

EA+EE: Enhancing the World Bank's Energy Access Investments Through Energy Efficiency

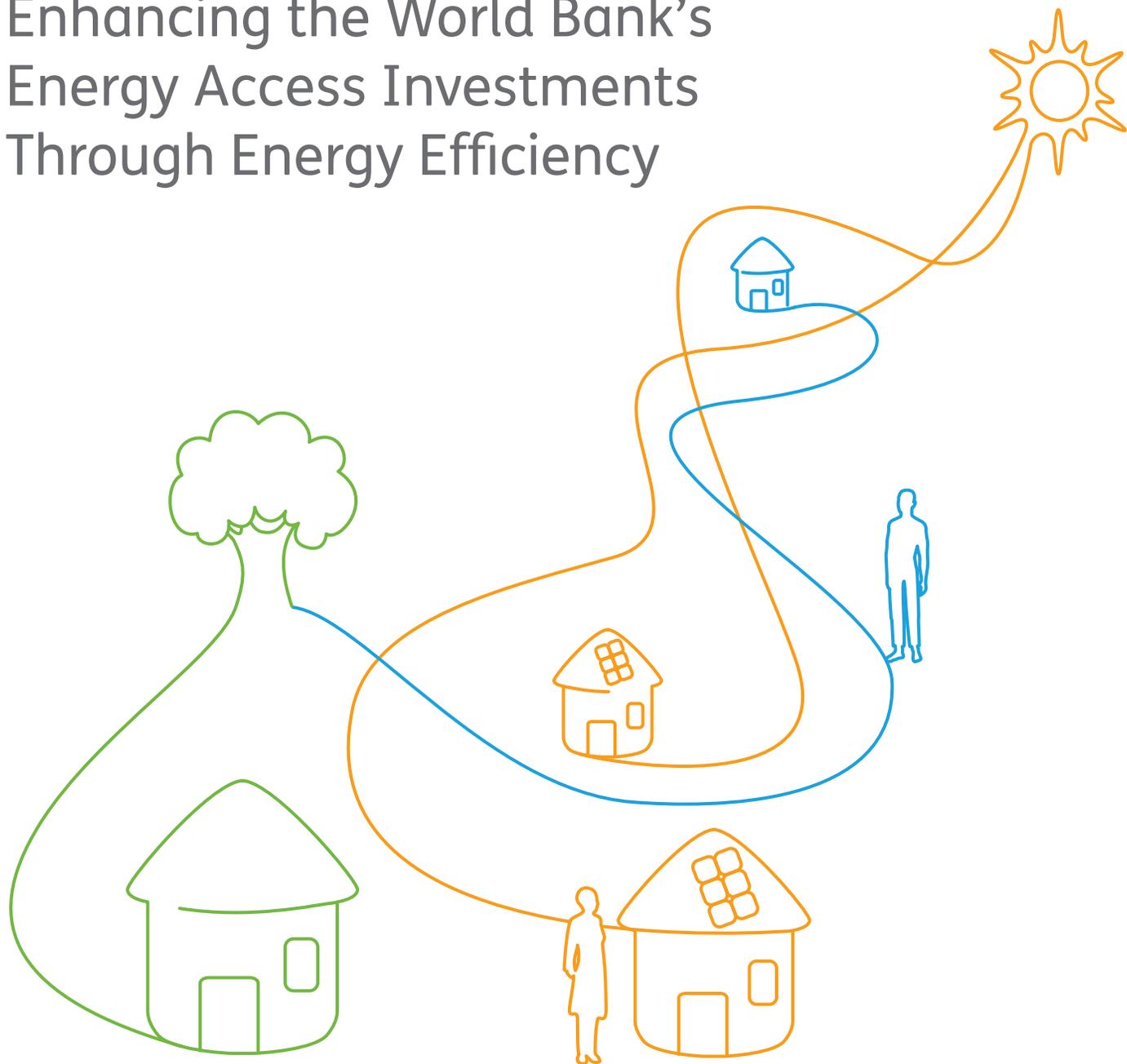


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LIST OF ACRONYMS

| | |
|-------|-------------------------------------------------------|
| AFR | Africa |
| BoP | Base of the Economic Pyramid |
| CFL | Compact fluorescent lamp |
| EA | Energy access |
| EAP | East Asia Pacific |
| EE | Energy efficiency |
| ESCO | Energy service company |
| ESP | Energy service provider |
| GDP | Gross domestic product |
| ICR | Implementation Completion and Results Report |
| LAC | Latin America and Caribbean |
| LED | Light emitting diode |
| NGO | Non-governmental organization |
| PAD | Project Appraisal Document |
| PV | Photovoltaic |
| RE | Renewable energy |
| REP | Rural Electrification Project |
| REAP | Renewable Energy and Rural Electricity Access Project |
| RERED | Renewable Energy for Rural Economic Development |
| SAR | South Asia |
| SEAD | Super-efficient Equipment and Appliance Deployment |
| SHS | Solar home system |
| SME | Small- and medium-sized enterprise |
| SSC | Sales and service center |
| TTL | Task Team Leader |
| WB | World Bank |
| Wp | Watt-peak |
| WTS | Wind turbine system |

EXECUTIVE SUMMARY

More than 1.2 billion people around the globe lack access to electricity, and another billion suffer from unreliable access. Energy poverty is all too common among the world's poorest 4 billion people—a group collectively known as the Base of the Economic Pyramid (BoP)—and is particularly prevalent among economically and socially vulnerable communities, disproportionately affecting women, children, and ethnic and/or religious minorities.

According to the International Energy Agency, access to energy (energy access or EA) “plays a strong role in poverty eradication, reducing infant mortality, improving education, ameliorating gender inequality, attaining environmental sustainability, and accelerating global economic growth and prosperity.”¹ Energy efficiency (EE) is a powerful, regularly overlooked driver of EA, and it has the potential to fundamentally reshape and accelerate global efforts to deliver modern energy services to BoP communities. **Energy service—not energy supply—is what accomplishes the goals of energy access, and efficiency can maximize the delivery of energy service while minimizing the financial, social, and environmental costs of energy supply.**

The World Bank (WB) has for many years been financing and conducting work to increase access to modern energy services among energy poor communities, and its efforts vary greatly from project to project, based largely on client-country context, requests, and needs. In mid-2014, CLASP evaluated a selection of recent WB EA projects to identify opportunities to expand and more effectively integrate and operationalize EE, a process and set of principles we refer to as EA+EE. Following a review of project documents, interviews with project managers, and extensive project evaluation, we prepared a

series of recommendations for how efficiency can amplify and help to lock in the impacts of upcoming WB EA projects. These recommendations include:

- ▶ **LEAD WITH EFFICIENCY:** Develop tools, analytics, and models that equip project staff, clients, and implementers to first manage supply- and demand-side inefficiencies through EE, and then develop the generation needed to cover supply gaps.
- ▶ **COMMUNICATE THE BENEFITS OF EA+EE:** Develop tools, resources, educational modules, and communications materials to highlight and reinforce the importance of EA+EE to WB staff, technical contractors, and clients.
- ▶ **SET GOALS TO MAXIMIZE EA+EE:** Establish project success and performance indicators to appropriately reflect EA+EE principles and properly incentivize delivery of energy service at least cost.
- ▶ **IMPROVE PRODUCT PROCUREMENT:** Equip project staff and clients with a procurement system that drives purchases based on energy and life-cycle performance as well as price to overcome procurement challenges and inspire competition and innovation among vendors.
- ▶ **LEAVE EA+EE MARKETS BEHIND:** Build market infrastructure for efficient products by training new and existing vendors, creating appropriate market forces, and educating consumers on the benefits of efficiency.
- ▶ **RETHINK SUBSIDIZED ENERGY TARIFFS:** Support markets for energy efficient products and behavior by exposing end-users to the true cost of energy; off-set costs through energy efficiency subsidies, rebates, and incentives funded by tariffs.
- ▶ **EDUCATE CONSUMERS:** Train new and existing customers on how energy usage

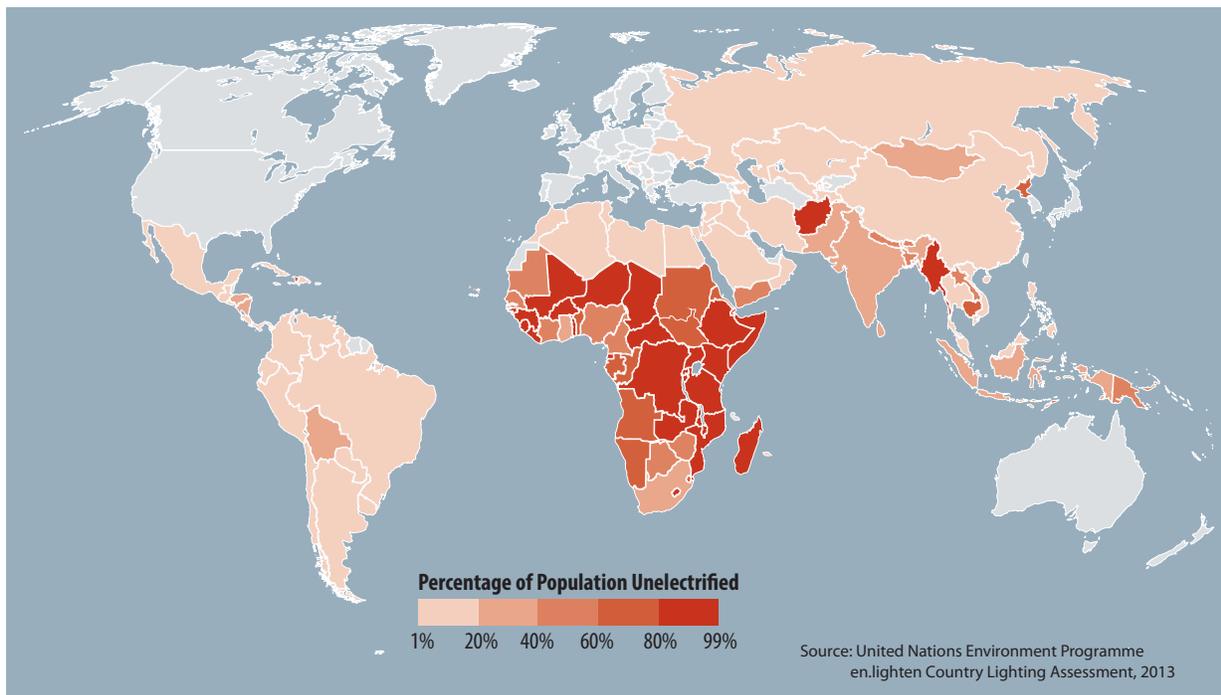
will impact their energy bill or the performance of their off-grid systems, and encourage them to demand energy efficient products.

