SPECIAL FEATURE SEAR

ENERGY EFFICIENCY

A KEY ENABLER FOR ENERGY ACCESS

Matt Jordan, CLASP, Jenny Corry, CLASP, and
Ivan Jaques, World Bank

SEAR

ENERGY EFFICIENCY
A KEY ENABLER FOR ENERGY ACCESS

Matt Jordan, CLASP, Jenny Corry, CLASP, and Ivan Jaques, World Bank

INTRODUCTION

Energy itself does not meet the needs of energy-poor households, businesses, and communities. Rather, it is the services that energy enables—such as lighting, telecommunications, refrigeration, cooking, transportation, and mechanization—that transform lives and accomplish the goals of energy access. Yet billions of people today in developing countries (in both rural and urban areas) lack sufficient access to reliable, cost-effective modern energy services, which would help lift them out of poverty.

What can be done to improve this picture? A potent, too-often overlooked resource in global efforts to deliver modern energy services at least cost is energy efficiency. By reducing the energy supply investments required to provide energy services, greater efficiency optimizes the delivery and utility of energy service while mitigating the costs and harmful social and environmental impacts of energy supply. One estimate even suggests that universal access to modern energy services could be delivered using 50—85 percent less energy if currently available efficiency measures were utilized.[1]

The benefits of energy efficiency are well-documented in residential, commercial, industrial, and transportation sectors in developed economies, and theory and limited experience from the field suggest that efficiency is a first-order energy access resource. Wherever energy supply investments are needed, energy efficiency should reduce the amount of investment needed. Wherever existing supply resources fall short, or are unduly expensive on the margins, energy efficiency should (i) improve sectoral or system reliability and performance and (ii) mitigate marginal fuel or tariff costs.

Unfortunately, energy efficiency is too rarely used as a resource in energy access efforts, and there are important gaps in the research and techno-economic analysis needed to support its use. The goal of this special feature is to highlight the role of energy efficiency as an energy access resource, along with providing an overview of opportunities where energy efficiency is supporting—and in many cases enabling—significant energy access impacts.

FRAMEWORK FOR INTEGRATING ACCESS AND EFFICIENCY

Energy access programs and policies often approach access as a supply-side problem, structuring efforts in such a way that the construction, availability and utilization of energy supply—rather than the provision of reliable energy services at least total or life-cycle cost—is the goal. This approach is evident in programs and projects that set and work toward targets like "10,000 MW of new generating capacity installed", "50,000 new connections," and "150,000 MWh consumed."

Energy access is a supply-side problem, but it is also a demand-side problem—and addressing the demand-side often mitigates supply-side needs. Integrating energy efficiency into energy access efforts requires that practitioners approach access holistically, shifting the way projects are designed and success is measured to prioritize the provision of reliable energy service at least cost. By reducing supply investments and consumers' energy costs, smart deployment of energy efficiency can dramatically accelerate energy access impacts—but, in time, it may also yield significant energy efficiency impacts. For example, as table 1 shows, at the lowest access level, energy-efficient light emitting diodes (LEDs) can radically reduce the size and costs of the solar PV and batteries needed to provide service, making these technologies affordable for vast new market segments. At the middle access level, energy-efficient appliances can increase the number of connections a mini-grid can support and lower a system's capital cost requirements, potentially improving financial viability. These access levels reflect a multi-tier framework adopted by the Sustainable Energy For All (SE4ALL) initiative to track global energy access.

In countries where power sector reform and grid extension efforts are necessary, robust markets for efficient products and services typically do not exist. Thus, programs and policies that build sustainable markets that reward energy efficiency can have significant impacts, sending appropriate signals about efficiency's value, encouraging commercial and technological competition on the basis of efficiency, and locking in efficiency's benefits over the long-run. Power sector development and reform offer a chance to build energy efficiency into the foundation of emerging energy markets, avoiding the challenges of established markets where efficiency is leveraged to address longstanding problems ex post.

In off-grid contexts, solar companies are working to build a global market that could someday reach hundreds of millions of consumers. The unique economics of the off-

TABLE 1 Energy access interventions and indicative energy efficiency benefits

The EA+EE Opportunity in Context

ACCESS TIER	TECHNOLOGY OR MODE OF DELIVERY	ENERGY EFFICIENCY'S VALUE PROPOSITION
TIER 1	Solar Portable Lanterns / Pico PV	Energy-efficient light emitting diodes (LEDs) radically reduce the size and costs of the solar PV and batteries needed to provide service, making these technologies affordable for vast new market segments.
TIER 2,3,4	Off-Grid Systems	Energy-efficient appliances radically reduce energy supply needs, allowing a given off-grid system size to provide greater service and smaller, more affordable systems to provide equivalent service.
	Micro- and Mini-Grids	Energy-efficient appliances and devices can increase the number of connections a mini-grid can support, and can reduce a system's capital cost requirements, potentially improving financial viability.
	Industrious / Community Uses	Energy efficiency reduces the energy costs and/or extends the run time of motorized products such as mills, grinders, and pumps. Efficient solar LED street lights increase public safety and facilitate after dark commerce. Efficient solar pumping systems for irrigation have been found more cost effective than the average electric pumps.[2] Efficient medical applications operate more reliably in under-electrified rural clinics, or require smaller and more affordable off-grid energy systems.
TIER 5	Grid Electrification / Power Sector Reform	Supply- and demand-side efficiency improvements can enhance power sector reliability and financial performance; lowering prices for consumers, and increasing likelihood of energy bills being paid. In sectors with subsidized tariffs, efficiency can lower government costs.

