Progress Report 2014

Energising Development – Phase 2

Draft Version for the Governing Board

energising development

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The German Federal Ministry for Economic Cooperation and Development
The UK Department for International Development
The Norwegian Ministry of Foreign Affairs
The Australian Department of Foreign Affairs and Trade
The Swiss Agency for Development and Cooperation

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April 2015

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Key achievements since 2005

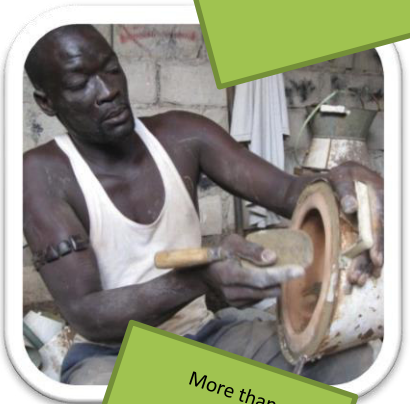
3.45 million
household members with electricity

30,500
small and medium enterprises with a modern form of energy

Energy access for
13.9 million
people accomplished

10.45 million
household members with improved cookstoves

16,000
social institutions with a modern form of energy



More than
35,000
technicians, stove producers, sales men etc. trained

1.38 million t of CO_2
saved per year

A. Overview

The Energising Development (EnDev) programme is a coordinated and harmonized effort of several donors to improve energy access on global scale as main target. The donor partnership consisted in 2014 of:

- the Netherlands Ministry of Foreign Affairs Directorate-General for International Cooperation (MFA / DGIS),
- the German Federal Ministry for Economic Cooperation and Development (BMZ),
- the Norwegian Ministry of Foreign Affairs (MFA-NOR),
- the Australian Department of Foreign Affairs and Trade (DFAT),
- the UK Department for International Development (DFID), and
- the Swiss Agency for Development and Cooperation (DEZA / SDC).

EnDev aims to achieve sustainable access to energy for minimum 18 million people worldwide by 2019 (5 million in phase 1 from 2005 to 2009; additional 9 million in phase 2 from 2010 to 2015 and additional 4 million from 2016 to 2019) with a currently planned total budget of EUR 315 million. The strategy of EnDev is geared towards developing and promoting sustainable pro poor markets for energy services and off-grid products.

By December 2014, EnDev in its second phase has facilitated sustainable[1] access to modern energy services[2] to 8.89 million people. Households were connected to the national grid or isolated grids, or use electricity through photovoltaic systems. Others benefited from improved and cleaner cooking technologies, such as improved firewood and charcoal stoves or biogas plants (see table A.1). In addition, more than 8,500 schools, health stations and community centres got access to improved cooking energy or electricity, or other modern energy carriers. Furthermore, 18,500 small and medium enterprises gained access to modern forms of energy for productive use.

Table A.1: Adjusted number of people with access to modern energy services (EnDev 2, in million)

lighting / electrical appliances	cooking / thermal energy	total households
2.63	6.26	8.89

Facilitating access to modern energy service is a key requirement to reduce poverty, to improve the standard of living, and as a means to inclusive social, economic and low carbon development. Consequently, the success of the programme does not only depend on the number of people reached but also on the impact of the modern energy service provided on income, health, education and well-being.

EnDev continuously analyses the impacts of its country activities to verify the assumptions regarding the relation of energy access and sustainable development. In addition, the sustainability of the EnDev results and impacts are regularly investigated. Since 2009, EnDev has carried out almost 110 baseline, impact and sustainability studies. Results of the studies until 2013 were presented in previous reports. The present report adds to these key findings of studies finished in 2014.

Financially, EnDev developed as scheduled. The expenditures for EnDev 2 activities in 2014 reached a new peak of EUR 33.6 million.

[1] Sustainable access here refers to long-lasting access.

[2] The term modern energy service refers to electricity as well as to natural gas, LPG, and biogas as cooking fuels and to advanced cookstoves for solid fuels that have higher combustion efficiency (at least 40% in comparison to traditionally used stoves).

Peru: Ban Ki-moon presents a dish cooked on an ICS promoted by EnDev during the COP20 in Lima

Uganda: At this year's Energy Week in September 2014, Energising Development Uganda launched its newly developed stove brand "Good Stove – Better Cooking" and offered all cookstove types at display in the EnDev tent

B. Current status of the EnDev 2 programme

By December 2014, the EnDev partnership comprised 26 activities in 24 different countries. In 18 of the 24 countries EnDev is supporting access to improved cookstoves, in 18 access to off-grid solar technologies (solar home systems and solar lanterns), in 11 countries access to minigrids (either solar or hydropower-based minigrids), in 11 countries grid extension or densification are promoted and in 3 countries access to biogas. Table B.1 presents a summary of this information.

Table B.1: Overview of technologies supported in EnDev countries

	stoves	biogas	other cooking/ thermal	SHS	picoPV	solar mini grid	hydro mini grid	grid	other lighting/ electricity
Bangladesh	●			●	●				
Benin	●				●			●	
Bolivia	●		●	●	●		●		
Burkina Faso	●								
Burundi	●			●	●				●
Cambodia		●							●
Ethiopia	●			●	●		●		
Ghana								●	
Honduras	●		●	●			●	●	
Indonesia		●				●	●		
Kenya	●				●			●	
Liberia	●		●		●	●			
Madagascar	●								
Malawi	●				●				
Mali				●	●	●			●
Mozambique	●			●	●		●	●	
Nepal	●						●	●	
Nicaragua	●			●	●		●	●	
Peru	●		●	●	●			●	
Rwanda					●		●		
Senegal	●			●		●		●	
Tanzania	●				●				
Uganda	●			●	●		●	●	
Vietnam		●							

By December 2014, EnDev 2 facilitated sustainable access to modern energy services and technologies for about **8.89 million people**. Out of these, 2.63 million people (30%) were connected to the central grid or a mini grid or used standalone systems. 6.26 million (70%) are now using improved cooking technologies, such as improved firewood and charcoal stoves or biogas plants (Figure B.3). In addition, **8,500 social institutions** gained access to improved cooking systems or electricity and **18,500 small and medium enterprises** now have access to a modern form of energy for productive use.

