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Development impacts of electrification of education and health institutions in the ACP-region

Experiences from EU-supported projects in ACP countries 2007-2019

7 AFFORDABLE AND CLEAN ENERGY

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, 57 are directly related to SDG3 improving Good health and well-being and SDG4 Quality education.

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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Introduction

This discussion paper covers the way in which public services in developing countries are affected by electrification and to what extent these impacts are understood today. It is based on experiences from the ACP-EU Energy Facility that has supported energy access projects in Sub-Saharan Africa, the Caribbean and the Pacific (ACP).

Besides the explicit contribution towards the achievement of Sustainable Development Goal (SDG) 7: Affordable and clean energy, granting electricity access to health and educational facilities can trigger an additional set of effects placing us a step closer in the accomplishment of several complementary goals:

SDG3 (Good health and well-being): affordable energy is a prerequisite to eliminate poverty. Today poor people pay a large portion of their income for fuel.

SDG4 (Quality education): Extended hours of study. Use of Information and Communication Technology. Higher rates of teacher retention and training.

SDG5 (Gender equality): Increased literacy rates for girls. Increased out-of-home employment.

SDG10 (Reduced inequalities): Reduced gap between urban-rural dwellers and developed-developing countries. Better education leads to better job opportunities in adulthood.

Background

Access to electricity has risen steadily in the last decades. While in 1990 about 71% of the population had access to electricity; that number has risen to over 87% in 2016. The total number of people without electricity has fallen from 1.5 billion in 1990 to below 1.1 billion by 2017 (Iea.org, 2019). The main challenge lies in Sub-Saharan Africa: 42.8% of the region's population did not have access to electricity by 2016, according to World Bank (WB) estimates.

Education and health institutions are generally overlooked

Access to electricity policies primarily focus on private structures. For example, Sustainable Development Goal 7, Affordable and Clean Energy, states that 1 in 7 people in the world lack access to electricity, but this neglects to consider the number or percentage of schools and health facilities that are stuck in energy poverty. Initial screenings of donor websites reflect a predominant focus on domestic access to electricity, whereas public structure electrification projects are less prominent and less frequent. Donor analytics, such as the Donor Tracker (2019) do not even account for actions in the electricity sector.

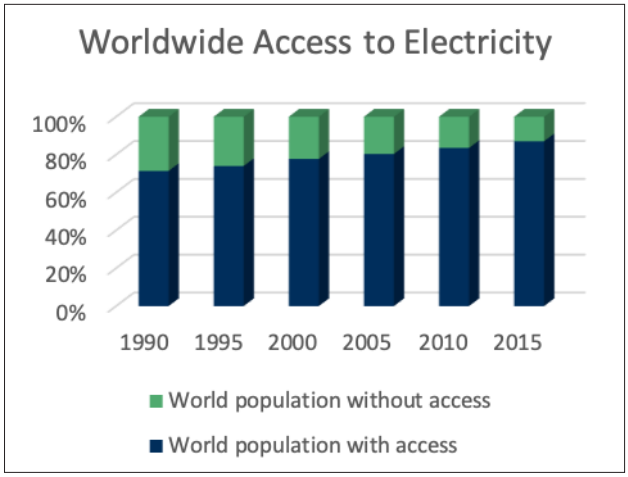

Figure 1: Worldwide access to electricity
Based on World Bank estimations

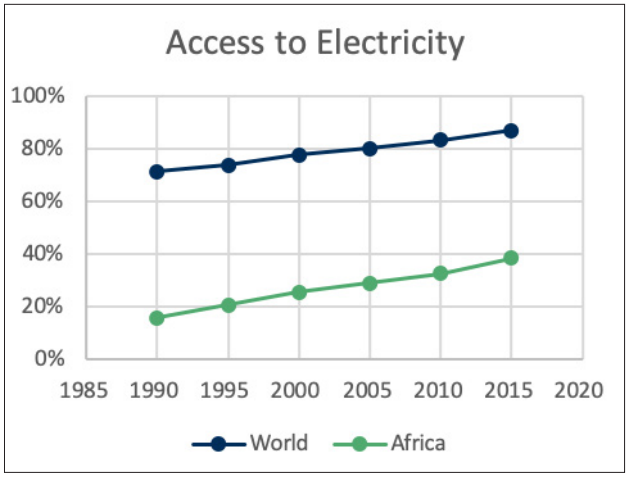

Figure 2: Worldwide access vs. Africa
Based on World Bank estimations

Assessments of impact evaluations done by multilateral banks and public institutions yield the same results: Electrification impacts on education and health facilities are largely undocumented, not only for ACP countries but worldwide. Here are a few examples:

1) The ADB analysed 85 impact evaluations conducted worldwide[1]. 61 of the evaluated projects were focused on the impact of electrification on households. The remaining projects were mostly focused on firms and other industrial-related factors/ objects. With only three exceptions, all of the 23 projects in ACP countries were located in Sub-Saharan Africa and focused on households. No project in the entire sample focused on the impact of electrification on schools or on health facilities (Raitzer, Blöndal and Sibal, 2019).

2) The Independent Evaluation Group (IEG) evaluated 121 WB electrification projects worldwide, concluding that most connections in rural areas are residential, therefore focusing on households rather than public structures. A limited selection of projects did provide electricity to health facilities, and its effects were evaluated by the IEG. Projects implemented in Bangladesh, Kenya, Nicaragua, Rwanda, Ghana, and Egypt have shed light on the impact of electrification on opening hours, preservation of vaccine cold chains[2], and retention of staff. As for the benefits of electrification of schools, they remain largely undocumented in WB projects and, therefore, the IEG highlights the need of future studies to corroborate impacts (Independent Evaluation Group, 2008).

Boy using a candle to read at night
Photo: Programa Comunitário para Acesso a Energias Renováveis

[1] The studies include evaluations conducted by other entities, as thus far the ADB has only conducted 4. Focus of studies include the following countries/regions: South Africa, Bhutan, El Salvador, Honduras, India, Rwanda, Viet Nam, Nicaragua, Ethiopia, Mexico, Benin, Argentina, Bangladesh, Brazil, Pakistan, Peru, Indonesia, China, Uganda, Tanzania, Morocco, Ghana, Nigeria, Senegal, Africa, Latin America and the Caribbean, PRC, Philippines, Kenya, Colombia, Guatemala, Cambodia, Nepal, Yemen.

