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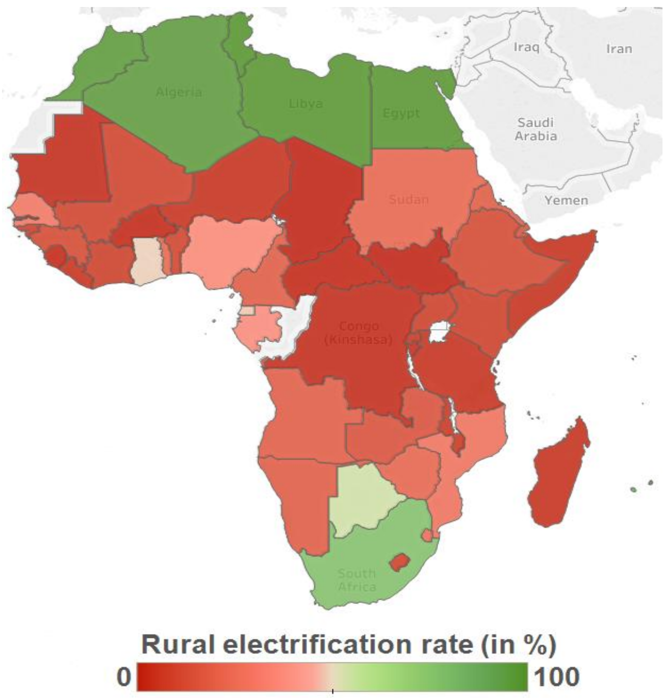
ENERGY STORAGE: BUSINESS SOLUTIONS FOR EMERGING MARKETS

With the application of new storage capacity technologies, advances in the capabilities of energy networks promise to deliver not only efficiency and productivity gains but also business opportunities for remote areas in emerging countries. New technologies, including those in the fields of batteries and off-grid solutions, can potentially change the way electricity is delivered to rural and remote households, and can also supply businesses and infrastructure with energy. Communication and service delivery options can be boosted with access to information technology infrastructure. Such access is required to bridge the "digital divide" and realize the potential of digital services in low-income countries or frontier markets.

Information and communications technology, or ICT, is critical in today's global economy as education, work, and information are increasingly disseminated over digital platforms. Access to ICT contributes to economic growth and promotes new and innovative industries.

Individuals and organizations with access to digital services enjoy a distinct economic advantage over populations that lack it. This gap, often referred to as the digital divide, has been a subject of intense focus in efforts to develop and support emerging markets.[1]

Figure 1: Rural Access to Electricity in Africa (2013)



Source: Data from World Energy Outlook 2015, International Energy Agency; illustration by IFC Thought Leadership, 2016.

Large technology companies have also launched efforts to bring internet connectivity to rural areas of emerging market nations. For example, Google's Project Loon[2] and Facebook's Project Aquila[3] seek to provide internet access via weather balloons and solar-powered aircraft. Microsoft's White Space project[4] seeks to utilize unused frequency bands of the television spectrum for internet connectivity.

According to a McKinsey Global Institute report, increasing internet access in Africa could transform sectors as diverse as agriculture, retail, and health care, and contribute as much as $300 billion per year to Africa's GDP within 10 years.[5] The 2016 World Development Report demonstrates that increased access to ICT in developing regions contributes to job creation, increased labor productivity, expansion of business and entrepreneurship, and additional consumer benefits.[6]

Cost Declines Enable New ICT Opportunities

One reason the digital divide remains prevalent in emerging economies is the limited access that rural areas have to affordable and reliable electricity. Fortunately, recent cost declines in solar photovoltaics and energy storage technologies are making micro-grids in these remote areas an increasingly viable strategy that can bridge the digital divide without the use of capital-intensive transmission lines.

