Energizing Africa:

Achievements and Lessons from the Africa Renewable Energy and Access Program (AFREA) Phase I

WORLD BANK GROUP

ESMAP
Energy Sector Management Assistance Program

Africa Renewable Energy and Access Program (AFREA)

Photo (above): Isabel Neto
Cover photo: Stephanie Nsom

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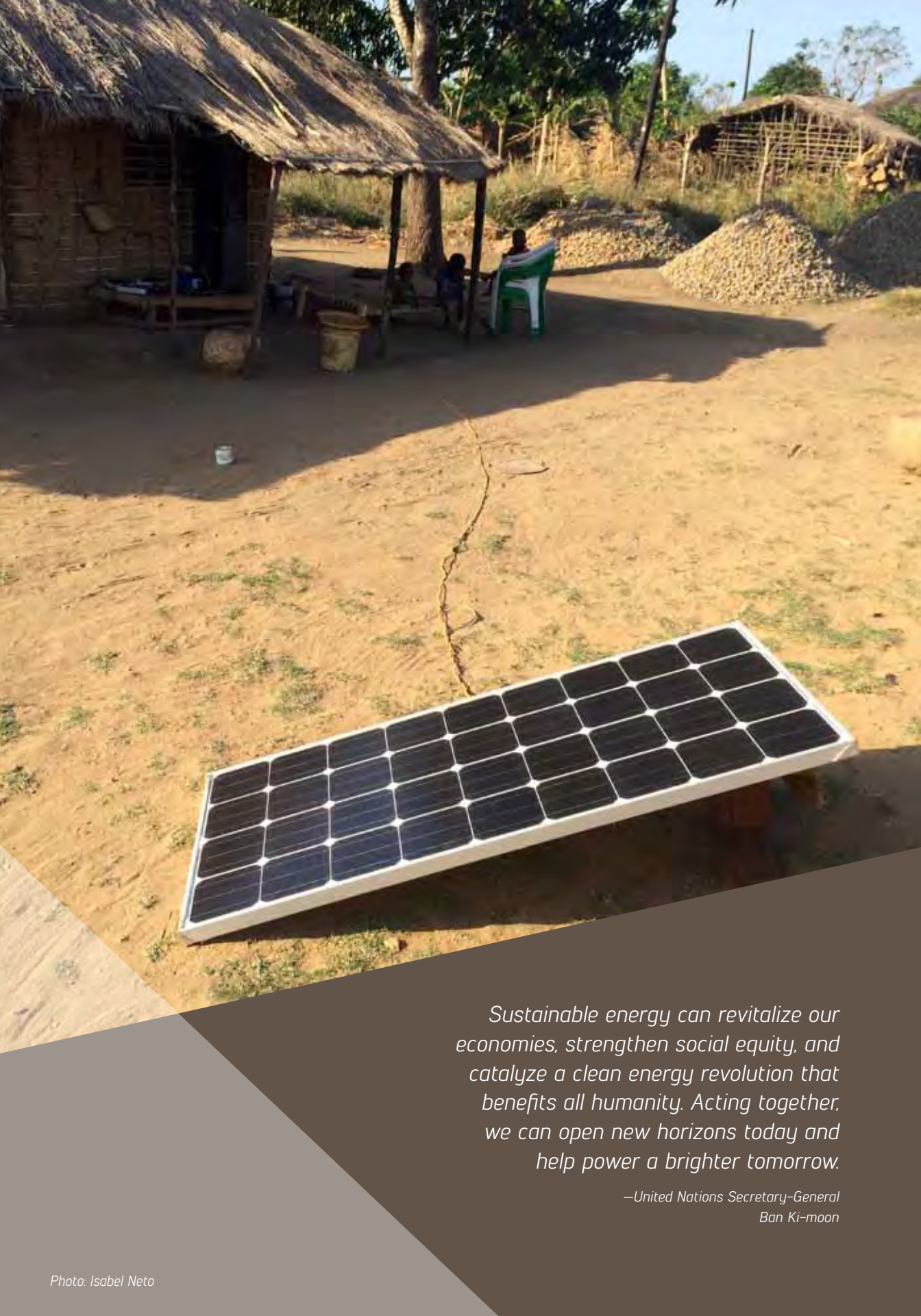
Photo: Mitsunori Motohashi

Acronyms and Abbreviations

ACCES	Africa Clean Cooking Energy Solutions
AEI	African Electrification Initiative
AFREA	Africa Renewable Energy and Access
BEIA	Biomass Energy Initiative for Africa
CEIF	Clean Energy Investment Framework
CO_2	carbon dioxide
CSP	concentrating solar power
CST	concentrating solar thermal
DIY	do-it-yourself
EARP	Electricity Access Rollout Program
ECOWAS	Economic Community of West African States
ESMAP	Energy Sector Management Assessment Program
FiT	feed-in tariff
FY	fiscal year
GEF	Global Environment Facility
GIS	geographic information system
GIZ	German Federal Enterprise for International Cooperation
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
km	kilometer
KNUST	Kwame Nkrumah University of Science and Technology
kW	kilowatt
kWh	kilowatt-hour
LED	light-emitting diode
LG-QTM	Lighting Global Quality Test Method
LLL	Lighting Lives in Liberia
LPG	liquefied petroleum gas
MW	megawatt
NEAP	National Electrification Access Program
NGO	nongovernmental organization
PROGEDE II	Second Sustainable and Participatory Energy Management Project
PV	photovoltaic
QA&TS	quality assurance and technical support
RREA	Rural and Renewable Energy Agency
SE4All	Sustainable Energy for All
SSA	Sub-Saharan Africa
SWAp	sector-wide approach
SWER	single-wire earth return
SWS	shield wire scheme
UN SG	United Nations Secretary-General



Sustainable energy can revitalize our economies, strengthen social equity, and catalyze a clean energy revolution that benefits all humanity. Acting together, we can open new horizons today and help power a brighter tomorrow.

—United Nations Secretary-General Ban Ki-moon

Photo: Isabel Neto

The African Energy Challenge

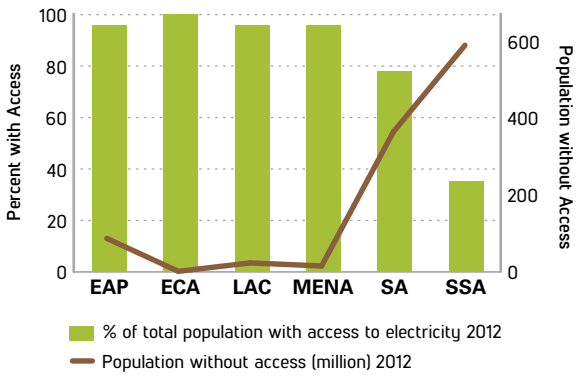
Access to energy and economic development go hand in hand. Improving electricity supply and distribution boosts economic growth, creates jobs, and expands the reach of educational and health services. It can also empower women, providing income-generating opportunities and enabling them to spend their time more productively.

Unfortunately, more than 589 million people in Sub-Saharan Africa (SSA) live without access to electricity: only 35 percent of the population in SSA has access, compared with 96 and 78 percent in East Asia Pacific and South Asia, respectively (Figure 1). For most Africans, electric power is inaccessible, unaffordable, or unreliable. The lack of both quality energy services and access to modern sources of fuel—such as natural gas, liquefied petroleum gas (LPG), diesel, and biofuels—traps them in a world of poverty.

This inaccessibility to modern energy in SSA touches all sectors of society—health clinics cannot refrigerate vaccines, students find it difficult to read after dark, and businesses have shorter operating hours (see also Figure 2). Even Africans with modern energy face unreliable and unpredictable supplies for which they must pay high prices.

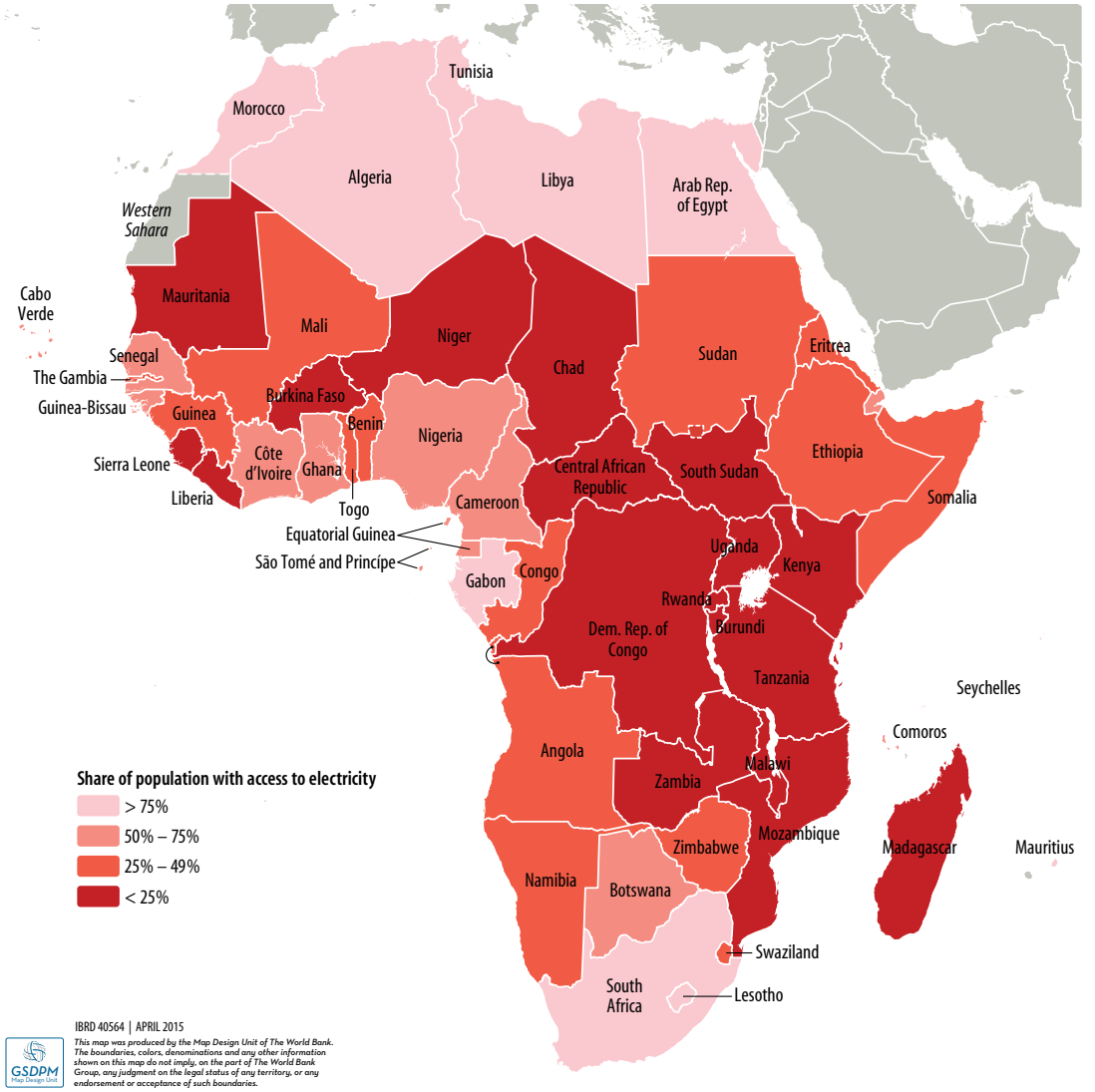
Currently, the energy sector of SSA meets neither the needs nor the aspirations of its citizens. Africa's development challenges will become even more daunting as population growth in many SSA countries is projected to outpace electrification efforts. If current trends continue, electrification rates will grow from 35 to 51 percent, but the absolute deficit of people without electricity will also grow from its 2012 level of 589 million to over 645 million by 2030. Clearly, action is needed to accelerate electrification beyond its business-as-usual pace.

FIGURE 1: ACCESS ACROSS DEVELOPING REGIONS



The World Bank Group's engagement in the energy sector is designed to help client countries secure the affordable, reliable, and sustainable energy supply needed to end extreme poverty and promote shared prosperity. The Bank's approach mirrors the objectives of the Sustainable Energy for All (SE4All) initiative—achieving universal access, accelerating improvements in energy efficiency, and doubling the global share of renewable energy by 2030. The Bank recognizes that each country determines its own path for achieving its energy aspirations: each country's sustainable energy transition involves a unique mix of opportunities and challenges, prompting different emphases on access, efficiency and renewables.

FIGURE 2: ACCESS TO ELECTRICITY IN AFRICA



Africa is well endowed with energy resources. Ensuring that they are available at the exact time, place, and form in which they are needed will remain a significant challenge for years to come. Helping countries chart low-carbon growth paths will reduce future dependence on fossil fuels. Off-grid renewable technologies—such as small hydro, solar, or sustainable biomass—may represent the least-cost power supplies for site-specific challenges. New technology, ranging from low-cost electrification techniques to improved cookstoves and solar photovoltaics (PV), can provide solutions for clean and efficient delivery of both traditional and modern fuels. Effectively bringing these new solutions to bear in the context of SSA provides the raison de être for the Africa Renewable Energy and Access program.

