Discussion paper no 4

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Energy efficiency: is it relevant for the bottom-of-the-pyramid?

Experiences from EU-supported projects 2007-2019

7 AFFORDABLE AND CLEAN ENERGY

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

ACP-EU Energy Facility *Monitoring*

European Commission

DANISH ENERGY MANAGEMENT DEM FOR SUSTAINABLE IMPACT

The ACP-EU Energy Facility (http://energyfacilitymonitoring.eu)

This discussion paper is one in a series of discussion papers based on experiences from the ACP-EU Energy Facility (EF).

The EF was established in 2005 to co-finance projects on increasing access to modern and sustainable energy services for the poor in African, Caribbean and Pacific (ACP) countries, especially in rural and peri-urban areas. 173 project proposals have been granted co-funding from the EU for a total of 0.4 billion euros; 50% of the total project-budgets of 0.8 billion euros.

The projects have been, and are being, implemented in the period 2007-2021 with 90% of projects completed in 2019. The projects cover a wide range of technologies:

Electricity grid-extensions in rural and peri-urban areas, hydro-powered mini-grids, solar and hybrid-solar mini-grids, stand-alone solar solutions for businesses, households and public institutions, portable solar equipment mainly used for lighting, clean energy solutions for cooking such as improved firewood and charcoal cook stoves as well as biogas, biofuels for electricity generation, and capacity development of public institutions in the energy sector.

Among the 173 Energy Facility projects, 77 are directly related to energy efficiency.

Danish Energy Management (DEM) has been granted the contract of providing technical assistance for the monitoring of the EF projects in the period 2011-2019. This discussion paper is based on information and data gathered during this period as well as current research and experience from other development interventions.

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Glossary

Energy efficiency (EE) refers to the use of technologies that require less energy to perform the same activity. Using a light-emitting diode (LED) light bulb or a compact fluorescent light (CFL) bulb that requires less energy than an incandescent light bulb to produce the same amount of light is an example of energy efficiency.

Energy conservation (EC) is any behaviour that results in the use of less energy. Turning the lights off when leaving the room and recycling aluminium cans are both ways of conserving energy[1].

[1] US Energy Information Administration website

Introduction

This discussion paper raises some of the key considerations on whether energy efficiency is relevant and how projects supported by the ACP-EU Energy Facility have mainstreamed energy efficiency.

Energy efficiency is a fundamental tenet of Sustainable Development Goal **SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all.** Although SDG 7 considers energy efficiency on a national level, mainstreaming energy efficiency requires not only the introduction of energy efficiency policies but also project-based interventions to roll them out. **SDG12: Ensure sustainable consumption and production patterns** incorporates energy efficiency as a strategy to reduce consumption, and specifically targets developing countries to de-couple economic development from resource use.

Moreover, access to energy and clean water is mandatory in view of the realization of other SDGs:

SDG1 (No Poverty): Affordable energy is a prerequisite to eliminate poverty. By reducing the burden of energy costs, higher levels of energy access become more affordable.

SDG3 (Good health and wellbeing): Less air pollution from more efficient use of fossil fuels will improve health conditions for the poor.

SDG5 (Gender equality): As end users of energy, efficiencies can both reduce the time spent in drudgery for women and enable them to investment in high priority expenses, e.g. their children's education.

SDG13 (Climate Action): Energy efficiency is a core component of any climate mitigation strategy, as there is a direct link between energy use and carbon emissions.

This paper addresses the complex discussion around energy efficiency for the poor, addressing:

- How and why energy efficiency is relevant,
- what energy use patterns are for low income households and the activities they are undertaking,
- the experiences of the ACP-EU Energy Facility projects in implementing energy efficiency measures,
- the opportunities for the promotion of energy efficiency for rural end users.

Background

Energy poverty, i.e. the lack of access to modern and clean energy, is one of the most critical challenges for achieving many of the Sustainable Development Goals (SDGs). More than 1.1 billion people in the world have no electricity. Nearly 3 billion people – or 40% of the world population – uses traditional biomass for cooking, lighting and heating. Approximately 4 million people die every year from indoor air pollution, mainly women and children due to their traditional household responsibilities. Recognising men's and women's different energy roles, needs, priorities and ensuring equal rights to energy access, is crucial to achieving Sustainable Energy for All (SE4All).

The primary objective of expanding the energy system is to provide affordable and sustainable access to energy services to all parts of the society both for commercial and social residential purposes. Energy efficiency is a key tool for making the most of available energy resources.

Electricity at a school
Photo: Danish Energy Management (DEM)

The United Nations' (UN) Sustainable Development Goal no. 7 (SDG 7) seeks to "Ensure access to affordable, reliable, sustainable and modern energy for all". SDG 7's first target (7.1) explicitly defines access as universal access to energy *services* by 2030 and target 7.3 calls for doubling the rate of energy efficiency improvements by 2030 (UN 2017)[2]. The two objectives are interlinked as improving the efficiency of the energy use and demand maximizes the impact on energy access1.

In practice this noble goal is not being achieved. For example, among the 173 interventions supported by the ACP-EU Energy Facility ('the Energy Facility") in the period 2007-2019, energy efficiency has often not been taken into adequate consideration throughout the supply chain, with the general exception of those projects that include components on improved cook stoves, improved cooking fuel production or on low consumption lightbulbs. Broadly in the energy access sub-sector, energy efficient cooking receives the most focus and attention when addressing energy efficiency at the bottom-of-the-pyramid (BOP). This is primarily because efficient cooking is a tangible, direct intervention that has significant impact on the BOP. Efficient cooking is

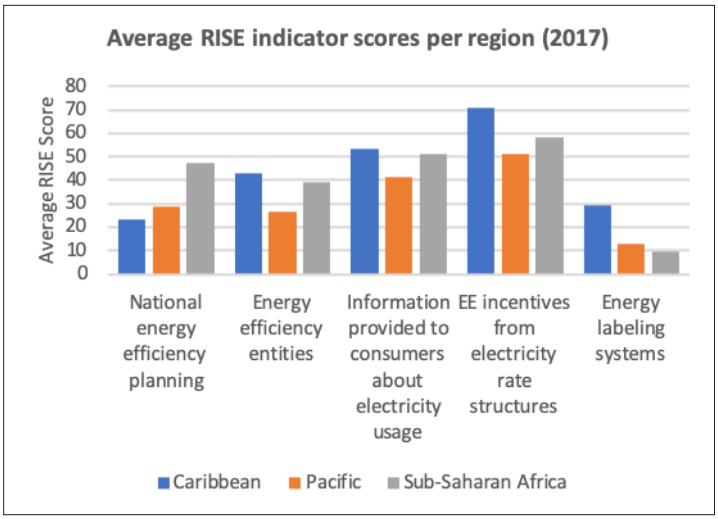
[2] 7.1.: By 2030, ensure universal access to affordable, reliable and modern energy services. And 7.3.: By 2030, double the global rate of improvement in energy efficiency https://sustainabledevelopment.un.org/sdg7