Note: SE4All has developed a multi-tier framework for global tracking of energy access. Tier 1 represents very low energy service and Tier 5 includes full grid connectivity with higher power appliances. See "Beyond Connections: Energy Access Redefined", ESMAP, 2015.

grid market—where the costs of solar PV and batteries can be as much as 58 percent[3] or more[4] of purchase price—place an extraordinary premium on energy efficiency, as shaving even a single watt from an off-grid appliance's load leads to lower initial solar package costs or improved service, and often both. This has led one scholar to predict that significant "investment in the development of super-efficient appliances for off-grid applications should lead to a major acceleration of energy efficiency improvement rates globally."[5] Moreover, the cost of these systems has gone down in part thanks to the emergence of direct current (DC) end-use appliances, where renewable energy-based off-grid solutions are expanding rapidly. These appliances eliminate the need for inverters and reduce distribution losses, maximizing the use of limited output from small generation units. The increasing adoption of renewable energy off-grid access systems can boost the demand for DC appliances, helping reduce their cost (due to economies of scale-induced market transformation) and opening new markets.

ENERGY EFFICIENCY'S CONTRIBUTION IN EXPANDING AND SCALING-UP ENERGY ACCESS

In 2011, the International Energy Agency (IEA) estimated that $640 billion will be needed by 2030 to achieve global access to electricity.[6] However, recent analysis suggests that the same level of energy service assumed in IEA's analysis can be provided much more cost-effectively—for about $200 billion—if currently available energy efficiency technology is utilized.[7] Indeed, as figure 1 shows, greater end-use efficiency could reduce energy usage and energy supply needs in all five SE4All access tiers, ranging from 46 percent at tier 5 (highest level) to 83 percent at tier 1 (lowest level).

EA+EE Benefits to Consumers

Across the board, energy efficiency reduces the need for energy supply investment—but it can also reduce the costs of access that consumers and project implementers face, and can make many (primarily off-grid) energy access business models technically and economically feasible.

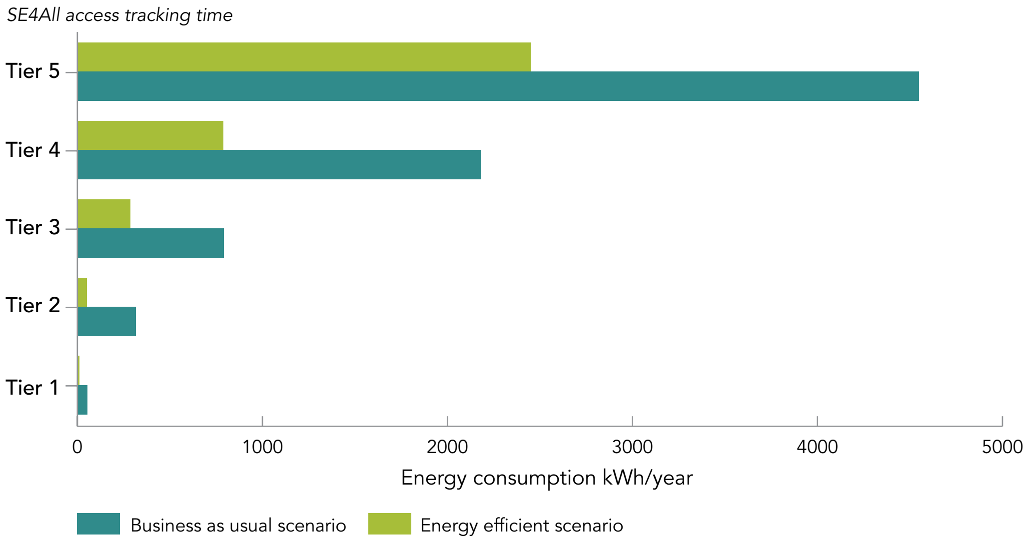
Off-Grid Solar Portable Lighting and Home Systems

In recent years LED lighting has become far more energy efficient and affordable, and these trends are expected to continue. LED efficiency and price improvements, along with improvements in battery technology and declining solar PV prices, have reshaped off-grid solar portable lighting markets, enabling smaller, significantly more affordable solar PV and battery configurations to provide equivalent and improved lighting service to underserved consumers (Figure 2). For example, in 2009, a LED and lead acid battery cost about $45, but in 2014, a LED and lithium battery was half that price and is now closer to $12.

Similarly, energy efficiency can make larger off-grid solar home systems more affordable. According to a recent analysis by researchers from Humboldt State University,

FIGURE 1 Better energy efficiency could sharply reduce energy usage

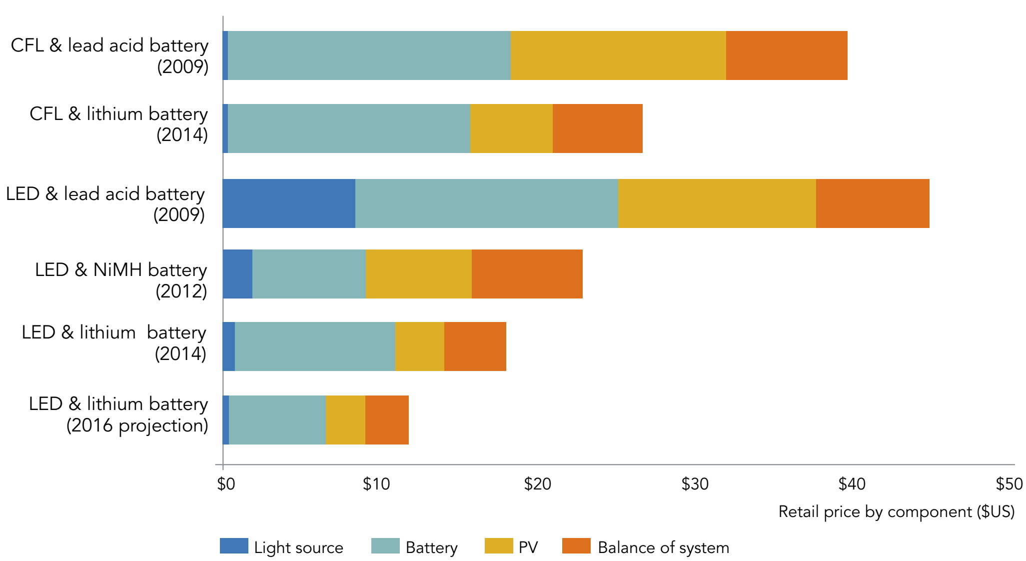
(Energy Use Reduction Potentials for each SE4All Access Tier by Improving End-Use Efficiency (kWh/household/year))



Source: Craine, S. et al. "Clean Energy Services for All: Financing Universal Electrification" 2014.
Note: Tier 1 represents very low energy service and tier 5 includes full grid connectivity with higher power appliances.