Photo: Bruno Demeocq, Lighting Africa

Photo: Richard Hosier

AFREA Phase I

In 2009, the World Bank established the Africa Renewable Energy and Access program (AFREA) to focus on the special needs of the energy sector in Africa, where limited access to modern energy constrains development and the opportunity presents itself to leapfrog to cleaner renewable energy supplies, instead of "locking in" to conventional carbon dioxide laden fossil fuels. The Bank set up AFREA as part of its Energy Sector Management Assessment Program (ESMAP) and Clean Energy Investment Framework (CEIF). The Netherlands contributed over $28 million to the CEIF Multi-Donor Trust Fund to finance AFREA. This report provides a retrospective overview on AFREA Phase I achievements and lessons learned.

The Bank's support of AFREA has allowed task teams to pilot innovative technologies and cutting-edge market-transformation programs that respond to the needs identified by energy practitioners in client countries. As such, the program has served as an incubator: promising ideas have been tested and important lessons have been learned, both from successes and from activities that fell short of expectations.

AFREA program support has been most effective when it has been linked to shaping, leveraging, and empowering the development and implementation of the Africa Energy Practice's International Development Association (IDA) portfolio. The program is designed to help expand access to modern energy services by improving service delivery and scaling up innovations in electricity, lighting, and cooking. In terms of conventional electrification, the program focuses on improving the pace, effectiveness, and efficiency of extending the grid to communities without access; creating enabling environments and markets for new technologies (Box 1); and finding promising avenues for meeting the needs for modern energy services using renewable sources.

BOX 1: SENEGAL'S SOLAR LANTERN LIBRARY

Students in 58 selected rural schools in Senegal were introduced to a different kind of lending library—a library of solar lanterns. These libraries allowed students to borrow solar lanterns, so they could study after dark and their families could experience the benefits of a clean, safe, affordable lighting source.

The schools that received the Lantern Libraries were chosen based on their lack of electricity, their relatively large student body, and their regions' high poverty rate, so as to maximize impact. In all, 4,798 lanterns were made available to the Ministry of Education and were managed by the schools, giving 6,115 students direct access to the lights. Because of the large average family size in the region, this means that approximately 55,000 people were directly exposed to the technology.

By creating a low-risk opportunity to test solar lanterns, the libraries addressed a common risk-aversion tendency. These Lantern Libraries have strongly affected commercial sales. Following a test period to try out the lamps, 35 percent of families in the Lantern Library region purchased lanterns. In contrast, only 15 percent of people in control communities where no Lantern Library was installed purchased lanterns. In East Africa, experience shows that only about 10 percent of consumers in rural communities are early purchasers of lanterns.

"My children are studying longer now because other lighting products would not allow them to study for a long time. I am no longer buying batteries for them. This is a very good initiative. We are very grateful," said Bourry Sarr Nioro Kaolack, whose children were part of the Lantern Library.

Table 1 lists the national and regional projects supported under AFREA I. This publication zooms in on the key regional programs that were supported: Lighting Africa, the Biomass Energy Initiative for Africa (BEIA), Africa Clean Cooking Energy Solutions (ACCES), the Gender and Energy Program, and the African Electrification Initiative (AEI). One chapter also documents the results of a successful national program—the Rwanda Sector-wide Approach (SWAp). Summaries of the remaining activities and their results appear in Annex 1 of the report.

TABLE 1: REGIONAL AND COUNTRY-SPECIFIC AFREA I PROJECTS AND DISBURSEMENTS (IN US$)

	Disbursements	Page Number of Project Description
Regional Projects		
Lighting Africa (LA)	4,468,347	15
Africa Electrification Initiative (AEI)	1,249,434	33
Gender and Energy Program	1,395,382	29
Africa Clean Cooking Energy Solutions (ACCES)	571,773	19
Biomass Energy Initiative for Africa (BEIA)	3,255,968	19
Toolkit Solar Photovoltaic (PV)	259,714	40
Africa Energy Access Scale-up Plan Consultations	561,895	40
West Africa Renewable Energy Education Project (REEP)	966,247	40
Country-Specific Projects		
Rwanda: Sector-Wide Approach (SWAp)	1,551,491	25
Nigeria: Enhancing the Climate Resilience of Growth	297,750	41
South Africa: Concentrated Solar Power	99,574	41
Liberia: Catalyzing New Renewable Energy	3,087,815	42
Rwanda: GEF Sustainable Energy Development Project	3,946,221	43
Mali: Energy Access for Productive Uses	1,091,246	43
Benin: Modernization Biomass Energy Services	1,944,444	43
Total Disbursements AFREA 1 Activities	24,747,302	
Program Administration	1,366,867	
GRAND TOTAL	26,114,169	

Note: South Sudan and Niger activities (US$106,000 and US$70,000 disbursed respectively) were officially AFREA II-approved activities that were partly funded from AFREA I resources, and therefore these activities are not included in this table.

Photo: Mitsunori Motohashi

Photo: Lighting Africa

Lighting Africa

Nearly 600 million people or 65 percent of SSA's population have no connection to the electricity grid. Solar photovoltaic lighting systems can provide basic electricity services that are affordable and portable. And if the private sector and the government have worked together to prepare the market, they can provide coverage to unelectrified areas in a very short time.

Traditionally, people without access to the grid have relied on expensive, polluting, inefficient, fuel-based lighting products, such as kerosene-powered lamps, battery torches, and candles. Solar-lighting products provide a healthy, safe alternative to kerosene lamps and candles. About 7.5 million quality-verified solar lighting products have been sold in Africa over the past five years, enabling approximately 37 million people across the continent to have access to clean, modern lighting products. However, market penetration of the products remains low, presenting an enormous business opportunity. In Africa, companies selling solar lighting products that meet the quality standards recorded an average 140 percent year-on-year growth in sales between 2009 and 2014.

Background

Upon its launch, the Lighting Africa program focused on building markets for affordable, high-quality, modern solar-powered lighting products. Initially, the program was a Global Environment Facility (GEF)-sponsored initiative of the International Finance Corporation (IFC). Later, the World Bank joined the collaboration, helping to bring in further support from AFREA, ESMAP, Italy, the Netherlands, and the United States. As a long-term goal, the program seeks to enable 250 million people without grid electricity to access clean, affordable solar lighting products by 2030.

Building initially upon two pilot projects implemented by IFC in Ghana and Kenya starting in 2007, Lighting Africa now operates in 10 additional countries—Burkina Faso, the Democratic Republic of the Congo, Ethiopia, Liberia, Mali, Nigeria, Senegal, South Sudan, Tanzania, and Uganda. The program has focused on market development for pico-PV products that provide light and mobile phone charging, especially those using light-emitting diodes (LEDs), which have increased dramatically the volume of light provided per unit of electricity consumed. Lighting Africa works with private sector, manufacturers, distributors, consumers, financial institutions, development partners, and governments. Overall, it has helped to stimulate the market, build confidence in the lighting products, and ensure that consumers can identify high-quality products that represent a good value proposition.

Lighting Africa's approach to the challenge comprises five main elements:

- **Quality assurance**—Builds consumers' and other stakeholders' confidence in the sector by developing a quality assurance framework. In the early stages of the program, low-quality solar lanterns were at risk of spoiling the market. To counterbalance this effect, Lighting Africa has supported the development of quality standards and has built the capacity for local laboratories to test lanterns (Box 2).
- **Market intelligence**—Attracts companies and investors to the solar lighting market by providing market intelligence, such as mapping users' needs, estimating how much consumers currently spend for their lighting needs, and determining what types of lanterns are in greatest demand.
- **Business support**—Provides business development services to partner companies. Access to finance can be key to local distributors. Lighting Africa connects companies to potential financing sources, such as local banks or microfinance operations.

BOX 2: SETTING QUALITY STANDARDS FOR SOLAR LIGHTING DEVICES

In April 2013, Lighting Africa celebrated having the International Electrotechnical Commission (IEC) approve its quality assurance framework for solar LED lighting devices—the Lighting Global Quality Test Method (LG-QTM)—as the world standard for clean, off-grid lighting products. The IEC approval helps harmonize quality assurance systems, thereby eliminating the need to test new products, resulting in savings that can be transferred to buyers through lower-priced, high-quality products.

Developed by Germany's Fraunhofer Institute for Solar Energy Systems, the LG-QTM quality assurance standard has become the cornerstone of Lighting Africa. It now serves as a minimum-quality benchmark for manufacturers to attain when making solar products, and for consumers to look for when buying them. This avoids "market spoilage," whereby the proliferation of lower-quality products drives out the higher-quality products in a "race to the bottom," which benefits no one.

"The people with the greatest need for reliable, off-grid lighting are the ones hit hardest by faulty products that come with inflated claims," said Dr. Michael Gatari, a professor who runs Lighting Africa's quality assurance laboratory at the University of Nairobi, Kenya. "The new IEC standard will help provide these consumers with more choices for quality, modern off-grid products."

- **Consumer awareness**—Creates awareness among potential consumers of the benefits of modern solar lighting products over fuel-based (kerosene) lighting.
- **Policy strengthening**—Improves the policy environment for off-grid solar lighting products. Lighting Africa works with governments to provide a favorable policy environment to enable the growth of the market and the adoption of off-grid lighting products as part of their rural electrification programs.

Solar Lighting Products

Lighting Africa initially provided support to the development of the market for solar lanterns and single-task lights, particularly those using LEDs. These products can cost as little as US$10 for a basic task light. As the manufacturers mastered the production of high-quality solar lanterns with LEDs, they began to move into the production of larger, portable, plug-and-play or do-it-yourself (DIY) systems with multiple light points and opportunities to deploy more electrical appliances, including phone chargers, fans, radios, color televisions, and computers. The products do not require a technician to install them, as did previous generations of solar home systems, and they retail for less than US$200. To ensure the quality of the products, all are subjected to a rigorous quality assurance framework similar to that already being applied to solar lanterns.

Who Benefits from Lighting Africa?

Consumers, industry, governments, and development organizations all benefit from Lighting Africa's work. Consumers are assured of affordable, high-quality solar lighting products from companies that work with Lighting Africa and its sister programs. Manufacturers and distributors gain from the wealth of information made available by Lighting Africa on markets, consumer needs, and industry quality standards. Governments profit from the program's advice on how to integrate modern off-grid lighting products into their rural energy access programs, and how to use the market approach to sustainably increase access to energy. Development organizations implementing off-grid lighting programs can access Lighting Africa's experiences to guide them in designing and implementing their programs.

Impacts

The impacts so far have been impressive. To date, more than 50 products have met or surpassed Lighting Africa's quality and performance standards, with more than 7.5 million products sold in 20 African countries. In addition, the IEC in 2013 adopted Lighting Africa's quality assurance framework for solar LED lighting devices as a global industry standard. Moreover, the awareness campaigns that educate consumers about the benefits of solar products have reached more than 22 million people at 1,500 village forums. Finally, the Lighting Africa team has engaged with client governments in 12 countries to discuss options to help catalyze local markets for small PV systems. In addition, in FY14 alone, Lighting Africa influenced IDA funding in the amount of US$ 875 million in Burkina Faso, DRC, Ethiopia and Mali.

Lessons Learned

Because of its success in stimulating the growth of markets for innovative technologies targeting those at the bottom of the pyramid, other programs are looking at the lessons from Lighting Africa, and exploring how to apply them to their work. Following are some key lessons from Lighting Africa's experience.

Market Stimulation Is Essential

Market development and transformation activities can have tremendous impact, if carried out in conjunction with policy and private-sector initiatives. Instead of just giving away lanterns, it is more effective to leverage the private sector and government to develop the solar market, which results in a greater impact for less total funding.

Government Help Is Needed to Shape the Enabling Environment

For a solar lighting program to be successful, government support is needed, especially to remove any market, regulatory, or policy barriers. Initially, Lighting Africa's two pilot projects provided no support for policy changes, which limited their success. Only when support was provided for both policy reforms and private-sector development did the markets show dramatic growth.

Solar Lanterns Are More Than Gadgets

At first, governments were skeptical of solar lights, viewing them as mere gadgets. They did not see solar lighting as real electricity and thought that supporting Lighting Africa meant abandoning further grid investments as the two options were seen as mutually exclusive. To change governments' viewpoint, Lighting Africa had to show officials the products through a series of workshops and conferences attended by both representatives of government and the private sector. The program demonstrated to doubtful policy makers that solar lanterns serve as the entry point to an expanded menu of modern electricity services that combines both on-grid and off-grid supplies to meet the emerging electricity needs in a sustainable way.

Consumer Awareness Is Key

The Lighting Africa program discovered that its public awareness campaign needs to be coordinated with the distributors, to ensure that solar lanterns are available once awareness is raised. Obviously (in retrospect), unless supplies are readily available in-country, awareness raising will only waste limited funds and lead to frustration on the part of consumers.