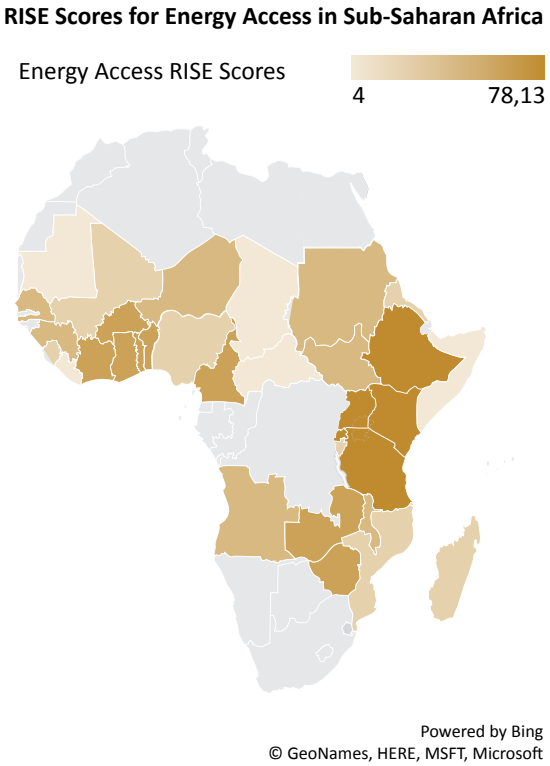
a significant issue that is the sole focus of Discussion paper 7. The current paper focuses on how to integrate energy efficiency in the delivery of electricity.

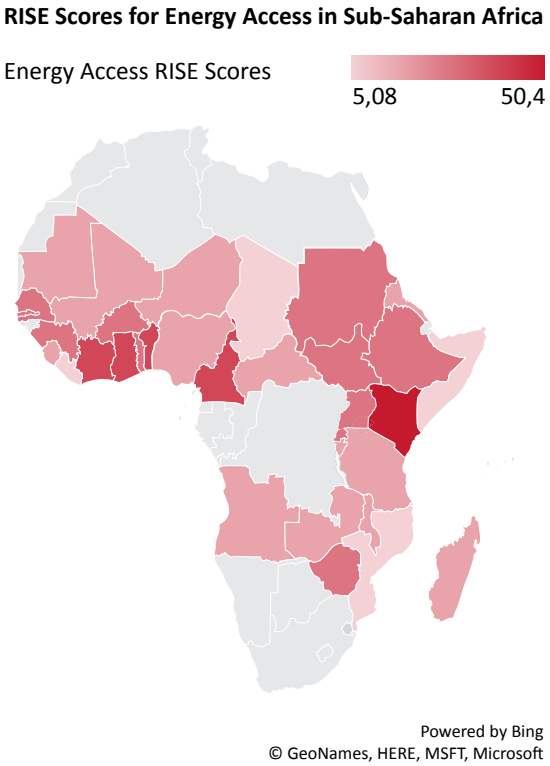
According to the World Bank Regulatory Indicators for Sustainable Energy (RISE) 2018 report in the period 2010-2017, there has been a significant increase in global RISE scores for energy efficiency, as one quarter of the surveyed countries have adopted good practic¬es for policies and regulations[3]. Almost 60 percent of the RISE countries have legislation in place to support energy efficiency, but adoption of specific energy efficiency measures is lagging.

In the regions relevant to the ACP-EU Energy Facility, it is apparent that particular measures have been taken, primarily related to the electricity tariff structures and supporting energy efficiency incentives schemes. However, the implementation of a measure that is visible to the general public, such as energy efficiency labelling, is limited.

Based on the data available relating to energy efficiency, this paper zooms in on sub-Saharan Africa. Despite the positive progress that has been made in energy access, it is notable that the increase in measures to promote energy efficiency is lagging.







[3] RISE – Regulatory Indicators for Sustainable Energy – is a global inventory of policies and regulations that support the achievement of SDG7 – electricity access, clean cooking, energy efficiency, and renewable energy. RISE tracks the regulatory indicators that can be compared across 133 developed and developing economies – from Afghanistan to Zimbabwe – and over time, from 2010 to 2017.

The above maps clearly show there is a disconnection between energy efficiency and access to modern energy services. While energy efficiency can contribute significantly towards improving access to modern energy services, energy sector investments in many developing countries have largely focused on increasing energy access by increasing supply. This is because the links between energy efficiency and energy access, are often overlooked.

This oversight of energy efficiency is frequently a missed opportunity, as investment in efficiency is often a very cost-effective energy resource. In combination with grid expansion and new clean energy generation, efficiency efforts can help to ensure that reliable power is provided to the maximum number of customers at a lower cost than would be required to increase generation alone. To illustrate the scale of the potential, the UN states that if people worldwide switched to energy efficient lightbulbs, the world would save US$120 billion annually (UN, 2019).

In reality, the two concepts are inextricably linked: improved energy efficiency frees capacity for improving access, while providing access in an energy-efficient manner is more cost effective than retrofitting at a later stage[4]. In addition to this, by mainstreaming energy efficiency, the level of service that can be offered with the same generation capacity increases. For example, super-efficient off-grid appliances enable consumers to purchase smaller (and therefore less expensive) solar photovoltaic panels, lowering energy costs to customers by as much as 50%. However, no analysis has been done to show this linkage for on-grid[5].

> Energy service – not energy supply – is what accomplishes the goals of energy access and efficiency can maximize the delivery of energy service while minimizing the financial social and environmental costs of energy supply' (CLASP, 2018)[6].

