SECTOR FOCUS 5

Energy

Reliable and affordable access to electricity services is fundamental to achieving the World Bank Group's twin goals: shared prosperity and elimination of extreme poverty by 2030. Efforts to meet the Agenda 2030 Sustainable Development Goal to "ensure access to affordable, reliable, sustainable, and modern energy for all" will also require increased investment, new and refined technologies and systems, and institutional reform. To help the world achieve this energy transformation, the effective use of information and communication technology (ICT), including data and advanced analytics, is already playing an essential role.

Changing energy business models with ICT

Providing electricity to the approximately 1 billion people without access to affordable and sustainable electricity services presents an enormous challenge and opportunity.[1] In Sub-Saharan Africa, only 14 percent of people have access to grid electricity; however, nearly 70 percent now have access to mobile phones.[2] By the end of the decade, it is estimated that nearly 930 million people in Africa will own a mobile phone,[3] creating not only a huge demand for phone charging, but facilitating a variety of energy and other services through the use of mobile phones.

A potential symbiotic relationship therefore exists between the development of information and communication technologies and increasing energy access in Africa and other low-access areas. As an example, cell towers require a local power supply, but in many rural areas the surrounding communities lack access to electricity. Energy service companies in many parts of Africa have been oversizing the energy generation unit of the tower and providing local consumers with access to electricity. The Mobile for Development program of the Groupe Speciale Mobile Association (GSMA) explores such opportunities.[4]

To address some of the financing challenges of rural energy services, companies in Africa and South Asia are leveraging ICT and sensors utilizing cellular networks through various financing models.[5] For example, in the same value chain all the way from electricity distribution to maintenance, ICT is being deployed through short message service (SMS) or voice interaction with clients to collect and analyze mobile data, facilitate mobile payment systems, and utilize applications that are increasingly enabled by the internet. These innovative products and services are facilitating a significant increase in energy access globally. In East Africa alone, they have reached 14 million people in six years. The average annual market growth is 140 percent, according to market research by the World Bank Group's Lighting Africa Initiative.[6]

In East Africa, falling costs of ICT and efficient appliances have enabled off-grid photovoltaic (PV) systems to provide more energy services at a lower price. Instead of relying on traditional means of collecting payments (with high transaction costs and losses), electricity bills can now be paid by cellphone through mobile money services such as M-Pesa. This approach also generates large amounts of data on mobile money transfers, and has helped to establish credit histories for a previously underserved segment of the population. Energy supply companies combine financial information with geographic and census

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data to identify new markets and to differentiate customers based on varying levels of service, thus allowing them to tailor the service to the customer's ability to pay.

ICTs have also been deployed to reduce risks for suppliers and to facilitate after-sales service by tagging energy systems (such as solar PV panels and batteries) with sensors so that they can be tracked as they pass through distributors and are sold and installed. The sensors capture remote real-time data about the equipment, enabling the provider to monitor performance and offer maintenance support. Companies like M-Kopa and Off Grid Electric in East Africa have call center agents that resolve most payment or service-related queries, while remaining service issues are addressed by a fleet of technicians on motorcycles who are radio-dispatched.

ICT, the smart grid, and demand management

Improved real-time information and automated controls are increasing the efficiency of the electricity grid all over the world. The "smart grid"—which has come to define a broad range of sensors, meters, and controls enabled by information technology (IT), as well as large-scale and real-time data collection—can enhance the operational efficiency of the electricity system by optimizing energy transactions.[7] The integration of ICT into the grid can improve system security through more rapid analysis of service interruptions and prediction of outages. Connected devices and software offer customers access to real-time data to help them manage their energy usage more effectively, while advanced meters and automatic controls provide opportunities for energy efficiency, such as automatic dimming of street lights, or turning off lights or air conditioning in unoccupied rooms and buildings.