The focus of the EnDev programme is on Sub-Saharan African countries. Around 58% of the committed EnDev 2 funds are currently allocated to this part of Africa (Figure B.1). The share of least developed countries (LDC) supported by EnDev is 59% (Figure B.2).

The figures reported here are verified in the field through detailed lists of customers of energy services and products, and sales figures of energy companies and retailers. EnDev does not simply add outcomes achieved in the course of the programme but tries to capture also those processes which reduce outcomes through so-called adjustment factors. Thus, figures of six-month reporting

periods are adjusted down before the total number of beneficiaries is presented to donors and the public.

EnDev applies four adjustment factors:

- a "sustainability adjustment factor", which takes into account that the access provided to modern energy technologies is not sustainable in all cases;
- a "windfall gain factor", considering that some beneficiaries supported by EnDev would have gained access to modern energy services anyway even without support;
- a "double energy factor", which accounts for beneficiaries which already have access to modern energy services in the same category (modern cooking energy technologies or electricity);
- a "double EnDev counting factor", which ensures that beneficiaries availing from both modern cooking energy and electricity through the EnDev programme are only counted once in the aggregate figure.

Figure B.1: Funding by region

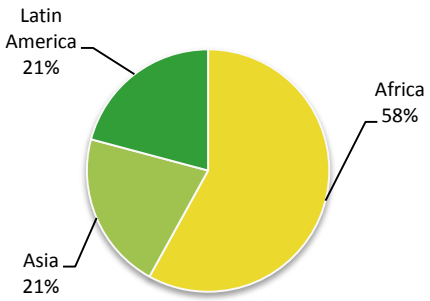
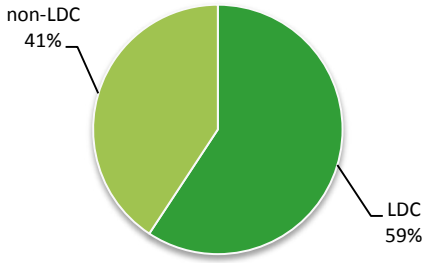


Figure B.2: Funding by countries



In addition, the EnDev figures already include a discount for replacement in order to consider the limited lifespan of some of the technologies promoted. This typically concerns cookstoves and picoPV devices: in order to continuously benefit from the service, the system may have to be bought more than once over the course of the monitoring period. Later-stage sales may go to beneficiaries reported before. It would therefore be wrong to simply add up all sales numbers.

In the past, EnDev has subtracted 100% of the systems after their estimated life-span. However, evidence emerges that this is approach may be overly conservative. Not all systems registered in EnDev's monitoring require replacement, because, for example, people buy replacement systems from providers not captured by EnDev's monitoring. EnDev currently develops an enhanced replacement logic which takes these and related aspects into account.

Figure B.3: Adjusted number of household members provided with modern energy services in a sustainable manner (EnDev 2)

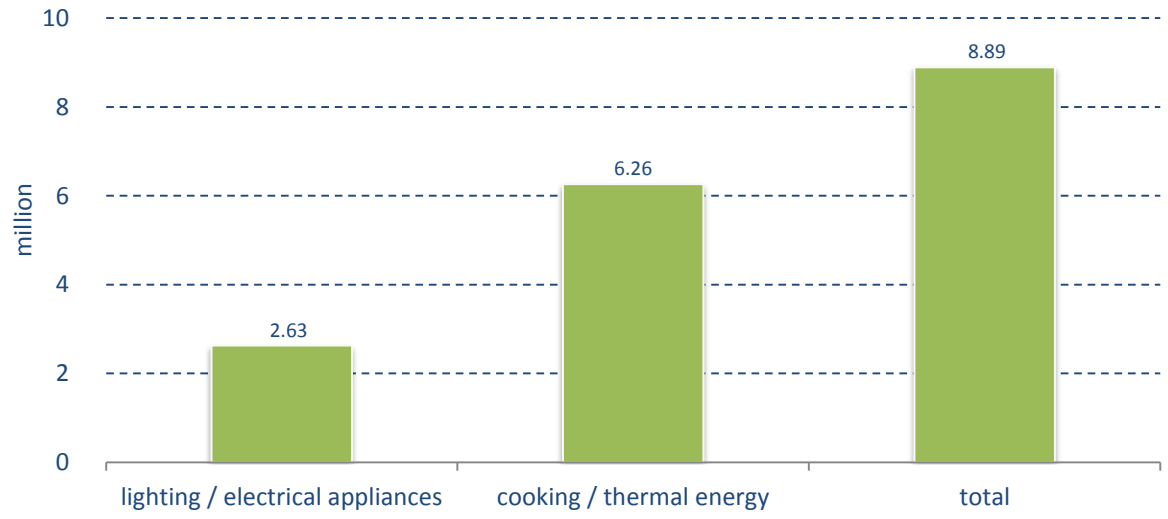
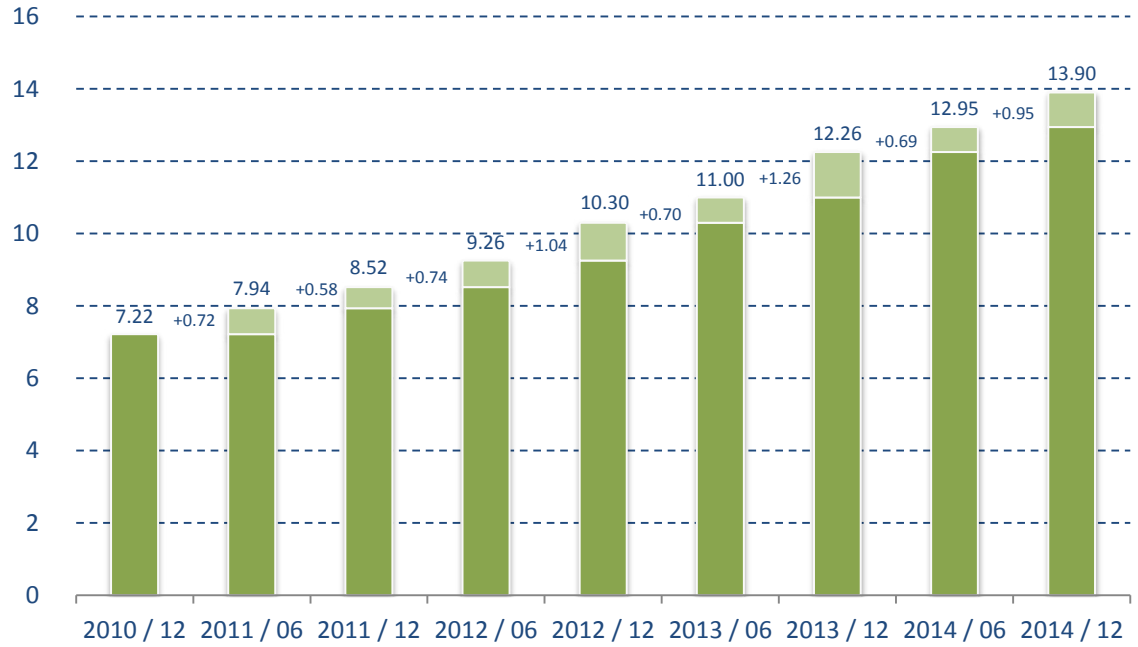