Marketing Should Appeal to Consumers' Aspirations

As marketing executives everywhere know, what often sells a product is the image associated with it in the consumers' minds. The Lighting Africa program found that rural consumers desire to purchase solar lanterns and solar home systems because they associate these products with not only greater convenience but also a better quality of life. As rural dwellers aspire to a more comfortable and prosperous life, aspirational values begin to constitute an effective driver of market sales for new, innovative products such as solar lanterns (Box 3).

BOX 3: KENYAN FLOWER WORKERS GIVEN CREDIT TO ACCESS CLEAN LIGHTING

"When I put on the new solar lights, my child thought it was electricity and told me to turn on the TV! There is no difference from electricity; solar light is very bright," said Jacinta, a flower worker, on installing a solar-powered home lighting system.

Thanks to a loan from her employer, Olerai Flower Farm in Narok, Kenya, Jacinta purchased and installed her clean lighting system in 2011. Olerai advanced all employees easy-to-pay loans to buy lamps by providing the first 50 percent up front and then the remainder over a period of three months.

One of Lighting Africa's components is business support. By pairing the lighting manufacturer with employers like Olerai, the program helped ensure that low-cost, high-quality, off-grid lighting products could reach the people who most need it.

Farm workers may spend a large share of their daily wages on kerosene, which can be expensive. The monthly saving from solar lighting helps Jacinta cope with escalating food and living costs. Jacinta also became aware of other benefits through Lighting Africa's consumer awareness component. "Kerosene smoke caused eye irritation and the light was not enough. When I was not home, I always had to ask someone to go and sit with my kids because the paraffin lamps were not safe. Now the children can just switch the lights on and start studying safely."

Photo: Klas Sander

Biomass Energy Initiative and Africa Clean Cooking Energy Solutions

Biomass Energy Initiative (BEIA) for Africa

Biomass fuels supply a majority of SSA's energy needs, especially the energy used by an estimated 81 percent of SSA households for cooking. Biomass fuels also provide the energy for many agricultural, commercial, and industrial applications, and will continue to be a predominant local source of energy for decades to come.

Current uses of biomass fuels in SSA present grave health, environmental, and social concerns. As a result of indoor air pollution and chronic respiratory illnesses from the use of primitive cookstoves, the World Health Organization's estimates suggest that between 2000 and 2030, 8.1 million premature deaths will occur among children and 1.7 million premature deaths will occur among adult women in SSA. At the same time, Africa's biomass resources are immense, and if sustainably managed, can provide the basis for significant renewable electricity generation and supply through both isolated and national electrical grids.

To help modernize the biomass energy sector, the World Bank launched BEIA in 2010, supporting nine promising, innovative pilot biomass energy projects in eight SSA countries. BEIA was implemented as part of the AFREA program and received additional co-funding from the governments of the Netherlands, the United Kingdom, and Germany. The initiative focused on technologies ranging from charcoal to briquettes to social biofuels, and from high-efficiency cookstoves to bioelectricity. It used innovative delivery models and relied on private initiatives, social enterprises, and public–private partnerships.

BEIA sought to test promising approaches that could be incorporated into the future World Bank lending portfolio and provide resources to African organizations to undertake pilot activities. It covered the following thematic areas:

- Enabling market conditions to ease the commercialization of cleaner and more efficient cookstoves.
- Modernizing the charcoal industry by improving the industry's environmental sustainability and energy efficiency at both the charcoal producer's and the end-user's levels.
- Demonstrating the feasibility of social biofuels, such as the use of small-scale biofuel production systems to supply a local market with fuels.
- Increasing power capacity using bioelectricity—that is, relying on biomass as fuel for power generation both for sale to the grid operator and for direct consumption.
- Strengthening leadership in biomass energy through higher-level training for technical and professional leaders.

BEIA Pilot Projects

In consultation with client countries, the AFREA team allocated support to nine initiatives based upon innovative approaches, the track record of sponsorship, geographical diversity, and conformity with the strategic areas in the biomass supply and demand chains. The overall intention was to push the frontiers of biomass energy in Africa through the following nine initiatives:

Promoting High-Performance Cooking Stoves

- **Uganda**—Promotion of Improved Biomass Top Lit-Up Draft Stoves
- **South Africa**—Promotion of Improved Biomass Rocket Stoves
- **The Gambia**—Promotion of Improved Biomass Vesto Stoves

Modernizing the Charcoal Industry

- **Tanzania**—Promotion of Charcoal Briquettes
- **Rwanda**—Promotion of Charcoal Producers' Organization

Demonstrating the Feasibility of Social Biofuels

- **Kenya**—Scaling Up Biodiesel Production
- **Benin**—Promotion of Social Biofuels
- **Ethiopia**—Promotion of Ethanol Micro-Distilleries

Increasing Power Capacity with Bioelectricity

- **Uganda**—Promotion of Bioelectricity in Uganda

Outcomes of BEIA Projects

As part of the AFREA program, the majority of BEIA projects showed a strong potential for replication and scale-up, with five of the nine initiatives securing additional funding for scale-up activities. Over the course of its initial project cycle, BEIA made strides in changing people's attitudes toward biomass energy. As a means of symbolizing this shift, the heads of state of Tanzania and Uganda both purchased BEIA stoves and briquettes at public shows.

Overall, BEIA pilot projects have helped to uncover what works and does not work in the biomass sector, advancing the global conversation on biomass energy. These projects have demonstrated how biomass energy initiatives not only produce clean energy, but also create employment opportunities for communities, empower women, incubate entrepreneurship, and protect the environment (Box 4).

Impacts

In Rwanda and Tanzania, the BEIA schemes helped modernize the charcoal industry. The project in Tanzania enabled 720 people in 12 villages to be trained in producing charcoal from agricultural waste, while the program in Rwanda helped a cooperative improve its charcoal kilns. Meanwhile, the Modernizing Biomass Energy in Benin program is promoting sustainable woodfuel production and a market management system for 300,000 hectares of forests. The projects in Benin, Ethiopia, and Kenya each also helped demonstrate the feasibility of small-scale locally produced and consumed biofuels.

BOX 4: SCALING UP BIODIESEL PRODUCTION TRANSFORMS A COMMUNITY IN KENYA

Close to 70 percent of Kenya's energy needs are met from relatively inefficient and unsustainable forms of fuel, such as wood and charcoal. For rural households, the percentage is much higher. When villagers in Naro Moru, 200 kilometers (km) from Nairobi, started processing Croton tree seeds to make biodiesel, they didn't realize the extent and speed with which it would transform their community and inspire a shift in other forested communities.

Following two years of training and investment, a local nongovernmental organization's (NGO's) Self-Help Center has used the AFREA-funded BEIA Scaling Up Biodiesel Production Project to reduce dependence on woodfuel, conventional diesel, and kerosene. Using biodiesel made from Croton seed oil as an alternative energy source at the household level has increased household incomes, reduced poverty, and improved environmental sustainability.

This project has generated employment opportunities for 3,000 individuals per year in directly collecting seeds, managing seed collection centers, transporting feedstock, grading and packing seeds, and processing and marketing biodiesel. Related income and employment opportunities include commercial nurseries and business development services.

Women manage more than 20 nurseries connected with this project, and an estimated 456,000 seedlings were planted on farms. Farmers were trained through practical demonstration of on-farm agroforestry, tree-planting techniques, and forest management.

A lesson that can be drawn from this project is that finding a business model that ensures equitable distribution of benefits and a transparent decision-making process may be a precondition for making a program such as this work for all involved. Integrating the social, environmental, and economic aspects of development increases the chances of sustainability and continuity. A functional monitoring framework that has built-in feedback mechanisms is an indispensable tool in program management.

In addition, in South Africa, a thriving market for efficient biomass stoves resulted in the sale of 8,000 stoves and 4,000 energy-efficient products, and in Kenya, a pilot scheme to scale up biodiesel production boosted daily output from 300 liters to more than 1,000 liters.

Africa Clean Cooking Energy Solutions (ACCES)

In 2012, the World Bank launched the ACCES program. Building on the Lighting Africa model and several of the successful BEIA-supported pilot projects, ACCES seeks to promote the enterprise-driven, large-scale adoption of clean cooking solutions throughout SSA. The overarching goal of ACCES is to reduce poverty, health-related risks, and the adverse environmental impacts associated with traditional cooking technologies and practices by stimulating the uptake of high-quality, efficient cookstoves. As practiced throughout much of Africa, cooking with biomass relies upon a three-stone hearth, which not only uses wood inefficiently, but also emits pollutants that endanger human health and harm the global environment.

The social implications of cookstoves are particularly important to women and girls, who are primarily responsible for cooking—thus, inhaling most of the pollutants. Plus, they often spend hours each week collecting fuelwood, which translates into lost opportunities for completing education and generating income.

Focus on Market Transformation

Recent developments in clean cooking technologies—including cleaner, more efficient cookstoves, efficient charcoal kilns, briquetting, pelleting, and advanced fuels—create an opportunity to accelerate SSA access to and penetration of modern fuels and cooking appliances. ACCES seeks to develop a market-transformation program to demonstrate that an enterprise-driven approach to disseminating clean cookstoves could reach a majority of African households, and that efficient fuel production practices and alternative fuels could be promoted to supply fuels sustainably.

Rather than just giving away the stoves, the program helps commercialize clean cooking solutions by using a market-based solution. Although the technological innovation in building LED lanterns running on low-voltage direct current seems to be quite complex when compared with the design of fuel-efficient wood stoves, the opposite is the case. Making wood-burning stoves that can operate efficiently outside the laboratory is a challenge that involves considerable changes in human behavior to implement effectively.

Unlike solar lanterns, the benefits of clean cookstoves may be apparent only to women and children who do the cooking, rather than to the entire household. Nevertheless, some of the same approaches and tools that proved successful for Lighting Africa are being drawn upon to transform the market for fuel-efficient cookstoves. The ACCES framework has provided three main lines of support:

1. **Managing quality**—Enhancing product information and consumer confidence through the establishment of a regional Quality Assurance and Technical Support program (Box 5).
2. **Delivering products**—Strengthening industry supply chains through the linkages among manufacturers and distributors.
3. **Activating customers**—Engaging consumers through timely and targeted consumer awareness, commercial marketing, and promotion campaigns.

With some variations, these three lines of support echo the Lighting Africa framework.

Importance of Knowledge Management

Knowledge management is a key component of ACCES. It encapsulates various knowledge generation, dissemination, communication, and exchange activities. For example, to develop a comprehensive understanding of the household cooking sector, ACCES commissioned a landscape study entitled *Clean and Improved Cooking in Sub-Saharan Africa*. The study outlined market opportunities and barriers to scale, the main actors in the sector, and key cookstove technologies and markets; recommended business models; and reviewed past and ongoing activities and programs.

ACCES Activities under AFREA I

As a blend of World Bank and client-executed activities, the ACCES program began carrying out programs in the Democratic Republic of the Congo and Senegal, and on the regional level under AFREA I. In the Democratic Republic of the Congo, ACCES supported the Forest

Investment Program-funded project Improved Forested Landscape Management Project, in preparation for the design of cookstove support activities. In Senegal, the ACCES team conducted a market and value-chain assessment for a project that promotes sustainable use of biomass resources. And at the regional level, the ACCES program has initiated a quality assurance and technical support system to ensure standards for clean, efficient cookstoves.

Impacts

In the Gambia, South Africa, and Uganda, project work helped develop sustainable businesses and stimulate a market for high-performance modern cookstoves and briquettes. Furthermore, the creation of the Africa Clean Cooking Initiative program followed from a consultation process involving more than 130 stakeholders representing government, NGOs, the private sector, and donors. Subsequently—following the Lighting Africa model—ACCES has initiated development of a regional quality assurance and technical support system to create performance standards for clean cookstoves.

BOX 5: ESTABLISHING A COMPREHENSIVE QUALITY ASSURANCE AND TECHNICAL SUPPORT SYSTEM FOR COOKSTOVES

As part of its "Managing Quality" line of support, the ACCES regional Quality Assurance and Technical Support (QA&TS) program has helped to steer the clean cooking market toward higher-quality products that present a stronger value proposition to consumers and provide a level playing field for market competition. Activities along the value chain that improve stoves or fuel quality complement the QA&TS program. Through incorporating technological and market readiness into ambitious national programs, ACCES has helped countries establish realistic and practical targets to encourage—rather than hamper—innovation and competition.

The metrics used for the program—efficiency, emissions reductions, safety, and durability—aim to be consistent with the ongoing global efforts to develop performance standards and testing capacity for cooking technologies. Moreover, these metrics are able to further evolve as the international scientific and policy community moves toward more precise and practical measurements of stove performance.

Under AFREA I, the ACCES QA&TS program developed several tools and programs that will continue to be used as ACCES under AFREA II turns more toward the implementation of country programs:

- *Rapid baseline assessment of performance* for the most common cooking products in its target countries and baseline assessment of gaps in capacity, testing, and quality control in regional knowledge hubs.
- *Minimum stove performance thresholds* in order for products to qualify for program investment support along the value chain. The thresholds accurately reflect national goals and expectations, and may vary in their level of ambition according to sectoral priorities, with the goal of supporting progressively higher-performing technologies over time.
- *Quality Assessment Scorecard and Test Methods* to incorporate a comprehensive checklist of quality control measures covering design, performance, manufacturing, and distribution of stoves and fuels. This tool provides cookstove manufacturers, distributors, and program implementers a definition of quality that allows them to assess their product and to either scale up their investment or return to the drawing board.