Incorporating energy efficiency measures in energy access projects provides benefits, including:

- **Reducing peak loads**: energy efficiency lowers the investments needed to meet demand during peak hours and frees up resources to supply energy to more people.
- **Reducing energy costs**: Households can afford more energy services or save on total energy costs.
- **Saving governments' money**: Lower energy consumption reduces government expenditure where tariffs are subsidized and/or supply is tight.
- **Preventing technology lock-in**: Appliances and other energy-using devices can stay in developing world markets for years beyond their expected useful life. Deploying highly efficient technologies prevents the long-run lock-in of inefficient products.
- **Facing the future increase in energy consumption that is generally faced when households' income grows**[7].

[4] Stephane de la Rue du Can, , David Pudleinerb, Katrina Piellic: Energy efficiency as a means to expand energy access: A Uganda roadmap

[5] Phadke, A., Jacobson, A., Park, W., Lee, G., Alstone, P., Khare, A., 2015. Powering a Home with Just 25 W of Solar PV: Super- Efficient Appliances Can Enable Expanded Off- Grid Energy Service Using Small Solar Power Systems. Lawrence Berkeley National Laboratory, Schatz Energy Research Center, Energy and Resources Group, and University of California, Berkeley

[6] World bank CLASP Report: EA+EE: Enhancing the World Bank's Energy Access Investments Through Energy Efficiency (January 2015)

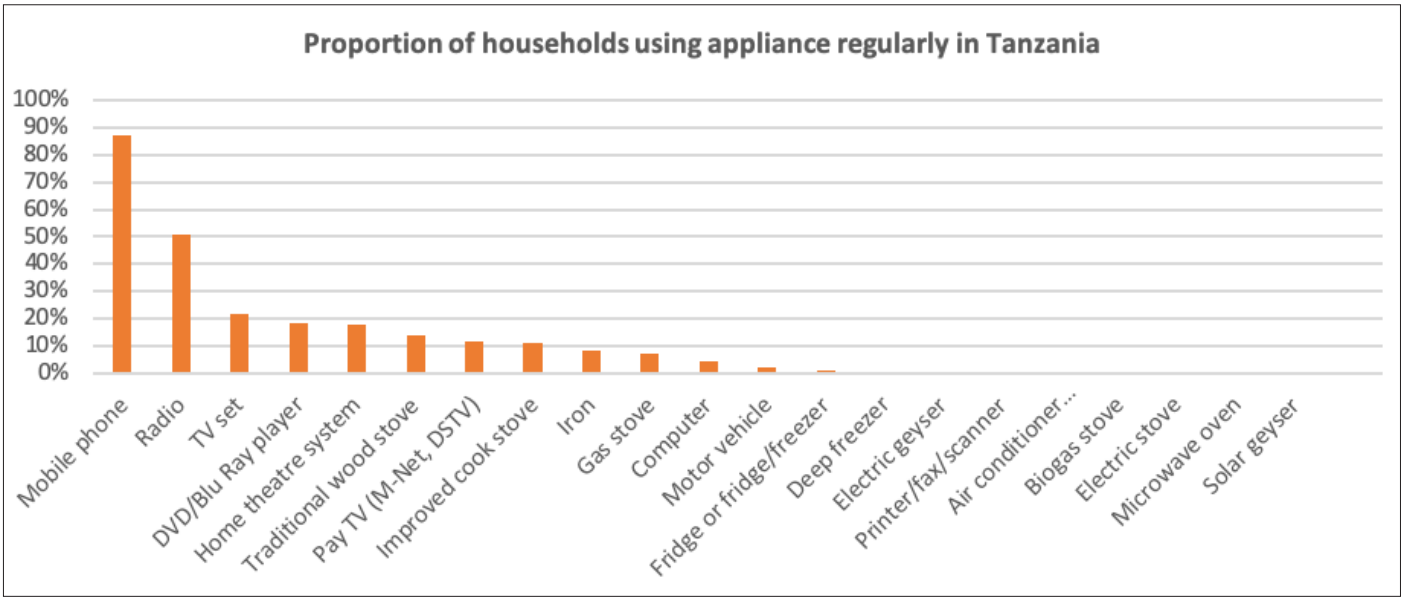
[7] ibid

This paper seeks to describe rural energy end-use and the technologies rural households are purchasing to initiate their journey up the energy ladder. Further, it considers which technologies the bottom-of-the-pyramid (BOP) is likely to purchase as their standard of living increases. Based on this and the lessons learned from the Energy Facility, it describes what are considered to be key strategies for addressing energy efficiency at the BOP.

Rural electricity end use

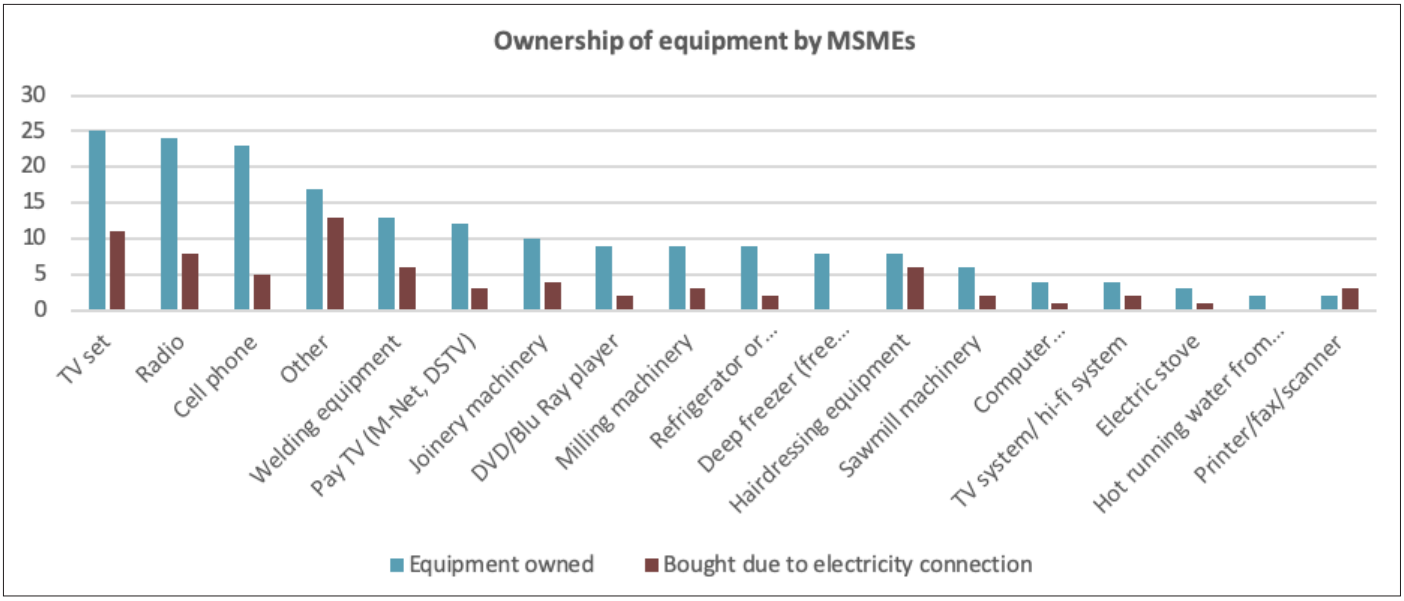
Pre-electrification, rural households in sub-Saharan Africa *primarily* use energy for cooking and lighting. In some colder climates, they may use firewood for heating. Post-electrification, the energy-consuming activities that take place in the home, tend to increase, including entertainment, lighting, refrigeration, cooling and heating. Most rural households continue to cook using traditional fuels and therefore this discussion paper focuses on electricity end use (see Discussion Paper 7 for more information).