Figure B.4: Development of EnDev 1+2 adjusted figures per semester



We expect that on the long run the replacement factor will slow down the number of additional beneficiaries per semester, as markets will face certain saturation. EnDev is currently studying more in detail market development in post EnDev intervention periods. This will have a major impact on the replacement factor. In this reporting period EnDev already applied a more dynamic model for Kenya as intermediate phase in anticipation of results of studies to be implemented in 2015.

EnDev uses a tier system for defining different levels of access to electricity. In this system access to electricity is defined in terms of services, for which both “energy” and a device turning the energy into a useful service are required. As it is often difficult to directly monitor a service, access can be claimed by demonstrating access to the respective device and the required energy. Alternatively, access can be claimed on the grounds of certain electricity consumption.

The EnDev tier system is aligned with the tier system of the SE4ALL global tracking framework that was published in May 2013 and which is currently updated. Based on this system the EnDev electrification outcome figures in the different tiers are as follows:

Tier	Services	Typical system	Number of people
5	tier 4 services plus use of devices typically requiring a few kilowatt like air conditioners	grid	257,592
4	tier 3 services plus use of devices typically requiring a kilowatt like water heaters, irons	limited grid	176,826
3	tier 2 services plus use of devices typically requiring a few hundred watt like rice cookers, refrigerators	minigrid	112,376
2	bright light, radio, telephone plus use of devices typically requiring tens of watts like TV, video, fan	solar home system	1,768,780
1	medium bright light and, if possible, limited radio use and telephone charging	picoPV, battery charging station	315,417
		total	**2,630,991**

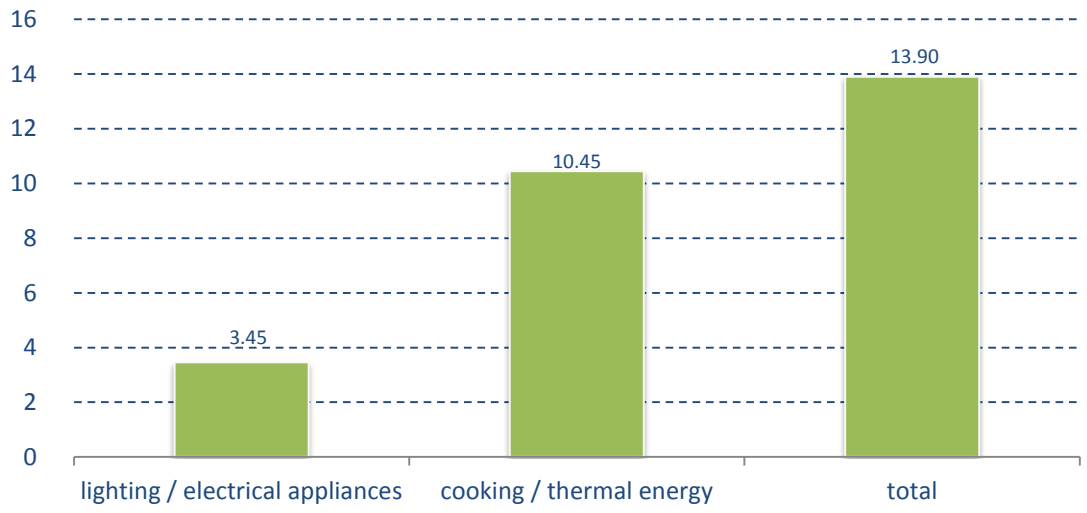
These figures reflect only those people which had no access to electricity beforehand. In several cases EnDev facilitated a better access (higher tier) for households that already had at least basic access to electricity (minimum tier 1). The number of beneficiaries whose access was raised to a higher level (i.e., in addition to the reported EnDev outcomes) is 195,633.