[2] The vaccine cold chain is the system of storing and transported vaccines at recommended temperatures from the point of production to the point of use.

3) A policy brief drafted by the Inter-American Development Bank (IADB) assessed 27 journal articles and 23 working papers, focusing on Africa, the Americas and Asia[3], and estimated the causal effects of electricity access improvements on livelihoods. Of the 50 studies, 12 concern firms' outcomes; the rest, focus on households as the unit of observation. The analysed studies provide evidence of the impact of electrification on education, labour and income at the household level, and fail to address situations in which public structures are included in electricity provision (IADB, 2017).

Several studies concern the benefits of the electrification of schools[4], however, their approaches are mostly descriptive without producing robust data regarding the impacts of electrification.

Further actions in this regard are needed to better understand and complement actions undertaken in the field and the analysis of experiences from the ACP-EU Energy Facility can contribute to a better understanding. Among the 173 ACP-EU Energy Facility (EF) projects, 57 have devoted efforts to electrifying schools and health facilities, for the large majority of them, as a side activity to providing electricity to households.

Health and education impacts of electrification

The nexus between education and poverty has been extensively studied. Education is one of the main drivers of social mobility, broadening horizons and granting labour opportunities that are otherwise inaccessible to those out of school. Electricity provision has the potential of considerably improving the educational experience, yielding better learning outcomes. Access to electricity and lighting allows for longer study hours, with classes beginning earlier in the morning and finishing later at night. It also enables the use of modern technologies in the classroom, providing children new skills, improving engagement and encouraging individual learning (Webanywhere.co.uk, 2019). Moreover, electricity strengthens the attraction and retention of skilled teachers, often a problem in rural un-electrified areas (UNDESA, 2014).

Possible impacts of electrification of schools

- Extended hours of study
- Use of ICT
- Improved staff retention
- Improved school performance

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

According to UNESCO estimates from 2017, only 35.1% of primary schools in Sub-Saharan Africa had access to electricity, and only 50.7% in Southern Asia (United Nations Foundation and SEforALL, 2019). Electrified schools are not distributed evenly across regions but often concentrated in urban areas, meaning that the majority of the population does not reside in close proximity to electrified schools, furthering the divide between rural and urban dwellers. Collectively, UNDESA estimates that a total of 188 million children attend schools that lack any type of electricity supply (UNDESA, 2014).

A recent survey of 78 countries found that 59% of low- and middle-income countries' health care facilities lack access to reliable electricity (Cronk and Bartram, 2018) . According to a recent study of 11 Sub-Saharan major countries, on average one in four health facilities had no access to electricity at all, and only 28% of health facilities and 34% of hospitals had what could be called "reliable" access to electricity (Adahir Rohani et al, 2013). As in the case of education, access to electricity has a series of positive impacts on the provision of health services. The literature on this topic is relatively scarce; however, the existing studies point out that electricity access may have a significant impact on prolonging night-time service provision, attracting and retaining skilled workers, and providing faster emergency responses, especially for childbirth emergencies (WHO, 2014).

Possible impacts of electrification of health services

- Extended hours of operation
- Improved health service provision
- Improved diseased treatment and retention
- Use of ICT
- Improved management
- Improved staff retention

Experience from the ACP-EU Energy facility

57 EF projects have been analysed for this dicussion paper. In terms of energy source, solar power is dominant while the least applied technology is wind power. Other technolgies involve electrification through grid extension. Besides electricity, a handfull of projects have also distributed (or enhanced the production) of improved cooking stoves, reducing the fuel needed to cook, the time spent cooking and indoor air pollution.

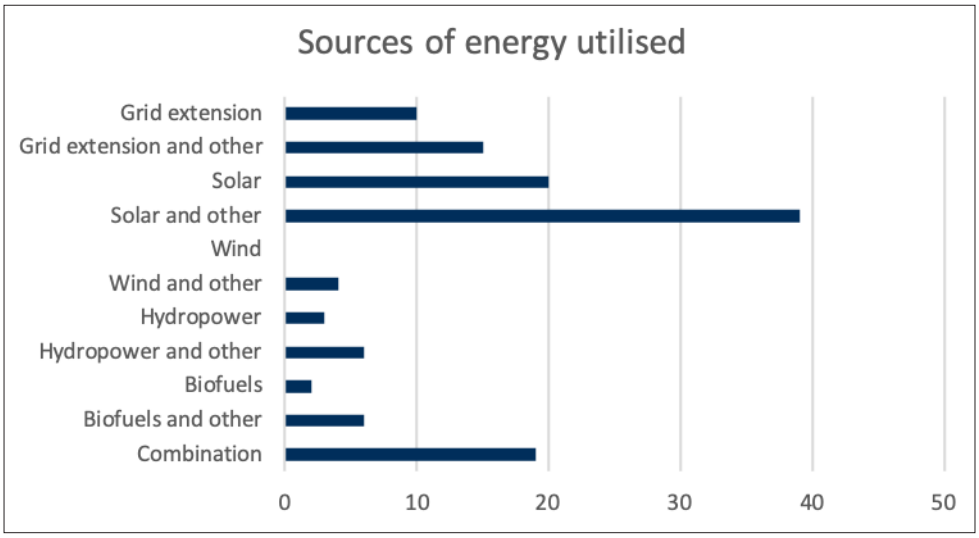

Figure 4: Energy technologies used to improve energy access in education and health institutions among the 57 EF projects.

Three main limitations were encountered when analysing the implemented projects: 1) Firstly, not all projects have final reports and/or final evaluation reports. 2) Secondly, several projects have not measured the impact on the beneficiaries, as the reports merely state the amount of schools or health facilities that were electrified by the initiatives. Whether the electrification efforts have led to any educational or health progresses remains unknown for these projects. In some cases, this lack of information can be traced to the design of the projects, as the objectives, indicators and outcomes of some are based on the amount of facilities electrified and not on the benefits that such electrification could have on the facilities and users themselves. 3) Lastly, for most projects, not enough time has passed since the finalisation of the projects to properly assess the impact on the beneficiaries.

These limitations mean that the EF projects cannot provide a complete documentation of impacts. For some dimensions, the amount of evidence is quite strong, while on other dimensions it is quite weak or none can be found.