FIGURE 2 Off-grid LED lighting becoming cheaper and more efficient

(Retail price of pico-solar off-grid products that provide lighting service of 120 lumens for four hours per day)



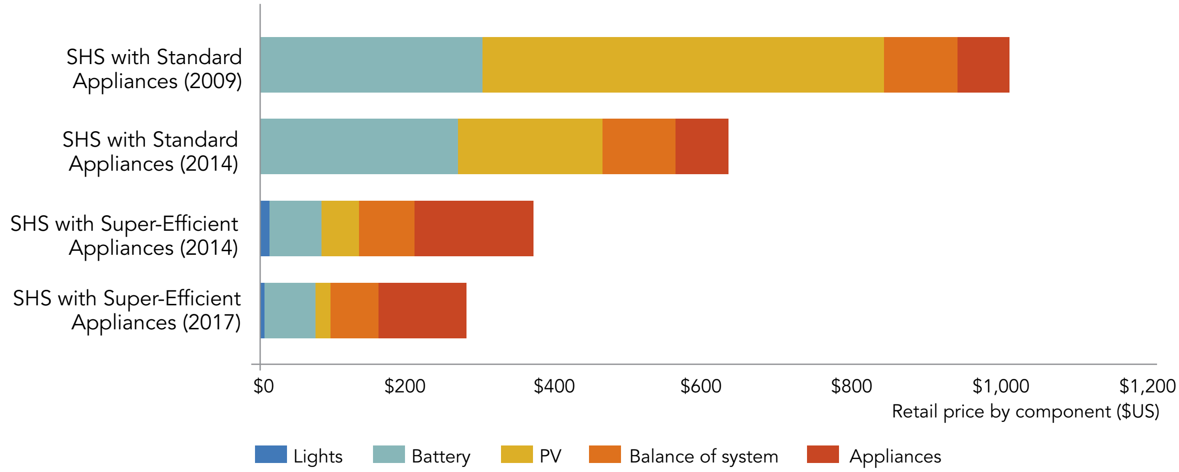
Source: Phadke, A. et al. "Powering a Home with Just 25 Watts of Solar PV: Super-Efficient Appliances Can Enable Expanded Energy Access Using Off-Grid Solar Power Systems." 2015.

Lawrence Berkeley National Laboratory, and the University of California, "the upfront cost of a typical off-grid energy system can be reduced by as much as 50 percent if super-efficient appliances and right-sized solar PV and batteries are used, while delivering equivalent or greater energy service."[8]

It is worth noting that the technologically advanced, super-efficient appliances often do have a higher upfront cost—but as figure 3 shows, that additional cost is more than made up for by a corresponding reduction in energy supply costs. Moreover, as super-efficient off-grid appliance markets have scaled up and become more competitive, the marginal cost of super-efficiency has declined. Take the case of Bangladesh, which is home to the world's largest solar home system market. When its solar home system companies phased out tubular and compact fluorescent lighting in favor of LEDs, customers purchasing solar home systems saw remarkable, immediate improvements in the lighting value they received. For example, when Bangladesh's Grameen Shakti (a non-profit village energy scheme) introduced LEDs in 2013, it led to a dramatic rise in lighting service value (Figure 4).

FIGURE 3 Solar home systems increasingly offering more for less

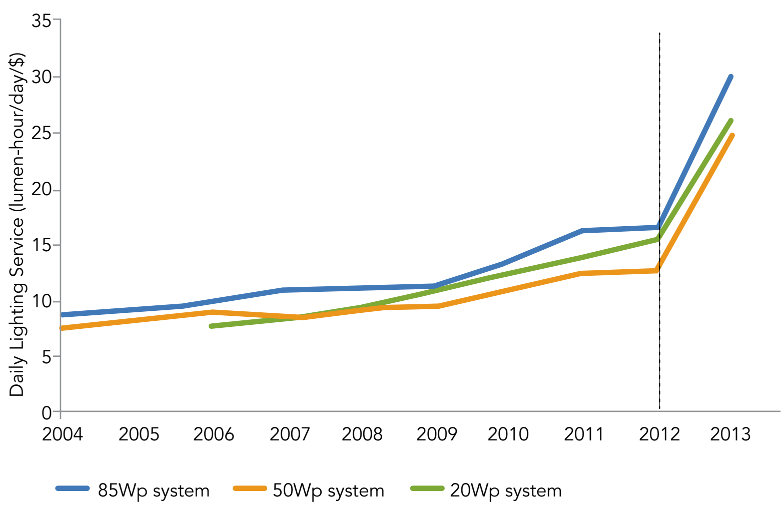
(Retail purchase price for three solar home systems that provide identical levels of service)



Source: Phadke, A. et al. "Powering a Home with Just 25 Watts of Solar PV: Super-Efficient Appliances Can Enable Expanded Energy Access Using Off-Grid Solar Power Systems." 2015.

FIGURE 4 LED usage in Bangladeshi solar home systems boosts lighting service

(Impact of Super-Efficient LED Technology on the Price of Daily Lighting Service (lumen-hour/day/dollar); Indicative Grameen Shakti SHS configurations, 2004 to 2013)



Source: CLASP analysis (forthcoming)

The positive impacts that efficient lighting have had on off-grid energy service markets need not remain limited to lighting. These price and service impacts are wholly transferable to other, more advanced forms of energy service like refrigeration, telecommunications, and industrial appliances.