In the last report EnDev also applied a tier system for improved cooking systems for the first time. The system was intensively discussed with partner organisations and World Bank staff responsible for the preparation of the new version of the Global Tracking Framework of the SE4ALL initiative. The system is largely in line with the system presented in the 2015 tracking framework. EnDev outcomes are attributed to the 5 tiers as follows:

Tier	Services	Number of people
5	Access to needed quantity of energy source: ≥ very high Health protection: ≥ very high Convenience: ≥ very high	0
4	Access to needed quantity of energy source: ≥ good Health protection: ≥ high Convenience: ≥ high	0
3	Access to needed quantity of energy source: ≥ fair Health protection: ≥ sufficient Convenience: ≥ sufficient	54,840
2	Access to needed quantity of energy source: ≥ limited Health protection: ≥ medium Convenience: ≥ medium	3,638,977
1	Access to needed quantity of energy source: ≥ deficient Health protection: ≥ low Convenience: ≥ low	2,562,030
0	Access to needed quantity of energy source: ≥ highly deficient Health protection: ≥ very low Convenience: ≥ very low	2,417
total		**6,258,264**

When looking at the overall EnDev programme, starting from phase one in 2005 up to December 2014 in phase two, the **total number of people** having gained sustainable access to modern energy services on household level amounts to **13.9 million** (Figure B.5). The total number of **social institutions** is about **16,000**, the total number of **enterprises** is around **30,500**, respectively.

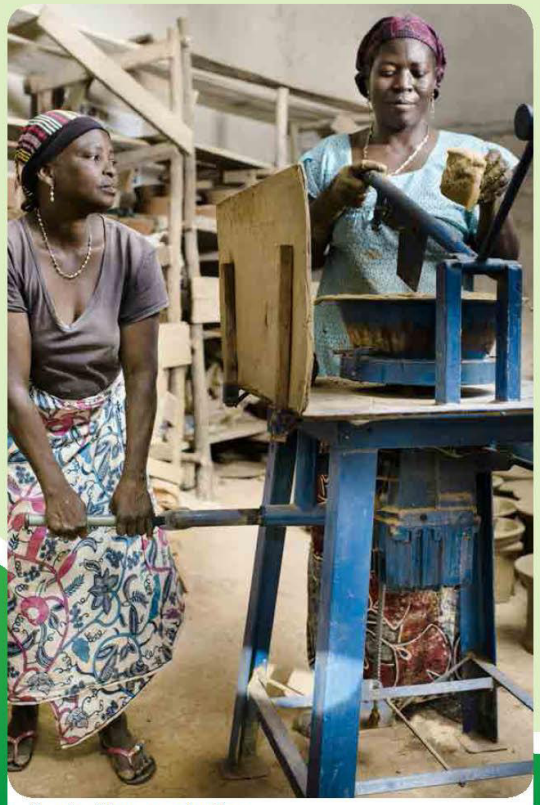
Figure B.5: Adjusted number of household members provided with modern energy services in a sustainable manner (EnDev 1 and 2 combined)



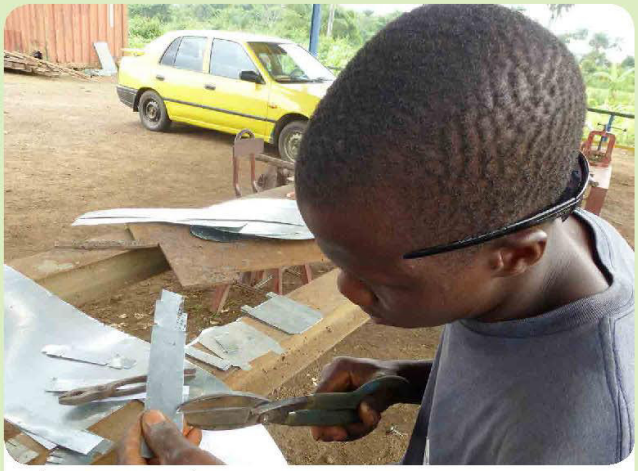
The absolute numbers of verified beneficiaries (taking into account replacement but not the adjustment factors described above) are 16.1 million for EnDev 2 and 25.1 million for EnDev 1 and EnDev 2 combined. In 2015 EnDev will further strengthen the validation of its monitoring system and the application of its key processes and set of regulations, as per suggestion of the 2014 external evaluation.

Rwanda: Preparations for the installation of a biogas digester

Peru: Villagers with picoPV systems (models: **Sun King Pro** *and* **Fosera***) in San Juan del Abiseo, San Martin*



Benin: Stove production



Liberia: Stove production training to construct a **Red Fire Pot** *ICS*

C. Impacts of EnDev 2

In addition to facilitating sustainable access to modern energy technologies and services EnDev aims at:

- reducing health risk and problems related to the use of traditional energy services, especially for women and young children, who are most affected,
- reducing climate-damaging emissions,
- reducing deforestation,
- promoting investments in and the use of renewable energies,
- developing and strengthening pro-poor markets for improved cookstoves and off-grid solar products,
- stimulating productive use of the access to modern energy services and technologies,
- increasing the efficiency of the use of energy sources, and
- improving people's general living conditions.

The current EnDev monitoring and reporting system is measuring the number of people that gained access to modern energy services, key attributes of the promoted energy technology or service, the turnover of involved companies, the creation of jobs along the value chain of the supported energy technologies or as a result from benefitting from the access to modern energy technologies, and the reduction of greenhouse gas emissions. In an ad-hoc and limited way, projects report on the direct benefits of having access to energy services as well, such as cost savings, improvement of the health situation, better educational conditions and opportunities for income generation.

In addition to the regular reporting, impacts of EnDev are studied through baseline studies, impact assessments covering specific topics, mid-term reviews and ex-post evaluations. The findings of the studies are also used to confirm or improve the adjustment factors, which are applied to the reported outcome figures.