Impact in schools

Evidence from the EU-ACP Energy Facility projects suggests that electrifying schools leads to extended hours of study, both in terms of classes offered and possibility to do homework in the school in the evening. Several projects also claimed having improved overall school performance, which is often documented but not checked against a control group which is necessary in order determine if the promising data variations indicate causality or not. Use of ICT and staff attraction and retention also seem to improve when granting access to electricity.

The figure below illustrates the weight of each benefit according to project findings and reports:

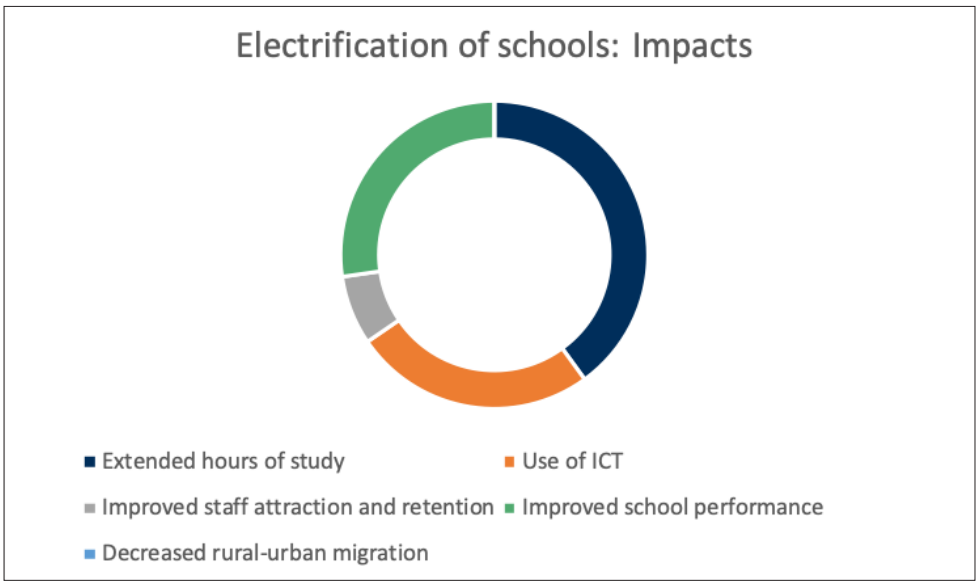

Figure 5: Impacts of electrification of schools in the ACP-EU Energy facility

Extended hours of study

Lighting can extend hours of study, enabling schools to hold classes both early in the morning and in the evenings. Additionally, it enables the lighting of libraries and additional classrooms where children can study on their own and prepare for classes (UNDESA, 2014).

Evidence from 22 EF-projects suggests that there was indeed an improvement in study time for pupils and planning and marking time for teachers as a result of access to lighting. Additionally, reports indicate that several schools are now conducting classes in the evenings as well. In the *Somalia Energy and Livelihood Project (SELP)*, 80% of the electrified schools were offering evening classes between 6.30 pm to 10.30 to a total of 2,412 students, comprising both regular pupils and adult learners (54% of the schools offers adult classes). Evidence from other projects indicate the same: 920 students in the Mocimboa school in Mozambique, electrified through the *Rural Electrification Project in Cabo Delgado Province (Phase III lot 2)* work during the day and now have the opportunity to study at night; and in Kenya, solar light, installed in 8 schools through the project *Promoting use of*

sustainable energy in Wajir District, is allowing 360 students to benefit from evening classes. Providing evening classes is particularly relevant for children from pastoralist communities, as the new scheme allows them to work during the day and attend classes in the evening.

In contrast, findings from one project point out that the benefit of extended study hours due to electrification are not universal: The electricity provided to a group of schools through the project *Light up our Futures* in Liberia is having limited impact as the schools are not running in the evenings and teachers do not live on the school premises.

Classroom with electrification
Photo: Renewable energy for local development

Use of ICT

Electricity facilitates the use of new ICT, including television, computers, internet, radios and others. In this regard, UNESCO reports indicate that "ICT can improve student achievement, improve access to schooling, increase efficiencies and reduce costs, enhance students' ability to learn and promote their lifelong learning, and prepare them for a globally competitive workforce" (UNESCO, 2011). The benefits of the use of ICT in the classroom have been thoroughly discussed in the education literature; however, further evidence regarding the use (and affordability) of ICT in predominantly poor and remote settings is needed.

Evidence from 14 EF-projects indicates that electrified schools are resorting to new technologies to improve their teaching methods and administrative tasks. Reports suggest that schools are now using televisions, radios and tape recorders, making teaching easier and more entertaining for students. Evidence from the project Best Ray (Bringing Energy Services to Tanzanian Rural Areas) indicates that 50% of the electrified primary schools have acquired computers. Several schools have indicated they now impart computer lessons, and the quality of education is said to have improved with access to the internet. Furthermore, administrative tasks can be done more efficiently with the use of computers, reducing teachers' and other staffs' time.

Use of TV in classroom
Photo: Renewable energy for local development

Computer lesson
Photo: DEM

Enhanced staff retention

Electricity can enhance staff retention and teacher training, which in turn can enhance school performance (UNDESA, 2014). Teacher and school authorities are reluctant to work in deprived areas hence teacher attraction and retention tend to be a substantial problem in non-electrified schools. Evidence of staff attraction and retention has indeed been documented in the evaluation of one WB projects in Ghana (Independent Evaluation Group, 2008). In Sub-Saharan Africa and South America, electrification has allowed teachers to use computers to "engage in professional societies, conduct e-learning, better manage student marks and parental reports, search for educational content, and plan lessons" (UNESCO, 2011 in UNDESA, 2014).

Evidence from 4 EF-projects points out that the electrification of schools has led to increases in teacher attracting and retention. According to project reports, being able to acquire electrical appliances has had a very positive effect on teacher retention, as several schools pointed out that teachers are now more motivated and inclined to live in more remote areas. Reports from the *Msamala Sustainable Energy Project* in Malawi, which provided electricity to 10 schools in Malawi has indicated that the installation of solar panels has attracted at least 5 teachers per school in three years to teach in rural areas. Authorities from the local school in Chipendeke, Zimbabwe, who now have access to electricity due to the efforts of the project *Catalysing modern energy service delivery to marginal communities in Southern Africa*, have claimed that their staff is now composed by trained and skilled teachers while they no longer depend on temporary tutors. Furthermore, staff improvement and increased enrolment has led the Chipendeke authorities to propose the establishment of a secondary school and an evening school to be able to cater for the increased number of students, product of the recent electrification efforts.

