, the U.K. smart grid market continues to develop and provide opportunities for U.S. exporters. The U.K. DECC’s assessment of future challenges to the electricity market cites the near-term need for “balancing technologies”, including:

- demand-side response (DSR) platforms and programs;
- electricity storage systems;
- network interconnections for increased access to bulk supplies across international borders and distributed generation at the local level;
- distribution automation technologies; and
- consumer engagement and energy efficiency programs to support the development of DSR and achieve customer-oriented objectives of the Energy Bill.

It is also important to note that meeting electricity supply challenges in the U.K. will likely create opportunities for vendors in the more traditional T&D equipment segments as well. Ofgem estimates that the U.K. will need approximately $200 billion of investment in new infrastructure, such as new transformers and cabling, by 2020. Additionally, DECC’s Community Energy Strategy, which foresees an additional 1 million homes with distributed energy by 2020, could be a driver of future opportunities for microgrid equipment and services.

There are also a number of risk factors that could limit the great potential of the U.K. smart grid market and U.S. exporter opportunities. Implementation of the Energy Bill has already been highly politicized, and electricity market reforms could under-achieve as a result. Additionally, many stakeholders – including consumer groups – are skeptical of the value of smart grid technologies and have raised privacy and cyber security concerns. The need to solve these issues in the United Kingdom may, in fact, create more opportunities for smart grid firms, but U.S. exporters will face top vendors from across Europe in one of the world’s most promising and competitive electricity services markets.

Know Your Buyer

United Kingdom purchasers of U.S. smart grid goods and services include generation, transmission, and distribution companies. This includes transmission networks operators such as National Grid, Scottish Power Transmission, Scottish Hydro Electric Transmission and Northern Ireland Electricity, as well as distribution networks operators such as Electricity North West, Northern Ireland Electricity, Northern PowerGrid, SP Energy Networks, SSE Power Distribution, U.K. Power Networks and Western Power Distribution.

Summary of Resources

- U.K. Office of Gas and Electricity Markets: https://www.ofgem.gov.uk/
- Data Communications Company: https://www.smartdcc.co.uk/
Addendum: Resources for U.S. Exporters

The U.S. Government has numerous resources available to help U.S. exporters: from additional market research, to guides to export financing, to overseas trade missions, to staff around the country and the world. A few key resources are highlighted below. For additional information about services from the International Trade Administration (ITA), please visit www.export.gov.

http://export.gov/reee/
This online portal provides a one-stop shop for RE&EE exporters – including T&D equipment, smart grid ICT, and energy storage – to connect to news, events, and market intelligence resources from U.S. Government agencies under the National Export Initiative. RE&EE exporters can also sign up to receive a quarterly e-newsletter. Additionally, the portal includes the latest information from the Department of Commerce's Renewable Energy and Energy Efficiency Advisory Committee, a Federal Advisory committee that advises the Secretary regarding the development and administration of programs and policies to expand the competitiveness of U.S. exports of RE&EE goods and services.

Country Commercial Guides
http://export.gov/ccg/
Written by U.S. Embassy trade experts worldwide, the Country Commercial Guides provide an excellent starting point for what you need to know about exporting and doing business in a foreign market. The reports include sections addressing: market overview, challenges, opportunities, and entry strategies; political environment; selling U.S. products and services; trade regulations, customs, and standards; and much more.

Basic Guide to Exporting
http://export.gov/basicguide/
A Basic Guide to Exporting addresses virtually every issue a company looking to export might face. Numerous sections, charts, lists and definitions throughout the book’s 19 chapters provide in-depth information and solid advice about the key activities and issues relevant to any prospective exporter.

Trade Finance Guide: A Quick Reference for U.S. Exporters
http://www.export.gov/tradefinanceguide/index.asp
Trade Finance Guide: A Quick Reference for U.S. Exporters is designed to help U.S. companies, especially small and medium-sized enterprises, learn the basics of trade finance so that they can turn their export opportunities into actual sales and achieve the ultimate goal of getting paid on time for those sales. Concise, two-page chapters offer the basics of numerous financing techniques, from open accounts to forfaiting and government assisted foreign-buyer financing.