In 2014, ten studies were finalised. The studies cover electrification as well as stove projects in seven countries and cover technical topics (for example, recycling of lead acid batteries in Nicaragua and Honduras, performance of picoPV systems after two years in the field in Peru, development of the Red Fire Pot charcoal stove in Liberia, effect of artificial ageing and wear on efficiency of stoves in Peru), impact (external impact assessment Rwanda) and sustainability (cookstoves in Ethiopia). A number of studies has been initiated or is planned for 2015, for example a comparison of EnDev and non-EnDev sites in Nepal, a study on sustainability of hydropower sites in Bolivia, a SHS and pico-PV baseline study in Ethiopia, a market study in Malawi and a sustainability study on stoves in Bangladesh. A comprehensive overview of the achieved impacts of the entire programme was published in the second edition of the EnDev Report on Impacts (EnDev, 2013). An increasing number of studies use an EnDev-developed **tablet application** for surveys.

Furthermore, EnDev is closely following the international discussion and is regularly evaluating publications on impacts of access to modern energy services. Major findings of these publications are incorporated in the following chapters on the impact of EnDev activities.

Health

Traditional lighting and cooking devices which burn solid and liquid fuels are a main cause for fire accidents and serious respiratory and eye diseases as they produce pollutant emissions such as carbon monoxide, particulate matter, nitrogen dioxide, volatile organic compounds including benzene, and polycyclic aromatic hydrocarbons partly visible as smoke and soot. EnDev contributes to the reduction of health risks through the promotion of improved cooking systems and of electric lighting.

Cooking systems: EnDev's concept to reduce exposure of household members (particularly women and children) to toxic emissions is based on:

- reducing of the quantity of emissions through a) improved stoves with higher combustion efficiency, and lower heat losses b) improved fuel quality and c) fuel switch

- removing pollutants from the cooking site through chimneys, flues, hoods or ventilation
- reducing exposure to pollutants through changed cooking practices and placing of the stove and kitchen

EnDev is promoting improved fuelwood and charcoal stoves that reduce fuelwood and charcoal consumption by 20 up to 50%. The reduction of emissions is slightly higher due to improved burning processes. EnDev is also supporting the use of high quality fuels (e.g. well dried fuelwood and charcoal) and fuel switches (e.g. from dung or crop residues to wood or charcoal) at the same time considering cost and availability of these high quality fuels. In addition, EnDev is supporting cooking solutions that are potentially free of emissions such as gasifiers and gas. Thus, EnDev supported the installation of more than 28,000 biogas stoves improving the health situation of 54,000 persons. Cooking solutions based on gas or electricity are generally relative expensive or require a well-established infrastructure. For large part of poor households these so called advance cooking solutions will not be accessible in the near future.

About 340,000 households (roughly 1,700,000 persons) got access to an improved cookstove with chimney. This way the combustion gases are vented to the external atmosphere reducing the exposure to those inside the building. If the chimney is well sealed and a re-entering of smoke into the building avoided, in-house emissions and emission exposure are reduced down to almost zero. Another 290,000 households (roughly 1,450,000 persons) cook outside or in open cooking shelters where air exchange rate is high. As a result exposure levels to air pollutants are generally significantly lower in comparison to indoor cooking. The magnitude of this difference still has to be studied.

Exposure to smoke and soot can also be reduced by limiting the cooking time through the use of pot lids, food preparation before starting to cook, pre-soaking certain foods in water, and the use of insulating containers keeping food warm such as cooking bags. Behaviour changes, such as extinguishing fire when not in use, and moving children away from the cooking area, further decrease exposure to indoor air pollution. Kitchens have generally higher air pollution levels as living rooms if they are separate from each other. Thus, staying in the kitchen for a longer period of time will increase exposure level, staying more time outside the kitchen or in the living room will decrease exposure level. The bigger the distance between the stove side and the living room the lower the indoor air pollution is.

EnDev promotion campaigns are based on these three pillars: technical improvement through better cooking devices, improvement of cooking environment, and improvement of social environment of cooking behaviour.

In summary there is strong evidence that EnDev's cooking interventions contributed to considerably reduce exposure to air pollution for at least **3 million people among them 500,000 women and 1 million young children**.

Electric lighting: Most of the 250 million households, which lack access to electricity, use candles, fuel-based lamps (mainly kerosene) or dry-cell battery driven torches and lamps for lighting. From a health perspective, kerosene lamps are most harmful as they emit carbon monoxide, carbon dioxide, sulphur dioxide, nitrogen dioxide, formaldehyde, various volatile organic compounds and particulate matter of different sizes. Scientific studies show that 7−9% of kerosene consumed by a simple wick lamp is converted to carbonaceous particulate matter (3-10 mg/g PM25)[3]. The exposure to toxic gases often exceeds international standards for ambient air quality. Exposure to emissions of kerosene lamps affects more family members as in the case of stoves, and occurs over longer time periods (several hours per evening). Children are most vulnerable to the emissions since PM inhalation can hamper lung development. Kerosene lamps are also one of the main causes of fire accidents, burns, and poisonings. Poisonings from ingestion of kerosene, especially in children, are common in households where kerosene is stored in small, unlabelled containers or soft drink bottles.

[3] Lam N., Y. Chen, C. Weyant, C. Venkataraman, P. Sadavarte, M. Johnson, K R. Smith, B. Brem, J. Arineitwe, J. Ellis, & T. Bond (2012) Household Light Makes Global Heat: High Black Carbon Emissions From Kerosene Wick Lamps, Environmental Science & Technology 46(24):13531–13538.

Electric light can prevent these negative health impacts. In addition, it improves people's safety while in the dark (e.g. against thefts, snakes) and hygiene within homes. In several studies families noted a decrease in the dirtiness of the walls and reported that they clean their houses more often.

How a sustainable market for ICS is creating opportunities for Mozambican youth in Chamanculo C.