Improved school performance

The benefits from lighting, ICT use and improved teacher attraction, retention and training are often thought to lead to better outcomes in school performance: Less absenteeism; higher enrolment, graduation and completion rates, and higher test scores (UNDESA, 2014). As mentioned above, no impact evaluation seems to have tested such assumptions thus far, although evidence suggests that higher electrification rates correlate with higher completion rates. Further studies should attempt to isolate factors and elucidate whether such relationship entails causality nor not.

Electricity at a home
Photo: Programa Comunitário para Acesso a Energias Renováveis

Evidence from 15 EF-projects indicates that electrified schools have seen increased rates in enrolment for pupils, increased attendance rates, and improved performance of students. All though this could be attributed to other factors, beneficiaries say themselves that electricity is the main cause as it allows for studies in the evening. Results from the project *Catalysing modern energy service delivery to marginal communities in Southern Africa*, show that in Chipendeke, Zimbabwe, student enrolment increased by 68% from 350 and a new 3 classroom block has been constructed to accommodate the increase in student intake. In Mali, 24 schools were powered by PV lighting by the *Projet d'Accès Aux Services d'Énergies Renouvelables de Kita (PASER-K)* and compared to 2012-2016, schools have reported a 12% increase in pass rates. In Malawi, interviews with the head teachers revealed that electrification provided by the *Msamala Sustainable Energy Project* improved the performance of pupils; for instance, in the 2012 examination results there was an overall 82% pass rate, compared to a 52% pass rate in 2010. On average, schools with installed solar panels saw an improvement of 24%, whereas schools without solar panels registered a 5% increase in pass rate. In the schools electrified by the *Community Based Green Energy Project* in Kenya, performance increased, on average, 10%. In Zimbabwe, the reports from the project *Rural Sustainable Energy Development* in Zimbabwe have documented, on average, an increase in the pass rate from 33% to 60%. Such increase has been attributed to opportunities for pupils to study at night, together with higher rates of staff retention.

In addition, the electrification of schools can help **decrease the rates of rural-urban migration**. As communities find their villages and social institutions' infrastructures improved, families are less inclined to seek better opportunities in rural areas[6]. However, no evidence from the implemented projects supports nor contradicts this claim.

The table below contains a list of benefits as described in the literature review, indicating whether they were present in the project reports and illustrating the strength of the evidence found.

Table 1: Evidence from the EF of impacts of electrification of schools

Possible impacts	**Experience in the EF**	**Evidence level**
Extended hours of study	✓	♦♦♦
Use of ICT	✓	♦♦♦
Improved staff retention	✓	♦
Improved school performance	✓	♦♦♦
Decreased migration	✗	
Legend	✓ = Present ✗ = Absent	♦ Low ♦♦ Medium ♦♦♦ Strong

Impact in health facilities

Besides the numbers of facilities reached, the impact on the populations is not very well documented in the EF projects. Several projects have reported to have improved health service provision due to electrification efforts. However, a few projects have better accounts of their impact. Overall, the greatest benefit seems to be enjoyed by women: The improvement of maternity services -in several cases leading to maternal mortality rate reductions- was the most documented benefit from the electrification of health facilities. The extension of hours of operation and improved disease treatment and prevention were frequently cited in the project reports as well.

The figure below illustrates the weight of each benefit according to project findings and reports:

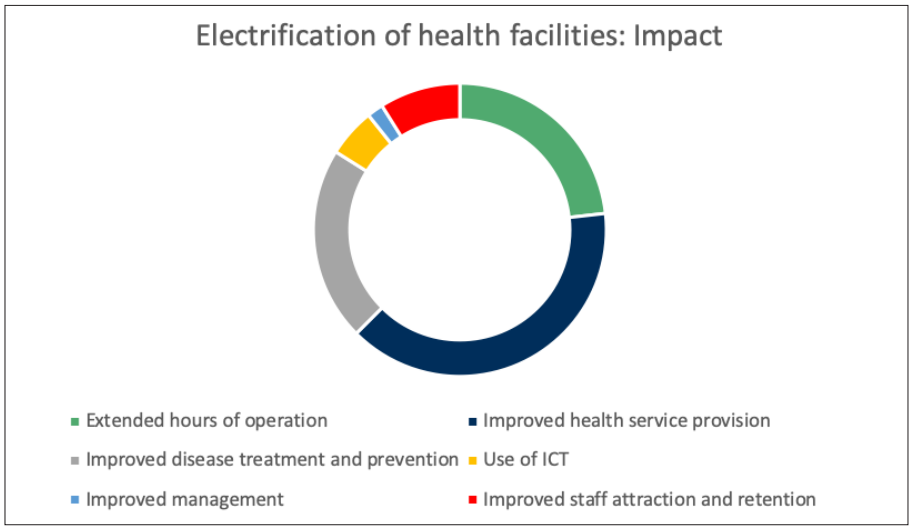

Figure 6: Impacts of electrification of health facilities in the ACP-EU Energy facility

[6] Ter-Wengel, 1985; Gurung, Prakash Gurung, Eun Oh, 2011

Extended hours of operation

Lighting can extend hours of operation, increasing night-time health provision therefore increasing the opportunity for visits, especially in cases of emergencies. Evidence from Bangladesh and Kenya suggests that electrified health facilities indeed tend to operate longer - on average, one hour extra per day (Independent Evaluation Group, 2008).

Findings from 13 EF-projects indicate that health facilities in project sites have extended their opening hours once they had access to electricity. The reports presented little hard evidence, loosely stating that they have adequate lighting in during the nights and can therefore receive and treat patients in better circumstances. Evidence from the *Somalia Energy and Livelihood Project (SELP)* highlights that of the 12,626 patients benefiting from the installation of 21 solar systems in rural health facilities, 1,003 patients receive medical treatment mostly at night. Additionally, 71% of the Maternal and Child Health Care Clinics are functional in the evenings as a result of solar installations and 7-10% of their patients are attended to in the evenings/nights. In Mali, the introduction of solar lighting in maternity hospitals by the *Projet d'Accès Aux Services d'Énergies Renouvelables de Kita (PASER-K)* has made it possible to start using social services at night with quality lighting. Night births take place in better conditions. The availability of hot water has also improved the quality of care for newborns and their mothers. In Mauritania, a solar kit was installed in the birthing room of a health hut by the *Projet d'Initiatives Locales d'Electrification Solaire (PILES)*. Before they used candles, and sometimes the nurse had to be able to tell whether a woman had to give birth by the light of a fire, that they had to light in the door, when they had no candles.