Under AFREA I, ACCES explored the feasibility of national technical bodies implementing an energy guide-labeling scheme to enable consumers to understand the lifetime costs and benefits of a particular stove. This guide is meant to enhance product information and consumer confidence in product quality.

Photo: Richard Hosier

Photo: Stephanie Nsom

The Rwanda SWAp

During the first decade of the 21st century, Rwanda made robust progress on both social and economic indicators as it emerged from its fragile status. However, access to electricity remained a constraint to further development. Rwanda's energy infrastructure was dilapidated. By 2008, only 6 percent of, or 500,000, Rwandans—mostly in urban and peri-urban areas—had access to grid electricity. The available generation capacity was limited to 50 megawatts (MW), and the country relied heavily on imported automotive diesel oil, which made the electricity supply both unreliable and expensive. Against this background, the government of Rwanda made the ambitious commitment to triple household access to electricity over a five-year period in order to move the country forward.

Setting Up the SWAp

To help the government address Rwanda's severe electricity access issues, the World Bank and other donors collaborated to establish a sector-wide approach (SWAp). The idea behind a SWAp is that a whole sector can be transformed through collaboration and coordination, in contrast to the more common piecemeal approach, whereby each development partner selects projects for support independently. SWAps allow development partners to coalesce behind a government vision through integrated technical, financial, and implementation planning. In the best of cases, all individual projects are embedded within the SWAp framework.

The Rwandan SWAp represents the first of its kind to be implemented in the infrastructure sector. A major advantage with the Rwandan SWAp was that all financing supports a holistic plan, as endorsed by the government to meet its own objectives. The approach enabled even smaller donors without their own technical capabilities to support the SWAp.

The World Bank played a pivotal role in the operationalization of the Rwandan SWAp, first by assisting in the formulation of the Electricity Access Rollout Program (EARP) investment prospectus, which laid the groundwork for technical, financial, and implementation planning. This document, presented to a donor financing roundtable in 2008, provided a transparent and targeted implementation strategy for the least-cost achievement of Rwanda's electrification goals for the period 2009–12. The strategy included aggressive targets to increase electricity connections from 100,000 in 2008 to 350,000 in 2012, and to provide electricity connections to numerous schools, health centers, and other social infrastructure.

Implementing the SWAp

A sector working group made up of key stakeholders and development partners implemented the SWAp. The working group provided a forum for joint planning and coordination among all key stakeholders. Traditionally, a SWAp streamlines finances by pooling funding. In the case of Rwanda, because of some systemic procedural constraints (such as not being able to use country systems or the specific targeting by some donors), pooling of funds could not be achieved. Nevertheless, all activities, albeit the funding mechanisms and procedures, are selected following the agreed-upon program rollout prioritization criteria, and reporting covers the whole program.

The first step in preparing the SWAp was to decide which parts of Rwanda would immediately receive electricity and which would have to wait. To identify the physical locations and least-cost electrification options to be targeted, a team fanned out across the country, mapping population density and areas of economic activity with global positioning system-measuring instruments linked to a computerized geographic information system (GIS). The fieldwork process included marking

the location of every school, health clinic, and government administrative center in Rwanda, in order to provide electricity to these public institutions.

Drawing on the experience of other countries (including Tunisia), changes were made in the grid-construction techniques used, thereby lowering the capital costs of distribution infrastructure. The cost per customer connection fell because of planned efficiencies, such as changing from lattice-framed towers to wooden poles. In addition, the use of ready boards reduced the costs of wiring households. The program design also allowed for staggered connection payments to lower the amount that households had to pay up front.

AFREA: Making Green Connections

AFREA's focus for Rwanda and the SWAp was to strengthen and increase the use of renewable energy. With joint financing from the GEF, the AFREA program implemented the Rwanda Sustainable Energy Development Project to improve policy and institutional frameworks and increase private-sector participation in the renewable energy sector.

Rwanda used this technical assistance to develop the Renewable Energy and Policy Strategy, which was approved in 2012. The strategy led to adopting a micro-hydro feed-in tariff (FiT) in early 2012, and training entrepreneurs in biomass, PV, small-hydro energy, and energy efficiency. The AFREA program also supported the analysis of the regulations required to tap Rwanda's Lake Kivu methane for power, as well as efforts to enhance the sustainable use of biomass and clean cooking solutions in Rwanda.

Overall, AFREA initiatives enabled Rwanda to more effectively blend renewable energy into the electricity system, while promoting those small and middle enterprises working on renewable energy.

Generating Results

In just four years, the Rwanda SWAp project has yielded amazing progress in increasing access to electricity. The rapid scale-up of electricity access has exceeded the government's original targets. The two main results are a large of number new grid connections and the reduced costs of connections.

New Grid Connections

During the project's four-year period, household connections were tripled, increasing from 100,000 to 390,000 as of December 2013. This translated to an increase from 6 percent to 16 percent of households being able to utilize electrical power. Additionally, all new households connected under the project are using energy-efficient compact fluorescent lamps. The project program also increased connections to schools, health centers, and administrative offices, with more than half of Rwanda's health centers and roughly 40 percent of its schools having access to electricity as of December 2013.

Reduced Costs of Connections

Before the EARP, the cost of a household electrical connection was in the range of US$2,000. The SWAp helped bring the cost down to US$880 through technical changes and rollout cost optimization. The program initially focused on connecting households within 5 km of the existing grid (which was estimated to cover 60 percent of all households). That decision accounts for a good part of Rwanda's success in reducing connection costs and increasing connection rates.

Reaping the Impacts

Between 2009 and 2012, nearly one million Rwandans gained access to electricity, more than 1,400 km of new distribution networks were built, and electricity connections tripled. The number of schools connected to the grid rose from 715 in 2009 to 1,226 in 2012, and health centers with electric power grew from 169 to 286, respectively. Furthermore, the electrification increased the international competiveness of coffee and tea, Rwanda's major export crops, by lowering energy costs. Rwandans are realizing numerous other benefits as well (Box 6).

BOX 6: BENEFITS OF THE RWANDA SWAp GO BEYOND THE NUMBERS

For Edward Kasumba, Coordinator of Electricity Access Rollout with Rwanda's Energy Water and Sanitation Authority, the benefits of the SWAp were far reaching. He was impressed not just with the increase in the number of households connected to the grid, but also with how the quality of life was dramatically improved in rural areas because of the improved social services. "Schools that never before had computers were connected to the Internet—which is a very great achievement in remote areas—and hospitals and health centers that had been unable to afford fuel for their generators were able to operate equipment that had been sitting unused."

Mr. Kasumba also noted that the SWAp had brought a new vitality to many far-flung areas. "On the economic side, we've seen that business centers are able to work into the night and that shops and markets are able to use refrigeration to keep their produce fresh."

Learning from the SWAp

Other countries doing similar work could learn from the Rwanda SWAp. The fundamental building block of a SWAp is the development of an investment prospectus grounded in sound sector planning. This has proven to be effective, if the following conditions are present.

Strong Government Buy-in

Ownership by the government was key for the Rwanda SWAp to be effective.

Investment Prospectus

The main tool used in the Rwandan SWAp was the investment prospectus. This document put forth a credible program framework for the electricity sector's development, provided rigorous technical and financial analyses to aid implementation, and helped leverage donor funding by providing a clear plan of action and reducing the preparatory activities that donors had to conduct before allocating funds.

Data Collection

The collection of data from a number of different sources was critical to developing a spatial network expansion plan based on demand assessment and affordability.

Strong Commitment from a Lead Partner

The access program in Rwanda (which is applicable to similar post-conflict and low-income countries) benefited greatly from both the government's commitment to increase access and the World Bank's ability to drive the process, convene development partners, and mobilize grant funds for the upstream analytics that resulted in the SWAp.

Coordination Facilitated through the Sector Working Group

The primary mechanism under the SWAp is centralized management and planning though the Sector Working Group. By providing a platform for developing a joint, harmonized strategy, the SWAp reduced the coordination costs of stakeholders in the sector.

Least-Cost Planning

The transfer of experiential knowledge on cost-lowering design and implementation features can overcome barriers, especially those of affordability.

Financial Sustainability

While subsidies are often needed when increasing access to the poor, it is important to assess the financial sustainability of any access program by realistically forecasting loads based on consumers' ability to pay. Doing so makes possible an accurate estimate of the additional support needed from government (in the form of subsidies or transfers) and donors. In the case of Rwanda, actual household demand has been lower than expected, thus constraining the utility's revenues. A greater programmatic emphasis on income-enhancing productive uses of electricity should be added to future efforts in response to this lesson.

Photo: Vanessa Lopes Janik

Gender and Energy Program

Initiated in 2009, AFREA's Gender and Energy Program offered pilot approaches, developed expertise, and worked with energy teams and clients to begin integrating gender into energy-sector operations. The program worked with Bank energy teams to establish relationships and projects and create results "on the ground."

The Gender and Energy Program under AFREA I developed and mainstreamed the application of good practices in applying gender-sensitive approaches in energy projects and policies. The program worked in six countries—Benin, Kenya, Mali, Senegal, Tanzania, and Zambia—and preparatory work was conducted in Liberia and Mozambique.

The program's mantra was to be very practical—working with project teams and governments to design specific project components and activities to improve the lives of women and men. Activities included helping increase women's awareness of and skills for productive uses of energy, and developing financial literacy training programs for women to learn more about energy pricing and subsidies.

While the focus differed for each country, the gender-mainstreaming process remained the same. Gender Assessments were carried out to gather data and information from various stakeholders, and Gender Action Plans were designed to address gaps and opportunities. These actions were then monitored and reported on, so that lessons could be learned and knowledge shared. Various workshops were conducted with rural energy agencies, utilities, and ministries to build capacity and share experiences.

The program has also incorporated gender activities into AFREA's regional programs, such as ACCES, Lighting Africa, and AEI. In addition, local gender and energy experts have been hired to support and advise the World Bank energy teams and government counterparts on implementing and scaling up these activities. The program has developed approaches on how to integrate gender through assessments, fieldwork, client dialogue, workshops, and action plans. It has also supported research and training; provided information through toolkits, presentations, case studies, newsletters, and videos; and developed a roster of gender and energy practitioners for the Africa region who have been drawn upon to share experiences for capacity building and regional workshops.

Gender and Energy Up Close

In Senegal, poverty, energy, and gender are inextricably connected. Therefore, programs that integrate gender into energy issues are essential for tackling poverty. Among the poor, women bear the brunt of limited access to modern energy services, as their responsibilities extend to gathering firewood and cooking.

The Gender and Energy Program's activities in Senegal's Second Sustainable and Participatory Energy Management Project (PROGEDE) show how gender integration has moved beyond advocacy to action and demonstrate how gender is central to development. Building on the successful PROGEDE I, PROGEDE II is a community empowerment program designed to preserve the overall forest ecosystems on which many poor rural Senegalese families rely. Launched in 2011, PROGEDE II effectively mainstreamed gender by ensuring that women beneficiaries participated in decision-making processes; developed skills in technical production, entrepreneurship, and organizational management; and benefited from increased incomes.

With the support of the AFREA Gender and Energy Program, the PROGEDE II project team reached out to rural women to ensure their inclusion in project activities (Box 7). PROGEDE II also helped families to diversify

BOX 7: TAMBACOUNDA'S HERO

Many residents of Tambacounda, a rural town about 400 km southeast of Dakar, Senegal, consider Fatoumata Souaré a hero, because she and her children own and operate a sustainable charcoal production business that nets about US$2,800 every three months. The income has allowed Mrs. Souaré, who lost her husband a few years ago, to build a new house, install a solar panel, send her children to school, and purchase health insurance for her family. Mrs. Souaré is one of many residents in rural areas of Senegal who have benefited from the World Bank–sponsored PROGEDE II project.

their household fuel needs away from wood, supported beekeepers to modernize their craft, and brought improved seeds and larger yields to farmers. Selected project components included the following:

- **Institutional Reform of the Charcoal Value Chain**—This component supports establishing charcoal production concessions that increase the share of income from charcoal production for local governments and local communities in a gender-equitable manner. Activities included outreach and awareness raising with respect to relevant policies, laws and reforms, business development training, and measures designed to improve access to urban markets.
- **Sustainable Wood Fuels Supply Management**—This component supports sustainable community forestry management, the establishment and cataloging of biodiversity community reserves, and eco-friendly income-generating activities, such as gardening and honey production.
- **Promotion and Diversification of Modern Household Energy**—This component works to improve the production and dissemination of improved stoves, to develop an understanding of household energy consumption and supply, and to build the capacity of the Ministry of Energy's Directorate of Petroleum Products and Household Energy.