Potentially one of the most revolutionary internet-based innovations in the electricity sector is the ability to adjust consumer demand by providing new signals and transparency. "Demand response" allows electricity consumption to be reduced during peak periods based on agreed-upon reductions in power supply. For example, consumers agree to minor reductions in air-conditioning demand during summer peaks in exchange for a rate cut. This helps increase system reliability, reduce energy supply costs, and lower generation investments due to the reduced need for operational reserves. The International Energy Agency (IEA) estimates the savings potential for demand response programs in competitive markets at 15 to 20 percent of peak demand.[8] So far, such systems have been introduced largely in advanced economies of the Organisation for Economic Co-operation and Development (OECD) and emerging economies. But the development of low-cost sensors that will increasingly be factory-installed in all electrical appliances (televisions, refrigerators, fans, air conditioners) will allow both the monitoring and control of electricity use by consumers and electricity suppliers.[9]

One of the biggest challenges for the power sector of the future is the need to "balance" electricity generation and load on a particular grid. The growth of variable renewable energy is creating new challenges for planners and power system operators, who must rely on other sources of supply when the sun goes down or the wind stops blowing. Predicting such variations in energy production is challenging. In combination with (more predictable) demand variations, it can lead to deviations in power frequency and power system reliability issues, and increase the need for grid balancing assets, such as fast-ramping gas power plants or electric storage.[10] Research by the IEA shows that renewable energy costs can be reduced significantly through new forecasting and digital technologies that can help balance generation and load by monitoring and predicting the supply of variable energy resources.[11] In countries and regions with growing shares of renewable energy such as California, Denmark, and Germany, electricity markets are now designed to match supply and demand on a minute-by-minute basis through sophisticated auctions, regulatory mechanisms, and control systems that rely on the internet.[12]

Energy, open data, and the internet

Having high-quality, easily accessible information on energy resources, demand, and usage is crucial to supporting the formulation of government policies, and can be a catalyst for commercial investment. Just as the existence of high-quality geological data is an imperative for fossil fuel licensing and exploration, publicly available data on renewable energy resources is one of the first steps a country can take to encourage investment. ICT facilitates this resource assessment and mapping through the use of supercomputers to analyze years of historical meteorological and satellite data, by facilitating the transmission of measurement data from field-based instruments, and by supporting the wide dissemination of outputs through open data platforms.

A recent trend in the United States is the provision of anonymous energy use and performance data that can support energy efficiency markets and services.[13] The industry-led Green Button Initiative in the United States is another voluntary industry data standard for utilities and companies; it allows consumers to make their energy consumption data available to service providers, which can help consumers lower their energy bills or "green" their energy supply through home energy efficiency solutions or the design and financing of renewable energy equipment. Since 2012, more than 50 utilities and electricity suppliers have signed on to the initiative, providing over 60 million homes access to their detailed energy use data.[14] In India, a pilot project launched by Prayas Energy Group, a nongovernment organization, has installed around 100 devices in volunteers' homes to measure the availability and quality of electricity on a continuous basis.[15] The results provide a potentially powerful, crowdsourced flow of information that can help consumers understand the causes and impacts of power shortages, and can help policy makers and utility companies prioritize power system investments.

Given the rapid growth of the ICT industry, there has been an increased focus on how much energy the sector uses. Recent estimates of energy use by ICT—split almost equally into energy use by communication networks, computers, and data centers—show that the sector accounts for between 3 and 4 percent of total global electricity consumption, and that energy consumption increased around 7 percent per year between 2007 and 2012.[16] While a breakdown of how much of this increased demand came from developing countries is not readily available, this share is likely significant, as more than 750 million new users have been added in China and India alone since 2000. There are many ways to reduce the energy use from the ICT industry, including moving to faster systems. For example, 2G networks (which are common in developing countries) require over 400 kilowatt-hours (kWh) of electricity per year to deliver 12 gigabytes (GB) of data (1 GB per month), while a 3G network consumes less than one-tenth that amount (35 kWh), and a 4G network uses one-sixtieth (7 kWh).[17] In addition, the industry is exploring new technologies, including microtracing—a new, leaner technology for fiber access that uses less energy. However, many of these gains are offset by ever rising volumes of data.

While it is too early to judge the overall impact of digital technologies on the energy sector, especially in developing countries, it is clear that many of the trends described above will continue to affect energy consumers and suppliers. Ensuring that benefits and synergies are maximized will be critical to meeting the sustainable energy goals of the World Bank's client countries.

Notes

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2. Ericsson 2014.
3. Ericsson 2014.
4. GSMA 2015.
5. Vogt 2015.
6. http://www.lightingafrica.org.
7. MITei 2014.
8. IEA 2014.
9. Spijker 2014.
10. Martinez-Romero and Hughes 2015. *Power frequency* refers to the frequency of oscillations of alternating current in a power grid.
11. IEA 2014.
12. Martinot 2015.
13. U.S. Department of Energy, "Open Energy Data."
14. U.S. Department of Energy, "Green Button."
15. Prayas Energy Group.
16. TREND Consortium Partners 2014.
17. Koomey 2013.

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