Trade Missions http://www.export.gov/trademissions/
Department of Commerce trade missions are overseas programs for U.S. firms that wish to explore and pursue export opportunities by meeting directly with potential clients in local markets. Trade missions include, among other activities, one-on-one meetings with foreign industry executives and government officials that are pre-screened to match specific business objectives.

Certified Trade Fairs
http://www.export.gov/eac/show_short_trade_events.asp?CountryName=null&StateName=null&IndustryName=null&TypeName=International%20Trade%20Fair&StartDate=null&EndDate=null
The Department of Commerce's trade fair certification program endorses overseas trade shows that are reliable venues and good markets for U.S. firms to sell their products and services abroad. These shows serve as vital access vehicles for U.S. firms to enter and expand into foreign markets. The certified show/U.S. pavilion ensures a high-quality, multi-faceted opportunity for American companies to successfully market overseas. Among other benefits, certified trade fairs provide U.S. exhibitors with help facilitating contacts, market information, counseling and other services to enhance their marketing efforts.

Upcoming certified trade fairs include:
- Power-GEN Asia; Seoul, Korea September 20-22, 2016
- European Utility Week; Barcelona, Spain November 15-17, 2016

International Buyer Program
http://export.gov/ibp/
The International Buyer Program (IBP) brings thousands of international buyers to the United States for business-to-business matchmaking with U.S. firms exhibiting at major industry trade shows. Every year, the International Buyer Program results in millions of dollars in new business for U.S. companies by bringing pre-screened international buyers, representatives and distributors to selected shows. U.S. country and industry experts are on site at IBP shows to provide hands-on export counseling, market analysis, and matchmaking services. Each IBP show also has an International Business Center where U.S. companies can meet privately with prospective international buyers, prospective sales representatives, and business partners and obtain assistance from experienced ITA staff.

The Advocacy Center
http://www.export.gov/advocacy/
The Advocacy Center coordinates U.S. government interagency advocacy efforts on behalf of U.S. exporters that are bidding on public-sector contracts with overseas governments and government agencies. The Advocacy Center helps to ensure that sales of U.S. products and services have the best possible chance competing abroad. Advocacy assistance is wide and varied but often involves companies that want the U.S. Government to communicate a message to foreign governments or government-owned corporations on behalf of their commercial interest, typically in a competitive bid contest.

Global Energy Team
http://www.export.gov/industry/energy/index.asp
The Global Energy Team is a network of global energy specialists that draws on experiences across the U.S. Commercial Service, Foreign Commercial Services, and Department of Commerce headquartered industry analysts. The team provides on upcoming events, trade leads, and market research.

U.S. Commercial Service
http://www.export.gov/usoffices/index.asp
With offices throughout the United States and in U.S. Embassies and consulates in nearly 80 countries, the U.S. Commercial Service utilizes its global network of trade professionals to connect U.S. companies with international buyers worldwide. Whether looking to make their first export sale or expand to additional international markets, companies will find the expertise they need to tap into lucrative opportunities and increase their bottom line. This includes trade counseling, actionable market intelligence, business matchmaking, and commercial diplomacy.
Appendix A: Methodology

Score Categories and Weighting

The Smart Grid Top Markets methodology integrates data and information on global markets and trade, including the critical contributions of commercial specialists from U.S. Foreign Commercial Service posts in every nation ranked in the report. The resulting data and analyses are combined using a weighted scorecard methodology to produce relative rankings of the 34 subject markets – an expansion of two additional markets, Israel and New Zealand, from the 2015 Smart Grid Top Markets Report.