The Maarifa Information Centre in Tanzania[7] and the EFACAP School in Lascahobas, Haiti, are examples of off-grid renewable and battery storage projects bringing ICT to rural areas (see boxes below).[8 9]

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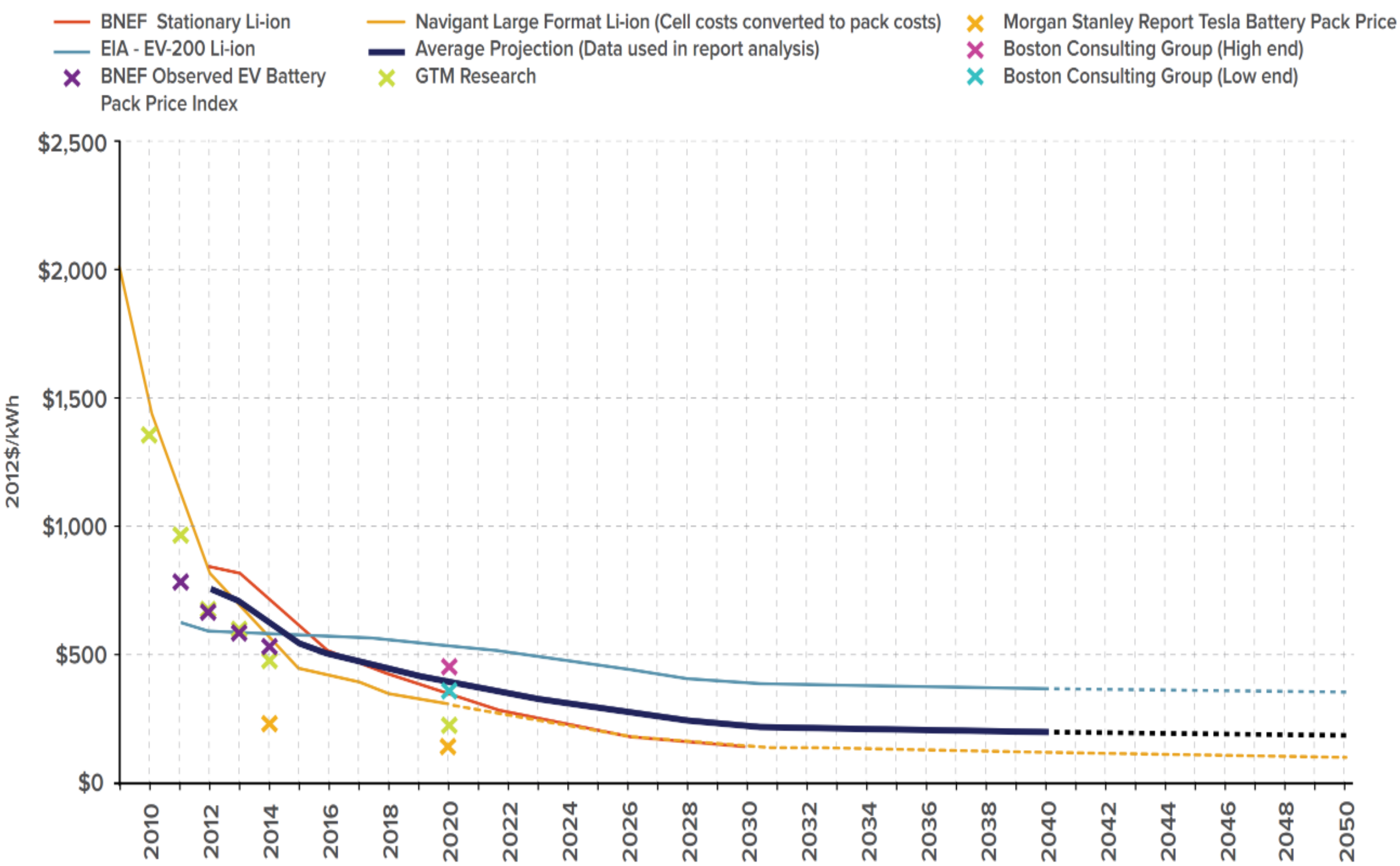
Solar energy prices have declined more than 63 percent since 2000[10] and the cost of lithium-ion energy storage has fallen by up to 70 percent over the last two years and is expected to continue to drop.[11] Energy storage cost declines are primarily due to the recent increase in lithium-ion battery production for electric vehicles and other uses.