Cookstoves. All over the world, about 3 billion people each day prepare their meals on inefficient, traditional cookstoves, or over open fires, using solid fuels.[9] Yet energy-efficient cookstoves reduce the amount of fuel needed, improve health outcomes, and contribute to social and economic development for families and communities where there is a high reliance of solid fuels for cooking.

LED street lighting. Off-grid solar LED street lighting provides communal lighting and promotes public safety and after-dark social and commercial activity. As with solar home systems, without efficient LEDs much larger, more expensive solar PV and battery configurations are needed. In grid-connected settings, municipal street lighting can account for 20 percent or more of a city's electric load. Retrofitting street lights with LEDs can achieve massive energy savings--reducing energy supply constraints, freeing up energy for other uses, and potentially improving grid reliability. Recent experience in Guadalajara, Mexico, suggests that energy savings from retrofitting streetlights with LEDs can exceed 50 percent.

Medical devices. As most medical devices are designed for use in developed, grid-connected communities, few medical device manufacturers have considered the impacts of energy efficiency in rural and energy-poor communities throughout the developing world. If developed, medical devices like refrigeration, sterilizers/autoclaves, and monitors that are energy-efficient, affordable, and compatible with off-grid solar would bring important life-saving technologies to the energy poor.

Agriculture and agribusiness. Many energy poor communities depend on agriculture for nutrition and income. Access to energy services improves agricultural productivity by reducing labor, keeping produce fresh and salable, and optimizing processes. Energy efficiency reduces the costs to farmers and improves the reliability of these services.

EA+EE Benefits to Utilities and Service Providers

Utilities and other grid-connected energy service providers typically earn revenue for each unit of energy sold (for example, kilowatt hours), creating a clear incentive structure that encourages the consumption of energy and discourages efficiency. Nevertheless, energy efficiency is an important part of the energy service business model.

Large-scale deployment of highly efficient end-use products reduces peak demand, which in turn mitigates load shedding and the need for large new generating supply investments. One way to do this is with energy efficiency standards and labeling, as Ghana has done (see Box 1). Reduction in peak demand can reduce the need for spot generation and energy/fuel imports, which can be extraordinarily expensive and can complicate sectoral and utility financial planning. Wide scale energy efficiency can also result in better service and customer satisfaction, which—especially when coupled with the lower energy bills enabled by energy efficiency—can improve the likelihood that customers pay for services in good time. Supply-side efficiency gains (like using super-efficient distribution transformers) can enhance system reliability, improve financial performance, and ensure that megawatts generated become megawatts sold (see Box 2).[10]

EA+EE Benefits to Governments and Multilateral Organizations

For years, government and multilateral organizations have invested significant resources in energy access. Corresponding investments in energy efficiency optimize these investments by reducing additional energy supply needs and maximizing the delivery and value of each unit of energy produced.

In economies where tariffs are subsidized, governments have a strong incentive to invest in energy efficiency and reduce the outlay of subsidies. While removing subsidies entirely and exposing consumers to "the true cost of energy" would do more to encourage efficiency, this is rarely a politically acceptable option. In these cases, government support of energy efficiency can deliver a win-win-win: reduced expenditure on subsidies, mitigated peak demand and strain on the grid, and lower energy bills for low-income consumers.

INTEGRATING EFFICIENCY INTO ACCESS PROJECTS: CHALLENGES AND BEST PRACTICES

Given that the value of energy efficiency as an energy access resource is often overlooked, what can be done to turn this situation around? A big part of the problem is that policymakers and practitioners may not be aware of the valuable role energy efficiency can play, and they are usually hampered by a lack of resources, or an inadequate understanding of, available tools and options. Barriers include:

Lack of political and market champions. Economies requiring access interventions often lack a strong and vocal community of efficiency stakeholders to inform project and policy design. In addition, there is typically little overlap between the professional communities who work on energy efficiency and energy access: energy access experts are not necessarily energy efficiency experts, and vice versa.

Lack of visibility. Improving energy service and sector performance with efficiency has longer time horizons, is less visible, and is harder to quantify than adding generating capacity. Politically, "shovel ready" projects may be more appealing than efforts to obviate the need for shovel ready projects.

Financial constraints. Many products with superior energy performance have a higher up-front cost, but have significantly lower life-cycle costs. Rather than taking this into consideration, procurement processes tend to favor products with the lowest initial price.

Lack of market infrastructure and quality assurance protocols. Self-sustaining commercial markets require a good deal of infrastructure that is often lacking in countries with low levels of energy access. Creating self-sustaining markets for quality- and energy-performance assured products and enforcing standards is harder still.

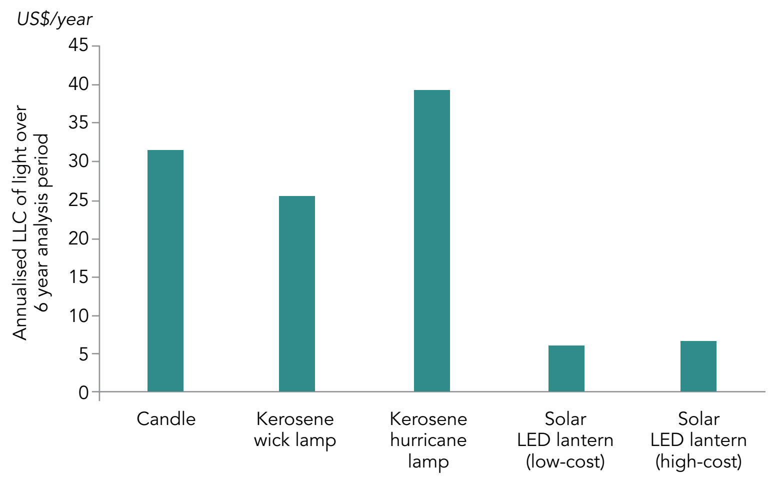
Variability in usage patterns for energy using products. For some products, like cookstoves, variation in long-standing usage patterns and practices make meaningful product comparison across markets and regions difficult. Moreover, the tastes and preferences that these usage patterns express may complicate adoption of new technologies. In addition to higher upfront prices, efficient products may present challenges to usability or cultural practice. This is not limited to emerging markets: consumer preferences in the United States led to significant challenges and political pushback with regard to the wide-spread adoption of compact fluorescent lights, despite their energy-efficiency benefits.