Each scorecard is based on quantitative and qualitative analysis that integrates data and information on key smart grid export market drivers, based on four category scores:

1. Smart Grid Market Growth Potential Score
2. Trade Factors and U.S. Competitiveness Score
3. Key Economic and Energy Sector Investment Indicators Score
4. Strength of Domestic Industry Score

Weighing of categories 1 and 2 varied for the three reported sector and sub-sector rankings. No modifications to the weighing were made in the 2016 report. The weighing was as follows:

OVERALL RANKING
1. Smart Grid Market Growth Potential Score: 40%
2. Trade Factors and U.S. Competitiveness Score: 30%
3. Key Economic and Energy Sector Investment Indicators Score: 20%
4. Strength of Domestic Industry Score: 10%

T&D EQUIPMENT SUB-SECTOR RANKING
1. Smart Grid Market Growth Potential Score: 0%
2. Trade Factors and U.S. Competitiveness Score: 70%
3. Key Economic and Energy Sector Investment Indicators Score: 20%
4. Strength of Domestic Industry Score: 10%

SMART GRID ICT SUB-SECTOR RANKING
1. Smart Grid Market Growth Potential Score: 70%
2. Trade Factors and U.S. Competitiveness Score: 0%
3. Key Economic and Energy Sector Investment Indicators Score: 20%
4. Strength of Domestic Industry Score: 10%

The following sections provide in-depth detail and reference data for each of the above components to the scorecard.

1. Smart Grid Market Growth Potential Score

The development of the smart grid in a given market is dependent on a range of factors that can be impacted by policy, regulatory, investment, electricity industry, consumer, and/or wider economic and business environment. In order to quantify the potential for export growth in a given market, ITA developed a scoring system to quantify market potential across smart grid market drivers and factors impacting the U.S. smart grid industry competitiveness in a given market. This component of the Top Markets analysis focuses on the market potential for exporters of Integrated ICT and Services in particular and includes the critical contributions of smart grid commercial specialists from the Foreign Commercial Service Post in every nation ranked in the report. No modifications to the criteria were made for the 2016 Smart Grid Top Markets Report.
Figure A1: Summary of ITA Smart Grid Market Development Country Score Criteria

<table>
<thead>
<tr>
<th>Driver [Share of Score]</th>
<th>Criteria</th>
<th>Example of Driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Commitment [10%]</td>
<td>Has the government developed ambitious smart grid deployment targets and a strategic plan to achieve them? Is the government likely to follow-through on this plan and achieve these targets?</td>
<td>Smart Grid Road Maps, published cost benefit analysis, and government leadership to coordinate standards and interoperability are examples of government objectives and strategic planning. A country’s record at meeting deployment or spending objectives is an example of evidence for follow-through.</td>
</tr>
<tr>
<td>Energy Policy Drivers [10%]</td>
<td>Are the country's policy and market objectives for the wider energy sector helping to drive deployment of the smart grid?</td>
<td>Carbon reduction, renewable integration, and increased energy efficiency are examples of wider energy sector policy objectives that would help drive the deployment of the smart grid.</td>
</tr>
<tr>
<td>Regulatory Drivers [10%]</td>
<td>Do regulations in the electricity sector incentivize or directly support smart grid investment or development by utilities or other stakeholders?</td>
<td>Regulatory frameworks that enable demand response, de-coupled markets, or energy efficiency programs would be supportive of the smart grid.</td>
</tr>
<tr>
<td>Grid Investment and Electricity Market Activity [10%]</td>
<td>Are utilities and other smart grid stakeholders investing in the modernization of the grid and smart grid solutions?</td>
<td>Market data and other factors, including the finance environment for utilities, provide a measure of grid investment in a given market.</td>
</tr>
<tr>
<td>Additional Smart Grid Drivers or Barriers [10%]</td>
<td>Are there other factors either supporting or hampering smart grid development in the market?</td>
<td>The adoption of energy storage, electric vehicles, and various green building technologies are examples of other drivers. Resistance to smart grid by consumers or other stakeholders is an example of a barrier.</td>
</tr>
<tr>
<td>Smart Grid Business Environment and U.S. Competitiveness [10%]</td>
<td>Does local competition or other business environment factors impact the export potential of U.S. smart grid products and services in the market?</td>
<td>Inter-agency experience working with the country on smart grid issues is considered in this component.</td>
</tr>
<tr>
<td>Local Assessment of Smart Grid Market and Commercial Potential for U.S. Exporters [40%]</td>
<td>Based on U.S. &amp; Foreign Commercial Service specialists’ assessment of market maturity (10%), government and regulator efforts (10%), public awareness (10%), and U.S company interest and export success (10%) in the subject smart grid market.</td>
<td>The survey also provides an on-the-ground analysis of various policies and drivers that is included in all other assessment categories above.</td>
</tr>
</tbody>
</table>
2. **Trade Factors & U.S. Competiveness Score**