Based on a study of mini-grid projects that received support from the ACP-EU Energy Facility in Tanzania, the most common appliances bought and owned by rural households were related to communications and entertainment technology. Only 28% of consumers made use of energy efficiency lightbulbs, irrespective of the tariff being applied and therefore the cost of lighting. This may be linked to the cost of energy efficient bulbs and their quality, or a lack of knowledge of the benefits of energy efficiency.



For the SMEs, prior to the installation of the mini-grid, energy-consuming equipment was being used by micro, small and medium enterprises (MSMEs), particularly for milling, and the less energy intensive equipment, such as radios, TVs and mobile phones. The equipment was previously powered by non-renewable energy sources, such as batteries or a diesel generator, and some users had purchased solar home systems for lighting and mobile phone charging.

Figure 1: Electrical equipment owned and bought by MSMEs due to electricity in Madagascar and Tanzania



The switch from diesel to electric-powered motors has improved the efficiency of the MSMEs, particularly the mills. Their throughput per kWh had improved, although detailed data was not being collected on this.

The choice of appliances bought by rural consumers is context specific. A global survey of the most in-demand products for off-grid users performed by the Efficiency For Access Coalition illustrates that globally, lighting, televisions and mobile phones are the top three priorities[8]. Refrigeration and cooling are also high on this list but are not relevant to all climates in off-grid areas and are not necessarily affordable.

Figure 2: Global off-grid appliance demand (source: Efficiency for Access Coalition, 2018)

		2014 SURVEY RESULTS (MODIFIED*)	2016 SURVEY RESULTS (MODIFIED*)	2018 SURVEY RESULTS
ANTICIPATED CONSUMER DEMAND	1	LED lighting appliances	LED lighting appliances	LED lighting appliances
	2	Mobile charging banks	Televisions	Televisions
	3	Televisions	Mobile/Smart phones	Mobile/Smart phones
	4	Radios	Mobile phone charging banks	Refrigeration/Freezer units
	5	Refrigeration	Refrigeration	Fans
	6	Fans	Fans	Mobile phone charging banks
	7	Laptops	Radios	Radios
	8	Tablets	Laptops	Electric cookstoves
	9	Rice cookers	Hand power tools	Tablets/Laptops
	10	Clothes irons	Small speaker systems	Modems, web routers, internet/ connectivity equipment

[8] Off-Grid Appliance Market Survey. (2018). Resource document. Efficiency for Access Coalition.https://storage.googleapis.com/e4a-website-assets/Market-Survey-2018.pdf. Accessed August 2019

Taking three appliances, television, refrigerators and fans, a study showed that the efficiency of these products has improved autonomously. The most efficient televisions put forward to the Global LEAP awards had improved in energy efficiency by 35% for between 2016 and 2017, however the relative efficiency of appliances is becoming more diverse, with the least efficient being 8 times less efficient than the best[9].

However, what is not apparent is how the BOP transitions between products and their energy consuming behaviour changes. Based on research performed in South Africa and Mexico, as middle income countries that have a significant low-income percentile that are transitioning up the living standards spectrum, the choice of follow-on appliances included an electric stove (South Africa) and a fridge (Mexico) (DEM, 2015, Gerter, 2012). However, there is a significant lack of data to understand the complexities about how appliances are used and shared within rural communities. As reflected in the mini-grids study in Tanzania, appliances used for the home and business are not necessarily distinct and may be shared by more than one household.

The relevance of energy efficiency measures

Energy efficiency measures cover the range of energy-consuming activities, for households this includes the building envelope (the structure and appliances used) and transport. Many energy efficiency programmes consider the political, legal and regulatory framework, looking to government to set the standards and requirements for the goods and service providers linked to increased energy efficiency. However, measures that are relevant to the least energy-intensive user group at the bottom-of-the-pyramid appear far removed from this centralised planning.

Energy efficiency measures can be implemented at various levels:

- overarching policy and regulation
- supply-side measures
- demand-side measures.

Overarching policy and regulation

There are several overarching policies that have a significant impact on BOP energy consumption. They specifically relate to the cost of electricity and the appliances that are used. Buildings standards are not relevant policy measures for rural communities where structures – and the construction of them – are informal.

The application of **tariff subsidies**, which has the purpose of facilitating social and economic development and wellbeing, counteracts the drive for energy efficiency. In Europe, the price signal given by the tariff has a proven effect on the amount of energy consumed but also when it is used based on flexible tariffs mechanisms (Stamminger & Anstett, 2013). In sub-Saharan Africa, only two countries – Seychelles and Uganda – supply electricity without fiscal loss, despite that commitments have been made on a regional level to introduce cost-reflective tariffs[10].

The introduction of **appliance standards and labelling** are key measures to improving the overall efficiency of appliances. However, programmes such as these are challenging to roll out on a national scale for consumers that have the financial resources and level of education to understand the complexity[11]. For the rural poor, cost is often an over-riding motivation and

[9] Lai, E., Muir, S. and Erboy Ruff, Y. (2019). Off-grid appliance performance testing: results and trends for early-stage market development. Energy Efficiency.