His name is Carlos Matsinhe, he is 22 years old, 6 months ago he was an unemployed youth of Chamanculo C, a neglected quarter of the capital Maputo. Carlos accumulated a huge debt to finance his studies, he was about to leave university because he couldn't afford the fees anymore. Before giving up, he decided to make a last attempt to gain money by offering logistic support to a friend (an ICS promoter from Chamanculo C): he started carrying stoves with a wheelbarrow within Chamanculo C muggy alleys, gaining USD 100 per month. His friend saw his outstanding entrepreneurial potential and informed the project manager: that's how Carlos became an ICS salesman. From day one he was the ICS seller of the week accumulating bonuses that allowed him to earn income of up to USD 800 per month. His volume of sales and instalments collection is at least double compared to other promoters every week! He is an inspiration for other youth and of course he is still attending University.

Carlos is one of the 35 youth now working as ICS salesman in Chamanculo C. The project was originally designed to subsidize the access to improved stoves for the families in Chamanculo C. It turned out to be a big success by changing the approach towards the creation of a sustainable market for ICS in the middle of one of the oldest Maputo markets. Through linking up with another project, it was possible to create access to a communal fund for the development of Chamanculo C, leading to more people getting access to ICS.

The project implemented by AVSI (Associazione Volontari per il Servizio Internazionale), an Italian NGO founded in 1972 is working on improving the quality of life in slums in many countries around the world. AVSI has a very close relation to the community due to a long term presence inside the slums. AVSI's approach addresses problems such as the lack of funds to build up a business or to buy an improved cookstove, the uncertain product quality, and concerns about durability of stoves among both salesman and users. Door to door sales, payment by instalments and a new warranty system were key to achieve 80% penetration of ICS's in Chamanculo C in less than seven months. The prize for a new ICS is covered by the amount of money that can be saved on fuel. AVSI offers a reduction on the price of the ICS in case users exchange their old charcoal stoves for the ICS.

These results suggest that more flexible sales offers can greatly speed up the use and acceptance of efficient cookstoves. Much remains to be learned though about how to apply new offers to safer stoves. The next step in the project will be the creation of an association of youth that will continue to implement the project with a progressive independence from AVSI and GIZ support.

The precise number of people relying on fuel-based lamps is not known. The Climate and Clean Air Coalition (CCAC) estimates that 1.3 billion to 3 billion people depend on fuel based lamps consuming 5 to 65 million tonnes (Mt) of kerosene per year, producing an estimated 40 to 500 Mt of CO_2, as well as black carbon (BC) and other pollutants.[4] In some countries it is observed that the baseline for lighting is slowly shifting from kerosene and candles towards low-quality lanterns powered by non-rechargeable batteries. Although people might reap short-term benefits in terms of hygiene and health, the batteries disposed in the natural surroundings pose a new environmental threat which may result in negative effects on human health in the long run.

Electric power is important for any well-functioning health care system. It enables clinics to refrigerate vaccines, sterilise medical equipment, provide lighting in wards and operating theatres, and make use of communication equipment. In 2013, EnDev assessed the impacts of the electrification of health centres with PV systems in Ethiopia. All electrified health centres are now open 24 hours a day. Prior to this, only few health centres offered nightly emergency services. The provision of health services was generally limited to the phase between sunrise and sunset. People use the new night service, especially women, as the outside lighting makes them less afraid to visit the centre at night or in the evening darkness. The number of deliveries at night doubled in those centres that had an emergency service. In addition, 80% of the health centres now offer inpatient service compared to 40% before the electrification. The installation of the PV system has also resulted in improved laboratory services, such as better diagnosis of tuberculosis, malaria and HIV with the help of electric microscopes and refrigeration of test kits. The number of vaccinations also increased. Vaccines as well as medical drugs can now be preserved without major losses. Health staff and patients reported that the quality of treatments had improved dramatically due to better lighting. Surgical interventions were much safer and easier with electric lighting, and hygiene in the clinic had improved, resulting in reduced risk of infections. The report also notes that solar electrification has helped retain qualified health staff in the rural post, and has reduced cost of lighting and charging of mobile phones, which clinic staffs need in order to communicate. As a consequence of the improved service, health centres now have more clients and are economically more viable. The results of the EnDev impact study in Ethiopia confirm similar findings from a study in Ghana not related to EnDev interventions mentioned in the last progress report.

However, an EnDev study in Honduras demonstrated that the impact of the electricity access in the health sector depends on the availability of the electrical equipment. If health centres are not adequately equipped, the improvement of services is not so pronounced.

Electrification through grid extension, mini hydropower plants or photovoltaic installations helps to reduce waste problems by decreasing the demand for small dry cell batteries. Used batteries are usually discarded in the local environment as toxic waste without further treatment. However, special attention must be paid to the proper disposal of the solar batteries, a process that is still in its infancy in many project regions.

Climate-related impacts

EnDev promotes the use of renewable energies for rural electrification, the substitution of fossil fuel-based technologies (e.g. kerosene lamps) and an increased efficiency of biomass-based energy applications (improved cookstoves, biogas plants). All three activities contribute to emission reductions. For improved cookstoves, which consume 20-50% less biomass, an annual CO_2 reduction of about 0.5 t-1 t per household is assumed on average, depending on stove technology, user behaviour, fuel quality and fuel origin. If all 500 million households worldwide which currently are still using traditional cooking technologies would gain access to modern cooking solutions around 250 – 500 million tonnes of CO_2 emissions could be avoided. A significant reduction of particulate matter and soot (black carbon) is achieved due to a better and more complete combustion, too.

[4] For more information on kerosene use, see this kerosene briefing of the CCAC.