The *Smart Grid Top Markets Report* seeks to quantify the discrete opportunity for U.S. manufacturers of T&D equipment. In order to estimate U.S. export growth potential to a given market, this category score incorporates existing trade data, along with an analysis of additional market factors that will impact growth potential.

In the 2015 *Smart Grid Top Market Report*, T&D equipment exports were forecasted based on a linear regression trend line fitting 2009 through 2013 actual trade data. The 2015 forecasted data from the 2015 *Smart Grid Top Markets Report* for U.S. global exports was overestimated by approximately 10 percent, while individual country predictions for each of the studied countries reflected overestimations of data as large as 54 percent. Although the forecast overestimated U.S. exports as frequently as it did underestimate exports, the percentage deviation in the underestimations was significantly larger in more cases, as highlighted by a 4,500 percent underestimation for Spain (or $3.6 million in export revenues). Other underestimations larger than 100 percent of the total revenues included Denmark and Sweden. As a result, ITA modified the methodology for this category scoring for the 2016 Smart Grid Top Market Report.

In the 2016 *Smart Grid Top Market Report*, the methodology for the Trade Factors and U.S. Competitiveness category was modified from the 2015 Report to an equal weighting among the following three normalized values: total absolute export value from the previous year (2015), recent absolute growth in total U.S. exports (2013-2015), and BMI’s projected electricity consumption annual growth percentage (2015-2020).