The WB currently incorporates EE principles and practices into many of its EA projects, and in many cases this has proven to be highly impactful. However, full and optimal utilization of EE is often limited by a lack of resources, capacity, or understanding of the options available and the role that efficiency can play in improving project outcomes. Addressing these gaps can help accelerate the achievement of WB project goals and amplify their impacts, drive technical and market innovations, and save consumers, clients, and projects money.

Moreover, an important, though perhaps not readily intuitive, outcome of EA+EE is that positive energy efficiency outcomes—not just energy access outcomes—often come of it. EE is, in many cases, a necessary condition for meaningful, cost-effective, and affordable EA, and has grown essential to many access efforts (particularly in off-grid contexts)—this dynamic has driven some remarkable EE outcomes, and will continue to do so.

This evaluation, and the associated recommendations, is intended to help the WB consider the development of an actionable EA+EE strategy. It is, we hope, a beginning of a larger conversation about the role that energy efficiency can and will play in energy access, and vice versa.

FIGURE 1: Percentage of National Population Unelectrified



INTRODUCTION AND CONTEXT

Worldwide, approximately 1.2 billion people lack access to electricity, and another billion lack reliable access. Energy poverty and extreme poverty are tightly correlated, and energy-poor people are frequently among the world's poorest 4 billion, a group collectively known as the Base of the Economic Pyramid (BoP). Energy poor BoP consumers tend to be extremely economically and socially vulnerable, and are disproportionately women, children, and ethnic and/or religious minorities. The map on the previous page illustrates the global scale and distribution of energy poverty.

Energy service, not energy supply, is what is demanded by energy poor consumers.

Energy poverty is a fundamental barrier to eradicating global poverty and building shared prosperity.² The costly, dirty fuels (e.g. kerosene, charcoal, and diesel) used by energy poor BoP consumers to meet daily needs have major negative health, environmental, and financial consequences, greatly exacerbating their already precarious socioeconomic status. According to the International Energy Agency, Energy Access (EA) “plays a strong role in poverty eradication, reducing infant mortality, improving education, ameliorating gender inequality, attaining environmental sustainability, and accelerating global economic growth and prosperity.”³

The technologies and processes needed to provide energy poor BoP consumers with access to many modern energy services exist, and include grid extension, generators, solar home systems (SHSs), small wind turbine systems (WTSs) and renewable mini-/micro-grids. These technologies displace pre-modern fuels and greatly reduce their social and environmental impacts. The challenge lies of EA in delivering these technologies to underserved BoP markets reliably and affordably.

In un-electrified rural or peri-urban regions, distributed (“off-grid”) energy technologies offer cost-effective, reliable modern energy services that improve quality of life, displace pre-modern fuels, and drive socioeconomic development. In under-electrified regions, where households and businesses are unable to get adequate energy service due to high costs, energy generation shortfalls, or other market failures, grid extension, supply enhancement, pricing / tariff reforms, and other energy sector reforms are reliable interventions, while off-grid technologies can serve as an important stop-gap for consumers awaiting the benefits of these interventions.

In nearly any context, EE can greatly amplify and accelerate the impacts of EA. Energy *service*, not energy *supply*, is what is demanded by energy poor consumers. Energy efficiency maximizes the delivery and utility of energy service while minimizing the costs and negative social and environmental impacts of energy supply. As such, EE is an enormously potent tool in efforts to deliver modern clean energy services—and the resulting improvements to quality of life—to the billions of energy poor people around the world.

The World Bank & Energy Access

The World Bank (WB) has for many years been financing and conducting work to increase access to modern energy services. The WB's EA efforts vary greatly from project to project, based largely on client-country context, requests, and needs. However, they typically fall into three main categories:

1. Financial and operational reform of energy sector;
2. Increased or enhanced grid connectivity and reliability; or
3. Provision of energy service to off-grid consumers and communities.

At the request of WB, CLASP has reviewed and evaluated a range of WB energy access projects and made recommendations for how to optimize future and ongoing EA project impacts through better integration of EE. This report will refer to this nexus of energy access and energy efficiency interventions as EA+EE.

EA+EE is already reshaping and accelerating global efforts to deliver modern energy services to those who need them most. Throughout the developing world, highly-efficient light emitting diode (LED) technologies are enabling affordable access to modern lighting for un- and under-electrified communities by dramatically reducing energy investment costs; this principle of efficiency unlocking affordable access extends to other, non-lighting applications. EE minimizes consumer and energy supply costs and is a technical and financial requirement of many (primarily off-grid) EA business models. While EE drives improved EA outcomes, EA

is simultaneously driving improved EE outcomes.

“The LED lamp holds great promise for increasing the quality of life for over 1.5 billion people around the world who lack access to electricity grids. Due to low power requirements, it can be powered by cheap local solar power.”

— Royal Swedish Academy of Sciences, announcing the 2014 Nobel Prize in Physics

The WB already incorporates EE principles and practices into many of its EA projects, and in many cases quite successfully. However, utilization of energy efficient technologies and interventions is too often limited by a lack of resources, capacity, or understanding of the role that EE can play in improving EA project outcomes and of how to incorporate it. Much more can be done with regards to EA+EE to amplify the impacts of WB efforts, and to accelerate energy’s role in eradicating global poverty and building shared prosperity.

TABLE 1: WB Projects Analyzed

| STATUS | TITLE | COUNTRY | REGION | TYPE | SETTING |
|---------------------------|--------------------------------------------------------|------------|--------|-------------------------------|--------------------|
| CLOSED | Rural Electrification Project | Peru | LAC | Grid Enhancement | Rural |
| | Renewable Energy for Rural Access | Mongolia | EAP | Off-grid | Rural |
| | Renewable Energy for Rural Econ. Dev. | Sri Lanka | SAR | Off-grid | Rural |
| | Household Energy and Universal Access | Mali | AFR | Off-grid | Rural / Peri-Urban |
| ACTIVE OR PIPELINE | Decentralized Electricity for Universal Access Project | Bolivia | LAC | Off-grid | Rural |
| | Rural Electrification | Laos | EAP | Grid Enhancement and Off-grid | Rural |
| | Rural Electrification and Renewable Energy Development | Bangladesh | SAR | Off-grid | Rural |
| | Rwanda Electricity Access Scale-up | Rwanda | AFR | Grid Enhancement | Rural / Urban |

EA+EE AT WB

Project Methodology & Limitations

The WB provided CLASP with documentation—including Project Appraisal Documents (PADs), Implementation Completion and Results Reports (ICRs), and other project documents—for more than 40 on- and off-grid EA projects. CLASP conducted an initial review of these documents to inform the selection of projects for closer study and Task Team Leader (TTL) interviews. In consultation with the WB, CLASP identified projects to represent both past and current projects from four target regions: Latin America and Caribbean (LAC), East Asia Pacific (EAP), South Asia (SAR), and Africa (AFR).

CLASP reviewed documents and conducted interviews with the TTLs responsible for the eight projects identified in Table 1. CLASP asked TTLs questions about project background and design, and how EE was or might have been integrated into the project. From these projects, CLASP developed seven case studies, which can be found in the Appendix.

The recommendations for greater integration of EA+EE that are included in this report are based on these case studies, and are intended to assist the WB as it considers the scope and goals of future EA projects. CLASP in no way intends this report, or any evaluation or recommendations in it, to be critical of past or ongoing projects. Rather, the purpose is to provide ideas on how the WB, its project teams, and its clients might optimize the impacts of future projects through EA+EE.

Limitations to This Analysis

CLASP's analysis and the recommendations made here are based on publicly-available project planning and review documents, as well as interviews with the TTLs of a relatively small group of WB EA projects. A review of every WB EA project was not scoped as a

SOME OF THE BENEFITS OF EA+EE⁴

- **REDUCE PEAK LOADS** – EE lowers the investments needed to meet demand during peak hours and frees up resources to supply energy to more people.
- **REDUCE ENERGY COSTS** – Households can afford more energy services or save on total energy costs.
- **SAVE GOVERNMENTS MONEY** – Lower energy consumption reduces government expenditure where tariffs are subsidized and/or supply is tight.
- **PREVENT TECHNOLOGY LOCK-IN** – Appliances and other energy-using devices can stay in developing world markets for years beyond their expected useful life. Deploying highly efficient technologies prevents the long-run lock-in of inefficient products.

part of this effort, nor was in-depth project data or techno-economic analysis. Such analysis may be appropriate in developing the educational and communications tools and modules recommended here, and CLASP recommends it as an area for future study.

Definitions

Energy access is an extraordinarily diverse field, and the meaning of the term varies widely across national jurisdictions and WB projects. Depending on context, a great many market and policy interventions can be leveraged to achieve EA goals. For any given EA intervention that is considered, a distinct suite of EE interventions will be applicable.

For purposes of this report, “energy access” means that previously un- or under-served

households, businesses and communities have achieved or been granted new or enhanced access to reliable, affordable, and adequate modern energy services, either through grid-connected service or off-grid systems. By “energy efficiency” we mean a decreased amount of energy required to maintain or improve the level of energy service provided to households, businesses and communities.

EA+EE: The Basics

Designing EA projects to strategically emphasize and leverage EE benefits from their outset will improve project outcomes and help accelerate the pace of progress toward the Sustainable Energy for All goal of delivering universal access to sustainable energy by 2030. By creating new markets and models for EE products and interventions, EA projects can, in turn, help drive global EE gains.

Fundamental to the theory of EA+EE is the recognition that the provision of energy does not, in itself, accomplish energy access goals—rather, these goals are accomplished by the services that energy enables. Energy poor BoP consumers do not want a diesel generator, or a SHS, or a connection to a mini-grid; instead they want the services that these technologies enable. To put this another way, consumers do not want a kilowatt-hour, they want a kilowatt-hour’s worth of reliable lighting, or entertainment, or productivity. *Energy efficiency enables faster achievement of energy access goals by maximizing the energy service that can be achieved by any given energy access investment.*

Energy Service vs. Energy Consumption

A commonly made point in discourse surrounding energy access is that gross domestic product (GDP) per capita is highly correlated with per capita energy consumption.

That is, at least historically, the wealthier the economy, the more energy the average citizen would tend to consume.