[10] Kojima, Masami; Trimble, Chris. 2016. Making Power Affordable for Africa and Viable for Its Utilities. World Bank.

[11] CLASP (2005) Multi Country Comparative Evaluation Of Labeling Research.

therefore, they will be likely to choose an inefficient and perhaps used appliance. Access to finance for rural households to purchase efficient appliances is critical[12].

With respect to the commercial and light industrial activities that are being undertaken, these primarily incorporate the use of motors and pumps. Therefore, introducing **minimum energy performance standards** for the sale of **efficient motorised equipment** can have an effect on new products entering into the market. It is less likely that used motorised are purchased, and particularly if appliance financing has been sourced. However, this will not address the efficiency of the use of the equipment and optimisation of processes.

By the last count, national **public awareness programmes** have been introduced in three sub-Saharan African countries and six countries have performed **mass roll-out programmes**, particularly of lightbulbs and solar water heaters[13]. However, the low cost of electricity and the high cost of efficient appliances are barriers to rural households being able to make an informed choice for the better.

Water heater
Photo: DEM

Supply and demand side measures

Supply-side energy efficiency include enhancing performance of technology and reducing systems losses:

- **More efficient generation/conversion, including:**
  - Minimising waste heat generation and recovering waste heat to an economic maximum;
  - Improving maintenance practices;
  - Utilising equipment that has been manufactured to the best modern standards of efficiency, e.g. electric motors, transformers, boilers;
  - Better control systems and metering of key operating parameters.

[12] Copenhagen Centre on Energy Efficiency (2015). Accelerating Energy Efficiency: Initiatives and Opportunities, Africa. Copenhagen Denmark.

[13] idem

- **More efficient transmission and distribution systems, including:**
  - Increased use of distributed generation;
  - Maintenance of the grid network;
  - State-of-the-art technologies such as low-loss transformers, smart metering, etc.

Demand-side energy efficiency measures typically include:

- **Better built structures**
  - Allowing for natural light
  - Reducing heat loss

- **More efficient equipment and appliances in all sectors, including stoves and cooking equipment, lighting, domestic appliances, air conditioning systems.**
  - Improved maintenance of all equipment.
  - Improved metering of fuel, electricity and steam flows and of key operating parameters such as temperatures. Such figures feed into routine monitoring and performance analysis, activities that can be applied in all sectors.

- **Awareness raising and capacity building to change human behaviour.**

Experience from the ACP Region 2007-2019

The discussion about energy efficiency for off-grid energy supply has only recently become a priority. Previously, the assumption was made that technology suppliers and project developers would be motivated to ensuring that the appliances and equipment used was efficient as this would reduce generation costs. However, it is clear from the projects supported by the ACP-EU Energy Facility (Ef) that this has is not necessarily the case.

Solar panel installation at a secondary school
Photo: DEM

Two projects supported by the EF engaged at a policy level, addressing energy efficiency: *2007/195-989 Energy access for the poor: improving energy governance by informing and engaging ACP legislators implemented by E-Parliament* and *FED/2011/231-674 Supporting Energy Efficiency for Access in West Africa (SEEA-WA)* implemented by ECOWAS. The most significant challenges of engaging in capacity development at the policy level is the turnover of staff in the public sector. Those that engaged in the projects were often moved to different departments or functions, therefore limiting continuity and a long-term change.

In the case of ECOWAS, the commitment at regional level exists towards achieving specific energy efficiency targets but this does not filter down to the national governments. In general, for the same reason that capacity development programmes are needed, national governments are reluctant to address energy efficiency as it is understood to be energy conservation.

77 projects in the EF have directly promoted energy efficiency in relation to electricity; some at institutional level as the examples described above, while 69 projects have promoted energy efficient measures either through a grid extension, mini-grid or off-grid solar solution (Solar Home systems, portable PV, energy service centres etc.).

The following table summarises the energy efficiency measures applied in electricity access projects in the ACP-EU Energy Facility according to the type of project[14].

	Supply-side measure			**Demand-side measure**				**Total # projects with EE measures measures**	**Total # of projects**
Type of electricity access project	Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs/ LED	Awareness raising		
Grid	3				1	8	5	13	31
Mini-grid	2	2	3	1	2	22	7	28	50
Off-grid					3	30	6	39	48
All electricity access projects	4	2	2	1	4	50	18	69	132

Out of 132 electricity access project, 69 applied energy efficiency measures. 82% of the off-grid projects had an energy efficient measure, 56% of the mini-grid projects and 42% of the grid-extension projects.

Energy efficient lighting is by far the most applied EE measure. However, almost half of the 69 projects are off-grid solar PV projects where energy efficient lighting is required due to conserve the battery so in these cases, the projects actually didn't do anything additional other than promoting the off-the-shelf product. In only a few cases, was energy efficiency awareness raising also incorporated and a very few also promoted efficient appliances. Also for mini-grid and grid extension projects, distribution of efficient light bulbs is the main measure applied.

The challenge with the installation of energy efficient light bulbs is that they are rarely replaced with bulbs that are either efficient or of the same quality. The poor-quality efficient lightbulbs has led to some users to abandon the efficient version and buy incandescent lightbulbs. A few examples: In the project *Rural Sustainable Energy Development in Zimbabwe* a school in Zimbabwe that had over 30 energy efficient light points was left with only 1 incandescent light bulb in the Head Master's office due to the cost of replacement, in *Increased Access to Electricity Services* 1000 efficient light bulbs were distributed, but the post-projects mission four years after found none of these still functioning, and in *Red de centros de servicios energéticos básicos alimentados con sistemas fotovoltaicos basados en la mejora de servicios sociales básicos y en desarrollo de capacidades locales y la autogestion* in Mozambique, an evaluation found up to 28% of the installed light bulbs broken after installation. In addition, the project had installed DC light bulbs which could not be purchased in the local markets making it impossible to replace damaged ones.

[14] Several projects appear in different cells either because they have promoted several EE measures or they have use multiple solutions; ex: grid and off-grid in the same project.

In general, few electricity access-projects (18 out of 132, less than 10%) include a specific energy efficiency awareness campaign. Moreover, since in general, these campaigns are done by the end of the projects, they may not be given full interest (particularly when the projects are delayed).