Lessons Learned

Mainstreaming Is Challenging

The very notion of mainstreaming means that an activity is not a stand-alone, one-time intervention, but rather is fully integrated into the project cycle. This poses the greatest challenges for gender mainstreaming, but is also the key to its success. The Gender and Energy Program team has found that integrating gender considerations into the project design stage constitutes best practice, as it allows for dialogue with the government, proper project scoping, and ensuring that gender is considered across the full project, including monitoring, evaluating, and reporting aspects. Having a project manager and task team leader provide the space during team missions and meetings to discuss gender issues with the government has proven to be an essential step in the process.

Solutions Should Be Practical, Not Theoretical

A second lesson from the first phase of the Gender and Energy Program is the need for practical solutions and interventions. In part, this means practically dealing with the country's actual energy situation. Staff members have commented that they are permanently learning: as experts in the field of gender and energy are limited, staff members continuously share experiences among themselves and with colleagues from other sectors, institutions, countries, and regions (Box 8).

Knowledge Products Should Be Readily Available

The Gender and Energy Program team has also learned to have knowledge materials available, as they tend to be in demand. Such materials as toolkits and template terms of references help staff members, client project teams, and other development partners build on practical experiences and tailor projects to their own specific gender-sensitive development actions.

BOX 8: TANZANIAN WOMEN TURN MANURE INTO FINANCIAL OPPORTUNITIES

Many poorer families in Tanzania spend a large portion of their income on wood or charcoal for cooking. This reliance on woodfuel represents not just a financial hardship but also an environmental challenge, as valuable trees are destroyed to provide the woodfuel and smoky cooking fires cause health problems.

Low-cost sustainable energy is vital to Tanzania's growth. Women play a key role in switching to alternative fuels. They are not only major consumers of green energy, but also budding entrepreneurs. An increasing number of households in Tanzania are headed by women—30 percent. And women produce 70 percent of all agricultural output.

Three years ago, Judith Mugeta's family of eight lived on US$90 a month, which her husband earned teaching at the local school. Nearly half of that income was used to buy wood or charcoal fuel for cooking. That's changed for Judith and her family.

Gender training at the highest level of Tanzania's energy sector has led to new opportunities for Judith, her family, and her community. Judith is now using cow dung to make an alternative fuel: biogas. Dung and water are mixed together and stored underground in a large vat. Anaerobic digestion creates the biogas (methane), which is piped into Judith's kitchen. No more smoky fires. No more spending the bulk of the family's income on expensive firewood and charcoal. "I'm very happy," Judith says. "I can make (biogas) in a short time but I'll be using it for the next 24 hours."

Judith learned about the financial possibilities of biogas through a multi-step process that started with AFREA's Gender and Energy Program, which trained officials in the Tanzanian Rural Energy Agency about how men and women use and access energy differently. When the agency expanded training opportunities for women, Judith attended a 10-day workshop, where she learned about the money she could save by switching to biofuel. She created a business plan and secured a loan of US$2,000. With that, Judith bought two pregnant cows and installed the biogas system.

Since she's spending less time tending to the cooking fire, Judith can focus on selling the milk her cows produce. Within just a few months, she has more than tripled her family's income. With their extra money, Judith reports that she and her husband are paying the costs of university for their older children. "Our son wants to get a master's degree. Now we can support him using the money we saved from my husband's job, instead of using that money for household expenses."

The benefits extend beyond the family. Judith has also hired two young adults in her community. One helps with cooking and cleaning, while the other helps make biogas and takes care of the cows. The money they earn helps their own families.

Judith isn't complacent. She's already planning her next business venture. "Our future plans are to put a roof on the chicken coop. Once we have finished that, and have put a roof over some other rooms, we'll start raising laying hens." She'll sell eggs from the chickens to earn even more income and perhaps create more jobs and more revenue for the community.

To see the video of Judith's story, please, visit ***https://www.youtube.com/watch?v=DIdnOkyDgOA***.

Photo: Mitsunori Motohashi

Africa Electrification Initiative

SSA electrification practitioners often face difficulties in obtaining the practical and timely operational know-how needed to tackle the many economic, technical, institutional, legal, and political barriers that they encounter in their daily work. Even in cases where regulations, policies, and necessary institutions are in place, relevant and up-to-date operational experiences and implementation techniques are not always easily accessible. Therefore, achieving national and regional universal access targets will require not only enormous resources—an estimated US$1 billion a year to achieve universal access by 2030—but also significant investment in capacity and implementation expertise.

In 2009, the World Bank set up AEI as a vehicle to address these existing knowledge gaps and facilitate exchange of skills and knowledge among SSA electrification practitioners who are actively working on day-to-day access issues within the energy ministries, utilities, rural energy agencies, regulatory agencies, universities, and research institutes in the region. AEI aims to create and sustain a living body of practical knowledge and a network of practitioners in the area of design and implementation of rural, peri-urban, and urban on-grid and off-grid electrification programs.

In June 2009, AEI launched Phase I with a kick-off practitioner workshop in Maputo, Mozambique. Phase I established a network of SSA senior electrification practitioners, identified the issues where practitioners face the most significant knowledge constraints and that are of greatest interest for their daily work, and recognized the most suitable long-term information dissemination mechanisms for AEI.

The following areas became the primary focal topics of AEI's activities:

- Efficient rural electrification agencies and rural electrification funds
- Low-cost electrification technologies
- Pro-access regulations for mini-grids
- Productive uses of electricity
- Connection charges
- Access to finance/subsidies
- Grid intensification
- Off-grid PV technology
- Effective monitoring and evaluation.

Phase II of AEI involved research and analysis of the practical issues of interest for the SSA electrification practitioners identified during the previous phase. During this phase, a series of AEI discussion papers and how-to manuals were completed, and a number of workshops and knowledge exchange events were organized. Phase II also involved the development of knowledge dissemination mechanisms: the AEI Web site; an online network for members, including a private space for discussing various electrification topics; and an online archive of operational documents for use by practitioners.

Activities Carried Out under AEI

Rural Electrification Agencies and Rural Electrification Funds

In November 2011, AEI hosted a workshop in Dakar on Institutional Approaches to Electrification: Experiences of Rural Energy Agencies and Funds in Sub-Saharan Africa. The workshop examined how rural electrification agencies and funds interact with national utilities, ministries, and regulators, and encouraged practical knowledge sharing in the region. Following the event, AEI produced the practitioner handbook *Institutional Approaches to Electrification: Experiences of Rural Energy Agencies and Funds in Sub-Saharan Africa*.

Another AEI event was the Panel on Institutional Approaches to Electrification, which was held during the World Bank Energy Week in 2011. The panel covered different institutional approaches to electrification, focusing on Mali's rural electrification program (which has created more than 50 isolated diesel-fired mini-grids); Kenya's and Ethiopia's utility-led electrification approach; and Bangladesh's rural electrification cooperatives system, modeled after the U.S. cooperative system.

Low-Cost Electrification Technologies

AEI has hosted a series of Low-Cost Electrification Technology Workshops, co-organized with the European Union Energy Initiative (EUEI) Partnership Dialogue Facility. The first event, held in Arusha, Tanzania, in September 2013, targeted English-speaking countries in the SSA region and presented low-cost grid-extension technologies that have been used to reduce electrification costs in such countries as Ghana, New Zealand, and South Africa, These technologies include single-phase reticulation, the shield wire scheme (SWS), single-wire earth return (SWER), and low-cost high-tension grid extension. A follow-up practitioner's workshop targeting Francophone countries was held in Cotonou, Benin, in March 2014.

In response to strong interest from the Zambian Ministry of Energy, whose representatives attended the Arusha workshop, AEI held a targeted Local Low-Cost Electrification Technology and Policy Practitioner Workshop in Lusaka in May 2014, where representatives of energy stakeholders from Ethiopia, Ghana, Namibia, and Togo shared their countries' experiences with implementing low-cost electrification technology projects utilizing the SES and SWER technologies. The event was part of broader AEI technical assistance to Zambia on low-cost electrification technologies.

Pro-access Regulations for Mini-grids

In a follow-up to the AEI workshop on Institutional Approaches to Electrification, held in Dakar in 2011, AEI produced the handbook *From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa—An Implementation Guide for Regulators and Policymakers*. Since its release in December 2013, the book has been downloaded more than 8,800 times, becoming the second most popular publication in the World Bank's Directions in Development series.

AEI events included a seminar on Small Power Producers in Tanzania (Washington, DC, November 19, 2010) and World Bank Energy Week 2011 (Washington, DC, March 14–16, 2011). These seminars covered lessons from Tanzania's experience of creating clear and "light-handed" regulatory systems to promote on-grid and off-grid generation of electricity by small power producers.

Productive Uses of Electricity

AEI has collaborated with the German Federal Enterprise for International Cooperation (GIZ)/ESMAP research project on productive uses, or PRODUSE. This collaboration has resulted in a number of research papers and events, including Grid Extension in Rural Benin: Micro-Manufacturers and the Electrification Trap (2010) and Productive Uses of Energy—PRODUSE: Measuring Impacts of Electrification on Small and Micro-Enterprises in Sub-Saharan Africa (2013).

AEI held a roundtable discussion and the EUEI-led Productive Uses Workshop (Nairobi, Kenya, September 20–22, 2011), focusing on how productive uses of energy can be fostered and some concrete productive use planning and implementation steps.

Connection Charges

The 2013 AEI publication *Connection Charges and Electricity Access in Sub-Saharan Africa* reviews ways to improve electrification rates by addressing the issue of high connection charges and ways to mitigate them. The paper assesses ways to introduce low-cost technologies and materials in distribution networks and household connections, making bulk purchases of materials and adjusting technical standards to reflect the lower loads of households that use a minimum amount of electricity. It also reviews various financing solutions, such as spreading connection charges over a reasonable period, rolling them into monthly service payments, subsidizing connections, and amortizing them through loans.

Access to Finance and Subsidies

AEI sponsored a panel on Innovative Financing for Rural Electrification, held at the World Bank Energy Days 2011 (Washington, DC, March 14–16, 2011). The panel covered various innovative approaches, including performance subsidies designed by Energizing Development/GIZ; a credit line for rural/renewable energy development and carbon finance, implemented

by the REA Tanzania; and microfinance for solar energy development in Uganda.

AEI also sponsored a training workshop on Paying for Results in the Energy Sector, held at the World Bank Energy Days 2012 (Washington, DC, February 23–March 1, 2012). Organized in cooperation with ESMAP and the Global Partnership on Output-Based Aid, the panel covered the concepts of results-based financing and output-based aid, the opportunities raised by these forms of aid, and the application of the approaches. Panelists from Bangladesh, Ethiopia, Liberia, and Uganda presented case studies.

Lessons Learned

Three lessons emerge most strikingly from AEI's experience.

Listening to Clients Is Key

Listening to clients' views of their needs is crucial to ensuring that you can help them. AEI has anchored its activities with this key lesson, both by noting clients' needs for relevant knowledge and by helping them to fill those knowledge gaps in their day-to-day work. All of AEI's activities and strategic themes are tailored to specific requests expressed by the clients and issues faced by electricity specialists in the SSA region. This approach has resulted in clients' high levels of satisfaction with AEI products.

South–South Knowledge Exchange Is Productive

Peer-to-peer exchange grounded in demonstrating the success stories of other African countries in improving access to electricity is one of the most potent ways of influencing decision making and gaining buy-in and confidence from local stakeholders in new technologies and policy methods. AEI's goal is to ensure a bottom-up approach to knowledge exchange, using a mix of techniques to allow practitioners to share their experiences and knowledge. This approach provides practitioners with the most relatable examples that come from their peers in the region.

Tailoring Activities to Fit Needs Is Effective

Over the course of AFREA I, experience with AEI demonstrated that for peer-to-peer learning to be effective, tailoring activities linked to specific clients and challenges is far more effective than convening broader, generic conferences. Along these lines, AEI also provides sufficient support to each country scenario, using a step-by step approach that gradually builds up the local capacity.

Photo: Stephanie Nsom

Conclusion: AFREA Phase I A Foundation for Progress

By the time all AFREA I projects had closed on June 30, 2014, AFREA Phase II was well under way. Its framework was designed to incorporate lessons and experiences from the first five years of operation in order to improve the efficiency and effectiveness of the program in achieving its goal: To increase both access to modern energy and the use of clean energy in SSA. These goals—which are consistent with those of the SE4All initiative and the World Bank's Directions for the Energy Group—will remain front and center throughout AFREA II.

The experiences, successes, and lessons from the larger AFREA I activities have been summarized in the previous chapters of this report; experiences from the remaining projects are reviewed in Annex I. Some of these lessons are technical and project-specific in nature. For example, the importance of product quality is a prerequisite to successful transformation of markets for new energy products, such as LED-lit PV lanterns (Lighting Africa) and improved cookstoves (ACCES). Another example is provided by the great success of the approach taken in the Rwanda SWAP, which now forms a best-practice model for SE4ALL's work (see Box 9). But still other lessons are broader in nature and have been used to inform AFREA's approach to programming as it moves forward. A few of these lessons are described below.