This observation is no doubt historically accurate, but it does not provide guidance for a future, energy-constrained world. Nearly every advanced economy is working to decrease per capita energy consumption through energy efficiency and other measures, and to decrease dependence on fossil fuels for reasons as diverse as national security and climate change mitigation. Taking these global issues into account, a method by which to meaningfully measure the distinction between energy consumption and energy service would very likely demonstrate that *per capita energy service* is a stronger indicator of GDP per capita than *per capita energy consumption*.

Incremental Costs of Energy Efficiency

In developed economies, the purchase of energy efficient technologies is often disincentivized because the efficient option – typically a newer, more technologically advanced product – is marginally more expensive than inefficient products that provide the same service. In developed economies, this upfront cost of EE has been and continues to be a barrier to the proliferation of efficient products.

But this need not be the case in the context of WB EA projects, and evidence from working EA markets suggests that it is not. Investments in new energy supply account for the vast majority of EA costs, and energy efficient end-use devices and appliances dramatically reduce the amount of energy supply required to provide service. The resulting decrease in energy supply costs more than makes up for the incremental costs of energy efficient technologies. In fact, forthcoming research from Lawrence Berkeley National

Energy efficiency enables faster achievement of energy access goals by maximizing the energy service that can be achieved by any given energy access investment.

FIGURE 2: Access Impacts of Efficiency Interventions



Laboratory and Humboldt State University indicates that super-efficient off-grid appliances can reduce the cost of off-grid energy service by up to 50%. One need only to look at the uptake of LEDs – a relatively costly, but super-efficient, lighting technology – in the Bangladeshi SHS market for evidence of this dynamic.

In grid-connected settings, large proportion of WB EA investments are in generating supply development and grid enhancements. While techno-economic analysis is needed to model impacts on existing and prospective WB projects, theory and evidence from the field suggests that large-scale market penetration of highly efficient end-use products reduces necessary supply and grid investments.

EA+EE: Coupling Access and Efficiency Interventions

The ideal WB energy access project would focus first on cost-effectively optimizing EE in an economy or sector – getting the most service possible from each unit of energy produced – and would then adjust supply to respond to any shortfalls. Cost-effective efficiency interventions can often stretch existing energy supplies, lower generation costs, reduce consumer tariffs, improve financial performance of a utility or sector, reduce peak demand, mitigate the need for load shedding, reduce the need for fuel imports, and grant more people access to energy services. The WB recognizes this, and many WB EA projects feature strong EE components.

Figure 2, previous page, provides an indicative list of common WB energy access interventions, the efficiency interventions that have been or might be coupled with them, and expected impacts.

Integrating EA+EE by WB Program Type

In the sections below, we discuss how EE has contributed, and can further contribute, to WB EA project success. Many WB EA projects include a combination of the intervention strategies that follow.

Energy Sector Reform

In many countries, energy generation and transmission infrastructure is insufficient to serve existing customers, let alone new ones. In these countries, electric grids often fail to satisfy demand due to aging infrastructure; demand that outstrips available supply; and sub-optimal management. Load shedding, brownouts, and blackouts are common, as are high energy rates/tariffs.

WB energy sector reform projects often include supply-side infrastructure improvements such as retrofitting power plants, replacing old power lines, and installing new, highly efficient transformers. These efforts typically offer strong return on investment because they tend to have a few discrete, high-impact points of intervention. Energy sector reform projects often “take back” as much as 10% of an existing grid’s wasted energy supply and lower generation costs. Supply-side efficiency gains improve the financial performance of the energy sector, and help ensure that more megawatts generated become megawatts consumed. These impacts help drive the socioeconomic goals of EA; reduced fuel imports and peak load drive its environmental goals.

Grid Extension and New Connections

Many WB demand-side EA efforts focus on connecting new customers to energy service infrastructure, and ensuring that those customers who are connected receive reliable service. These interventions can improve the ability of an energy sector to satisfy demand,

obviate costly peak and supplementary power generation, and reduce the need for fuel imports. Here again, energy efficiency can be used to amplify and accelerate EA impacts.

Eliminating inefficient end-use devices (e.g. lighting and appliances) through market-based approaches (e.g. product rebates, subsidies, market development and consumer education programs) or systematic replacement programs can greatly reduce peak demand, thereby lowering generation costs and freeing up capacity in the grid so that more consumers can be provided energy service. The use of efficient lighting and appliances also tends to lower consumer energy bills, leaving consumers with financial flexibility for other basic needs. This serves the socioeconomic development goals of EA.

Enabling Off-Grid Access

The cost-benefit analysis of last-mile grid extension is often unfavorable, so connectivity to traditional grid-based energy infrastructure is unlikely to be a viable near-term option for many energy poor BoP consumers. Small off-grid energy systems such as mini- and micro-grids and SHSs can provide these consumers with many of the benefits modern

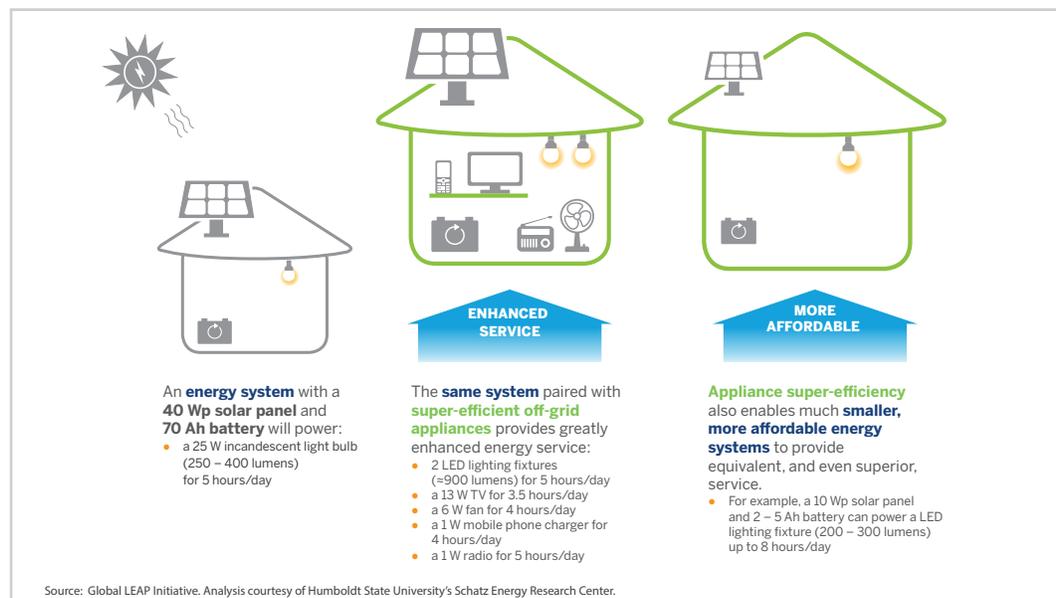
energy services, displacing pre-modern fuels and their negative impacts, and facilitating socioeconomic development.

Off-grid energy systems can be quite expensive for poor BoP consumers, and their ability to pay is one of many market barriers limiting the uptake of these technologies. As illustrated in Figure 3, off-grid appropriate, super-efficient appliances convey the same (and often improved) level of energy service as inefficient alternatives. Efficient appliances radically reduce the size and cost of the systems needed to provide a household or community with energy services, as system costs are driven largely by the cost of solar panels and batteries. The upfront cost of a typical off-grid energy system could be reduced by as much as 50% if super-efficient appliances and right-sized solar PV and batteries are used, while delivering the same or greater energy service. In this way, energy efficiency has made—and will continue to make—modern energy services available to vast new segments of the BoP consumer market.

Barriers to EA+EE

Many of the TTLs interviewed for this report understand very well that there are benefits

FIGURE 3: Off-Grid Appliance Super-Efficiency & Clean Energy Access



to incorporating EE into the EA projects they manage. Nevertheless, they are often held back from doing so because of resource capacity constraints, conflicting client-country and stakeholder priorities, and structural limitations in their projects.

Client & Stakeholder Engagement

Despite clear benefits, defining a substantive EE+EA contribution to projects has been a challenge for many TTLs. The political and economic incentives motivating clients and stakeholders drive many projects toward activities and milestones with visible, immediate impacts. As a result, many large EA projects focus on increased generation capacity through new power plant and renewable energy construction, grid extension, and the provision of off-grid solutions.

Improving energy service through EE has longer time horizons, is less visible, and is harder to quantify. Moreover, by virtue of needing EA interventions, many client countries do not have a robust marketplace of EE stakeholders to help inform project and policy design. For these and other reasons, when seeking financing for large EA projects, clients tend to have greater interest in brick-and-mortar projects that expand or improve energy supply.

Insufficient Resources/Capacity Devoted to EE Components

Many EA projects dedicate extensive financing to the expansion or improvement of energy supply infrastructure. In cases where EE is included in such projects it can be viewed not as integral to the project's success but rather as an additive, marginal task or burden.

For example, the Sri Lanka RERED project included an EE component to support the development of an energy service company (ESCO) market that would, over time, help

remove one of the key barriers to energy efficiency investment in Sri Lanka. However, this component received only 0.9% of the project's total financing. The project's TTL indicated that the component was not sufficiently funded to warrant the attention such a complex task required.⁵ Further, the tools at the project team's disposal related to this component were not well-aligned to the project's overarching EA goals.

The EE component remained a part of the project until the project's end, but its impacts were modest. The project's ICR suggests that "to reduce complexity and remain focused, it would have been better to limit the project to renewable energy and address energy efficiency in a more significant manner in a different project supported by the Bank or other development institution."⁶

Challenges to Effective Product Procurement

Many WB-financed EA projects have a bulk procurement component, whereby project staff or implementing partners purchase large orders of products like compact fluorescent lamps (CFLs) or SHSs. Effective product procurement requires complex management of technical specifications, price proposals, vendors, local policy, and local markets; efficient product procurement difficulties and delays have challenged more than one WB EA project component.

For example, Bangladesh's RERED included a massive CFL deployment initiative wherein Bangladeshi utilities were responsible for procuring CFLs. However, a strong market for CFLs did not exist in Bangladesh and the utilities had no previous experience with bulk procurement of efficient products. The products procured proved to be extremely low quality and ill-suited for Bangladesh's spotty electric grid. A survey revealed that 34% of

the products had failed within a few months, and laboratory tests revealed that product lifetime was significantly less than that called for in the WB technical specifications. A second phase of CFL procurement suffered from bidders submitting fraudulent performance guarantees or not submitting them at all, and was ultimately abandoned.

Getting EE procurement right is crucial to both project success and the achievement of larger EA goals. In developing countries, a product procured by a WB-financed project is often a consumer's first experience with a new technology and, even if subsidized, often requires a significant financial investment. Products that perform poorly or fail quickly can hinder the development of future markets for those products, and can negatively impact markets for related products. Moreover, inefficient products and product markets get locked in, limiting EA benefits until a market for competitive efficient products can develop.