Photo: DEM

On the supply-side, the introduction of prepaid meters was gradual across the projects and although they were primarily incorporated to improve revenue collection, they can be programmed to enable the users to proactively manage their consumption. The project *Electrification des communautés rurales avec des Micro-réseaux de Génération d'Energie Solaire Photovoltaïque Autogerés dans la Région de Zanzan (Côte d'Ivoire)* programmed the meters so they cut-off when the end user has spent his daily average consumption which is based on the tarrif he is willing to pay; this supply-side measure is helping end users to balance their end use with what they can afford. *Light up our Futures* in Liberia and *Servicio Energetico Sostenibile para poblaciones Rurales Aisladas mediante Micro-redes con energia renovables en la Isla de Santa Antao* in Kap Verde are examples of other solar mini-grid projects that are using smart meters to preserve the batteries, making the most out of the mini-grid within the current limitations that photovoltaic energy has.

A completely different way to tackle the limitations of batteries, is piloted by the project *Production durable d'électricité aux services des populations rurales et périurbaines en Afrique: développement du concept « flexy-energy »* that in Mali and Burkina Faso use diesel gensets controlled by a hybrid-controller instead of a battery parc; a method that reduce system losses involved in battery storage and other components.

Barriers to combining energy access and energy efficiency

CLASP and the World Bank (2015) identified obstacles and limitation constraining integrating Energy Efficiency projects into energy access and these include:

Client & stakeholder engagement: energy efficiency measures are much less visible and much harder to quantify than more 'concrete' activities resulting, for example, from grid or renewable sources development. International donors and IFIs are therefore less interested in financing such projects, and specialised financing tools (such as energy service companies – ESCOs) may be needed. Unfortunately, such tools may not always applicable in the concerned countries. However, ESCO-type contracts could potentially be organised in clusters of closely located communities, which may provide the economies of scale needed. Experience in the water sector has shown this approach works by outsourcing the operations and management and clustering schemes, achieving the scale for the private sector to engage (Godfrey, Gossa, & Paba, 2019).

Insufficient resources/capacity devoted to energy efficiency components: energy access projects often include large infrastructure components together with much smaller (in term of cost) energy efficiency components. As the result / impacts of the energy efficiency component are not tangible within a short period and do not contribute to the bankability of a project, there is little motivation to divert financing to energy efficiency measures. The technology, economy, regulation, awareness elements of efficiency should however be tackled along the whole 'value chain' (supply, demand).

Cost versus perceived benefit: In the typical projects considered here, energy efficient products (such as modern bulbs or appliances) are often considered expensive by the stakeholders and/or beneficiaries, even when they are subsidised. On the

contrary, usual poor efficiency products get locked-in in the concerned countries/areas, therefore impeding improvements, particularly when it comes to replacing the product. Moreover, project procurement methods do not always consider the life-cycle cost, which generally privileges the efficient products.

Market readiness: in the often remote and poorly developed areas where the projects take place, energy-efficient products (and spare parts) are often not available. The governments in the region have not been able to set up the relevant policy frameworks, implement them locally, support markets to respond, and remove inefficient products out of circulation, resulting in the continued use of old / inefficient products as a standard situation.

Conclusions and recommendations

There is an inertia to mainstream energy efficiency for the lowest intensity users. Despite of this, the potential growth in electricity demand simply due to the projected population growth from 1.3 billion people in 2017 to 1.7 billion in 2030 in Africa requires that action is taken as a preventive measure. The energy use patterns of rural households illustrate that the immediate priorities for appliance ownership are for entertainment equipment and mobile phones. However, more intensive equipment, like electric stoves, fridges, fans, irons, etc. follow closely. The goal for the rural poor in Sub-Saharan Africa is to improve their socio-economic status and the uptake of appliances will increase as this goal is being achieved.

> ***"Every country, no matter how developed you are, should be putting efficiency first."***
> – Rachel Kyte, CEO and special representative of the U.N. secretary-general for Sustainable Energy for All

Added to this, by being more efficient, the rural poor do not pay above the odds for the services they receive. The cost of achieving the level and quality of service, that the Sustainable Development Goals and project developers aspire to achieve, is reduced by incorporating energy and resource efficiency. However, the investment in these measures does not follow due to the fact that energy efficiency is not considered in the bankability assessment. It is only within smaller appliances in off-grid solar, that the limited capacity of current battery-technology is driving improvements in energy efficiency. The projects supported under the ACP-EU Energy Facility illustrate that this general trend: Inadequate resources and importance have been placed on this unless the technology limitations have driven and energy efficient approach.

The acknowledgement of the relevance of energy efficiency measures to rural consumers is perhaps where many project developers and financing institutions falter; energy efficiency is traditionally seen as a topic for larger energy consumers Potential measures for the rural poor specifically include the regulatory framework around project design, minimum energy performance standards, ensuring optimal performance of generation and distribution systems, and the application of minimum performance standards for various classes of equipment and appliances.

There are measures that cannot be directly applied to the rural poor, for example the introduction of ESCO models. However, lessons can be learned from other sectors, such as the water sector, in applying a clustered model to energy performance contracts, achieving economies of scale, for example with public facilities.

In an effort to integrate energy efficiency projects into energy access projects, the following recommendations could be considered:

- **MORE RESEARCH IS NEEDED FOR THE BOP TO UNDERSTAND ENERGY CONSUMING BEHAVIOUR:** A much greater commitment needs to be made to developing the evidence base that will inform how to respond to energy efficiency within in poor rural communities. While there are programmes being implemented by CLASP, Global LEAP, Lighting Global, and NREL, there is a lack of understanding on how energy consuming behaviour alters with increased access and income.

- **DEFINE AND INTEGRATE MINIMUM REQUIREMENTS FOR ENERGY EFFICIENCY IN PROJECT DESIGN:** Incorporate a requirement in the conditions for energy access financing that a strategy needs to be defined, budgeted and implemented to optimise energy efficiency. The projects should consider energy efficiency across the value chain, especially in the appliances that are increasingly financed by operators for productive use.

- **BUILD UNDERSTANDING AND CAPACITY INTERNALLY AND EXTERNALLY:** Develop the understanding within financial institutions, project developer organisations, and communities of energy efficiency and its importance for the BOP. The business case and the environmental and socio-economic benefits should be described.