### Figure A2: Top U.S. Export Destinations (2015), T&D Equipment Revenues ($ Millions)

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WORLD</td>
<td>$1,962.59</td>
<td>$2,264.20</td>
<td>$2,293.09</td>
<td>$2,058.91</td>
<td>$1,984.73</td>
<td>9.14%</td>
</tr>
<tr>
<td>Canada</td>
<td>$614.64</td>
<td>$748.36</td>
<td>$690.99</td>
<td>$639.20</td>
<td>$556.44</td>
<td>9.70%</td>
</tr>
<tr>
<td>Mexico</td>
<td>$206.87</td>
<td>$196.10</td>
<td>$217.72</td>
<td>$221.65</td>
<td>$326.97</td>
<td>9.65%</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>$47.17</td>
<td>$89.09</td>
<td>$73.50</td>
<td>$79.34</td>
<td>$78.71</td>
<td>14.87%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>$39.26</td>
<td>$45.61</td>
<td>$60.05</td>
<td>$73.43</td>
<td>$66.20</td>
<td>11.95%</td>
</tr>
<tr>
<td>Korea</td>
<td>$45.70</td>
<td>$68.91</td>
<td>$48.76</td>
<td>$59.88</td>
<td>$65.73</td>
<td>12.72%</td>
</tr>
<tr>
<td>Venezuela</td>
<td>$68.72</td>
<td>$49.48</td>
<td>$47.63</td>
<td>$53.41</td>
<td>$57.58</td>
<td>18.56%</td>
</tr>
<tr>
<td>Norway</td>
<td>$8.76</td>
<td>$17.42</td>
<td>$26.80</td>
<td>$38.45</td>
<td>$57.24</td>
<td>35.01%</td>
</tr>
<tr>
<td>China</td>
<td>$83.06</td>
<td>$73.65</td>
<td>$78.07</td>
<td>$66.19</td>
<td>$53.99</td>
<td>5.85%</td>
</tr>
<tr>
<td>Brazil</td>
<td>$34.48</td>
<td>$45.62</td>
<td>$94.83</td>
<td>$47.92</td>
<td>$40.83</td>
<td>14.67%</td>
</tr>
<tr>
<td>Japan</td>
<td>$68.16</td>
<td>$86.85</td>
<td>$73.88</td>
<td>$38.29</td>
<td>$38.42</td>
<td>7.58%</td>
</tr>
<tr>
<td>Singapore</td>
<td>$32.93</td>
<td>$35.90</td>
<td>$65.02</td>
<td>$38.14</td>
<td>$38.21</td>
<td>16.58%</td>
</tr>
<tr>
<td>Colombia</td>
<td>$44.12</td>
<td>$52.05</td>
<td>$50.06</td>
<td>$44.20</td>
<td>$32.11</td>
<td>10.42%</td>
</tr>
<tr>
<td>Ecuador</td>
<td>$51.79</td>
<td>$45.28</td>
<td>$63.92</td>
<td>$50.35</td>
<td>$31.82</td>
<td>25.58%</td>
</tr>
<tr>
<td>Germany</td>
<td>$18.40</td>
<td>$24.79</td>
<td>$26.67</td>
<td>$31.47</td>
<td>$27.48</td>
<td>8.16%</td>
</tr>
<tr>
<td>UAE</td>
<td>$18.82</td>
<td>$26.12</td>
<td>$39.92</td>
<td>$27.70</td>
<td>$25.89</td>
<td>17.30%</td>
</tr>
<tr>
<td>Australia</td>
<td>$33.57</td>
<td>$36.82</td>
<td>$34.03</td>
<td>$25.01</td>
<td>$24.94</td>
<td>4.72%</td>
</tr>
<tr>
<td>Philippines</td>
<td>$19.76</td>
<td>$18.50</td>
<td>$19.47</td>
<td>$28.07</td>
<td>$23.30</td>
<td>6.85%</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>$31.83</td>
<td>$27.73</td>
<td>$28.14</td>
<td>$21.98</td>
<td>$18.54</td>
<td>-0.08%</td>
</tr>
<tr>
<td>Peru</td>
<td>$18.93</td>
<td>$17.49</td>
<td>$14.66</td>
<td>$20.31</td>
<td>$18.24</td>
<td>23.10%</td>
</tr>
<tr>
<td>Dominican Rep.</td>
<td>$20.26</td>
<td>$18.44</td>
<td>$7.43</td>
<td>$10.71</td>
<td>$17.32</td>
<td>9.82%</td>
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The resulting category score and ranking is a relative measure of a market’s potential for absolute near-term growth in U.S. exports of T&D equipment.

Figure A2 provides historical data on the top 20 U.S. export destinations for T&D equipment manufacturers in 2015, including total exports ("World"). ITA’s data trend analysis informs about near-term project exports and the development of relativized country rankings and scores based on these projections.

Figure A3 demonstrates the link between a market’s total T&D equipment import revenue size (x-axis), the percentage of total imports met by U.S. suppliers (y-axis), and the value of the U.S. imports (size of bubble). Values are estimated from U.N. data from 2014.
Figure A4: Top 15 U.S. Export Destinations, 2015

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<td>Canada</td>
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<td>15 Australia</td>
<td>1.7%</td>
<td>United Arab Emirates</td>
<td>1.3%</td>
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The trade data trend analysis is supplemented by an Electricity Consumption Trend score drawing on Business Monitor International (BMI) electricity consumption predictions. This score quantifies potential growth in T&D infrastructure investment driven by a nation’s recent electricity consumption trends, while taking into account various market factors, including national policy, finance, and other economic factors, that could potentially drive or hamper the build-out of T&D infrastructure.