The procurement process may also be a place where project and WB requirements are contrary to EA+EE principles. TTLs who have overseen bulk EE procurement by clients in EA projects report that procurement decisions are typically made on an initial cost basis, whereas a life-cycle cost basis would be far more appropriate from an EA+EE perspective.

Market Readiness

The goal of every WB EA project is to foster markets through which energy service is made available – both technically and economically – to un- and under-served BoP consumers. However, creation and maintenance of a self-sustaining market requires a good deal of infrastructure that is often lacking in WB project countries.

For example, many WB projects focus on providing both on- and off-grid electricity services to rural communities, and promoting end-use EE to these communities presents significant challenges. It can be difficult to build functional competitive markets in sparsely populated regions with limited retail options. Consumer awareness and outreach programs to educate rural consumers on the benefits of EE can be expensive and time consuming; many governments of developing economies don't have the political and financial resources to coordinate national EE campaigns for their existing energy infrastructure.

Moreover, lessons and smart practices from other WB projects are not necessarily applicable to every new project. There is an extraordinary amount of variability among markets in the countries, regions, and jurisdictions served by WB projects, and the rationale for and methods of EA+EE vary accordingly.

RECOMMENDATIONS

To help the WB identify solutions to the barriers to EA+EE listed above, with the ultimate goal of maximizing the outcomes of future WB EA projects, CLASP suggests several efforts that might be undertaken at the WB institutional level and at the project implementation level.

Institutional Recommendations

1. LEAD WITH EFFICIENCY

Energy efficiency offers clear benefits to energy access projects. It maximizes the delivery of energy service while minimizing its economic, social and environmental costs. Energy access is not the provision of energy, but the facilitation of energy service. Scenarios where supply is inadequate, unreliable, or too expensive are anathema to EA efforts—and EE is the fastest, easiest, most cost-effective tool to mitigate these scenarios.

The ideal approach of any EA initiative would be to first manage supply- and demand-side inefficiencies through EE, and only then adjust supply as needed to meet demand. CLASP recommends that the WB begin to develop the tools and models to both convince and equip project staff, clients, and implementers to approach EA in this way.

2. COMMUNICATE THE BENEFITS OF EA+EE

EA+EE is an emerging concept, and the benefits are not presently obvious to project designers and managers. EA experts are not necessarily EE experts, and vice versa. If EE's benefits are not well understood, or are not clearly communicated, EE can seem like an additional burden to the project or, worse, irrelevant to project aims.

CLASP recommends that the WB develop tools, resources, educational modules, and communications materials to highlight and reinforce the importance of EA+EE to WB staff, implementers, and clients. CLASP also recommends that the WB make EA+EE an internal strategic priority, and perhaps include consideration of EE interventions and outcomes as a requirement in project design and reporting.

3. SET GOALS TO MAXIMIZE EA+EE

WB EA objectives and indicators are often structured around enhancing or improving energy supply capacity (e.g. adding additional megawatts to the grid) not electric or energy service. While structuring EA project milestones in this way makes sense in many regards, it may disincentivize EA+EE.

Project indicators drive project team action, and therefore should reward projects that are designed to maximize the benefits of energy service while minimizing its costs, instead of those that simply maximize supply or consumption. For example, a project objective of “Increase in megawatt hours consumed for commercial use” might very well disincentivize project staff and clients from pursuing EE interventions and technologies. On the other hand, a project objective of “Percent of population served by reliable off-grid clean energy system” may have positive EA+EE implications, as EE can expand off-grid clean energy markets.

CLASP recommends that the WB develop and establish project success indicators that appropriately reflect EA+EE principles, and properly incentivize delivery of energy service at least cost.

Setting EA+EE Goals: Rwanda

The Rwanda Electricity Access Scale-up and Sector-wide Approach (SWAp) project is the only WB access project analyzed as part of this report that explicitly connects an energy efficiency component to energy access outcomes. This project focuses on national grid extension to improve access to electricity in Rwanda. The two main barriers to achieving universal access in Rwanda are constrained generation at the national level and the high cost of electricity.⁷

To help reduce the cost of electricity for consumers and to reduce the impact on the national grid when new connections are made, approximately 900,000 CFL bulbs⁸ will be distributed to households by the national energy service provider Rwanda Electricity Corporation (RECO). The rationale for this approach was that by distributing CFLs to new customers the total impact on the grid would be smaller and the energy cost for customers would be reduced, thus helping to achieve the project's goal of improved access to reliable and cost-effective electricity.⁹ The indicators that are used to measure the increased adoption of energy efficient technologies are "percent of new customers receiving CFLs" and "estimated load reduction from EE investments in GWh".¹²

4. IMPROVE PRODUCT PROCUREMENT

The bulk procurement process for products purchased for WB-financed EA projects (i.e. SHSs, CFLs) tends to be consistent project-to-project. First, a product specification is developed and bids are solicited. Once the bids are in, any products that do not meet the specification are removed from consideration. Finally, the vendor is selected based on the low-

est priced bid. While this is a sound and reasonable process, it may not support EA+EE principles or help to build markets for the most impactful products.

While purchasing on least-cost makes sense from a project finance perspective, it may be contrary to EA project goals. The marginal incremental costs of a super-efficient product may be cause for disqualification in a least-cost procurement scheme, while a procurement process based on life-cycle cost analysis would reveal the product to be of vastly superior value. CLASP recommends that the WB develop procurement and accounting tools that encourage or require clients to procure products based on least life-cycle cost to maximize delivery of EA benefits over the long term.

A smarter, more flexible procurement system may also offer important secondary benefits. Product procurement under WB-financed projects represents a sizable market opportunity. Procurement rules that drive purchases based on energy and life-cycle performance as well as price could inspire competition and innovation among vendors, and help build out vital EA+EE market infrastructure worldwide.

Project Design Recommendations

5. LEAVE FUNCTIONAL EA+EE MARKETS BEHIND

WB projects are short-lived by design, and project financing is limited. To optimize human development and environmental impacts, it is important that projects leave behind self-sustaining market and policy infrastructure. Functional markets drive competition, which in time leads to more affordable, higher quality, more efficient products and services for consumers. While market readiness varies greatly

among the WB's client countries, some smart practices are evident. And, while replicating the markets that have enabled the success of certain WB EA programs may be impossible, building analogous market infrastructure and capacity is relatively straightforward.

CLASP recommends that, where EA+EE market infrastructure does not exist, the WB prioritize making the necessary investments.

EA+EE Markets: Bangladesh

One of the best examples of the power of energy efficiency to deliver access outcomes can be observed in the Bangladeshi SHS market.

Among other interventions, the program provided subsidies to make SHSs more affordable, and several partner organizations were set up to be distributors for the systems. These organizations competed heavily on price for customers—factors that contribute to lower prices included falling cost of photovoltaic (PV) panels and components, and efficiencies gained from scale and market experience. But nothing impacted the price of energy service, and the market, as significantly as the introduction of light emitting diodes (LEDs).

By using LEDs with a SHS, equivalent or better levels of energy service can be obtained with a SHS that uses a much smaller battery and PV panel. The resulting reduction in system cost more than covers any marginal increase in cost from improved appliance efficiency, and the entire SHS system is much more affordable. The rapid expansion of Bangladesh's SHS market has led to high demand for LEDs, and a notably strong marketplace of LED manufacturers has emerged in Bangladesh.

EA+EE Markets: Mongolia

Mongolia's Renewable Energy and Rural Electricity Access Project (REAP) established regional service centers for SHSs that helped to overcome some of the barriers that service provider's and project manager's face when providing off-grid energy to rural, dispersed populations. Prior to investing in a SHS, it is important for consumers to know that they will have an accessible resource to purchase replacement parts and receive repairs covered by warranties. In addition to these services, the regional service centers provide customers with more options for purchasing appliances that are compatible with their SHSs, including EE lighting and other equipment.

6. RETHINK SUBSIDIZED ENERGY TARIFFS

Many governments in developing countries subsidize energy to make it more affordable, or for political gain.¹¹ While subsidies do make energy more affordable, they tend to hide the true cost of energy and discourage up-front spending for energy efficient technologies.

In many WB client countries, reducing subsidies may not be feasible or desirable because doing so would raise consumer electricity costs. However, if the political will exists, it's possible to avoid subsidies and nevertheless pass savings on to consumers through rebates and incentives tied to EE. Doing so helps meet EA goals by freeing up grid capacity and lowering household energy cost, but does not hide the true cost of energy and disincentivize EE. The Super-efficient Equipment and Appliance Deployment (SEAD) Initiative is currently working with the government of Mexico to implement such an approach.¹²

CLASP recommends that the WB weigh opportunities for similar approaches at the outset of client country engagement.

7. EDUCATE CONSUMERS

It is important that clients and project teams are well-educated about EA+EE. However, building robust self-sustaining markets that will continue to advance EA+EE goals after WB financing and project teams leave requires that consumers understand the benefits of energy efficiency and make purchase decisions based on that understanding. When a new electric connection is made—either on- or off-grid—it is important for customers to receive training on how to use energy-consuming products safely and efficiently. Energy efficient behaviors may be unfamiliar to newly connected consumers, and project outcomes will be amplified if these customers understand how usage will affect their energy bill or the performance of their off-grid systems.

Many WB EA projects include EE consumer education through leaflet distribution, trainings by installers, radio and SMS advertisements, etc., but there is still room for improvement. For example, in the Rwandan project CFLs are distributed to each house newly connected to the grid, but educational materials are not distributed to explain the differences between CFL and incandescent bulbs. This lack of a consumer education component may have significant implications for the CFL market, energy system, and consumer ecosystem in Rwanda in years to come.

CLASP recommends that, in designing and implementing EA projects, the WB prioritize educating consumers on EE. The long-run implications of a cohesive effort to this effect could be astonishing.



Appendix: Project Case Studies

Lao PDR REP Phase I/II

TITLE: Lao People's Democratic Republic (PDR) Rural Electrification Project (REP) Phase I

APPROVAL: 27 Apr 2006

CLOSE: 31 Mar 2012

CLIENT: Government of Lao PDR (GoL)

IMPLEMENTING AGENCY: Electricité du Laos (EDL); Ministry of Energy and Mines (MEM)

Project Background & Overview

Amidst an expanding economy and declining poverty rates, rural electrification rates in Lao PDR rose dramatically from 16% in 1995 to 46% in 2004. Realizing the socioeconomic benefits of electrifying the highly rural country, GoL set a goal to electrify 90% of the country by 2020, with intermediate goals of 70% by 2010 and 80% by 2015. At the same time, GoL sought to expand the availability of surplus hydroelectric power – a key export for the country – and improve the performance of its state-owned, vertically integrated utility, Electricité du Laos (EdL).