Improved provision of health services

Electricity used for lighting, ventilation and the use of certain medical devices is needed to operate basic amenities. Additionally, electricity is particularly relevant for maternal care and obstetrics services: Adequate and continuous lighting, together with the modern electric medical equipment can be important life-saving measures for women and children during pregnancy and childbirth, especially in ACP countries where maternal and childbirth mortality rates are exceptionally high (United Nations Foundation and SE4ALL, 2019).

Evidence from 22 EF-projects suggests that service delivery has improved as a result of the electrification of health facilities. The installation of lights and electricity is reported to have improved women's situation considerably: 10 projects cite women as the main beneficiaries of electrification due to improved maternal services. Lighting at health centres has extended service hours and, in some cases, even made possible to have 24-hour maternity delivery services. According to reports from the project *Catalysing modern energy service delivery to marginal communities in Southern Africa*, in Chipendeke, Zimbabwe, delivery at the clinic increased by 300% from 3% soon after connection; although numbers have apparently levelled off. Evidence from 3 project sites from the project *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* in Mozambique indicate that electrification has led to an increase in the rate of institutional deliveries, as well as a reduction of mortality rates. In Zambezia, for example, institutional deliveries have increased by 7%, and maternal mortality rate has reduced by 30%; Sofala has seen a 46.75% increase in institutional deliveries, and an 11% reduction in maternal mortality rates; and Nampula has witnessed a reduction of maternal mortality rates of 103%. In Madagascar, the project *Pico-hydro électricité au service du développement rural (PHEDER)* has led to an increase of over 100% in delivery, resulting in a significant decrease in the incidence of home childbirth. Furthermore, anecdotal evidence from the "Community Based Green Energy Project" in Kenya shows that electricity enables the diversification of services such as laboratory services, which means that patients no longer have to travel long distances for basic lab tests as such service can now be provided by the local dispensaries. Lab services and the use of solar powered microscopes facilitate the improvement of diagnosis of diseases, as documented in the projects *Scaling-up rural electrification using innovative solar photovoltaic distribution models* in Uganda, *Cross-border Supply of Electricity to Rural Communities in Togo from Ghana and Cross-border Supply of Electricity to Communities in Burkina Faso from Ghana*, particularly relevant for children as direct analysis of malaria, for example, will allow for swift action.

Improved disease treatment and disease prevention

According to the UN Foundation, access to reliable electricity is vital to ensure the cold chain and preserve and store vaccines, blood and medicines requiring refrigeration (United Nations Foundation and SE4ALL, 2019). Data from Bangladesh, Nicaragua, Rwanda, Ghana and Egypt suggests that the cold chain is indeed stronger in electrified clinics, but the proportion of institutions providing immunization services between electrified and non-electrified institutions did not alter, and nor did the immunization rate. Thus, electrification can lower the costs of immunization, but is not likely to increase the extent to which such services are offered (Independent Evaluation Group, 2008).

Vaccine refrigerator at a health clinic
Photo: DEM

Evidence from 12 EF-projects suggests that electrification leads to improvement in vaccine and drug storage. Reports from the project *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 show, on average, a 30% increase in vaccinated children (including BCG and DPT). Findings from the *Community Based Green Energy Project* in Kenya reflect that 70% of the 48 health institutions covered by the project have improved their vaccine storage, and 92% of the facilities visited were using solar refrigeration systems for drug storage. Furthermore, all sampled facilities indicated increases in the number of days in which vaccinations are offered: While some facilities had reported offering vaccinations as low as once in two weeks prior to electrification, most centres were offering vaccinations in all 5 weekdays at the time of the evaluation. Before the project, most health facilities had no refrigeration facilities and could not provide immunization services consistently. The few that did, operated on kerosene and liquefied petroleum gas powered fridges which are expensive to maintain.

Use of new ICT

As in the case of schools, electrification can enable health facilities to use new ICT, improving communication, education and outreach (United Nations Foundation and SE4ALL, 2019). ICT services such as e-health and telemedicine can lead to improvements in health through a series of ways: the dissemination of public health information; by enabling remote consultations, diagnosis and treatment; by facilitating training and access to new information; and by reducing expenditures and time/resources through the improvement of administrative systems. Additionally, ICT allows to better monitor and respond to the incidence of public health threats as well as facilitates communication between health workers and patients (Munyoro et al, 2016; Lewis, Synowiec, Lagomarsino and Schweitzer, 2012).

Evidence from 3 EF-projects suggests ICT use in health facilities. A project in Somalia, the *Somali Energy Transformation (SET) Project*, indicated that electricity was being used to improve communications through the use of computers and radios; and a project in Burundi, the *Rural Electrification by Photovoltaic solar systems of 30 secondary schools and 20 clinics*, where the clinics will be able to offer video and television based health education to the community.

Improved management of patient records and referrals

Electricity can improve the management of patient records and referrals as electricity enables the use of computer-based services (United Nations Foundation and SE4ALL, 2019).

Evidence from 1 EF-project in Zambia, *Rural Electrification Infrastructure and Small-scale Projects*, shows that the health posts covered by the initiative have started using the Electronic Logistics Management Information System (ELMIS), aiding health data management and ensuring better health outcomes for people.

Health facility
Photo: DEM

Improved retainment of skilled workers

As in the case of schools, electricity can help attract and retain skilled workers, reducing absenteeism. Without electricity, such workers might otherwise opt to live (and sometimes even work) in better-off areas. The quality of the living conditions of health staff is said to be extremely important in the overall provision of health. Access to lighting, ICT and proper ventilation can help attract and retain better health professionals (Jimenez and Olson, 1998; Cabraal, Barnes and Agarwal, 2005). The impact of electrification on the effectiveness of health workers has well been studied in Bangladesh, finding a clear and significant link from electrification to reduced absenteeism: health workers were significantly more inclined to live in the same community if the facilities were electrified; that, in turn, significantly reduced the probability of the worker being absent from the facility (Schaudhury and Hammer, 2003).