With these recent cost declines it is helpful to assess the cost effectiveness of powering ICT with renewable energy and energy storage. This can be done using IFC's Storage Assessment Model (iSAM).[12]

Reducing battery installed costs to $300/kWh increases cost effectiveness by an additional 20 percent to 30 percent. Using today's storage and solar costs, iSAM model results show that providing off-grid power with renewable resources is already more cost effective than diesel generation. As solar and storage costs continue to decline, so will the cost of providing power for ICT in remote areas.

The cost comparison with diesel generation is important because most off-grid telecommunication towers are powered with diesel fuel. A 2012 study of telecom towers in East Africa showed that 23.5 percent of them are located in areas without access to grid infrastructure.[13] Some 95 percent of these off-grid towers are powered using diesel fuel. Additionally, 69 percent of grid-connected telecom towers include diesel generators for backup power. So there is enormous potential for solar and battery storage to offset diesel generation for both off-grid and grid-connected telecom towers and other rural ICT infrastructure.

Figure 2. Lithium-Ion Battery Prices Have Declined Sharply and Are Expected To Continue Declining



Source: Rocky Mountain Institute, The Economics of Load Defection – How Grid-Connected Solar-Plus-Battery Systems will Compete with Traditional Electric Service, Why it Matters, and Possible Paths Forward, April 2015.

Figure 3: Micro-Grid payback times and power costs with $500/kWh and $300/kWh Lithium-Ion Battery

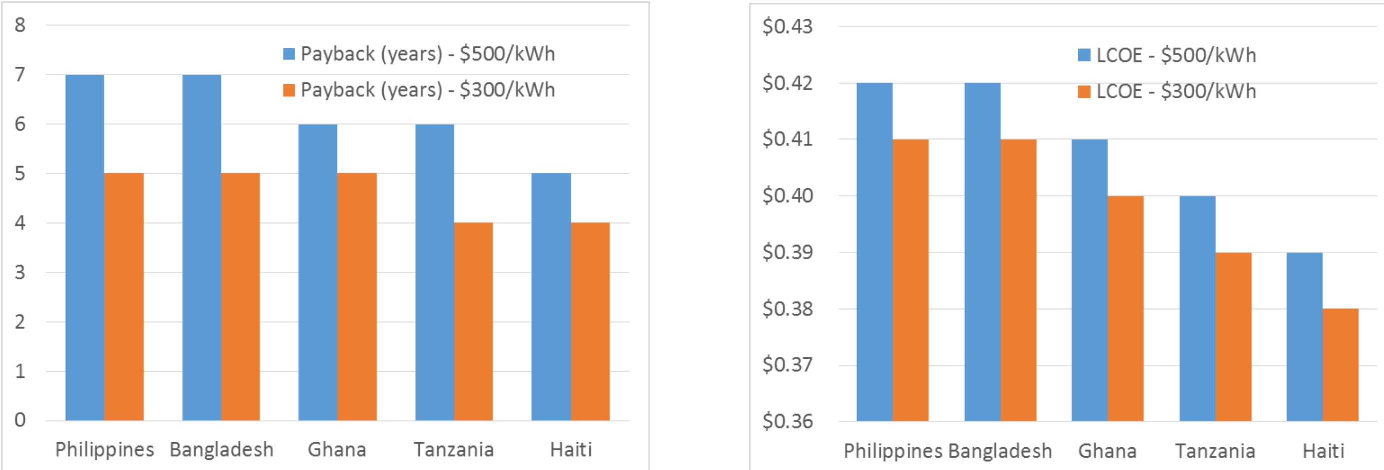


Figure 3 illustrates micro-grid electricity cost results from five selected countries. Key assumptions include a 30 kWh lithium-ion battery bank with a capital cost of $500/kWh and a 20kW photovoltaic installation at $3.00/W. As shown, payback periods range from five to seven years (compared to being powered with only diesel generation). LCOE is levelized cost of energy

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With continued cost declines, solar and battery storage may also open up new opportunities for ICT infrastructure deployment in remote locations where it has been cost-prohibitive for diesel power or where transportation of diesel fuel has been a challenge.