To support GoL's rural electrification efforts and its goal to improve EdL's financial sustainability, REP was structured to drive access through grid extension, off-grid SHS deployment, and supply- and demand-side efficiency gains for EdL. The project has succeeded in expanding energy access to rural communities, and has helped to improve EdL's reliability and financial performance.

Project Highlights and Lessons

The experience of Lao PDR REP is illustrative of the role that energy efficiency plays in expanding energy access, even if the linkages and impacts are not obvious or direct.

REP's TTL identified three ways in which energy efficiency enables improved energy access outcomes: Technical performance, financial performance, and enhanced consumer trust in energy service providers.

REP's TTL also shared experiences from working on a WB energy access project in Nepal. Lao PDR and Nepal face similar challenges in expanding rural electrification; however, for several reasons Lao PDR has been better able to provide reliable energy access and incorporate energy efficiency.

Driving Access & Sector Reform with Energy Efficiency

IMPROVED SUPPLY-SIDE EFFICIENCY is low-hanging fruit in energy access projects. Improving supply side efficiency means reducing the energy losses of an energy sector or utility by replacing inefficient transmission and distribution technologies and overhauling sectoral or utility performance. Every electron gained through such efficiency measures can be sold to consumers without constructing or purchasing additional energy supply. Because the scale is so large, and the points of intervention are relatively few, supply-side efficiency is an obvious, typically cost-effective place to start when energy

supply is inadequate to meet consumer demand. In many cases, megawatts of a utility or energy sector's energy supply can be reclaimed.

In the case of Lao PDR REP, EdL was able to reduce system losses from more than 19% in 2005 to about 10% in 2011. This freed up significant supply, allowing EdL to provide electricity to more consumers and improve the reliability of access for those who were already connected to the grid. By comparison, approximately 46% of people in Nepal are connected to the grid, but only 20% of those connected have reliable access to energy because of load shedding and efficiency losses.¹³

Whereas supply-side efficiency improvements mitigate energy supply losses to better meet consumer demand,

IMPROVING DEMAND-SIDE EFFICIENCY addresses the technical and behavioral losses stemming from how consumers use energy to better accommodate supply. In the context of energy sector reform projects that have energy access as a goal, it has much the same effect: en masse, demand-side efficiency improves access and reliability, lowers costs, and reduce load shedding—thus mitigating the need for additional supply. *In energy access, supply-side and demand-side efficiency efforts are complementary forces.*

However, in developing countries with highly dispersed population centers and limited energy infrastructure, implementing demand-side efficiency measures can be challenging. The market infrastructure needed to effect significant demand-side change – products, distribution channels, market signals, technical expertise, and policy support – is often lacking. The programs that will be the

most successful in integrating EA and EE are those that establish markets and policy infrastructure in which EE is valued and growing. These markets can be established deliberately, or they can grow out of other policies and reforms that encourage and enable consumers to purchase high-quality, affordable, and energy efficient products.

EA+EE and Financial Reform

EdL is a vertically integrated, state-owned utility, and its priorities are set by GoL policy. Its vision and mission include the promotion of “Lao PDR's socio-economic development through the provision of reliable power supply throughout the country.” As supply-side efficiency gains made EdL more financially stable, system costs were lowered, allowing the utility to subsidize local household connections through the Power to the Poor (P2P) program. P2P was a program designed to finance connection fees, which were often too expensive for consumers to pay upfront. The program provided eligible households with a meter and an interest-free three year loan to finance grid connection.

EA+EE and Consumer Trust

Delivering more reliable energy service to more people has improved EdL's relationship with its customers. This, in turn, has given EdL latitude to undertake many of the reforms needed to improve the utility's financial performance and sustainability, such as tariff increases and infrastructure improvements.

By contrast, Nepal's state-owned utility suffers from efficiency losses of 26% and loses \$0.02 on each kWh sold as its production costs outstrip its tariffs.¹⁴ To be financially sustainable, the utility needs to raise tariffs, but it cannot do so because it lacks the support of its customers. Without additional

revenue, the company is limited in its ability to invest in its distribution and transmission systems, which leads to further distribution losses, load shedding, and customer distrust.

Takeaways to Inform Future Project Design

LEAD WITH EFFICIENCY – The goal of EA is to provide *reliable, affordable, adequate* modern energy services to households, businesses and communities without those services. Pouring additional energy into an inefficient system can result in a huge drain on financial resources, and can run counter to the goals of EA.

Efficiency improvements to both the supply- and demand-sides of the energy sector can, depending on the context:

- Improve energy service providers' finances;
- Lower prices for consumers;
- Improve system and service reliability;
- Mitigate load shedding;
- Reduce reliance on erratic global fuel markets; and
- Give utilities and system operators the financial flexibility and customer and political support to make high-impact decisions.

The ideal EA effort will manage the existing energy system first, and then add to the system with additional supply as needed. This is the least-cost approach to energy access.

CONSIDER THE SECONDARY BENEFITS OF

EA+EE – Making the case for EE is not always straightforward or easy. To many policymakers and stakeholders in WB project client countries, the object of energy access is building new infrastructure. For political or

economic reasons, they greatly prefer building power plants over avoiding the necessity to build them. To develop support for EA+EE interventions, it is important to fully consider a project's goals and context and articulate where EE can help clients accomplish their goals and serve their constituents.

In the case of Lao PDR REP, for example, supply-side efficiency enhancements reduced the cost of energy service and improved the financial performance of EdL. This afforded EdL the flexibility to run programs like P2P and improve energy service in rural areas – thereby advancing a GoL objective and building customer and political support for necessary increases in EdL tariffs.

EA+EE is not just about the benefits of lower consumer costs, reduced CO₂ emissions, or system reliability—it is about all of these benefits and more. When scoping projects with clients, consider the various ways EE can help them accomplish their EA goals.

Bangladesh RERED

TITLE: Renewable Energy for Rural Economic Development (RERED)

APPROVAL: 31 Dec 2002

CLOSE: 30 July 2008

CLIENT: Government of Bangladesh (GoB)

IMPLEMENTING AGENCIES: Infrastructure and Development Company Ltd. (IDCOL),
Rural Electrification Board (REB)

Project Background & Overview

As recently as 2002, only 30% of the 129 million people living in Bangladesh had access to electricity. Nonetheless, the country was experiencing GDP growth of more than 5% annually – a rate of growth that continued through the end of the decade. This created a demand for energy that far outstripped the country's expanding but inadequate electricity generation capacity.¹⁵ Through the deployment of distributed renewables and energy efficient end-use devices, energy sector reform, and new grid connections, the RERED project worked to address these issues.

Project Highlights and Lessons

Through a well-publicized CFL swap-out program and the development of the country's world-leading off-grid SHS market, RERED dramatically transformed Bangladesh's energy landscape. The energy access lessons from RERED are justifiably qualified due to several factors—e.g. the country's population density; its rich framework of pre-existing microfinance institutions (MFIs) and non-governmental organizations (NGOs); and relatively high household cash flow due to remittances from the many Bangladeshis working abroad. Nevertheless, RERED offers relatively straightforward lessons on the role of energy efficiency in on- and off-grid ener-

gy access, as well as the impacts energy access can have on energy efficiency markets.

RERED CFL Deployment Program

At the time of RERED's first additional financing in 2009, peak electricity demand in Bangladesh was approximately 5,200 MWs, well above the country's generating capacity of 3,600 - 4,300 MWs. This persistent supply shortfall, and the attendant unreliability of the grid, prompted the GoB to slow down or stop new grid connections by 2007. Recognizing the constraints that this shortfall placed on the country's energy access and GoB's socioeconomic development goals, GoB launched the Efficient Lighting Initiative of Bangladesh (ELIB).

ELIB emerged from GoB's realization that new electric generating capacity would be long in coming. Moreover, new generation would be limited in its impacts due to the need to backfill existing shortfalls and compensate for demand that was growing consistently at 8-10% each year. With assistance from RERED, the Bangladeshi power sector had already addressed supply-side efficiency through significant loss reduction and rationalization initiatives, so demand-side management was the best available tool to address this issue.

ELIB was structured to encourage Bangladeshi ratepayers to exchange incandescent lamps for energy-efficient CFLs. Up to that point, market uptake of CFLs had been low in Bangladesh due to limited consumer awareness, high initial costs, and market spoiling caused by poor quality products. Through ELIB, Bangladeshi utilities procured millions of CFLs which, at the urging of the GoB, they planned to exchange for ratepayers' incandescent bulbs in one day. Schools, community centers, and other highly trafficked, centralized points were used as distribution centers.

Though hampered by several challenges, the CFL distribution program was successful in many regards. More than 5 million CFLs were distributed, and rolling out the entire program in one day required a good deal of logistics and publicity, which GoB and Bangladeshi utilities handled admirably.

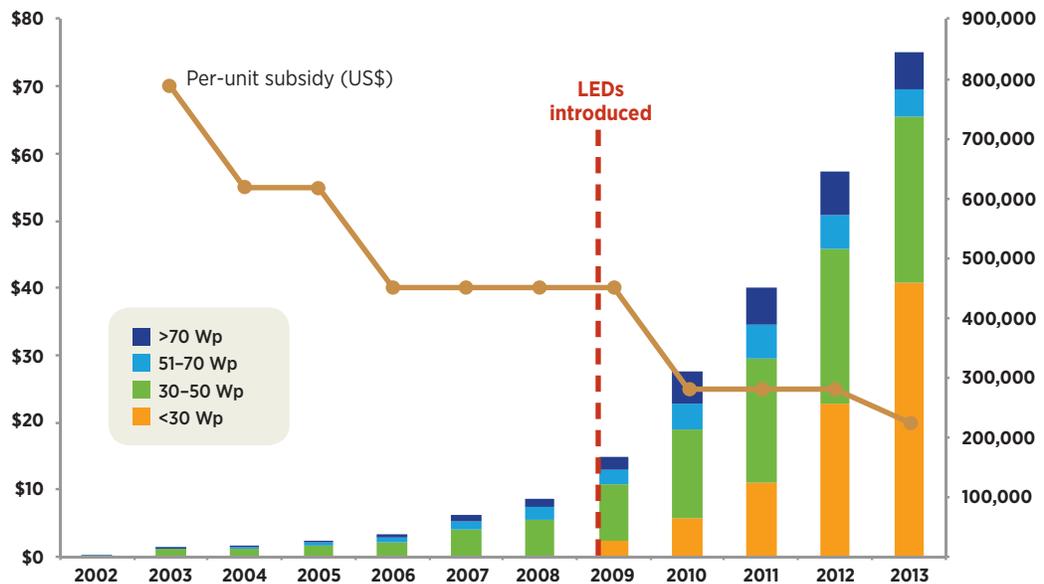
INSPIRING CONSUMER DEMAND – The program's publicity raised consumer awareness about energy-efficient products and energy

efficiency in general, which in turn raised demand for efficient products like CFLs. This heightened demand inspired a new, competitive market for efficient products in Bangladesh that continues to pay dividends, saving Bangladeshi ratepayers money, reducing peak demand, and providing a variety of positive social and environmental externalities.