In many countries it is not clear to which extent fuelwood and other biofuels originate from sustainable or unsustainable sources, which would influence the overall CO_2 balance. EnDev is planning to collect more field data about fuelwood sources for a more detailed picture of fuelwood and charcoal use. However, in any case it has to be considered that biomass burned in a stove is directly and immediately converted into CO_2, whereas saved biomass degrades. CO_2 is also emitted during this process but over a substantially longer time, and not nearly as completely. The degradation of vegetation is the primary source of carbon accumulation in the soil profile.

EnDev's calculation on saved and avoided CO_2 emissions is based on the following assumptions. An improved firewood cookstove needs on average 30% less firewood, it is used to prepare 80% of all meals and thus saves around 0.55 t CO_2 per year (on average, over all EnDev stoves) compared to cooking on open fires. The total savings of all EnDev stoves for one year amount to approximately 1,280,260 t of CO_2. This figure includes 175,181 t CO_2 for which emission reduction certificates have been generated and will be sold on carbon markets. Air pollutants as a result of incomplete combustion (including black carbon) are not included in this calculation.

One electric lamp powered by SHS, minigrid or grid connections replaces at minimum two kerosene lamps, thus saving at least 0.15 t CO_2 per year. A solar lantern replaces approximately 90% of a kerosene lamp, saving 0.068 t CO_2 per year.

The total CO_2 saving of 2.1 million stoves and access to electricity for 700,000 households supported by EnDev are 1,376,051 t of CO_2.[5] This is as much as the Norwegian road traffic emits in 50 days.[6]

Impact on deforestation and soil degradation

Fuelwood originates from a wide range of land-use systems. These include primary or secondary forests, trees outside forests, agricultural plantations, agroforestry areas and tree plantations. Data that EnDev collected in Latin America showed that most of the fuelwood is coming from a sustainable source in vegetation-rich areas. A significant part of the fuelwood is collected from small plots of land owned by the respective household. Other parts are collected from forest areas in a sustainable way. The degree of sustainability of fuelwood consumption decreases significantly in densely populated and dry areas as demonstrated by several international studies. Thus, there is no doubt that modern and clean energy services with improved energy efficiency contribute to the reduction of deforestation but the magnitude has to be investigated in more detail.

Development of pro-poor markets

For the development of self-sustaining markets it is essential that sales figures of energy products and services reach a critical mass of customers and sufficient turnover, allowing enterprises to stay in business on the medium and long term. Based on this concept, calculations were carried out about the total number of sold / installed energy technologies / services, and the corresponding turnover of the involved enterprises in countries with EnDev projects (see Figures C.1 and C.2). According to these data, yearly turnover of solar home system market (largely dominated by the Bangladesh

[5] For the time being CO_2 savings per year are only calculated for solar home systems, off-grid hydropower, picoPV and improved cookstoves of EnDev 1 and 2, which were present in December 2014. The calculation is – according to UNFCCC – based on default values and own assumptions if necessary. Within EnDev the adjusted outcome figures are used to calculate the CO_2 savings. However, the double EnDev factor will not be applied, as both electrical systems as well as improved cookstoves contribute to CO_2 reduction.

[6] road traffic emissions in Norway amount to 10.1 million t CO_2 (in 2013)

market) reached over EUR 200 million[7], and the yearly turnover of stove markets reached over EUR 16.7 million in 2014.

In addition to this, the average monthly turnover of solar retailers increased from EUR 6 million in 2010 to EUR 16 million in 2014; that of stove producers and retailers from EUR 670,000 to EUR 1,400,000. It is planned to analyse the sales and turnover data at greater detail in the upcoming reporting periods and to continuously assess the market development for different products and services.

Figure C.1: Estimated yearly turnover of SHS market in Bangladesh

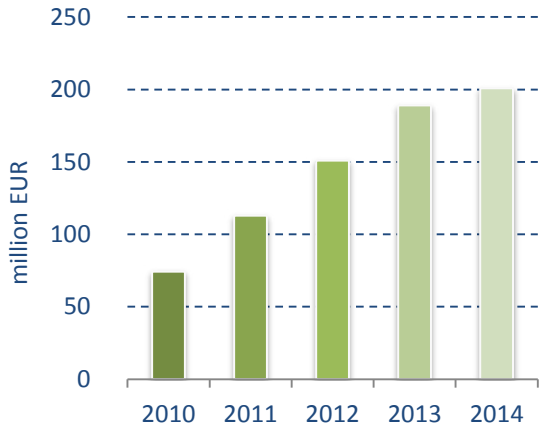
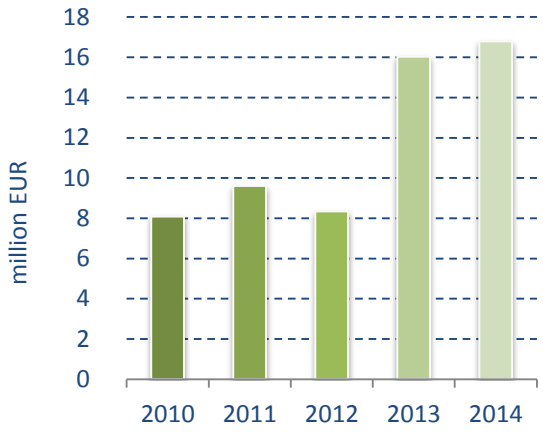


Figure C.2: Annual turnover of markets for stoves (currently just EnDev)



The figures do not reflect the full picture of the market development. Many enterprises are reluctant in disclosing sales and turnover data for tax reasons. In addition, the turnover data do not capture sales of all enterprises, because when markets grow, enterprises develop without EnDev support, either with or without support of other development organisations and donors. Especially the informal sector is difficult to include in a reliable sales and turnover monitoring.

In the last five years roughly 5.5 million improved stoves have been manufactured in our partner countries with the support of EnDev. This represents around 1.1 million stoves per year. The time needed to produce these stoves is 1,650,000 hours or 206,250 working days. This can be translated into roughly 900 full time job equivalents assuming 230 working days per year.