- **CONSIDER ENERGY EFFICIENT APPLIANCE FINANCING AND SUPPORT MARKET DEVELOPMENT:** Promote the demand for efficient products and engage with suppliers of equipment to respond, stimulating market forces. Measures could include efficient appliance financing for poor households that are connected, a scrappage scheme for inefficient equipment for customers of a mini-grid, and a public awareness campaign.

- **REMOVE SUBSIDISED ENERGY TARIFFS:** As an effective mechanism, by applying cost-reflective tariffs, raise the funds to support energy efficiency subsidies, rebates, and incentives.

References

CLASP (2005) Multi Country Comparative Evaluation Of Labeling Research.

Copenhagen Centre on Energy Efficiency (2015). « Accelerating Energy Efficiency: Initiatives and Opportunities, Africa ». Copenhagen Denmark.

Efficiency for Access Coalition: Off-Grid Appliance Market Survey. (2018).
https://storage.googleapis.com/e4a-website-assets/Market-Survey-2018.pdf. Accessed August 2019

Kojima, Masami; Trimble, Chris. 2016. Making Power Affordable for Africa and Viable for Its Utilities. World Bank.

Lai, E., Muir, S. and Erboy Ruff, Y. (2019): "Off-grid appliance performance testing: results and trends for early-stage market development."

Lawrence Berkeley National Laboratory: "Appliances Can Enable Expanded Off- Grid Energy Service Using Small Solar Power Systems". Schatz Energy Research Center, Energy and Resources Group, and University of California, Berkeley

Phadke, A., Jacobson, A., Park, W., Lee, G., Alstone, P., Khare, A., 2015. « Powering a Home with Just 25 W of Solar PV"
World bank CLASP Report: EA+EE: Enhancing the World Bank's Energy Access Investments Through Energy Efficiency (January 2015)

Stephane de la Rue du Can, David Pudleinerb, Katrina Piellic: "Energy efficiency as a means to expand energy access: A Uganda roadmap".

Annex: List of Energy facility projects promoting energy efficiency

Project #	Project Title	Country	Supply-side measure			Demand-side measure				Policy/ capacity building
			Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs	Awareness raising	
2007/ 195-949	The answer is blowing in the wind - Improving access to energy services for the communities of Futuna and Aneityum Islands (Vanuatu) using wind technology	Vanuatu							✓	
2007/ 195-950	Provision of renewable energy to 4 villages of North East Malekula Island, Malampa Province (Vanuatu) using locally produced copra oil as biofuel	Vanuatu							✓	
2007/ 195-951	Catalysing modern energy service delivery to marginal communities in Southern Africa	Malawi; Mozambique; Zimbabwe						✓		
2007/ 195-955	HydroBioPower: livelihood improvement in rural area through collaborative development of renewable energy sources in Oromia and Southern Nations Regional States of Ethiopia	Ethiopia						✓		
2007/ 195-961	Servicio Energetico Sostenibile para poblaciones Rurales Aisladas mediante Microredes con energia renovables en la Isla de Santa Antao (Cabo Verde)	Cape Verde			✓			✓	✓	
2007/ 195-964	Best Ray (Bringing Energy Services to Tanzanian Rural Areas)	Tanzania							✓	
2007/ 195-974	Somalia Energy and Livelihood Project (SELP)	Somalia							✓	

Project #	Project Title	Country	Supply-side measure			Demand-side measure				Policy/ capacity building
			Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs	Awareness raising	
2007/ 195-978	Red de centros de servicios energéticos básicos alimentados con sistemas fotovoltaicos basados en la mejora de servicios sociales básicos y en desarrollo de capacidades locales y la autogestión	Mozambique						✓		
2007/ 195-984	Providing access to modern energy for northern Uganda (PAMENU)	Uganda						✓		
2007/ 195-986	Programa de electrificación rural en República Dominicana basado en fuentes de energía renovable	Dominican Republic							✓	
2007/ 195-988	Projet d'Electrification de 28 Villages en zone rurale dans 9 Communes de la Province de l'Extrème Nord du Cameroun (PERPEN)	Cameroon						✓		
2007/ 195-992	Ligne électrique de Muhura	Rwanda						✓		
2007/ 195-993	Developing energy enterprises project East Africa	Kenya; Tanzania; Uganda						✓		
2007/ 195-994	Tsumkwe Energy	Namibia						✓	✓	
2007/ 195-995	Electrification des quartiers périurbains de la ville d'Abidjan avec prolongement du réseau existant	Cote d'Ivoire	✓							
2007/ 195-996	Solar energy for improved livelihood in Burkina Faso	Burkina Faso						✓		
2007/ 196-001	Projet d'Initiatives Locales d'Electrification Solaire (PILES)	Mauritania						✓		
2007/ 196-002	Msamala Sustainable Energy Project	Malawi						✓		

Project #	Project Title	Country	Supply-side measure			Demand-side measure				Policy/ capacity building
			Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs	Awareness raising	
2007/ 196-007	Projet d'Accès universel à l'électricité : Réseaux et Services publics d'électrification dans 20 localités rurales de 5 wilayas (Régions) en Mauritanie : PELEC 20	Mauritania						✓		
2007/ 196-012	Cross-border Supply of Electricity to Communities in Burkina Faso from Ghana	Burkina Faso; Ghana						✓		
2007/ 196-014	Electrification rurale décentralisée par énergies renouvelables dans le sud de Madagascar (RESOUTH)	Madagascar						✓		
2008/ 195-971	Increased Access to Electricity Services	Zambia	✓					✓	✓	
2008/ 19767	Increase Rural Energy Access in Rwanda through Public Private Partnership (IREA RPPP)	Rwanda						✓		
2011/ 231-578	Community Based Green Energy Project	Kenya					✓	✓		
2011/ 231-781	Providing Solar Home Systems (SHS) to the rural and peri-urban population of the region of Gabú in east Guinea-Bissau on a fee-for-service basis	Guinea-Bissau						✓		
2011/ 231-830	Programa Comunitário para Acesso a Energias Renováveis	Guinea-Bissau		✓					✓	
2011/ 231-845	Efficacité énergétique et Optimisation des systèmes d'électrification dans 20 localités défavorisées - PELEC II	Mauritania	✓							
2011/ 232-318	Rural Sustainable Energy Development in Zimbabwe	Zimbabwe						✓		
2011/ 232-367	Dotacion de Energia Renovable a Comunidades Rurales de Moca	Dominican Republic						✓		