THE CHALLENGES OF APPROPRIATE PRODUCT PROCUREMENT –

The rush to get a “quick win” from the program resulted in some design flaws that severely limited its impacts. Bangladeshi utilities were responsible for procuring the CFLs, yet they had no experience with bulk procurement of efficient products. Additionally, the procured products proved to be low quality and ill-suited for Bangladesh's spotty electric grid. A survey revealed that 34% of the products had failed within a few months, and laboratory tests revealed that the CFL's lifetime was significantly less than what was called for in the program's technical specifications. A second phase of procurement suffered from bidders submitting fraudulent performance guaran-

Figure 4: Verified SHS Sales in Bangladesh, 2002–2013



Note: Beginning in 2013, the per-unit subsidy was available only for SHSs smaller than 30 Wp.
 Source: IDCOL, Zadeque, S. et al. “Scaling Up Access to Electricity: The Case of Bangladesh.”

tees, or not submitting them at all. The second phase was ultimately abandoned.

RERED SHS Program

A good deal has been written about the success and particularities of Bangladesh's world-leading SHS marketplace.¹⁶ For the purposes of this report, which focuses on underscoring the potential of incorporating energy efficiency into energy access projects, *it is perhaps enough to say that there is no better example of the power of EA+EE than the Bangladeshi SHS market.*

The experience with SHSs in Bangladesh began with the country's recognition that achieving universal grid access would take decades. Off-grid SHSs offered a faster, more cost-effective way to extend basic modern energy services – lighting, television, mobile phone charging, etc. – to rural and remote households. The program began with a modest goal of deploying 50,000 SHSs and utilized an ownership model managed by IDCOL involving many of Bangladesh's MFIs, which became IDCOL Partner Organizations (POs), as well as a “fee for service” model led by the REB. By 2009, POs had sold 390,000 systems compared to the REB's 14,000. This demonstrated the effectiveness of the ownership model, and the fee for service model was discontinued.

EFFICIENT OFF-GRID APPLIANCES & COMPETITIVE SHS MARKETS

– Most of IDCOL's initial POs were existing MFIs, and they had long competed for the trust and business of rural customers. Subsidies lowered the prices that consumers faced for much of the program, and a \$20 USD per system capital buy down grant is as of this report still in place for the smallest systems. Nevertheless, POs competed heavily on price for customers. Any technical or business model improvement that could bring down prices and help POs reach

a broader set of customers was welcome. Falling solar PV and component prices – as well as the efficiencies gained from scale and market experience – helped to lower prices, but nothing impacted the price of energy service, and the IDCOL market, as significantly as the introduction of LEDs.

On average, low-voltage DC batteries and solar PV account for nearly 60% of Bangladeshi SHSs.¹⁷ By providing an equivalent level of service that requires far less energy, super-efficient appliances like LEDs dramatically reduce the size of the battery and PV module an SHS needs. Thus, a 20 watt-peak (Wp) system with super-efficient appliances can serve a household that would have once needed a much more costly 50 Wp system. This reduction in system cost more than covers any marginal cost increase from improved appliance technology, and the entire SHS is much more affordable to many more people.

Since IDCOL POs' introduction of LEDs in 2009, the market has seen a remarkable shift toward smaller, more affordable SHSs – and, consequently, a marked increase in households with modern electric services. IDCOL POs have now sold more than 3 million SHSs—and the vast majority of those have been sold since smaller, more affordable LED-bundled SHSs hit the market.

The rapid expansion of Bangladesh's SHS market has led to high demand for LEDs, and a notably strong marketplace of LED manufacturers has emerged in Bangladesh. Several Bangladeshi LED manufacturers performed very well in the 2014 Global LEAP Awards, an international off-grid appliance competition that recognizes off-grid compatible LED appliances and televisions for their affordability, performance, and energy efficiency.

Takeaways to Inform Future Project Design

PRIORITIZE EFFICIENCY IN OFF-GRID PROJECTS – Many factors have contributed to the remarkable success of the IDCOL-managed SHS market in Bangladesh, but few if any of them are as transferable as energy efficiency. LEDs and other super-efficient appliances like TVs and fans dramatically and cost-effectively lower off-grid energy costs, enabling demand and driving sales.

Any project featuring off-grid energy systems like SHSs should prioritize the efficiency of off-grid appliances. Efficient off-grid appliances dramatically lower the prices consumers face, spurring market growth and EA.

WHEREVER POSSIBLE, BUILD EA+EE MARKET INFRASTRUCTURE – The Bangladeshi SHS market is perhaps unique for the fecundity of the market- and policy-ecosystem from which it grew—at the time, perhaps no country in the world was as ready for a successful off-grid energy market as Bangladesh. From the outset, Bangladesh had reliable distribution channels, relatively robust technical and laboratory capacity, an eager and supportive government, consumer finance, and private actors with rational interest in a successful, competitive market. While replicating the degree of success of the Bangladeshi SHS market may be impossible, developing the elements of market infrastructure that enabled it is comparably straightforward.

In some regards, RERED's CFL distribution program failed to meet expectations. The program was hampered by procurement challenges, and it failed to meet its demand reduction goal due to the high number of lamp failures. However, in terms of market development and consumer education, the program exceeded expectations. By educating the Bangladeshi public on the ener-

gy- and money-saving potential of CFLs, the program created significant demand for CFLs—and, presumably, other energy efficient products. A competitive commercial market emerged to satisfy this demand, which continues to drive RERED and GoB energy access goals.

The WB's EA impacts will be longest lasting where its projects establish markets and policies that continue to drive an EA+EE agenda.

FACILITATE STREAMLINED, SMARTER PRODUCT PROCUREMENT – Challenges with product procurement and bulk purchasing have been the undoing of too many WB project components. In the case of Bangladesh RERED, the first round of CFL deployment was impaired by the utilities' lack of experience in bulk procurement; consequently, its demand management and energy access impacts were lessened. The second round was ultimately closed when project managers were unable to find reliable vendors.

In many WB EA projects, as was the case with RERED, procurement decisions are dictated first by the projects' or clients' technical specifications and second by least-cost principles. While this is completely reasonable, it may not be the best framework for the purposes of EA+EE. Many energy-using devices last many years, and so their quality, durability, and energy performance are fundamental to the value they provide to consumers, client government objectives, and social and environmental goals.

A tool or series of tools to help project managers, clients, and stakeholders quickly and easily compare and purchase commonly-procured EA products on the basis of the characteristics that matter most to EA+EE principles will save time and money, and help deliver project impacts.

Sri Lanka RERED

TITLE: Renewable Energy for Rural Economic Development (RERED)

APPROVAL: 7 Oct 2002

CLOSE: 31 Dec 2011

CLIENT: Government of Sri Lanka (GoSL)

IMPLEMENTING AGENCY: DFCC Bank

Project Background & Overview

At the time of RERED's origination, GoSL was eager to avoid an energy crisis. The island nation was electrifying relatively quickly, having set a goal to achieve 75% electrification by 2007, but many rural Sri Lankans – particularly in the less developed eastern provinces – were still without power. Moreover, Sri Lanka's grid often suffered generating capacity shortfalls and was heavily reliant upon conventional hydroelectric supply—any unexpected fluctuations in water levels could easily disrupt grid supply and economic development, risking political unrest. At the time, Sri Lanka's best recourse during such disruptions was the deployment of back-up generators using costly imported fossil fuels. Expanding and diversifying the electric supply through indigenous renewable energy (RE) sources, which were deemed least-cost, was a government priority.

RERED's stated objectives were to (1) improve the lives of unelectrified rural Sri Lankans through the deployment of distributed RE technologies such as off-grid SHSs and minigrids and (2) provide comparatively attractive financing to encourage private sector development of grid-connected RE supplies.

Project Highlights and Lessons

Leveraging market infrastructure and lessons learned developed by the earlier WB-backed Energy Services Delivery (ESD) project, RERED's components were designed to improve Sri Lanka's RE enabling environment, extend electricity to off-grid populations, diversify and secure grid supply through RE project finance and technical assistance, and enhance the country's EE and demand side management (DSM) capacity through consumer awareness and training of ESCOs.

Enhancing Grid Supply through Renewable Energy

Due to lack of familiarity and perceived risk, commercial banks in Sri Lanka were hesitant to finance RE projects and loans to developers were in short supply. The limited available finance came at unfavorable rates. Through the initial project and additional financing, RERED sought to supply financing to private sector developers sufficient to install 135 MW of grid-connected RE generation, an increase of 400% of the 31 MW installed at the time of project origination.

This component was highly successful. As of the time of the project's ICR in 2012, 147.8 MW of grid-connected RE had come online,

with another 36.5 MW under construction. Between 2003 and 2011 there was a period of rapid electrification in Sri Lanka, and 48% of this new capacity was from RE. The impacts are manifold: Sri Lanka now has a relatively diverse, more resilient power generation mix that is less reliant upon costly imported fossil fuels, and the country has developed “a world-class renewable energy (mainly mini-hydro) industry that is now expanding its services and investments to Africa and other Asian countries.”¹⁸

Extending Service to Unelectrified Populations

RERED’s off-grid component faced unforeseen challenges, and the goal of electrifying rural households with off-grid energy systems was revised from 161,000 to 113,500. Between 2005 and 2008, demand for and sales of SHSs fell from 2000/month to 800/month, due in large part to the country’s remarkable expansion of grid services, a tightening of loan availability due to frequent borrower defaults, and consumer perceptions about SHSs tainted by SHS vendors not honoring warranties and after-sales service obligations.

Despite these challenges, this component successfully delivered electricity to many Sri Lankans who may still be without electricity had they been forced to wait for the grid. As per the ICR, nearly 116,000 SHSs had been deployed with RERED support.