Using solar and storage to power information and communications technology has several additional advantages. When reliance on diesel fuel is lowered or eliminated, the overall project risk is reduced for volatile fuel prices and fuel theft. Also, solar and battery storage units have no moving parts, allowing for quiet operation and reduced maintenance compared with diesel generation.

Ghana

Ghana is an example of an emerging market nation in which access to the internet is limited in rural areas but where solar and storage solutions can have a meaningful impact on the deployment of internet and communications technology. Only 12 percent of Ghana's residents have access to a personal computer. As of 2012, there were 3.5 million internet users, about 13 percent of the population.

The Watly machine, now being tested in Ghana, is a current effort to use off-grid solar and storage.[14] The 140 kWh solar and battery unit provides electricity and internet access within an 800-meter radius, in addition to water purification services that can deliver 5,000 liters of safe drinking water each day.

Solar-Powered Internet Connectivity in Lascahobas, Haiti

Established in 2011, solar-powered Internet connectivity at the EFACAP School (Ecoles fondamentales d'application et centre d'application pédagogique) in Lascahobas, Haiti, demonstrates innovative methods for powering Internet and communications technology infrastructure in remote areas.

Using a 2.4 kW solar photovoltaic and battery system, a long distance wireless link was established between the school and a communications tower located in downtown Lascahobas. This allows some 400 students, teachers and administrators to charge their devices and laptops and access the Internet through a campus-wide WiFi hotspot array.

The school is also considering other ways that Internet access can be leveraged for the community, beyond educational uses.

Establishing wireless Internet connectivity at the EFACAP

Songambele Maarifa Centre in Tanzania

The Songambele Maarifa Centre in Tanzania demonstrates how renewable energy and battery power can enable ICT access in remote areas.

Powered by 1 kW of photovoltaic solar electricity, 1 kW of wind generation, and a battery system, the facility provides village residents with computer Internet access (via GSM network), educational videos and media, and other communication services.

The facility became fully operational in April 2015 and has enabled computer literacy among residents, increased crop harvests due to information obtained at the center, increased learning among youths, and even provided university education for some residents. The facility was made possible by support from Renewable World and coordination with the Arid Lands Information Network, and the Dodoma Environmental Network.

Source: Songabele Maarifa Centre

Solar and battery installations in Ghana are not without challenges, however. An assessment conducted by the Ghana Ministry of Energy found that installations are poorly maintained and often abandoned after three years.[15] There are also the difficulties of removing the accumulation of dust and bird droppings from solar panels, system failures due to mishandling of battery charge regulators, and a lack of access to fuses and other maintenance components.

Tanzania Case Study

Tanzania's internet penetration is even lower than Ghana's. Only 4 percent of residents have access to a personal computer and 11 percent have internet access.

Nearly 96 percent of Tanzania residents not covered by a cellular network live in a rural or off-grid location, suggesting that the focus of ICT growth in the region will be in these remote areas.

According to the 2012 GMSA Green Power for Mobile study, solar/battery/diesel hybrid solutions have great potential in Tanzania, where solar power has good availability, reliability, market acceptance, and supply chain readiness. Due to the recent cost declines in solar and storage solutions, these technologies are already being deployed in large numbers across the country.

For example, the Tanzania Government has announced the One Million Solar Homes initiative[16] which will deploy solar and battery storage solutions to a million homes over three years. IFC is providing $7 million for the first phase of the initiative, which is expected to reach 100,000 households and small businesses in Tanzania.[17] Currently, solar is being installed at a rate of 10,000 homes and businesses per month.[18]

Of course Tanzania too has challenges with this technology. There are barriers to adoption that include high initial capital costs, space requirements at ICT infrastructure sites, and scarcity of funding. There are also operational risks in terms of theft and breakage of solar panels as well as reliability issues due to weather variations.[19]

Business Opportunities

The benefits of increased access to internet and communication technology in remote regions have long been understood, yet the cost of infrastructure needed to provide it has been prohibitive. Now, however, with recent declines in energy storage costs, powering off-grid ICT infrastructure using renewable resources is an increasingly attractive option.