Perhaps the most fundamental lesson for program design is that it is essential to build around the experiences and challenges facing the Africa Energy Practice's operational staff in their day-to-day dialogue and work with clients across the African subcontinent. Operational staff members are in daily contact with the practitioners and clients and therefore have the most direct impact on shaping the efforts of client governments moving forward. These staff are also the first to pick up on emerging needs and challenges and therefore can effectively make use of funding for extra client training, capacity building, and development of tailored and timely information solutions. Building around the experiences, challenges and contributions of operational staff remains at the core of maintaining AFREA's relevance and cutting edge and maximizing the effectiveness of Bank support to energy practitioners and clients in SSA.

A second lesson concerns the overall scope of resources that the Bank is responsible for delivering to its clients in SSA: IDA resources. As nearly all African countries are IDA-eligible, using AFREA funds to develop, steer, and shape the design and implementation of projects supported by IDA is the most effective way to leverage AFREA resources to have the greatest impact. All AFREA grants need to be viewed from the perspective of how they will influence and improve the effectiveness of the region's IDA-supported activities.

Third, capacity building takes many shapes and forms. From large conferences—useful for generating enthusiasm and initiating activities—to tailored training and consultant support—developed in close dialogue with clients— utilizing the full range of capacity building tools is essential to maximize overall effectiveness. Thanks to AFREA Phase I, the African energy team is better able to select the appropriate tool to respond to an identified need. Through the work supported under AFREA Phase II, this skill will be refined further.

Finally, "South–South" experience sharing and peer-led training are more effective in inspiring and assisting energy practitioners to achieve their goals than traditional "North–South" training or "Bank–client" dialogue. Learning about what has worked from those who have made it work bolsters confidence, encourages active replication, and embodies an important formula for success.

Utilizing AFREA funds to support the mission of increasing access and clean energy in SSA has been

a privilege for the Africa Energy Practice. Being able to draw upon these resources to maximize project impact and learn-by-doing is an experience not available to Bank teams in all regions. As AFREA advances into its next phase, the Africa Energy Practice looks forward to being able to continue learning, experimenting, and enhancing the effectiveness of its core business of bringing clean energy and enhanced access to our client countries.

BOX 9: RWANDA SWAp—A MODEL FOR OTHER COUNTRIES

The results of the Rwanda SWAp have so impressed its observers that the model is being promoted for adoption around the world. It has inspired other African countries working with the World Bank—namely, Ethiopia, Kenya, Nigeria and Tanzania—to apply elements of Rwanda's approach, including the use of a systematic geospatial assessment of the electrification opportunities and challenges to develop an investment prospectus listing priority programs to be supported collaboratively among interested development partners to maximize results consistent with national priorities.

Rwanda's SWAp has served as a model for the Sustainable Energy for All (SE4All) Initiative to help developing countries attain the goal of universal access by 2030. As one of its technical contributions to the SE4All program, the World Bank has recommended that all countries prepare an investment prospectus built around detailed geospatial assessments of gaps and opportunities in a manner similar to that undertaken by Rwanda. The SE4All Technical Assistance Program in Africa is supporting access planning in Burundi, Guinea, Liberia, Mozambique, and Senegal. As part of this support, all of these countries will develop their own investment prospectus to initiate their SWAp.

SE4All is using the SWAp as a planning tool in "high impact countries", that is, countries with large un-electrified populations in both Africa and Asia. As a result, these countries will be better able to build a consortium of funders and investors interested in contributing their resources to help these countries reach the goal of universal access. able to build a consortium of funders and investors interested in contributing their resources to help these countries reach the goal of universal access.

Annexes

Photo: Mitsunori Motohashi

Annex 1: Other AFREA Phase I Activities

Africa: Decision Toolkit for Solar Photovoltaic (PV)

The Develop Decision Toolkit for Solar Photovoltaic grant supported the development of best-practice decision guidelines, models, and templates or toolkits for achieving least-cost energy solutions and incorporating the sustainability of energy services in social institutions, such as health clinics, schools, households, and other rural development sectors. While solar PV has been deployed across the remote and rural areas in developing countries to meet the essential service needs of communities, its long-term sustainability has often been below par, in part because of lack of both attention to proper design and provision of long-term maintenance services.

The grant supported community input and analysis needed to develop the solar PV toolkit, which is available in both French and English and also online. Drawing on experiences and good practices from throughout the world, the toolkit offers practitioners a guide that can be used to begin the long-term process of installing and maintaining solar PV energy systems.

A significant amount of knowledge from a range of practitioners was gathered to prepare the toolkit. A practitioner workshop, held in May 2010, showed evidence that the operational models in the toolkit should be tailored to each country, applying knowledge of the role of local government, the cohesiveness of communities, and other factors.

The toolkit extends AFREA's commitment to improving access to sustainable, affordable, renewable electricity in rural areas and enhancing the availability of solar PV systems to meet the growing needs of communities.

Africa: Energy Access Scale-up Plan Consultations

The Africa Energy Access Scale-up Plan Consultations grant contributed toward disseminating knowledge on energy-sector development in Africa, including best practices, energy-sector policies, and related climate change issues. The grant also provided policy support to the activities of the Secretariat of the Forum of Energy Ministers in Africa.

The various activities carried out under this grant have contributed to promoting dialogue and involvement by various stakeholders on the issue of achieving universal electricity access in Africa and securing the continent's energy future in a sustainable manner. The grant was instrumental in completing the World Bank's Africa Energy Strategy Update for Fiscal Year 2011–12 and supporting the well attended Ministerial Roundtable during the World Bank–IMF Spring Meetings in April 2011, which resulted in a discussion of the question: What would it take to transform Africa's energy sector? Also, the African Energy Ministers Conference, held in Johannesburg, South Africa, in September 2011, has been an important milestone in shaping consensus among African countries on the priorities for sustainable energy development. The Johannesburg Declaration adopted at the conference highlights the key energy challenges facing African countries and articulates a clear roadmap going forward.

AFREA's resources and skills in support of high-level events, such as the ones organized, constitute unique opportunities for governments, donors, and financiers to come together and reach a common understanding on the priorities for securing Africa's energy future in a sustainable manner.

West African: Renewable Energy Education Project (REEP)

This project seeks to upgrade the capabilities of the West African partners in the Renewable Energy Education Project—2iE (International Institute for Water and Environmental Engineering) in Burkina Faso, and the College of Engineering at Kwame Nkrumah University of Science and Technology (KNUST) in Ghana. The project's focus is on planning, delivering, and evaluating hands-on training to transfer know-how on renewable energy technology assessment and project implementation to its clients. The ultimate aim of this project is to enable The Energy Center, KNUST, and its partner institution 2iE to become capacity-building nodes for the recently established ECOWAS Regional Centre for Renewable Energy and Energy Efficiency, to be based in Cape Verde.

The two partner universities, 2iE and KNUST, successfully installed 20-kW peak-grid-connect PV systems on their campuses. Twenty-nine men and women at KNUST were trained in solar energy technologies (PV and

thermal), bringing the total number of people trained at the university to 57. At 2iE, 63 solar energy professionals, such as lecturers, engineers, decision makers, and technicians, were trained on PV technologies during the three sessions; 8 of these individuals are from the Université d'Ingénierie et de la Technologie Bobo-Dioulasso; École Supérieure des Techniques Avancées; and École Nationale Supérieure d›Ingénieurs, Université de Lomé. This brings the total number of people trained at both partner institutions to 120. Other activities included the installation of a weather station at 2iE, and development of a data-logging system, data collection and assessment, and creation of a Web site to access to those results.

Two stakeholder workshops brought together about 100 energy experts from across Africa and beyond, to inform national and subregional energy policy and research directions. The workshops produced a number of knowledge products, which are available on The Energy Center's Web site (*http://energycenter.knust.edu.gh*). AFREA's role in enhancing the technical knowledge and skills of energy practitioners in key institutions is essential to successful energy access scale-up.

Nigeria: Climate Change Implications for Growth in the Nonoil Sector

This grant aimed to develop a solid knowledge platform on low-carbon growth options that could contribute to the government of Nigeria's efforts to develop nationally appropriate mitigation actions.

During its two years of work, the team undertook a multiyear program of analytical work that evaluated how climate change considerations could be integrated into Nigeria's plans for growth and development, known as Vision 20:2020. The team organized more than 20 workshops on the different topics of low-carbon growth, with close to 80 participants from federal and state government agencies, academia, the private sector, civil society, and the community of development partners. Virtually all of the data and assumptions used in the analyses were discussed and validated with country stakeholders. Two books were published in the World Bank's Directions in Development series in June 2013: *Toward Climate-Resilient Development in Nigeria*, and *Low-Carbon Development: Opportunities for Nigeria*. A third book, *Assessing Low-Carbon Development in Nigeria*, was published in the World Bank Studies series. Outreach activities, including the launch event attended by high-level stakeholders, were undertaken to ensure wide dissemination of the findings. In addition, the grant has resulted in a US$30-million climate change component included in the Nigeria Erosion and Watershed Management Project.

The knowledge base created as part of this grant extends AFREA's support for a reliable, low-carbon, and sustainable power supply in Africa that supports competitiveness and employment and enables more businesses and people to realize their economic potential.

South Africa: Concentrating Solar Power (CSP) Incentives

The Concentrating Solar Power Regulatory and Financial Incentives grant was designed to enhance understanding of barriers to deployment of CSP in Southern Africa—particularly those related to technology applications—in order to inform government policies and build analytical capacities that allow partner countries to surmount these challenges and develop utility-scale solar thermal installations.

The grant was used for preparation of the analytical report *Concentrating Solar Power: Financial and Regulatory Incentives*, published in June 2012. A surge in demand for solar thermal power generation projects in several partner countries shows that concentrating solar thermal (CST) technologies could become an important source of renewable energy.

Merely replicating developed countries' schemes in the context of a developing country may not generate the desired outcomes. Against this background, this report analyzes and draws lessons from the efforts of some developed countries and adapts them to the characteristics of developing economies, assesses the cost-reduction potential and economic and financial affordability of various CST technologies in emerging markets, evaluates the potential for cost reduction and associated economic benefits derived from local manufacturing, and suggests ways to tailor bidding models and practices and structures for power purchase agreements for CST projects in developing-market conditions.

The results of the report were used in the design of regulatory incentive schemes for deploying renewable energy technology, including CST. For example, the design of South Africa's renewable FiT scheme was adjusted to introduce actions in combinations with the FiT.

Liberia: Catalyzing New Renewable Energy

This renewable energy project was designed to help establish the Rural and Renewable Energy Agency (RREA) in Liberia, to mobilize new and affordable renewable energy services for rural areas with little or no access to the grid. Spanning five years and two phases, the project included two pilot activities: (1) renovation of an existing micro-hydro power plant in a community of 2,000 people, and (2) sales of affordable solar lanterns for businesses and families located far from the grid.

In 2010 during Phase I of the program, President Ellen Johnson Sirleaf of the Republic of Liberia signed an Executive Order establishing RREA as a legal entity. The opening of RREA supports the government's efforts to expand access to electricity to residents throughout the country. Future workers attended training in the areas of renewable energy technology and development, GIS-based energy planning, computer science, finance, and other specific skills needed by personnel ready to operate RREA. The World Bank helped develop guidelines for setting up RREA's departments with proper controls and transparency, along with guidelines for RREA's hiring rules, personnel management, and daily operations. Branding was developed for RREA, including a logo and Web site (www.rrea.gov.lr), which was launched in May 2011.

In Phase II, RREA revitalized a micro-hydropower facility that had been destroyed during Liberia's civil war. The former 30-kW micro-hydropower plant had been operated by the community in Yandahun, Lofa County. Work on the facility, including installation, testing, and commissioning, was completed on March 31, 2013. The repaired and expanded Yandahun micro-hydropower project was officially dedicated in February 2014 by Her Excellency Ellen Johnson Sirleaf and handed over to the Yandahun community cooperative, which is responsible for the project's operation and maintenance. Today, the power plant provides access to sustainable energy for an estimated 200 locations, such as households, businesses, schools, and health clinics (Box A-1).

BOX A–1: REHABILITATING THE HYDRO PLANT IN YANDAHUN

In May 2009, a series of assessment studies determined that rehabilitation of the long-abandoned hydro plant in Yandahun would be an ideal pilot project opportunity for RREA. The assessments found that the generation capacity of the Yandahun plant could be doubled from its pre-war capacity of 30–60 kW. Moreover, restored electricity supply would provide income-generating opportunities for small enterprises in the area.

In 2011, construction started on the hydro plant, and less than two years later, the plant was fully commissioned. Liberian President Ellen Johnson-Sirleaf cut the ribbon at the ceremony for the plant, which now provides power to homes and businesses for the first time in more than a generation. Opening the mini-hydro plant represents an important step in bringing electricity to the millions of Liberians who currently live off the grid. "This is our flagship project—a real milestone," announced RREA General Director Augustus Goanue. "It demonstrates our emphasis on extending the benefits of electrification beyond the capital and therefore distributing the benefits of development more evenly."

AFREA's support has led to a promising opportunity for RREA from another international organization. In 2014, the Climate Investment Funds allotted RREA US$50 million to develop and implement a renewable energy investment plan.The financing will enable RREA to build a series of new mini-hydro plants connecting to new mini-grids in isolated rural areas. RREA is currently working with the government to identify projects where the new mini-hydro plants will be located.