Evidence from 5 EF-projects suggests that electrification leads to the attraction and retention of staff. Reports from the project *Rural Sustainable Energy Development in Zimbabwe* indicate that clinic staff is now motivated to stay at the newly electrified facilities offering their services to the communities. Anecdotal evidence from the project *Support the Ministry of Health and Social Welfare of Liberia in providing Renewable Energy Sources to Rural Primary Health Care Facilities* also points out that health workers now enjoy conducive environments in which to perform their work.

The table below contains a list of benefits as described in the literature review, indicating whether they were present in the project reports and illustrating the strength of the evidence found.

Table 2: Evidence from the EF of impacts of electrification of health facilities

Possible impacts	**Project reports**	**Evidence level**
Extended hours of operation	✓	♦♦♦
Improved health service provision	✓	♦♦♦
Improved diseased treatment and retention	✓	♦♦
Use of ICT	✓	♦
Improved management	✓	♦
Improved staff retention	✓	♦♦
Legend	✓ = Present ✗ = Absent	♦ Low ♦♦ Medium ♦♦♦ Strong

The common challenge of long-term sustainability

Long-term sustainability is the area where the highest number of projects have reported problems: In an evaluation scale going from A to D, 26 out of the 57 projects have received scores of C (problems) and D (serious deficiencies), highlighting the need to emphasize sustainability issues when designing and implementing electrification projects. Projects encounter large difficulties once the implementation period is over and a new institution has to take over the management of the energy source.

The first problem faced by EF projects is related to the **technical aspects** of the systems installed. Some project reports have stressed that the systems were unable to be repaired due to the lack of availability of spare parts in the local markets, making system reparation extremely difficult or costly, as was evidenced by the projects *Promoting use of sustainable energy in Wajir District in Kenya, Promoting Renewable Energy Services for Social Development in Sierra Leone (PRESSD-SL)*, amongst others[7]. Reports from *Support the Ministry of Health and Social Welfare of Liberia in providing Renewable Energy Sources to Rural Primary Health Care Facilities*, suggest that public procurement processes for products not found on the local market pose additional difficulties for public structures, which not only struggle to afford such products but also face challenges and delays in procuring them.

A second problem is related to the capacity building provided by project implementors. Projects are often finalised without having devoted enough time to train the local communities (system managers and local technicians) and/or government staff, resulting in technical as well as managerial difficulties, as was registered in projects Malawi, Mozambique, Zimbabwe, Kenya, Sierra Leone, Burkina Faso, Ghana, Uganda and Liberia[8]. Without properly trained local technicians and poor managerial and financial skills, both public institutions and community organizations managing the sources encounter serious difficulties maintaining the energy systems and are often unable to operate them without external assistance. Reports from the project *Support the Ministry of Health and Social Welfare of Liberia in providing Renewable Energy Sources to Rural Primary Health Care Facilities*, which electrified over 200 health facilities, indicate that the project finalised without providing proper capacity building to the Ministry of Health (MoH), which not only lacked the budget to maintain the systems but also the required technical skills. Thus

[7] "Enabling 18.000 people to access sustainable small scale solar power in 2 districts of Cabo Delgado"; "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"; "Support the Ministry of Health and Social Welfare of Liberia in providing Renewable Energy Sources to Rural Primary Health Care Facilities"

[8] See next page.

far, the systems have been maintained due to the external assistance provided by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), which is working with the MoH and provides support to health facilities. The need to train local technicians also applies for government-ran systems, as was also evidenced by the project *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* in Mozambique, where repairs are constrained by the long distances technicians have to travel from the city to the rural health centres when local technicians are not available.

The third and major problem is the **fragility of the project's long-term financial sustainability**. Evaluations of a considerable number of projects questioned the long-term financial viability of the projects, as often governments, public institutions and community-based organizations lack the funds and revenue streams to maintain and operate the systems[9].

Evidence from several projects suggests that public management models with governments in charge of the operation and maintenance of the energy sources do not guarantee long-term sustainability of the projects per se. While having their buy-in is extremely important, experience shows that while governments have strong incentives to maintain the energy systems, they often lack the financial resources to maintain and repair the installations, as was evidenced by the above-mentioned project in Liberia, the project *Increase Rural Energy Access in Rwanda through Public Private Partnership (IREA RPPP) in Rwanda and Red de centros…* in Mozambique, amongst others, where governments had no budget allocated to the operation and maintenance of the newly installed systems. It is worth noting that the lack of government support does not necessarily lead to system failure, as was evidenced by the "IREA RPPP", where public institutions managed to operate and repair the systems themselves. However, whether they will be able to cope with major repairs or not remains to be seen. Furthermore, public infrastructure faces an additional vulnerability in government-operated systems as inability of the schools to afford electricity services caused the public utility company to disconnect the institutions from the electricity supply as evidenced by the *Rural Electrification Infrastructure and Small-scale Projects* in Zambia.

In a similar line, community ownership can lead to higher levels of commitment and protection of the electricity sources, but they seldom have the financial means needed to address operability issues that might arise. Without prior preparation and/or revenue collection, public institutions cannot afford to repair the systems once they start to fail, as was highlighted in reports from *Catalysing modern energy service delivery to marginal communities in Southern Africa* in Malawi, Mozambique and Zimbabwe; and *Rural Energy Activating Livelihoods* in Sierra Leone, amongst others. Without the necessary funding, they rely on fundraising activities and assistance from governments which, as stated above, can be difficult to secure. Furthermore, not only does the lack of funds affect their ability to maintain the systems, but it prevents schools and health facilities from harnessing the benefits of electrification as well, as evidenced in the *Community Managed Renewable Energy Programme for Rural Ethiopia*, where schools and health facilities cannot exploit the services available due to lack of resources.