Energy Access + Energy Efficiency

By raising awareness and providing training to small businesses, RERED’s EE component was designed to support the development of an ESCO market, thereby removing one barrier to energy efficiency investment in Sri Lanka.

For several reasons this component was challenging, and it was decided that a refo-

cus on the project’s larger, more impactful components was in order. The component’s challenges were attributable to the relatively limited resources allocated – it received just 0.9% of the project’s total financing – and competition for the services offered by the component from a larger, more favorably financed Environmental Friendly Solutions Fund (E-Fund), an initiative to drive EE in Sri Lanka supported by the Japanese government.

Despite the challenges and ultimate shuttering of its EE component, RERED offers constructive opportunities to consider the role of energy efficiency in energy access, the impacts of energy access upon market and/or sectoral energy efficiency, and how WB access and efficiency interventions might in the future be better tailored to complement one another.

EA+EE & PROJECT STRUCTURE – Per RERED’s ICR and conversations with the project’s TTL, from the outset it was difficult to give the project’s EE component adequate attention. First, the component was relatively small, accounting for just 0.9% of total budget. Signals to RERED team members about what would “make or break” the project were clearly aligned with the project’s larger, supply-side components. Successfully implementing EE market transformation programs can be quite challenging—doing so while driving much larger supply-side initiatives would be a tall order for any team.

Second, focused as RERED was on mitigating issues like electricity generation shortfalls, it was the project team’s sense that the role of the project’s EE component in the larger sectoral reform strategy wasn’t adequately articulated. GoSL had several goals related to the provision of energy to its citizens, but its most pressing goal was the development

and reliability of supply side resources. While the development of EE market infrastructure is valuable in and of itself, it's not clear that RERED's EE component targeted the parts of the Sri Lankan market that would optimally address this goal.

It might be that a refinement of component scope, tools or data related to the beneficial role of EE in supply-side enhancements, and/or better communication of the component's contribution to GoSL and RERED objectives might have facilitated greater GoSL, market, and project team engagement.

STAKEHOLDER ENGAGEMENT & PARTNERSHIP – RERED's progenitor, ESD, emphasized energy access through off-grid RE systems and spurring private sector investment in grid-connected RE supply development. In making the request that resulted in RERED, GoSL was motivated to sustain the successes and private sector engagement achieved by ESD, and ESD stakeholders were convened to scope RERED. It might well be that Sri Lankan or regional EE stakeholders could have played a larger, higher impact role in scoping RERED and developing GoSL's appetite for efficiency.

Further, the Japanese government was evidently invested in successful reform of Sri Lanka's energy sector, and its E-Fund program served as something of a competitor to RERED's EE component. There might have been an opportunity to collaborate with E-Fund and its implementing agents such that both projects benefitted.

ACCESS DRIVING EFFICIENCY – While EE was not at the center of GoSL's distributed RE strategy, it does appear that the Sri Lankan off-grid RE market helped support the emergence of an efficient products market (as it did in Bangladesh).

The project's TTL reports that visits to rural off-grid communities that had benefitted from the project's SHS efforts showed that nearly all households and SMEs with SHSs were using CFLs. How CFLs came to this segment of the market is unclear. Given the limited income of most off-grid people and the marginally higher upfront cost of CFLs, it's fair to assume that the CFLs' use was driven by the energy capacity needs of the SHSs. Because of the capacity limitations of off-grid energy systems, these households and SMEs would not be able to power multiple appliances had they continued using incandescent lighting.

Takeaways to Inform Future Project Design

STRUCTURE MATTERS – Where EA+EE is desired or essential, the WB would be wise to design components such that they're sufficiently funded and the role of EE in EA, and vice versa, is evident in project reporting indicators. This will help send appropriate signals to project team members, clients, and market stakeholders.

Project structure matters—align project component design, metrics, and incentives with EA+EE goals.

DRIVING THE EA+EE NARRATIVE – Despite its many benefits, energy efficiency remains a tough sell in many policymaking and market circles. This is particularly true in the energy access community, a field largely dominated by people motivated by the socioeconomic benefits of extending clean and reliable energy supply to BoP communities, but less engaged by the specifics and implications of end-use.

Many energy access professionals have not been exposed to, or do not yet appreciate, the EA+EE dynamic. Resources and financial

products that help the WB's project team members and clients appreciate that a MW avoided is *at least as valuable* as a MW installed – and that *energy service*, not *energy itself*, is what is needed and desired by under-electrified people – could rapidly push the EA+EE issue forward, generate cutting edge project models, and help the energy access community realize faster, more cost-effective human and environmental impacts.

Because of its position, the WB has a remarkable opportunity to drive this agenda. The benefits that EE brings to EA are relatively clear – lower project and consumer costs, mitigated after-market risk, longer run times and more reliable supply, etc. – but the benefits of EA+EE to larger EE goals may prove to be even more significant. Markets requiring access are typically energy “green fields,” and work there could very well generate technological innovations and smart business/project models with global benefits. Positioning efficiency as essential to access might, in time, show that access was essential to efficiency.

Financial product and models, and educational and communications tools, are needed to convince clients and WB EA staff of the value of EA+EE, and to equip them to act.

LEVERAGE & DEVELOP EA+EE PARTNERSHIPS

The WB often brings a good amount of financing to its access projects, and market and development stakeholders are generally keen to leverage such funds and/or participate in the resulting programs. In some project markets it might be possible and fruitful to partner at the project outset with EE programs, industries, or practitioners—where these EE stakeholders do not yet exist, the WB might consider helping develop that community. Doing so, the WB and its clients

will likely achieve improved access outcomes, and the market as a whole will benefit from greater energy efficiency infrastructure.

Where possible, bring EE stakeholders into the EA project planning and implementation process. Where such stakeholders do not yet exist, strongly consider including the development of that stakeholder community as a core project component.

Peru Rural Electrification Project

PROJECT APPROVAL: 7 March 2006

PROJECT CLOSE: 30 June 2013

CLIENT: Republic of Peru

IMPLEMENTING AGENCY: Ministry of Energy Directorate of Competitive Funding (DFC) & General Directorate of Rural Electrification (DGER)

Project Background & Overview

Peru has seen sustained economic growth in recent years, which has aided poverty reduction and job creation efforts and created increased demand for electricity. However, poverty rates in rural Peru remain significantly higher than in urban Peru. As recently as 2012, poverty levels in rural Peru were 53% but just 14.5% in urban Lima. Adding to this complexity, there is a marked difference between energy access rates in urban and rural areas. The 2007 census found that only 29.5% of rural Peruvian areas had access to electricity.

To expand electricity coverage and expedite poverty alleviation objectives, the Government of Peru (GoP) has invested an average of US \$40-50 million per year for electrification. Yet, these investments were insufficient to meet GoP's energy access goals expeditiously, and additional funds were needed.

To increase access to efficient and sustainable electricity services in rural Peru, the Peru Rural Electrification Project (REP) included both grid extension and off-grid components. By expanding electricity service, the project aimed to improve the quality of life in rural areas and to support economic development through the productive use of energy.

To achieve these objectives, REP invested in rural electrification projects using both on- and off-grid renewable energy systems, implemented a pilot program to increase the use of electricity for income generation, and provided financing for hydropower investments.

Project Highlights and Lessons

REP did not have an explicit energy efficiency component; nevertheless, this project illustrates that even if energy efficiency is not explicitly included in a project, it is often incorporated to achieve access objectives. For example, Peruvian energy service providers (ESP) participating in the program provided training on energy use and costs when connecting a new customer, which was important to the financial stability of these new ESPs. If customers did not manage their usage and were unable to pay their energy bill, the ESPs' business models would become untenable.

The project also included a "productive uses of electricity" component to encourage income-generating uses of energy, which the project designers and ESPs hoped would also increase the customers' ability to pay for energy services. This component's goal was to encourage the use of 18,000 MWh of pro-

ductive electric use, which the project met and exceeded.

CAPACITY BUILDING THROUGH ENERGY EFFICIENCY EDUCATION

– To build a viable, sustainable customer base, ESPs led community training initiatives on energy use and safety for the newly connected. Training was also provided to recipients of SHSs, as they needed to understand which appliances could safely and effectively be used with their system. Per conversations with the project TTL, a significant portion of training time was spent explaining demand management principles and the importance of using efficient end-use devices to keep energy costs low. REP training materials were not available as of this writing. However, these training programs were a notable success of the project, and there may be an opportunity to leverage REP's experience with new customer training for future access projects.

DESIGNING SHS MARKETS – The project set a goal of distributing 20,000 SHSs through rural ESPs but was only able to distribute 7,100. Per the project TTL, the primary constraint in meeting the target was that the tariff-setting process delayed the products' availability because ESPs could not buy and install systems without a set tariff. However, the project succeeded in demonstrating a novel off-grid financing model, approved by Peruvian regulators, which included cross-subsidization from grid-connected consumer.

All of the SHSs distributed through REP were 60 Wp, and were distributed with a fixed configuration of appliances: three CFLs and a black and white TV. One observation from the WB's experience in Peru is that many SHS customers were not satisfied with service provided by the 60 Wp panels, CFLs, and black and white TVs. Many of these customers invested in modular increases to solar

capacity so that they could run additional appliances like refrigerators.

Key Takeaways to Inform Future Project Design

CUSTOMER EDUCATION IS ESSENTIAL – When a new electric on- or off-grid connection is made, it is important for customers to receive training on how to use energy safely and efficiently. Energy use is a potentially difficult concept for newly connected customers, and everyone – customers, energy companies, and projects – benefits when customers understand how end-use devices will affect their energy bill or the performance of their SHS.

Work with ESPs, NGOs, and local governments to develop training materials on energy use that can be presented to newly connected customers.

SETTING APPROPRIATE METRICS – REP's "productive use" component was arguably its biggest success, driving more than 19,000 MWh of productively used electricity. However, as the WB moves to incorporate EA+EE principles, measuring marginal energy consumption, rather than the service or development goals met through that consumption, may prove counterproductive. Energy consumption enables socioeconomic development goals, but it is also subordinate to those goals, and a more efficient use of energy to meet WB and client objectives is desirable for a variety of reasons.

Design access projects to measure success in terms of increased energy service rather than energy consumption.

WORKING WITH LOCAL NGOS TO LEVERAGE INVESTMENTS

– The project TTL noted that working with local NGOs to communicate the importance of energy efficiency was very

effective. The NGOs understood the needs of local communities and were able to effectively advocate on customers' behalf to ESPs and other project stakeholders to enable and enhance energy access objectives. Identifying and involving the right local partners in training and outreach programs can be more effective than relying solely on ESPs, who may not have the appropriate skills or incentives.