Despite these challenges and the general lack of priority granted to efficiency by access efforts, examples of smart practices and effective models for efficiency's use and optimization exist.

Market Transformation Programs

FIGURE 5 More efficient lighting is also more affordable

(Life Cycle Cost Advantage of Efficient Lighting over Inefficient Lighting)



Source: CLASP analysis, 2015.

Note: This comparison provides an annualised net present value life-cycle cost of light for a six-year analysis period, assuming lamps operate 4 hr/day, kerosene costs of US$1/litre, and a 7 percent discount rate. Assumptions on sources are: candles $0.10 and 13 lumens, small wick lamp $1.50 and 15 lumens, hurricane lamp $4.00 and 30 lumens, small solar portable lantern $20 and 60 lumens, large solar lantern $40 and 225 lumens. Note that light output levels are not normalised in this comparison—it is assumed consumers enjoy improved light service when upgrading from candles.

BOX 1

Leading Africa into Energy Efficiency Standards: Ghana

In the 1980s and 1990s, Ghanaian demand for electricity grew along with the country's strengthening economy. Ghana's limited electricity supply was soon outstripped by this surge in demand, and by 1998 rolling blackouts were impacting businesses and households and decreasing the country's economic output. In response, Ghana in 2000 developed Sub-Saharan Africa's first standards and labeling policy, targeting room air conditioners, compact fluorescent lights, and refrigerators. A 2002 analysis found that by 2003 strong compliance with the room conditioner standard alone would free up 13MW of generating capacity. The analysis predicted that by 2013 the demand savings from this single standard would grow to 150MW, and by 2020 it would grow to nearly 250MW, all at a net savings to the Ghanaian economy.

BOX 2

Reducing Grid Loss with Super-Efficient Distribution Transformers

One relatively simple way to improve efficiency is through distribution transformers, which are an integral part of every grid. Transformers have a service life of about 30 years, but their useful life can extend well beyond that, particularly in developing economies. These long lifetimes make it critically important to consider life-cycle cost when procuring and installing transformers so as to avoid the lock-in of inefficient technologies. Inefficient transformers waste energy and add further strain to supply-strained grids.

Transformers are a globally traded product, and at least 16 developed and developing economies (including Brazil, China, India, Mexico, and Vietnam) have either minimum energy performance standards (MEPS) or labels in place that regulate or facilitate the installation of highly-efficient transformers. These existing efforts make establishing new programs and policies far less burdensome for developing economies.

In recent years, a slate of high-impact programs have taken a broad view of the development of energy access markets, from commercial investment and supply-chain management, to policy reform, to consumer awareness. These include the World Bank's Lighting Global program, Global Lighting and Energy Access Partnership, the Global Alliance for Clean Cookstoves, and UNEP's en.lighten initiative (table 2). Common to these efforts is (i) a thoughtful evaluation of their respective markets' fundamentals and barriers, (ii) a nimble market-based approach to improving those fundamentals and removing those barriers, and (iii) an appreciation of the importance of product quality and energy efficiency to sustainable market growth.

National Efforts

Mexico's solution to the digital transition. To facilitate recent advances in telecommunications technology, economies around the world are transitioning television broadcast signals from analog terrestrial to digital terrestrial. This entails a massive conversion of consumers' existing television technology from analog to digital receivers, wires, and/or satellites. Often, countries have used temporary analog/digital simulcasts, and some have deployed digital converter boxes.

Mexico has engineered an extraordinary approach to this issue that may serve as a model for countries seeking energy access solutions. Rather than providing or mandating costly, energy-consuming converter boxes, Mexico is piloting an effort to give away efficient digital flat-screen TVs.[11] The flat-screen TVs are significantly more expensive than digital converters,[12] but the energy savings reaped by Mexico—which subsidzes its tariffs—will more than cover the expense. The Super-Efficient Appliance Deployment initiative estimates that this could provide Mexico with a net benefit as high as US$877 million.[13] Programs like this will result in improved energy service for its beneficiaries, and the cost-savings could easily be reinvested in future energy access or efficiency efforts.

Creating a CFL market in Bangladesh. The World Bank's Bangladesh Renewable Energy for Rural Economic Development (RERED) project, launched in 2002, has helped spur the world's largest and most dynamic off-grid solar home system market. But that is not RERED's only focus. In 2010, Bangladesh and RERED launched the Efficient Lighting Initiative of Bangladesh (ELIB) to cope with a persistent supply shortfall—and the attendant unreliability of the grid—which was significantly hampering the country's energy access and socio-economic development goals.

ELIB encouraged ratepayers to exchange incandescent lamps for energy-efficient CFLs. Until that point, market uptake of CFLs had been low due to limited consumer awareness, high initial costs, and market spoiling caused by low-quality products. Through ELIB, Bangladeshi utilities ran a large consumer awareness campaign emphasizing the value of energy efficiency and procured millions of CFLs, which were exchanged for ratepayers' incandescent bulbs at convenient locations like schools and community centers. Despite operational challenges related to procurement that ultimately resulted in an early termination of the program, ELIB had a major impact by inspiring a new, competitive commercial marketplace for efficient products. This demand, and industry's rush to meet it, continues to pay dividends—saving ratepayers money, reducing peak demand, and providing social and environmental benefits.