[8] "Catalysing modern energy service delivery to marginal communities in Southern Africa"; "Promoting use of sustainable energy in Wajir District"; "Community Based Green Energy Project"; "Rural Sustainable Energy Development in Zimbabwe"; "Rural Energy Activating Livelihoods"; "Provision of modern, affordable and sustainable energy services to rural poor communities in West African countries from Jatropha curcas oil: an integrated approach based on technological transfer and capacity building improvement"; "Scaling –up rural electrification using innovative solar photovoltaic distribution models"; "Light up our Futures"; "Light up Liberia"; "Improved access to Energy services in isolated rural areas of Mozambique by application of photovoltaic systems"; "Support the Ministry of Health and Social Welfare of Liberia in providing Renewable Energy Sources to Rural Primary Health Care Facilities"

[9] "Support to the Ministry of Health and Social welfare of Liberia in providing Renewable Energy Sources to Rural Primary Health Care Facilities"; "Increase Rural Energy Access in Rwanda through Public Private Partnership (IREA RPPP)"; "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"; "Providing access to modern energy for northern Uganda (PAMENU)"; "Msamala Sustainable Energy Project"; "Catalysing modern energy service delivery to marginal communities in Southern Africa"; "Community Based Green Energy Project"; "Rural Sustainable Energy Development in Zimbabwe"; "Rural Energy Activating Livelihoods"; "Community Managed Renewable

Systems managed by community-based organizations face the same constraint, in certain cases mitigated by the establishment of fees. However, this represents another challenge for public institutions, as they do not possess the funds needed to pay for the electricity they consume. Without affordable fees, public institutions cannot afford electricity. In the project *Light Up Liberia*, for instance, schools that had been connected to the grid were disconnected soon after due to non-payment of bills, showing how such market-based schemes often cater the most "affluent" community members while overlooking those in greater need.

In order to ensure the long-term sustainability of the systems, projects need to include in their design long-term strategies to ensure that public institutions are able to maintain the systems and afford the electricity they consume. Considering that such institutions are often located in very poor and rural areas in low-income ACP countries, the creation of special funds, income generating activities, and/or guaranteed subsidies should be in place to ensure the sustainability of the electrification processes.

The "Project to Provide Electrification to Marginal and Depressed Rural and Peri-Urban Communities in Belize from Renewable Energy Sources Through Grid Extensions", for instance, is ensuring its long-term sustainability through the implementation a cross subsidies programme on electricity rates. Other projects, such as the *Msamala Sustainable Energy Project* in Malawi, *the Community Based Green Energy Project* in Kenya, *Rural Sustainable Energy Development in Zimbabwe* and *Up scaling access to integrated modern energy services for poverty reduction* in Tanzania have envisaged the creation of maintenance funds which are used towards the sustainability of the systems. Some initiatives promote the productive use of electricity to generate income thus helping cover operation and maintenance costs. Examples include mobile phone charging services, utilizing fridges to sell cold drinks to students and teachers, photocopying and printing, etc. Reports from the above-mentioned projects in Malawi, Zimbabwe, Tanzania, the "IREA RPPP" in Rwanda, and the *Community Managed Renewable Energy Program for Rural Ethiopia* indicate that several institutions are indeed engaged in income generating activities. Other projects, such as the *Red de centros…*-project in Mozambique, have even envisaged a scheme in which electricity provision to health facilities is coupled with the creation of community development centres, established with the purpose of using electricity for productive uses like a grinding mill. However, further evaluations need to be done in the future to assess whether such activities result in sufficient funds to cover the needs.

Lessons learned

- The hand-over of electricity installations to government bodies does not guarantee sustainability, as they often lack both financial and technical resources.
- Community involvement can be fundamental to ensure ownership, protection of the source and sustainability. However, management should only be devolved in cases where communities possess the necessary skills and resources to maintain them.
- Project implementers should plan to remain involved in operation and management (for at least a few years), to mitigate risks and ensure the sustainability of the action.
- Project implementers must assess financing needs over the expected lifespan of the energy source and not just the duration of the project financing the installation.
- Public institutions cannot afford to maintain the systems on their own; additional strategies need to be in place, such as the creation of maintenance funds or the promotion of income generating activities to decrease costs.
- Projects envisaging the use of private management models need to incorporate safeguard measures to ensure that the benefits of electrification -and electrification itself- indeed reaches the poor, including social institutions that, without preparation, cannot bear the costs of electrification.
- The possibility to apply cross subsidies, such as granting social tariffs to public institutions should be evaluated when implementing private or government management models.

Conclusion

About 60% of primary schools in Sub-Saharan Africa, and health care facilities in low- and middle-income countries, lack access to reliable electricity. Yet, the electrification of public structures is generally overlooked in academic literature and in access-to-energy policies. The focus on households as recipients of electricity provisions cascades down to the monitoring and evaluations of projects where impacts on electrifying public infrastructures are overlooked as well. Therefore, the impact of electrification on schools and health facilities remains largely undocumented.

The first conclusion that can be drawn from this analysis is the need to devote more efforts into understanding the development impact of electrification of public structures. This also means that development- and electrification policies and electrification projects should set objectives to this end, and that better methodologies should be developed to document impacts on education and health services.

Analysis of 57 Energy Facility supported projects shows some evidence supporting the assumption that electrification of schools means extended hours of study for students and improved school performance while electrification of health services also extends the hours of operation as well as it improves the quality of health services provided.
To make stronger conclusions than these, better data is needed. What lacks in general are systematic assessments that compare institutions with and without electricity, as well as before and after electrification (and sufficient time needs to pass before impacts of electrification efforts can be found). These need to be carried out to ensure better and evidence-based decision making by governments, donor institutions, and the private sector.

Analysis of the Energy Facility projects also highlights the importance of technical and financial management of the infrastructure provided. Before implementation, projects need to define a clear and sound continuation strategy, ensuring that the institution that is to take over indeed possess the necessary technical, managerial and financial skills to operate and maintain the system in the long-term. When it comes to public institutions, additional measures need to be in place for them to either reduce the costs or generate funds to maintain their systems or afford the electricity they can now enjoy. Further analysis, including the implementation of experimental projects to differentiate management types, needs to be done in order to harvest their full potential.

Recommendations

- Long-term financial sustainability concepts and contingency plans should be incorporated as critical criteria in the project planning and formulation for public infrastructure.
- Project planning and implementation needs to assure that the managers of the site – post implementation phase – are sufficiently well trained to manage and maintain the infrastructure, and are able to source spare parts for maintenance.
- Community involvement in all stages of the project is fundamental to ensure ownership, protection of the source and sustainability.
- Key performance indicators should be clearly defined and followed-up throughout all stages of the project cycle to allow monitoring and evaluation efforts to draw quantitative, comparable conclusions.