Identify the strengths of local partners active in the community to improve project outcomes.

STRUCTURING SHS MARKETS FOR SUCCESS –

This project did not fulfill its goal of backing the installation of 20,000 SHSs in large part because of the delay in establishing the SHS market's tariff. The project TTL also saw that energy service demand from at least some SHS purchasers was not met by the 60Wp SHS and its three CFLs and black and white TV. It may be that a more flexible and competitive SHS market, such as Bangladesh's – one with a variety of SHS sizes and super-efficient off-grid appliances and tariffs set and then adjusted as needed by ESPs and/or local NGOs – could have reached more customers, and achieved REP's objectives, more quickly.

“One size fits all” may not be the best approach for establishing new SHS markets. Packaging differently sized SHSs with a variety super-efficient products can provide a more diverse group of customers with more energy service at a lower price point.

Mongolia Renewable Energy and Rural Electricity Access Project (REAP)

PROJECT APPROVAL: December 19, 2006

PROJECT CLOSE: December 31, 2011

CLIENT: Government of Mongolia

IMPLEMENTING AGENCY: Ministry of Mines Resources and Energy

Project Background & Overview

Mongolia has a population of 3 million people, about 1.2 million of whom live in the urban capital of Ulaanbaatar. The remainder of the country's population is spread over its vast rural areas, primarily among small Soums (villages or prefectures) and groups of nomadic herders. At the outset of REAP, much of Mongolia was connected to a relatively reliable grid. Many off-grid Soums, however, relied on diesel-powered mini-grids, the reliability of which was subject to high-prices, the logistical challenges of diesel transport, and seasonal and global market fluctuations in fuel availability. Meanwhile, Mongolia's nomadic herders had negligible access to energy as a market for appropriate products and services, i.e. SHSs and small wind turbine systems (WTSs), had not yet developed because of highly dispersed communities and the herders' limited ability to pay.

REAP was designed to break down several of the barriers blocking the emergence of a market for appropriate rural electrification services in Mongolia. Its objectives were to increase access to electricity and improve the reliability of electricity service among the herder population and in off-grid Soums. It achieved this by building markets for SHSs

and WTSs that could serve nomadic herders and improve the reliability of electricity services in Soums through increased deployment of renewable and renewable-diesel hybrid mini-grids.

The project facilitated the sale of over 67,000 SHSs and WTSs, exceeding its target by almost 35% and greatly contributing to the Government of Mongolia's (GoM) goal of distributing 100,000 SHSs to herders by 2012. As a result, more than half a million people, including 60-70% of Mongolia's nomadic herders, now have access to modern and reliable electricity services.

In the interest of preserving the herders' unique culture, REAP provided them with SHSs and WTSs that were portable and adaptable to the nomadic way of life. The systems were available for sale in Soums, with a subsidy that covered roughly half of the cost of the system. There were some initial difficulties in getting the systems to market, as few Mongolian retailers or distributors had sufficient capital to purchase thousands of SHSs and WTSs. After a thorough market assessment of herders' demand for SHSs and WTSs, REAP emulated a parallel GoM program and procured large orders of off-grid systems, distributing them through Soum administration facilities and private retailers.

One of REAP's most innovative and high-impact features was the establishment of 50 certified regional sales and service centers (SSCs) at Soums throughout Mongolia. Rather than forcing the herder SHS customers to travel to Ulaanbaatar for after-sales service and upkeep, these centers offered affordable maintenance and component sales within a reasonable distance of the herders. This greatly reduced the incidental costs of owning SHSs and WTSs and improved their utility. They were also the start of a nascent technical industry and a market for replacement parts and off-grid-compatible appliances. The SSCs are privately operated, but were selected after receiving training and certification through REAP to ensure that technicians were qualified and had the skills necessary to service the off-grid systems.

The combination of the market assessment to identify herder demand for off-grid systems and the establishment of SSCs that could keep the systems functional and useful was extraordinarily effective. A survey of herders who had purchased off-grid systems through the REAP program found that 41.7% were "extremely satisfied," 51.7% were "very satisfied," and that 99.6% would recommend the systems to others. From a socioeconomic development standpoint, it is significant that 70.5% of the herders cited "increased productivity for work" as the key benefit linked with the installation of the off-grid system.¹⁹

Project Highlights and Lessons

REAP did not feature an explicit energy efficiency component, but it does present a good illustration of the value of establishing EA+EE market infrastructure. As seen in the Bangladeshi and Sri Lankan projects, the needs of the off-grid market will often drive demand for, and the development of, an efficient products market. REAP provides a good example of project leaders working

within a country's existing landscape to break down market barriers and encourage EA+EE market infrastructure.

LEVERAGE EXISTING MARKET DYNAMICS IN EA+EE MARKET DEVELOPMENT – The need for after-market service was a major barrier to the expansion of off-grid energy markets to nomadic herders in rural Mongolia. For herders needing to replace or repair SHS or WTS components or appliances, traveling hundreds of kilometers to an urban center like Ulaanbaatar would not have been feasible and would have caused them to fall back on candles and kerosene for energy service. This aspect of the Mongolian off-grid marketplace threatened to greatly reduce the usefulness of SHSs and WTSs to the herders and their positive development impacts.

REAP's solution to this challenge was to leverage existing technician/retail operations in Soums throughout Mongolia to foster a network of regional SSCs, to which SHS and WTS owners could more easily travel for any after-market sales or service needs.

This solution presents, in many ways, a "win-win" situation: far-flung Mongolian herders have an accessible resource for services related to off-grid systems and compatible appliances, the owners of the SSCs received training and additional customers, and the economies of the villages where the SSCs were established have received a slight boost. GoM and project team members can be reasonably well-assured that the off-grid systems distributed through REAP and other efforts will have lasting usefulness and impacts.

Though fairly obvious in hindsight, this solution required a fair amount of flexible, strategic thinking from the REAP team and GoM. It required a thorough understanding of the dynamics of the Mongolian marketplace

and recognition of its barriers, and significant dedication to working with market actors to develop capacity and raise awareness.

Ideas for Future Project Design

ASSESS AND WORK WITHIN THE DYNAMICS OF LOCAL MARKETS – Many WB access projects take place in rural areas with limited market infrastructure, and TTLs managing such projects have shared that it is often difficult to deliver consumers and businesses adequate energy service, training and support. REAP's response to these challenges (e.g. appropriate demand assessment, flexible procurement and sales model, establishment of SSCs) was essential to its success and the sustainability of its impacts. It provides a conceptual model for success in developing EA+EE markets in other contexts.

Like Bangladesh RERED, Mongolia REAP is a unique project with a unique context—but the lesson it provides in patiently assessing a market's barriers and flexibly responding to them is highly transferable.

Bolivia Decentralized Electricity for Universal Access Project

PHASE I:

PROJECT APPROVAL: July 2, 2007

PROJECT CLOSE: June 30, 2013

PHASE II:

PROJECTED IMPLEMENTATION START DATE: June 22, 2015

EXPECTED CLOSING DATE: Dec 1, 2021

CLIENT: Government of Bolivia

Project Background & Overview

Bolivia has one of the highest poverty rates and lowest rural electrification rates in Latin America. Its low population density and mountainous terrain has made it difficult for the country to achieve its goal of universal grid connectivity. The two-phase Decentralized Electricity for Universal Access project aims to increase affordable access to electricity in remote, rural areas of Bolivia and meet the national goal of universal access by 2025.

The first phase of the project was completed in 2013 and focused on extending off-grid access by installing over 7,000 SHSs and over 5,000 Pico PV systems in rural households, schools, clinics, and SMEs. The second phase of the project includes both grid extension and off-grid components. Both SHSs and Pico PV systems will be utilized to provide energy to off-grid customers. The SHSs will come with lamps and a cell phone charger; any other appliances will be purchased by the customer. Implementation of the second phase of the project will begin in June 2015.

The TTL for this project acknowledged that Bolivians would benefit from installing systems that use LEDs and efficient appliances, but it is challenging to build markets for

these products in rural, mountainous communities. The selection of lamps and other appliances available for purchase is very limited, and it is difficult to educate dispersed communities about the benefits of purchasing energy efficient products.

Energy efficiency was not mentioned in the PAD for the second phase of the project, but the project's TTL said that outreach activities are being planned to educate those who are newly connected to the grid about the importance of energy efficiency.

Project Highlights and Lessons

The barriers to EA+EE in Bolivia reflect those faced by many other countries with rural electrification goals: highly dispersed populations, relatively few market centers, and limited market infrastructure such as product availability and policy support.

The project's TTL recognizes the benefits of EA+EE, but lacks the tools and resources to robustly incorporate EE into this project. The suggestions made below are in line with feedback received from the project's TTL and consider lessons learned from other WB projects that could be applied in Bolivia.

Ideas for Project Design

CONDUCT RESEARCH TO INFORM PROGRAM

DESIGN – The second phase of this program has a component that will connect new consumers to the grid and educate them on energy use. Data on the energy use patterns for customers newly connected to the grid would be extremely useful in tailoring and targeting the program. Ideally, this research would demonstrate which tactics and programs are effective at teaching consumers to use energy efficiently and ensure that they are able to pay their energy bill.

DEVELOP A EA+EE MARKET INFRASTRUCTURE

– Mongolia’s REAP faced similar challenges to Bolivia in terms of providing energy to a large number of people who reside in sparsely populated rural areas. Under REAP, regional sales and service centers were established that were privately operated but trained and certified under the program to ensure they had adequate qualifications and knowledge to service the SHS industry in Mongolia. Service centers can fix problems with batteries and other parts of the SHSs, and also sell energy efficient off-grid compatible appliances. In Mongolia, this created business opportunities and commercial markets that did not previously exist and it may have the same effect in Bolivia—coupling the establishment of these sales and service centers with a consumer awareness effort built around energy efficiency could be particularly beneficial.

PROCUREMENT TOOLS ARE NEEDED TO

IDENTIFY HIGH QUALITY PRODUCTS – In the absence of a global standard for SHSs, or standards and labeling programs for the appliances that can be used with these systems, more data and information is needed to help both institutional purchasers like the WB and local consumers make informed decisions. A database of off-grid products with information on product testing, system compatibility,

standards, prices, product durability and other information would provide purchasers with more information about the market and help them avoid problems such as early product failure. A labeling or certification scheme system for off-grid products could also be considered; however, this presents additional challenges given that the standardization process moves slowly while the technology is evolving very quickly. Additionally, the economy may not be large enough to support labs to test products in small countries like Bolivia.

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