"We want to replicate the Yandahun project using the capacity we have gained," Mr. Goanue explained. "We now have the experience to go ahead and manage other similar projects around the country."

A second activity demonstrated the use of off-grid solar lighting devices for Liberia. Established as a pilot-phase business development effort, Lighting Lives in Liberia (LLL) was developed to use solar energy for a rapid scale-up of access to modern lighting. Since LLL's launch in February 2012, two orders of an estimated 20,000 solar products have been imported and sold by local retail partners. In August 2014, RREA donated 500 of these lighting products to the Ministry of Health for distribution to Ebola-affected areas in Liberia. The LLL pilot is being scaled up with financing support from GEF.

Rwanda: GEF Sustainable Energy Development Project

This project aims to strengthen and consolidate the Rwandan renewable energy market, by improving the policy and institutional frameworks of the renewable energy and energy efficiency subsectors, and increasing private-sector participation in the country's renewable energy sector.

The AFREA Trust Fund has supported several activities related to the project's energy policy, strategy, and management that have enabled government agencies in the energy sector to make informed decisions related to policy actions, project promotion, and private-sector engagement. By fully integrating renewable energy and energy efficiency activities, the project has led to considerable expansion of the solar, micro-hydro, and improved cookstove markets, thus reducing CO_2 emissions and avoiding incremental generation costs that would have been required to meet incremental demand from the energy efficiency savings and substitution. A new sector policy and several enacted laws together define the emerging sector structure and institutional framework. These include a government policy to increase private-sector investments and off-grid electricity distribution. As a result, a number of private firms are now participating in the Rwanda renewable energy market.

The project has had significant social and poverty-related impacts, including improving living conditions for users through the increased use of improved cookstoves, and sustaining local jobs related to the manufacturing of this technology. AFREA's role of enhancing the policy development capacity of key institutions, such as government ministries, is essential to successfully scaling up access to sustainable energy.

Mali: Energy Access for Productive Uses

This grant provided additional funding for the Household Energy and Universal Rural Access Project, which was designed to support the government of Mali's efforts to increase the access of isolated low-income populations to basic energy services, to help achieve economic growth and poverty reduction targets, including those linked with the Millennium Development Goals. The AFREA Trust Fund supported activities to increase renewable energy supply to households, small and medium enterprises, and health and education centers in rural and peri-urban areas. In addition, the grant supported activities to promote community-based woodland management, and to strengthen the energy-sector reform processes for increasing private-sector participation in decentralized energy service delivery. The use of grant resources as additional funding for an ongoing project allowed resources to be earmarked to specific investments, without having to use the grant resources to prepare them.

This grant is in line AFREA's funding objectives to support activities that help accelerate preparation and implementation of electrification subprojects based on renewable energy technologies to expand energy access in SSA.

This subcomponent will expand access to renewable energy in about seven villages in five different regions in Mali, thereby reducing greenhouse gas emissions. Focusing on multiplying the successfully established schemes of biofuel and PV mini-grids in Mali, AFREA Trust Fund grants will finance the expansion or construction of larger-scale renewable-technology mini-grids that can generate and distribute power to rural and peri-urban households, community institutions, and businesses. Focusing on villages where customers are concentrated enough to be economically interconnected, each renewable energy subproject is expected to provide 60–400 new connections. An additional off-grid renewable energy generation capacity of 250 kW will be installed under this subcomponent.

Benin: Modernization of Biomass Energy Services

This grant increased access to cleaner cooking fuel in the form of LPG, promoted energy-efficient use of charcoal, and supported income-generating activities that contribute to forest protection in Benin.

The grant supported training activities for men and women in improved, energy-efficient charcoal production, resulting in the training of 500 charcoal producers—more than initially planned. Energy-efficient production of charcoal will be scaled up under the implementation of the forest management plans covering 300,000 hectares, financed by IDA.

Over the course of this grant, 6,000 improved charcoal stoves were tested, labeled, and sold. Beneficiaries traveled to Senegal on a study tour to learn more about cookstove dissemination practices to help address difficulties in disseminating the new charcoal cookstoves. A revolving fund was set up and will ensure the dissemination of more than 10,000 improved charcoal stoves.

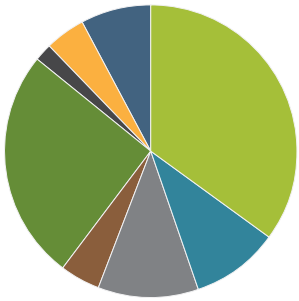
Regarding LPG stove dissemination, 16,000 LPG packages (LPG bottle and stove and connecting equipment) were acquired and were being commercialized at a subsidized price in four cities: Cotonou, Porto-Novo, Abomey Calavi, and Parakou.

The support for income-generating activities enabled the development of improved bee-keeping practices in rural communities and resulted in increased revenues in participating villages, exceeding initial expectations.

With this grant's focus on energy-efficient charcoal production and the dissemination of LPG package cookstoves, AFREA is helping to expand access to reliable and affordable modern energy services to both rural and urban families in Africa.

Annex 2: AFREA I Activities

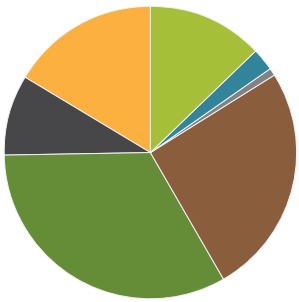
FIGURE A2.1: AFREA I—DISBURSEMENTS BY REGIONAL ACTIVITY



US$12.7 MILLION

- **35%** Lighting Africa (LA)
- **10%** Africa Electrification Initiative (AEI)
- **11%** Gender and Energy
- **4%** Africa Clean Cooking Energy Solutions (ACCES)
- **26%** Biomass Energy Initiative Africa (BEIA)
- **2%** Toolkit Solar Photo Voltaic (PV)
- **4%** Africa Energy Access Scale-up Plan Consultations
- **8%** Renewable Energy Education Project (REEP)

FIGURE A2.2: AFREA I—DISBURSEMENTS BY COUNTRY-SPECIFIC ACTIVITY



US$12.0 MILLION

- **13%** Rwanda: Sector Wide Approach (SWAp)
- **2%** Nigeria: Enhancing the Climate Resilience of Growth
- **1%** South Africa: Concentrated Solar Power
- **26%** Liberia: Catalyzing New Renewable Energy
- **33%** Rwanda: GEF Sustainable Energy Development Project
- **9%** Mali: Energy Access for Productive Uses
- **16%** Benin: Modernization Biomass Energy Services

Annex 3: AFREA I Outputs by Project

Africa Renewable Energy Access Program (AFREA)

FY 2012

Knowledge Products

- Brochure: AFREA Meeting Africa's Energy Needs and Widening Access to Sustainable Energy in Sub-Saharan Africa

Africa Clean Cooking Energy Solutions (ACCES)

FY 2011

Analytical & Advisory Activities

- Household Energy Access for Cooking and Heating (June 2011)

FY 2012

Analytical & Advisory Activities

- Africa country engagement: Country Prioritization Assessment in Landscape Report (East Africa Alliance Workshop)

Knowledge Products

- Africa consultation: East, West, and Southern Africa consultations; 3 consultation event reports disseminated; consolidated stakeholder report (Nairobi, Accra, Maputo)
- Report: Wood-based Biomass Energy Development for Sub-Saharan Africa: Issues and Approaches
- Brochure: Africa Clean Cooking Energy Solutions Initiative (ACCES, November 2012)

FY 2013

Knowledge Products

- Consultation: Consultation workshops in Senegal and Uganda; stakeholder interviews in Kinshasa
- DRC, Uganda: Consumer research study
- Africa: Technical Assessment of Cookstove Projects for the World Bank Biomass Energy Initiative for Africa
- Uganda: Results-based financing study
- Web site: ACCES Web site

FY 2014

Analytical & Advisory Activities

- Senegal: Baseline and Feasibility of Alternative Cooking Fuels in Senegal

Africa Electrification Initiative (AEI)

FY 2010

Knowledge Products[1]

- Discussion papers:
  - On-Grid and Off-Grid Small Power Producers in Africa: Key Implementation Questions For Electricity Regulators
  - Carbon Finance: Challenges and Opportunities in the Electrification Sector in SSA
  - Off Grid: Hybrid Models
  - Pico PV
  - Productive Uses (developed with GIZ and European Union Energy Initiative Partnership Dialogue Facility (EUEI-PDF))
  - Grid Connection Charges
  - Microfinance for Off-Grid Electrification
- Research/technical papers
  - What the Data Show: Access to Electricity in SSA
  - Subsidy Matrix
  - Ground-Level Regulatory and Policy Implementation Issues in Promoting On-Grid and Off-Grid Small Power Producers
  - Experience of Rural Electrification Funds/Rural Energy Agencies in SSA
- Africa Electrification Initiative (AEI) Maputo Workshop Proceedings | Energy Practitioners in Sub-Saharan Africa (December 2009)
- Support provided to Rwanda Electricity Company to identify speakers for the regional mini-workshop on Access to Electricity and Development of Local Industries in East Africa (April 2010)
- AEI Web site completed and launched
- Development of an online archive of operational documents for electrification in partnership with

1 Knowledge products include toolkits, operational guides, models, handbooks, databases, internal and external training, forums, and workshops.

Public–Private Partnerships in Infrastructure Resource Center for contracts, laws and regulation; some of the documents have been translated to English and French

- AEI Online Social Collaborative Network completed, discussions included the following topics: (1) On-Grid and Off-Grid Small Power Producers in Africa: Key Implementation Questions for Electricity Regulators; (2) Carbon Finance: Challenges and Opportunities in the Electrification Sector in SSA; (3) Hybrid Mini-Grids; (4) Pico PV; and (5) Microfinance and Rural Electrification.

FY 2011

Analytical & Advisory Activities

- Microfinance for Off-Grid Electrification
- Grid Extension in Rural Benin: Micro-Manufacturers and the Electrification Trap (AEI in cooperation with GIZ)
- Impact Evaluation of Productive Use—An Implementation Guide for Electrification Projects (AEI in cooperation with GIZ)
- Online Social Collaborative Network (continued):
  - 187 participants reached
  - Online discussions on:
    - Different Institutional Approaches to Electrification
    - Energy Access for the Urban Poor (with ESMAP)
    - Strategies for Promoting Productive Uses of Electricity (with EUEI-PDF)

Knowledge Products

- Symposium on Small PV—Applications, Rural Electrification and Commercial Use (June 6–7, 2011; University of Applied Sciences, Ulm, Germany)
- World Bank Energy Week 2011—panels on Institutional Approaches to Electrification and Innovative Financing for Rural Electrification (March 14–16, 2011, Washington, DC)
- Seminar on Small Power Producers in Tanzanian Villages (November 19, 2010, Washington, DC)

FY 2012

Analytical & Advisory Activities

- Africa: Discussion papers/write-ups posted since July 2011 via AEI Online Social Collaborative Network:
  - Strategies for Promoting Productive Uses of Electricity
  - Improving Electricity Access for the Urban Poor in African Cities
  - L'Amelioration de l'Acces a l'Électricité pour les Pauvres dans les Zones Urbaines Africaines (French)
  - Institutional Approaches to Electrification
  - Approches Institutionnelles de l'Électrification (French)
- Africa: Impact Evaluation of Productive Use | An Implementation Guide for Electrification Projects (led by EUEI)
- Senegal: AEI Dakar Workshop Proceedings
- Sub-Saharan Africa: AEI Call for Papers on Innovative Approaches for Access Scale-Up (10 papers submitted by SSA electrification). Winning papers:
  - Électrification Rurale en Zone Faiblement Monetarisee: Approche Innovante pour l'Électrification du Village de Goyala en Republique de Guinée (French)
  - Namibian Policy Perspectives on Solar Energy

Knowledge Products

- Training: Private-Sector Enabling Acceleration to Universal Access Panel and Paying for Results in the Energy Sector
- Workshop: World Bank Energy Days 2012 (Washington, DC, February 23–March 1, 2012)
- Training: Regulatory Review of the Power Purchase Agreements in Tanzania (Washington, DC, July11, 2012)
- Training: Urban and Peri-Urban Energy Access Practitioners' Forum (ESMAP Knowledge Exchange Forum 2012, Washington, DC, May 7–8, 2012)
- Workshop: Institutional Approaches to Electrification Practitioners' Workshop (Dakar, Senegal, November 14–16, 2011)
- Workshop: Productive Use of Energy Practitioners' Workshop (led by EUEI-PDF; Nairobi, Kenya, September 20–22, 2011)
- Workshop: Promoting Low-Carbon Energy in Africa through Carbon Finance Workshops (Africa Carbon Forum 2012, Addis Ababa, Ethiopia, April 17–20, 2012)

FY 2013

Analytical & Advisory Activities

- Africa: Africa Electricity Connection Costs and Electricity Access in Sub-Saharan Africa
- Africa: Africa Electricity Sector Data Analysis for Sub-Saharan Africa

- Africa: From the Bottom Up: Using Small Power Producers to Promote Electrification and Renewable Energy in Africa. An Implementation Guidebook for Regulators and Policymakers
  - Africa: Lighting Africa Operational Toolkit