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Annex 1: Overview of project evidence regarding the impact of electrification in schools

Project	Country	Extended hours of Study as a result of electrification	Use of ICT in education facilities as a result of electrification	Improved teacher retention as a result of electrification	Improved school performance as a result of electrification
Catalysing modern energy service delivery to marginal communities in Southern Africa	Malawi, Mozambique, Zimbabwe	✓	✓	✓	✓
Community Managed Renewable Energy Program for Rural Ethiopia	Ethiopia	✓	✓		
Rural Electrification Project in Cabo Delgado Province, Phase III lot 2	Mozambique	✓			
Best Ray (Bringing Energy Services to Tanzanian Rural Areas)	Tanzania	✓	✓	✓	
Somalia Energy and Livelihood Project (SELP)	Somalia	✓			
Improved access to Energy services in isolated rural areas of Mozambique by application of photovoltaic systems	Mozambique	✓			
Programme d'électrification rurale par réseau SBEE	Benin	✓			
Ligne électrique de Muhura	Rwanda	✓	✓		
Projet d'Initiatives Locales d'Electrification Solaire (PILES)	Mauritania	✓			✓
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	✓			
Cross-border Supply of Electricity to Rural Communities in Togo from Ghana	Togo, Ghana	✓			
Electrification rurale décentralisée par énergies renouvelables dans le sud de Madagascar (RESOUTH)	Madagascar	✓			✓
Promoting use of sustainable energy in Wajir District	Kenya	✓			✓
Rural Sustainable Energy Development in Zimbabwe	Zimbabwe	✓	✓		✓
South Togo from Ghana - Rural Electrification	Togo, Ghana	✓	✓		✓
North Togo from Benin - Rural Electrification	Togo, Benin	✓			✓

Project	Country	Extended hours of Study as a result of electrification	Use of ICT in education facilities as a result of electrification	Improved teacher retention as a result of electrification	Improved school performance as a result of electrification
Rural Energy Activating Livelihoods	Sierra Leone	✓			✓
Best Options for Rural Energy and Access to Light and Electricity (BOREALE)	Madagascar	✓	✓		✓
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	✓			✓
Scaling –up rural electrification using innovative solar photovoltaic distribution models	Uganda	✓	✓		
Rural Electrification by Photovoltaic solar systems of 30 secondary schools and 20 clinics	Burundi	✓	✓		✓
Electrificaçao da Comunidade de Majaua	Mozambique		✓		✓
Providing access to modern energy for northern Uganda (PAMENU)	Uganda		✓		✓
Somali Energy Transformation (SET) Project	Somalia		✓		
Msamala Sustainable Energy Project	Malawi			✓	✓
Community Based Green Energy Project	Kenya				✓
Provision of modern, affordable and sustainable energy services to rural poor communities in West African countries from Jatropha curcas oil: an integrated approach based on technological transfer and capacity building improvement	Burkina Faso, Ghana				✓
Increased access to electricity services (IAES)	Zambia		✓		
Rural Electrification Infrastructure and Small-scale Projects	Zambia	✓	✓	✓	✓
Legend		✓ = Present			

Annex 2: Overview of project evidence regarding the impact of electrification in health facilities

Project	Country	Extended hours of operation as a result of electrification	Improvement of health service provision as a result of electrification	Improvement of disease treatment & prevention as a result of electrification	Use of new ICT as a result of electrification	Improved management as a result of electrification	Improved staff retainment as a result of electrification
Community Managed Renewable Energy Program for Rural Ethiopia	Ethiopia	✓					
Somalia Energy and Livelihood Project (SELP)	Somalia	✓					
Providing access to modern energy for northern Uganda (PAMENU)	Uganda	✓	✓	✓			
Projet d'Initiatives Locales d'Electrification Solaire (PILES)	Mauritania	✓	✓				
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	✓	✓	✓			
Electrification rurale décentralisée par énergies renouvelables dans le sud de Madagascar (RESOUTH)	Madagascar	✓	✓				
Community Based Green Energy Project	Kenya	✓	✓	✓			
Rural Sustainable Energy Development in Zimbabwe	Zimbabwe	✓	✓	✓			✓
Rural Energy Activating Livelihoods	Sierra Leone	✓	✓				

Project	Country	Extended hours of operation as a result of electrification	Improvement of health service provision as a result of electrification	Improvement of disease treatment & prevention as a result of electrification	Use of new ICT as a result of electrification	Improved management as a result of electrification	Improved staff retainment as a result of electrification
Support the Ministry of Health and Social Welfare of Liberia in providing Renewable Energy Sources to Rural Primary Health Care Facilities	Liberia	✓	✓				✓
Pico-hydro électricité au service du développement rural (PHEDER)	Madagascar	✓	✓	✓			
Scaling –up rural electrification using innovative solar photovoltaic distribution models	Uganda	✓	✓	✓			
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	✓	✓	✓			
Catalysing modern energy service delivery to marginal communities in Southern Africa	Malawi, Mozambique, Zimbabwe		✓	✓			
Best Ray (Bringing Energy Services to Tanzanian Rural Areas)	Tanzania		✓				
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		✓	✓			

Project	Country	Extended hours of operation as a result of electrification	Improvement of health service provision as a result of electrification	Improvement of disease treatment & prevention as a result of electrification	Use of new ICT as a result of electrification	Improved management as a result of electrification	Improved staff retainment as a result of electrification
Cross-border Supply of Electricity to Rural Communities in Togo from Ghana	Togo, Ghana		✓				
Cross-border Supply of Electricity to Communities in Burkina Faso from Ghana	Burkina Faso, Ghana		✓				
North Togo from Benin - Rural Electrification	Togo, Benin		✓				✓
South Togo from Ghana - Rural Electrification	Togo, Ghana		✓				✓
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		✓				
Rural Electrification by Photovoltaic solar systems of 30 secondary schools and 20 clinics	Burundi		✓	✓	✓		
Somali Energy Transformation (SET) Project	Somalia				✓		
Increased access to electricity services (IAES)	Zambia		✓	✓			
Rural Electrification Infrastructure and Small-scale Projects	Zambia		✓	✓	✓	✓	✓
Legend		✓ = Present					