Project #	Project Title	Country	Supply-side measure			Demand-side measure				Policy/ capacity building
			Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs	Awareness raising	
2011/ 232-479	Solar energy for rural Kenya	Kenya						✓		
2011/ 232-617	Électrification rurale décentralisée interrégionale en Mauritanie (ERUDI)	Mauritania						✓		
2011/ 263-502	Développement du site de Petite Centrale Hydroélectrique de Mbakaou Carrière sur le Djerem Ouest et électrification rurale associée	Cameroon							✓	
2011/ 264-343	Microcrédit solaire et changement d'échelle au Burkina Faso, MICRESOL	Burkina Faso						✓		
2011/ 264-345	Production durable d'électricité aux services des populations rurales et périurbaines en Afrique: développement du concept « flexy-energy »	Burkina Faso; Mali		✓						
2011/ 264-697	Energy for All (E4A) - Alternative Energy Solutions for Rural and Peri-urban Timor-Leste	Timor-Leste						✓		
2011/ 264-851	Jatropha energy system - JES	Cameroon							✓	
2011/ 267-136	TRIODOS - Expanding Sustainable Energy Markets through Microfinance -Energy Enterprise partnerships	Kenya; Tanzania; Uganda						✓		
2011/ 267-189	Projet d'accès aux services électriques des localités de petites tailles de la Région de Sédhiou (PASES) - Sénégal	Senegal					✓			
2011/ 267-844	Developing and Demonstrating a Rural Energy Strategy and Master Plan for Liberia	Liberia								✓
2011/ 268-336	Integrated Approach to Meet Rural Household Energy Needs of Ethiopia	Ethiopia						✓	✓	
2011/ 270-457	Facilidad Sur Solar	Dominican Republic						✓		

Project #	Project Title	Country	Supply-side measure			Demand-side measure				Policy/ capacity building
			Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs	Awareness raising	
2011/ 270-635	ProgettoMondo Mlal : - Déployer de nouvelles opportunités de développement socio-économique par l'accès aux énergies durables dans le Plateau Central	Haiti						✓	✓	
2011/ 273-991	Programme d'accès aux services énergétiques, Commune rurale SAFO (PASE)	Niger						✓	✓	
2011/ 279-783	Pico-hydro électricité au service du développement rural (PHEDER)	Madagascar						✓		
2011/ 280-322	Best Options for Rural Energy and Access to Light and Electricity (BOREALE)	Madagascar						✓		
2012/ 023-438	Provision of affordable solar electricity to the peri-urban poor of Port Vila	Vanuatu							✓	
2012/ 283-253	Electrification des communautés rurales avec des Micro-réseaux de Génération d'Energie Solaire Photovoltaïque Autogerés dans la Région de Zanzan (Côte d'Ivoire)	Cote d'Ivoire			✓	✓		✓		
2014/ 340-491	Promoting Renewable Energy Services for Social Development in Sierra Leone (PRESSD-SL)	Sierra Leone						✓		
2014/ 340-501	Projet d'électrification de 16 villages en zones rurale et périurbaine dans 10 communes de la Région de l'Extrême-Nord du Cameroun	Cameroon						✓		
2014/ 340-559	Hydroelectric Energy for 20 Isolated Rural Villages in the Ludewa District, Tanzania	Tanzania						✓		
2014/ 341-047	Micro Power Economy, Tanzania Roll out	Tanzania						✓		
2014/ 341-877	Prepaid Energy – Rent to own solar home systems (off-grid)	Rwanda						✓		

Project #	Project Title	Country	Supply-side measure			Demand-side measure				Policy/ capacity building
			Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs	Awareness raising	
2014/ 343-720	JIRO KANTO - Electrification rurale de 12 communes de la région Alaotra Mangoro à Madagascar	Madagascar						✓		
2014/ 344-366	Access to energy services in rural and peri-urban areas in Northern Uganda (Teko Wa Project)	Uganda						✓		
2014/ 344-403	Développement de l'accès à un service électrique durable pour 50.000 personnes vivant dans des villages pôles de développement de MATAM - KANEL - RANEROU - GOUDIRY - BAKEL, très éloignés des lignes électriques	Senegal						✓		
2014/ 348-266	Scaling up access to modern electricity services on a regional scale in rural Sub-Saharan Africa by means of a fee for service business model	Cameroon; Guinea-Bissau; Mali; Uganda						✓		
2014/ 348-754	Scaling –up rural electrification using innovative solar photovoltaic distribution models	Uganda						✓		
2014/ 351-389	Electrification Rurale Décentralisée des Provinces du Ziro et du Gourma (ERD ZIGO)	Burkina Faso					✓	✓		
2014/ 351-553	PROGRES-Lait : Programme Régional d'Extension de l'Horizon des Opportunités de Valorisation de la Chaîne de valeur Lait par l'Accès aux Services Energétiques durables	Mauritania; Senegal					✓			
2014/ 352-393 / 2014/ 352-394	POWER KIOSK: Scaling-Up Rural Electrification in Kenya, Ethiopia and Madagascar	Ethiopia; Kenya; Madagascar						✓		
2014/ 352-925	Somali Energy Transformation (SET) Project	Somalia						✓		

Project #	Project Title	Country	Supply-side measure			Demand-side measure				Policy/ capacity building
			Reduce network losses	Energy management	Smart meters	Better structures	Efficient appliances	Efficient light bulbs	Awareness raising	
2014/ 352-933	Amélioration des conditions de vie des enfants et de leurs familles grâce à un accès à des services énergétiques modernes, propres et abordables dans 30 communautés pauvres du cercle de Kita au Mali	Mali								✓
2014/ 353-246	Electrification des zones rurales au Burundi à travers la mise en service de deux mini centrales hydrauliques, le renforcement photovoltaïque, l'extension du réseau rural, la connexion au réseau national et le renforcement des capacités locales	Burundi	✓							
2014/ 353-422	Light Up Liberia	Liberia						✓		
2014/ 353-458	Light up our Futures	Liberia			✓			✓	✓	
2014/ 353-512	Accès à des services énergétiques modernes et durables au Mali	Mali						✓		
2014/ 355-678	Rural Electrification by Photovoltaic solar systems of 30 secondary schools and 20 clinics	Burundi						✓		