Electrifying low-income urban communities in São Paulo, Brazil. Providing energy services to low-income urban areas can offer a unique set of challenges. Energy

TABLE 2 Overview of Global Energy Access Market Transformation Efforts

INITIATIVE	MANDATE
LIGHTING GLOBAL	The World Bank Group's Lighting Global program and its affiliates support "the growth of the international off-grid lighting market as a means of increasing energy access to people not connected to grid electricity." Lighting Global does this through a variety of targeted efforts, including investor education, industry matchmaking, policy reform, and consumer awareness. Lighting Global's efforts are built upon a best-in-class quality assurance framework for off-grid solar products that ensures that products receiving program benefits have an "appropriate balance product cost, quality, and performance" and themselves drive the market in the right direction.
GLOBAL LEAP	Global LEAP is the Clean Energy Ministerial's clean energy access initiative, and its efforts focus on promoting quality-assurance efforts, demand-side super-efficiency, and partner collaboration. Among other market development efforts, Global LEAP supports the Global LEAP Awards, an international competition to identify the world's highest-quality, most energy-efficient off-grid appliances – products that are essential to the growth and future of the off-grid market. Several other Global LEAP off-grid appliance programs provide market actors with the information and support needed to, like Lighting Global, nudge the market toward the right balance of price, quality, and energy efficiency.
GLOBAL ALLIANCE FOR CLEAN COOKSTOVES	The Global Alliance for Clean Cookstoves "is a public-private partnership hosted by the UN Foundation to save lives, improve livelihoods, empower women, and protect the environment by creating a thriving global market for clean and efficient household cooking solutions." Fundamental to Alliance's approach is a market development roadmap drawn up to drive innovation and scale in efficient cookstove design, sales, and use. National and international standards processes, labeling and certification of cookstoves, and consumer awareness, are central to their efforts.
EN.LIGHTEN	The United Nations Environment Programme's en.lighten initiative supports the United Nation's SE4All initiative by promoting policies that favor high market penetration efficient off-grid lighting, convening government and industry leaders to develop policy.

service providers are often hesitant to expand to these areas because of issues such as energy theft, uncertain land tenure, poor enforcement of legal regulations, lack of infrastructure, difficult geographic conditions, and the transitional nature of inhabitants.[14]

In 2005, the United States Agency for International Development, the International Copper Association, and several local partners launched the Slum Electrification and Loss Reduction Program in São Paulo. The program's objective was to test and evaluate sustainable and widely replicable approaches—including energy efficiency—that increase access to electricity service for low-income urban residents. Some of the specific issues that the project addressed were inefficient and overloaded transformers, illegal connections, lack of community lighting, and inefficient lighting and appliances.

Besides removing illegal connections, the project incorporated a suite of energy efficiency components—including community and consumer awareness, replacement of old and faulty wiring and transformers, and the replacement of inefficient appliances with efficient lighting, solar water heaters, and refrigerators. As a result, consumer payment rates rose to 90 percent, radically improving utility revenues, and households saved on average 200 kWh a month. The pilot project has since been scaled up and is now benefitting over 500,000 households and businesses in Brazil.[15]

FUTURE PROSPECTS AND PROJECTIONS

Energy access professionals around the world are accomplishing astounding things, introducing life-changing energy services to millions—but this can be done better, faster, and more cost-effectively through the smart utilization of energy efficiency.

Beyond lighting: The future of off-grid. To move beyond the provision of very basic energy services like lighting and mobile phone charging and serve more customers, the global off-grid marketplace needs a complementary, competitive marketplace of low-cost, energy-efficient, high quality, and well-designed off-grid appliances. However, due in part to a lack of familiarity with the off-grid market opportunity on the part of appliance manufacturers, as well as the risks and difficulties of market entry perceived by those manufacturers who are familiar with the market, such a marketplace does not yet exist. Plus off-grid companies are often ill-equipped to develop off-grid appropriate appliances of their own, and the market infrastructure to equip these companies to source great appliances is lacking. Efforts to address these issues are under way, including new Global LEAP programs that will encourage the development, marketing, and quick uptake of excellent off-grid appliances.

In the information technology and telecom sectors, the trend is toward products that have multiple uses. For many newly electrified households, a television or radio is the first appliance purchased after lighting needs are met. Low-power technologies like smart phones and tablets provide the option to have an energy-efficient device that meets both communication and entertainment needs.[16]

Smarter, skinnier grids. The design and construction of electric grids has not changed much over the past century, despite the technological advances and significant changes in the way we live and use energy. Highly efficient appliances flatten peak demand and need less energy supply. When less energy is needed, small communities can be powered using thinner, less expensive cabling and wiring. These "skinny grids," when combined with efficient transformers have the potential to reach households 5-10 kilometers from a power source at much lower cost than other commonly used rural electrification models.[17]

Decoupling energy access and energy supply. In places like California, policies to "decouple" utilities' revenues from their per-unit energy sales have enabled significant strides in the use and economic, social and environmental benefits of energy efficiency. It may be that in energy access contexts, a similar decoupling of energy sales and revenue, along with a coupling of energy service and revenue, could flip energy service providers' default incentives and drive the development of business models that provide services at least cost.

Market-responsive design. Early consumer response to CFLs was less than promising: the products neither looked nor performed according to the expectations and tastes of average consumers accustomed to incandescent lamps. This led to significant challenges and delays with regard to their market penetration, as well as political blowback, despite their money-saving and environmental benefits. LED lighting companies like CREE were paying attention, and their market strategy was built around products that look, feel, and perform according to consumer preferences.

Designers and manufacturers of efficient energy access products have something to learn from this example. Clean, efficient cookstoves will not sell if people do not want to use them. Off-grid households and businesses do not use small-scale refrigeration the way a university student might. Smart, iterative product design efforts that emphasize quality, efficiency, and consumer preferences will accomplish a great deal for energy access markets.