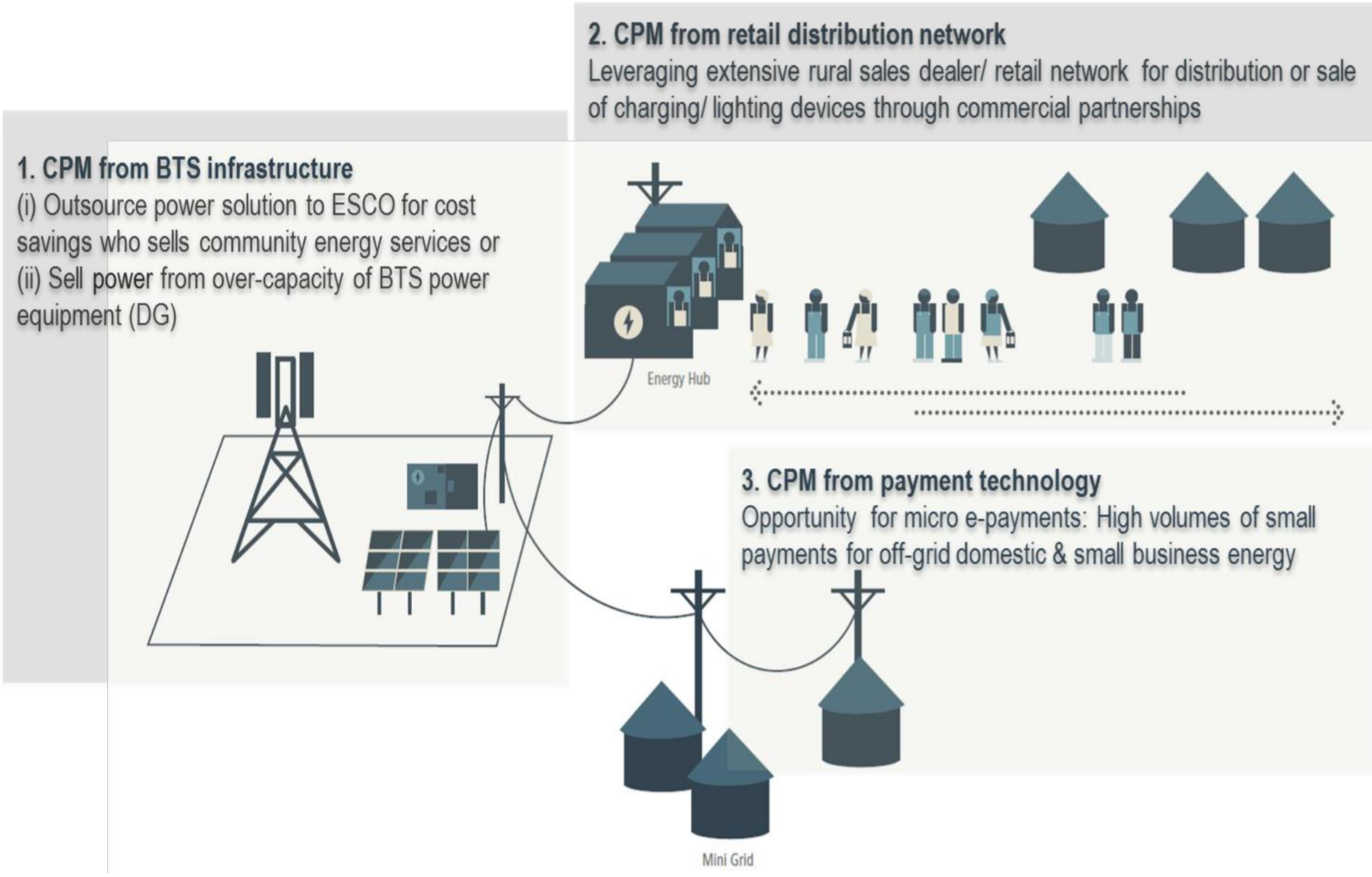
Providing that access is also an opportunity for established companies to reach new populations and potential customers. Expanded access will also foster local innovation and may contribute to entrepreneurship and new business opportunities in local communities.