Knowledge Products

- Policy research working paper: Connection Charges and Electricity Access in Sub-Saharan Africa
- AEI online Network posting: Developing a Carbon Development Mechanism Program of Activities: Lessons Learned from Senegal's CFL Distribution Program
- Conference: 3rd International Off-Grid Lighting Conference and Trade Fair (Lighting Africa, Senegal, November 2012)
  - Workshop: Regulatory Review of the Power Purchase Agreements in Tanzania (Washington DC, July 2012)

FY 2014

Analytical & Advisory Activities

- Africa: From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa
  - Africa: Overview of Low-Cost Technologies

Knowledge Products

- Workshop: Local Low-Cost Technology and Policy Electrification Workshop (Lusaka, Zambia, May 12–13, 2014)
- Workshop: Low-Cost Electrification Technologies Workshop (Benin, March 2014)
- Workshop: Low-Cost Electrification Technologies Workshop (Tanzania, September 2013)
  - Workshop: Low-Cost Electrification Technologies Workshop (Zambia, May 2014)

Africa Energy Access Scale-Up Plan Consultations

FY 2011

Analytical & Advisory Activities

- Africa: The Ministerial Roundtable "What Would It Take to Transform Africa's Energy Sector?" was held in Washington, DC, on April 15, 2011, as a side event to the World Bank Spring Meetings.
  - Africa: Africa Energy Ministers Conference "Road to Durban: Promoting Sustainable Energy Access in Africa" was held in Johannesburg on September 15–16, 2011

Biomass Energy Initiative for Africa (BEIA)

FY 2011

Analytical & Advisory Activities

- Africa: Biomass energy strategy for Africa (November 2010)
  - Africa: Biomass Energy Potential to Transform Sub-Saharan Africa, World Bank Intranet article (December 2010)

FY 2012

Analytical & Advisory Activities

- Africa: Wood-Based Biomass Energy Development for Sub-Saharan Africa | Issues and Approaches (September 2011)
  - Africa: Power Cogeneration and Charcoal Production: Technological Status and Commercial Prospects (January 2012)

FY 2013

Knowledge Products

- Workshop: Biomass Energy Initiative for Africa (BEIA) Close-Out Workshop (Tanzania, September 2012)

Capacity Upgrading for West African Partners in Renewable Energy Education Project (REEP)

FY 2012

Analytical & Advisory Activities

- Ghana: Integration of Photovoltaic Output into Electricity Distribution Grids | Studies on a 4-kWp System in Ghana (September 2011)

Knowledge Products

- Training: GIS Energy Planning and RET-Screen Energy Analysis Model Training at KNUST (Ghana, August 2011)
- Training: Renewable Energy Technologies and Energy Policy Training Program (7 sessions at KNUST/2iE, Ghana, January–May 2012)
- Webinar: CSP Technologies for Harnessing Solar Energy in Africa—Schott Solar (August 2011)

- Webinar: Resource Assessment for CSP Feasibility, an ECREEE—CENER project (May 2012)
  - Workshop: International Solar Energy Experts Workshop (I -SEE 2012)—College of Engineering, KNUST (Ghana, May 2012)

Concentrated Solar Power in South Africa

FY 2011

Knowledge Products

- Energy and Mining Sector Board Discussion Paper No. 24: Regulatory and Financial Incentives for Scaling Up Concentrating Solar Power in Developing Countries (June 2011)
- Regional workshop: CSP Development Potential in the Southern Africa Region in Gaborone, Botswana (May 2010)
- Paper: Presentation at Delhi International Renewables Conference in October 2010
  - Workshop: Potential for Local Manufacturing in India (New Delhi, June 2011)

Decision Toolkit for Solar Photo Voltaic (PV)

FY 2011

Knowledge Products

- Africa: Photovoltaics for Community Service Facilities: Guidance for Sustainability—English | French Version (December 2010)
  - Training: Decision toolkit to aid the more effective design and implementation of off-grid projects/ programs in health, education, and water sectors

Gender and Energy in Africa

FY 2011

Analytical & Advisory Activities

- Report draft: Methods and Approaches on Integrating Gender in Africa Energy Programs and Projects Toolkit
- Corporate reviews and contributions to World Development Report on Gender Equality and Development 2012
  - Lighting Africa report: Expanding Women's Role in Africa's Modern Off-Grid Lighting Market

Knowledge Products

- Workshop: Experience of the AFREA Gender Mainstreaming Program and Learning from Tanzania: Africa Regional Workshop on Mainstreaming Gender Equality in Infrastructure Policies and Projects (March 2011, Ethiopia)
- Workshop: Gender Equality and Access to Energy Services: The Experience of the Rural Electrification Agency of Mali: Africa Regional Workshop on Mainstreaming Gender Equality in Infrastructure Policies and Projects (March 2011, Ethiopia)
- Gender awareness training: Introduction to Gender and Energy Concepts (Rural Energy Agency, Tanzania)
  - Web page: ESMAP Gender and Energy Web page designed, developed, and launched

FY 2012

Analytical & Advisory Activities

- Africa: Gender support and contribution to the Africa Clean Cookstoves Energy Solutions Program (ACCES)
- Africa: Network of gender and energy experts in the Africa region established and expanding
- Mali: Gender assessments | Mali (July 2011)
- Mali: Gender focal point terms of reference and position developed in Mali/AMADER (August 2011)
- Mali, Tanzania, Senegal, Kenya, and Benin: Africa Gender and Energy Program activities initiated and implemented (May, 2012)
  - Tanzania: Gender assessments | Tanzania (May 2011)

Knowledge Products

- Newsletter: Tanzania | Championing Energy Solutions for Women (May 2012)
- Report: Expanding Women's Role in Africa's Modern Off-Grid Lighting Market (French, October 2011, Energy Sector Management Assistance Program)
- Video: ThinkEqual 2012 Campaign | Mali Gender and Energy Documented (April, 2012)
- Workshop: Gender and Energy session and knowledge exchange (AEI Workshop, Senegal, November 2011)
- Workshop: AMADER Gender and Energy Workshop (Mali, November 2011)
  - Workshop: Rural Energy Agency Workshop (Tanzania, June 2012)

FY 2013

Analytical & Advisory Activities

- Benin: Developing a gender assessment and action plan for Benin's Rural Energy Program
- Kenya: Gender assessment and actions plans for the Ministry of Energy and Kenya Power and Lighting Company
- Senegal: Implementing gender action in Senegal's Rural Energy Program
  - Tanzania: Implementation of gender action plan and capacity building for Tanzania's Rural Energy Agency

Knowledge Products

- Report: Expanding Women's Role in Africa's Modern Off-Grid Lighting Market (printed in English and French)
- Video: Energy to Change Women's Lives in Africa | Senegal
- Workshop: What Is Gender Mainstreaming and How to Empower Women through Cookstove Solutions (Global Alliance for Clean Cookstoves Forum, Cambodia, March 2013)
- Report: Collaboration with ESMAP to produce Briefing Note on *Integrating Gender Considerations into Energy Operations*
  - Tools: Collaboration with ESMAP to produce *Gender and Energy Online Resources and Tools* (http://www.esmap.org/node/2757)

FY 2014

Analytical & Advisory Activities

- Zambia: Gender component developed together with energy team and Zambia Electrical Supply Corporation utility for project
- Benin: Gender assessment report finalized
- Kenya: Continued dialogue on gender action plan
- Senegal: Continued implementation of gender action plan in Senegal's Rural Energy Program
- Tanzania: Continued implementation of gender action plan and capacity building for Tanzania's Rural Energy Agency
- Mali: Continued implementation of gender action plan for AMADER
  - Consultation and development of Phase II—AFREA II Gender and Energy Program

Knowledge Products

- (Already in FY13) Video: Tanzania—Sustainable Energy: African Women Turn Manure into Opportunity
- BBL: PROGEDE 2: Community-Led Sustainable Forest Management Creating Wealth for Rural Families and New Energy Sources in Senegal (Washington, DC, March 2014)
- Workshop: Capacity Building and Experience Sharing Workshop (Dakar, Senegal, April 7–9, 2014)
- Workshop: Gender Mainstreaming Capacity Building Workshop (Kenya Power, Nairobi, August 27–28, 2013)
- Workshop: Gender Mainstreaming Workshop Ministry of Energy and Petroleum (Nairobi, August 29–30, 2013)
  - Workshop: Gender and Energy Online Community of Practice space launched featured AFREA workshop (https://collaboration.worldbank.org/groups/gender-and-energy)

Lighting Africa

FY 2009

Analytical & Advisory Activities

- Africa: Lighting Africa Annual Report 2009
- Tanzania: Market Intelligence Report (June 2009)
  - Ethiopia: Market Intelligence Report (June 2009)

FY 2010

Analytical & Advisory Activities

- Africa: Lighting Africa Annual Report 2010

Knowledge Products

- Conference report: Lighting Africa 2nd 2010 International Business Conference and Trade Fair (July 2011)
  - Consumer education products: Series of public service announcement (PSA) materials from Strika (print, radio, and video) (https://www.lightingafrica.org/resources/multimedia/)

FY 2011

Analytical & Advisory Activities

- Africa: Lighting Africa Market Baseline Report (October 2010) (https://www.lightingafrica.org/resources/market-research/market-trends/)
- Africa: The Off-Grid Lighting Market in SSA: Synthesis Report (February 2011)

- Africa: Lighting Africa Annual Report 2011

Knowledge Products

- Consumer education products: Series of PSA materials from Strika (print, radio and video) (https://www.lightingafrica.org/resources/multimedia/)

FY 2012

Analytical & Advisory Activities

- Africa: Lighting Africa Market Trends Report (April 2012)
- Africa: Donor update brief 2012

Knowledge Products

- Conference report: Lighting Africa 3rd 2012 International Off-Grid Lighting Conference and International Trade Fair (February 2013)
- Consumer education products: Series of PSA materials from Strika (print, radio, and video) (https://www.lightingafrica.org/resources/multimedia/)

FY 2013

Analytical & Advisory Activities

- Mali: Consumption analysis (June 2013)
- Burkina Faso: Supply chain mapping (June 2013)

Knowledge Products

- Consumer education products: Series of PSA materials from Strika (print, radio, and video) (https://www.lightingafrica.org/resources/multimedia/)
- Training: Quality Assurance and Technical Support Consultative Committee Discussion (Senegal, September 5, 2013)

FY 2014

Analytical & Advisory Activities

- Nigeria: Consumer Insights Market Study, August 2013
- Mali: Supply chain mapping (July 2013)
- Senegal: Supply chain mapping (July 2013)

Knowledge Products

- Consumer education products: Series of PSA materials from Strika (print, radio, and video) (https://www.lightingafrica.org/resources/multimedia/)
- Conference: Solar in the Sahel Conference (Dakar, Senegal, May 1–7, 2014)

Nigeria Climate Change Assessment

FY 2013

Analytical & Advisory Activities

- Nigeria: Assessing Low-Carbon Development in Nigeria: An Analysis of Four Sectors
- Nigeria: Low-Carbon Development: Opportunities for Nigeria

Knowledge Products

- Workshop: Nigeria Climate Risk Assessments Workshop (December 2012)

Rwanda: Sector Wide Approach (SWAp)

FY 2013

Analytical & Advisory Activities

- Rwanda: Extending Access to Energy: Lessons from a Sector Wide-Approach

Rwanda Sustainable Energy Capacity Development Project

FY 2013

Analytical & Advisory Activities

- Rwanda: Development of renewable energy policy and strategy

Modernizing Biomass Energy Services in Benin

FY 2012

Knowledge Products

- Efficient Charcoal Production Workshop in Dakar (November 2012)

Catalyzing New Renewable Energy in Rural Liberia (Phase I)

FY 2012

Knowledge Products

- Workshop: During June 2–3, 2010, a World Bank energy mission helped RREA hold a workshop with key stakeholders (Government of Liberia, private sector, NGO)

Annex 4: World Bank Group Lending Operations Influenced by AFREA, FY2010–2014

AFREA activities have contributed to the identification and design of approved World Bank Group energy lending of **close to US$2 billion.** These lending operations are listed below.

Country	Project
Burkina Faso	Energy Access Project
Burkina Faso	Electricity Sector Support Project
Cameroon	Energy Sector Development Project
Cameroon	Forest Investment Program
Congo, Democratic Republic of the	Regional and Domestic Power Market Development Project
Ethiopia	Electricity Network Reinforcement and Expansion Project
Ghana	Ghana Energy Development and Access Project
Kenya	Electricity Expansion Project
Liberia	Lighting Lives in Liberia
Malawi	Energy Sector Project
Mali	Household Energy and Universal Access Project
Mali	Scaling Up Renewable Energy Program
Mali	Rural Electrification Hybrid System Project
Mozambique	Energy Development and Access Project
Rwanda	Electricity Access Scale-up and Sector-Wide Approach Development Project
Senegal	Second Sustainable and Participatory Energy Management Project
South Africa	Eskom Renewables Support Project
Tanzania	Energy Development and Access Project
Zambia	Increased Access to Electricity Project

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and Access Program (AFREA)

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