Least cost procurement. In 2006, the U.S. state of Rhode Island passed the Comprehensive Energy Conservation, Efficiency and Affordability Act—a law requiring utilities to invest in energy efficiency whenever doing so is less expensive than purchasing the electricity or heating fuel supplies that would be needed to meet that demand. This innovative yet simple mandate to do a cost-benefit analysis and pursue the least expensive option has quickly made Rhode Island one of the United States' most energy-efficient states, benefiting consumers, utilities, and the economy.

While the experience in Rhode Island is unlikely to be wholly transferable to each and every energy access context, the adoption of a least-cost procurement principle by energy access professionals, project developers and policymakers could radically improve how many energy access projects and programs are structured and ultimately perform.

EA + EE + RE. Energy efficiency and renewable energy are critically important to the future of energy access, but it may well be that energy access is even more important to the future of energy efficiency and renewable energy, particularly in off-grid solutions.

Off-grid energy access companies around the world are creating a global market that could one day serve *billions* of consumers, and that is entirely predicated upon energy efficient appliances and renewable energy generation solutions. Ask an off-grid entrepreneur and they will tell you: sustainable off-grid energy access simply does not work without energy efficiency and renewable energy. As such, energy access markets may hold the potential to drive technology, market, and policy innovation that could leapfrog longstanding challenges associated with deploying these technologies—unlocking untold economic and environmental benefits, and transforming the way the entire world consumes energy.

Price signals that encourage efficiency. While often unpopular, cost-reflective tariffs and prepaid or pay-per-use energy metering help consumers internalize the true cost of energy, modify behavior, and gravitate toward efficient devices and appliances. To date, country examples of truly cost-reflective tariffs are rare, but they do exist—such as South Africa's prepaid metering programs. Another tool can be import duty reform. Developing countries often impose high import duties on appliances and equipment, typically to protect domestic manufacturing, generate revenue, or impose a "luxury tax" on high-end goods. Reducing duties for high-quality, highly-efficient products—perhaps benchmarked against an international or regional standard—will lower downstream prices for these products and make them cost-competitive with inefficient products, spurring uptake and access benefits like lower costs and reduced load shedding.

RECOMMENDATIONS FOR OPTIMIZING IMPACTS

Energy efficiency is not a separate consideration from energy access. Rather, it is a foundation upon which access is delivered more cost-effectively and reliably. Energy access professionals would do well to keep the holistic nature of energy access in mind and to incorporate efficiency into project planning as a first-order resource. The following recommendations provide ideas for energy access policymakers and project planners as they pursue efforts to deliver energy service at least cost:

Make efficiency "first in the access loading order." The ideal approach of any access effort is to first address generation, transmission, and demand-side inefficiencies and then adjust supply to meet demand as needed.

Give efficiency a seat at the table. Energy access experts are not necessarily energy efficiency experts, and vice versa—and the public interest goals that draw individuals to these professional communities are not necessarily the same. Even so, these communities have a lot to learn from one another. Simply inviting efficiency experts into access project and program planning exercises may yield significant benefits.

Educate and equip consumers. Consumer awareness and quality-assurance efforts have a significant influence on the long-term efficacy of energy access efforts. Thus, it is vital to educate consumers about the benefits of high-quality, energy-efficient appliances and devices—and equip them to act on that education through certification schemes, labels, and quality-assurance frameworks.

Redefine success. Individual and institutional efforts tend to bend toward meeting goals and metrics. Defining success as "50,000 MW of generating capacity installed" will result in efforts to install 50,000 MW. Rather than setting project goals and metrics that imply that access is solely a supply-side problem, define success as delivering energy service at least cost and set the appropriate metrics.

ACKNOWLEDGEMENTS

CLASP consulted many experts when conducting research for this special feature. We'd like to thank the following individuals for their contributions:

Ranyee Chiang, Global Alliance for Clean Cookstoves
Stewart Craine, Village Infrastructure
Justin Guay, The Packard Foundation
Mark Hopkins, United Nations Foundation
Arne Jacobson, Humboldt State University
Hasna Khan, Prokaushali Sangsad Limited
Amol Phadke, Lawrence Berkley National Laboratory
Michael Scholand, United Nations Environment Programme
Kate Steel, United States Agency for International Development
Richenda Van Leeuwen, United Nations Foundation

NOTES

1. Craine, S., Mills E., and Guay, J. "Clean Energy Services for All: Financing Universal Electrification." 2014.
2. Phadke, A., et al. "Potential to Reduce Costs and Subsidy Requirements for Solar Pump Sets by Improving their Energy Efficiency." Forthcoming.
3. Hoque, S., & Das, B. "Analysis of Cost, Energy and CO2 Emission of Solar Home Systems in Bangladesh." International Journal of Renewable Energy Research 3(2). 2013.
4. Phadke, A. et al. "Powering a Home with Just 25 Watts of Solar PV: Super-Efficient Appliances Can Enable Expanded Energy Access Using Off-Grid Solar Power Systems." 2015.
5. Van Buskirk, R. "Accelerating the Global Pace of Energy Efficiency Improvement through Energy Access." 2015.
6. International Energy Agency, "Energy for All – Financing Access for the Poor." 2011.
7. Craine, S., Mills E., and Guay, J. "Clean Energy Services for All: Financing Universal Electrification." 2014.
8. Phadke, A. et al. "Powering a Home with Just 25 Watts of Solar PV: Super-Efficient Appliances Can Enable Expanded Energy Access Using Off-Grid Solar Power Systems." 2015.
9. Source: Global Alliance for Clean Cookstoves.
10. Raul Jimenez, R. et al. Tomas Serbrisky, Jorge Mercado. "Power Lost: Sizing Electricity Losses in Transmission and Distribution Systems in Latin America and the Caribbean." 2014.
11. Crayton Harrison. "Mexico to Give Away Hi-Def Televisions for Digital Transition." 2014.
12. Greg Scoblete. "Mexico's Turbulent Digital TV Transition." 2014.
13. SEAD Initiative. "The LEERA Model." 2014.
14. International Copper Association. "Pilot Project for Slum Electrification and Loss Reduction." São Paulo, Brazil. 2009.
15. Hopkins, Mark. "Enabling Energy Access Through Energy Efficiency." Presentation.
16. Interview with Justin Guay.
17. Interview with Stewart Craine.