3. Key Economic and Energy Sector Investment Indicators Score

In order to incorporate broader economic and investment data that could impact the growth of smart grid markets, this top markets report utilizes Business Monitor International's (BMI) Power Risk/Reward Rating of major international electricity markets. According to its stated methodology and illustrated in Figure A4, BMI’s score “considers a thorough and all-encompassing range of factors that affect the investment climate in the electricity sector.” Because smart grid development and deployment depends on these wider factors – including the health of the electricity sector, the overall investment climate and even the national economy – BMI’s score is a valuable addition to ITA’s analysis. Scores were accessed on December 21, 2015.

It is worth noting that in 2016, a handful of countries saw significant decreases in their power sector risk/reward index by BMI. Brazil (-14%), Russia (-12 %) and China (-11%) all dropped in ratings by more than 10 percent. On the other hand, Portugal (8%), India (7%), the Philippines (6%), the Netherlands (6%) and Spain (6%) experienced the largest positive net increases. Overall, 19 countries experienced decreases in ratings, five experienced no change and eight experienced increases in overall rating. New Zealand's rating was available for the first time.
### Figure A5: BMI Power Risk/Reward Ratings Methodology

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<td>Electricity generation, GWh, 5-year average</td>
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<td>Electricity generation, %</td>
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<td>Electricity consumption, GWh</td>
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<tr>
<td>Electricity consumption, %</td>
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<tr>
<td>Access to electricity, % of population</td>
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<tr>
<td><strong>Country Rewards</strong></td>
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<td>GDP per capita, %, 5-year average</td>
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<tr>
<td>Population, % change</td>
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<td>Electricity import dependence</td>
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<td><strong>Industry Risks</strong></td>
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<td>Transparency of tendering process</td>
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<tr>
<td><strong>Country Risks</strong></td>
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<tr>
<td>Corruption</td>
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</table>

4. **Strength of Domestic Industry Score**

The fourth component of the Smart Grid Top Markets analysis integrates data on the share of the market for electricity sector technologies that will be met by imports. This score is based on the analysis produced by Purdue University’s Global Trade Analysis Project (GTAP), which estimates the share of commodities that various industries procure from foreign vs. domestic markets. GTAP’s “import share” analysis includes an estimate of the electronic equipment and machinery that the electricity sector in a given market procures for its operations. While this category includes a range of equipment purchased in the electricity sector, it does provide a useful proxy – at a national level – of utility reliance on imports to meet its technology needs.

The Import Potential Score supplements ITA’s trade data analysis and provides a proxy data point for the potential demand in a market’s electric utility sector for a range of technologies, including some smart grid technologies. The Import Potential Score positively impacts Top Markets scores for countries that are more likely to import growing and evolving smart grid technologies.

GTAP data is updated on a five year cycle and was, therefore, not updated for the 2016 Smart Grid Top Market Report publication relative to 2015’s.
## Appendix B: Year-to-year Report Ranking Comparison

**Figure B1: Smart Grid Top Market Report Rankings Comparison, 2015-2016**

### Overall

<table>
<thead>
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### Figure B2: Smart Grid Top Market Report Rankings Comparison, 2015-2016

**T&D Sub-Sector**

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Figure B3: Smart Grid Top Market Report Rankings Comparison, 2015-2016, Smart Grid ICT Sub-Sector

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Appendix C: Citations

1. U.S. Census Trade Data via the Trade Policy Information System of the U.S. Department of Commerce: International Trade Administration.
17. U.S. Census Trade Data via the Trade Policy Information System of the U.S. Department of Commerce: International Trade Administration.
27. Smart Grid Today, Kepco regulation reaches 56 MW with 2 new Kokam systems, 7 March 2016
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