Telecom companies can also benefit from the increase in data demand and offset declines in voice revenue (due to increased communication via text and data). [20]

Cheaper storage and solar technologies will also create opportunities for independent power producers to invest in powering communications infrastructure. These include collaborations between telecom operators, local communication centers, schools, small and medium-sized enterprises, and other parties that benefit from expanded ICT access and delivery.

One emerging business model for financing and powering rural communications infrastructure is the Energy Service Company, or ESCo. In this arrangement the ESCo owns, operates, and maintains the on-site power generation equipment and sells power to the telecom company or other ICT infrastructure company.

Figure 4: The Community Power from Mobile (CPM) model illustrates how clean energy and information technology enables new business opportunities (BTS = Base Transceiver Station).



Source: GSMA Green Power for Mobile.

The network or telecom company pays the ESCo just as they would pay an electric utility if grid access were available. This model helps to reduce the costs and operational burdens of deploying power generation, which have typically been the responsibility of the network operator or tower company.

The ESCo business model has a long track record in developed countries, primarily in the energy efficiency industry where ESCos finance energy efficient upgrades for buildings and receive payment from the utility bill savings.[21]

For rural ICT infrastructure, the GSM Association estimates that the market potential for ESCos in East Africa alone is $155 million annually (in 2015), with the internal rate of return ranging from 22 percent to 31 percent.

Synergies also exist between the need to power internet and communications infrastructure and the need to provide power to populations without access to the electric grid.

As illustrated in Figure 4, the "community power from mobile" model is an opportunity for energy service companies to build "solar + storage" and diesel hybrid power plants. These can provide power for telecom towers and base transceiver stations and establish mini-grids to serve homes, businesses, and "energy hubs" for charging mobile phones.

The current lack of electricity access is a major barrier to mobile phone use for off-grid subscribers, where the cost of phone charging can be as high as 50 percent of a mobile user's monthly expenses.[22]

Further synergies and business opportunities between ICT infrastructure, renewable power, and mobile subscribers come from innovative payment methods such as pre-paid solar electricity services. Instead of relying on typical payment collection methods (with high transaction costs and losses), electricity bills can now be paid by cellphone through mobile money services such as M-Pesa in Kenya and Tanzania.

This approach also generates a large amount of data that helps to establish credit histories for a previously underserved segment of the population. This enables energy service companies or other energy suppliers to identify new markets and to differentiate customers based on varying levels of service, thus allowing them to tailor the service to a customer's ability to pay.

Conclusion

With rapidly declining costs for both solar photovoltaic and battery storage, new opportunities are emerging to power information and communications technology infrastructure in remote areas.

As a result, powering telecom towers and other ICT infrastructure in this way can be more cost effective than diesel generation. Coupled with the increase in the supply of lithium-ion batteries, this cost effectiveness gap will continue to grow. And new business models are emerging that leverage synergies between the need to power ICT infrastructure, the need to power off-grid populations, and the proliferation of mobile phones in emerging countries.

As ICT infrastructure expands—bringing telecommunication, internet connectivity, and power to remote regions—access to this infrastructure will foster education, entrepreneurship, and new business opportunities, and open new markets.

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[12] The IFC Storage Assessment Model, developed in 2016, is intended to assess a range of off-grid and grid-connected storage + solar scenarios. For additional model details and assumptions, please contact Peter Mockel (pmockel@ifc.org) or Sean Ong (sean.ong@outlook.com).
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