REFERENCES

Craine, S., Mills E., and Guay, J. "Clean Energy Services for All: Financing Universal Electrification." 2014.

Phadke, A., et al. "Potential to Reduce Costs and Subsidy Requirements for Solar Pump Sets by Improving their Energy Efficiency." Forthcoming.

Hoque, S., & Das, B. "Analysis of Cost, Energy and CO2 Emission of Solar Home Systems in Bangladesh." International Journal of Renewable Energy Research 3(2). 2013.

Phadke, A. et al. "Powering a Home with Just 25 Watts of Solar PV: Super-Efficient Appliances Can Enable Expanded Energy Access Using Off-Grid Solar Power Systems." 2015.

Van Buskirk, R. "Accelerating the Global Pace of Energy Efficiency Improvement through Energy Access." 2015.

International Energy Agency, "Energy for All – Financing Access for the Poor." 2011.

Raul Jimenez, R. et al. Tomas Serbrisky, Jorge Mercado. "Power Lost: Sizing Electricity Losses in Transmission and Distribution Systems in Latin America and the Caribbean." 2014.

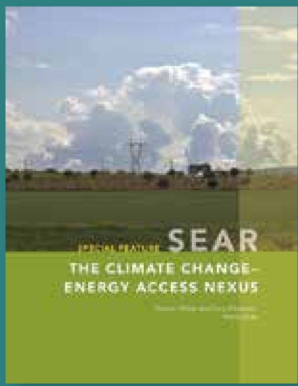
Crayton Harrison. "Mexico to Give Away Hi-Def Televisions for Digital Transition." 2014.

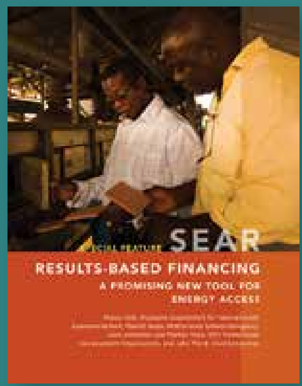
Greg Scoblete. "Mexico's Turbulent Digital TV Transition." 2014.

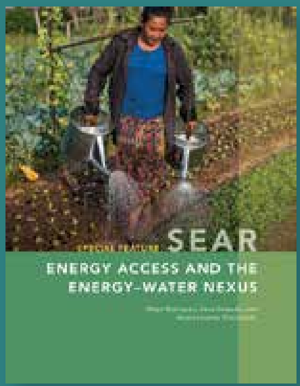
SEAD Initiative. "The LEERA Model." 2014.

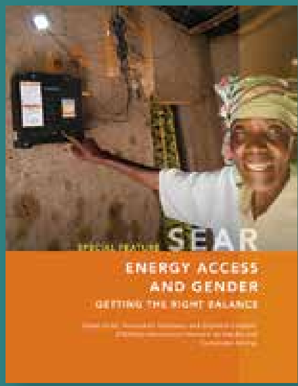
International Copper Association. "Pilot Project for Slum Electrification and Loss Reduction." São Paulo, Brazil. 2009.

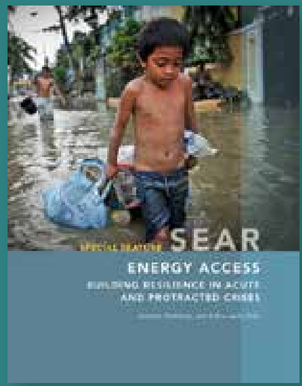
SPECIAL FEATURES

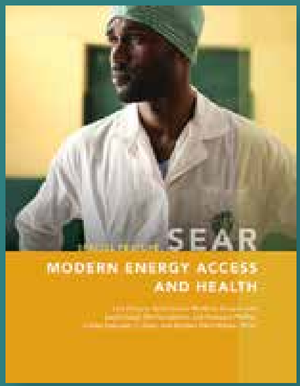


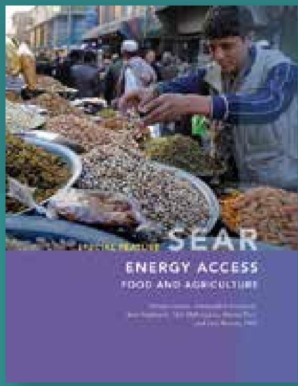


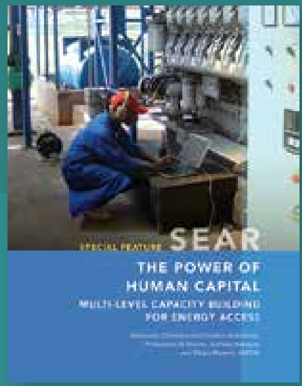


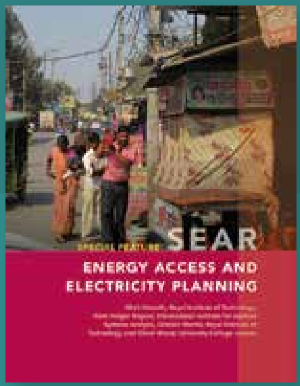












To download the State of Electricity Access Report, overview, and Special Features, visit:

http://esmap.org/SEAR

WORLD BANK GROUP

ESMAP
Energy Sector Management Assistance Program

SUSTAINABLE ENERGY FOR ALL