Therefore, EnDev is elaborating new indicators for market development, among them the creation of new jobs. As a first step, the number of working days for manufacturing and installing stoves has been calculated based on the assumption that a typical improved cookstove (either made by clay or iron sheet) is produced and installed in about 90 minutes. According to this estimate around 900 full time jobs equivalents have been created in the stove manufacturing sector (see box). EnDev will work out the concept and monitoring of job creation more in detail in the coming months. As a strategic issue, EnDev will further develop its understanding of market development dynamics in support of its design of country intervention strategies.

General improvement of people's living conditions

Impacts on income and employment: Households with efficient improved cookstoves need less firewood per meal than those without. As a result, these households could save part of their income.

[7] Based on IDCOL data, as well as on EnDev data and estimations

Savings can go up to EUR 45 per household per year (for those who buy firewood), but the effect is lost if households use the stove more frequently than the baseline technology or do not use it properly.

The use of biogas reduces energy expenditures in households and decreases their reliance on firewood and charcoal. In Rwanda, digester-owning households spent about 30% less money on energy as compared to the control group. This translates to an annual reduction in expenditure of about EUR 60. In addition, households owning biogas digesters increase the crop yield of their kitchen gardens when using the slurry.

Households connected to the grid or using a photovoltaic system reduce their expenditures for kerosene, candles and dry-cell batteries. Thus, the lifetime cost of kerosene lamps are generally higher than those of solar lighting systems or lighting that depends on grid based electricity. However, the overall impact on the family expenditures depends on the amount of the electricity consumed.

For small businesses, electrification makes a significant contribution to economic growth and poverty reduction. A bright illumination of markets and workshops helps to attract new customers, though partly to the disadvantage of businesses without electricity. With access to electricity, businesses can diversify the services they offer and extend their working hours into the evening.

The possibility to recharge mobile phones at home is another major advantage of electrification. It helps expand the use of mobile phones with positive social and economic impacts. Whereas before, frequent travels to visit family members, friends, and business partner had to be undertaken, telecommunication has now reduced the frequency of these visits and made communication easier. People are now much better informed than before. A study in Peru demonstrated that mobile phone expansion increased household real consumption, reduced poverty incidence, and decreased extreme poverty.[8] Phone charging at home also considerably reduces costs, as commercial charging in some countries reaches up to EUR 0.25 for a single charge.

In EnDev's experience, it is very rare for new income-generating activities to arise as a consequence of the new electricity supply alone. Economic development is therefore often restricted to (1) entrepreneurship in providing the energy service itself and (2) electrification of existing businesses. In addition, market access is often a limiting factor. A finding from remote villages in Indonesia illustrates this: even with reliable electricity access from micro hydropower plants, productive use did not take off because of lack of nearby markets on which the products could be sold.

However, economic development of rural populations is highly influenced by the level of education, the state of health and the general living conditions of households. All of these are positively affected by improved cooking technologies and access to electricity.

Impacts on education: Children in rural areas, especially girls, often spend a great deal of time on basic subsistence activities, such as collecting firewood. Less wood needed due to an improved cookstove reduces time for collection and increases school attendance. Although access to electricity does not have an immediate impact on the level of education, it influences learning performances by providing adequate lighting for children to spend more time studying and reading late in the evening. In a baseline study in Bangladesh, electrified households stated that they spend 2.26 hours on reading while non-electrified households spend 2 hours. Electricity creates the possibility of accessing information through radio or television.

Households at EnDev hydropower sites in Indonesia primarily operate lighting devices, but also use TV sets and other information and entertainment devices like CD or VCD players. They also charge their mobile phones. 81% of households name TV as their major source of information. Ownership and use of mobile phones is significantly higher in electrified households, compared to non-electrified households selected as a control group.

[8] D. Beuermann et al.(2012): Mobile Phones and Economic Development in Rural Peru; Journal of Development Studies Vol. 48 No11, 1617-1628.

The electrification of schools means that teachers can use computers, televisions and tape recorders: a significant contribution to the quality of the education system (sometimes critical to attract teachers and keep them in rural areas). In addition, adult education in the evening hours becomes possible. However, these impacts only materialise if the school administration purchases the necessary electrical equipment.

Genete from Merawi: Successful Entrepreneur in Bahir Dar, Ethiopia

Genete Tadesse was born in the small town of Merawi in Amhara Region. Until she attended sixth grade in school, Genete pursued a "normal" childhood life. Then, in 1979 she was forced to an arranged marriage to a man she did not know. In response, Genete fled 35km to Bahir Dar, the capital of Amhara Region, determined to continue her schooling while working as a daily labourer to cover for her bread and for tuition. Even after finishing secondary school, she continued to work for some 40 birr per day, until her marriage in 1984. She lived for more than a decade as a married woman but without paid job. In 2005 things changed for Genete when she took the chance to attend an improved cookstove producer training offered by GIZ EnDev. Along with the training, the project provided her with a production shed, a mould and accessories to allow her to start up the new stove business. "That was the turning point of my life," says Genete. "I am now leading a good life and I own a house with all necessary facilities."

While establishing and growing her business, Genete faced plenty of challenges such as lack of work space, water shortages, scarcity of raw material, and temporarily even relying on her son to help her dropping out of school. However, she managed to solve all those problems. "With support under a governmental programme for small and micro enterprises, I can now pump water from a hand-dug well, and after registering as a tax payer could obtain red ash." Her son finished his schooling as soon as she was able to employ a daily labourer.

Genete applies a variety of marketing strategies. Next to door-to-door sales promotion she cooperates with sales agents at the condition of 10% commission and also benefits from the Bureau of Women's Affairs' support in creating the link between her and stove buyers. Thanks to a governmental credit programme, she can also sell stoves on micro credit basis. "We sell 100 to 150 Mirt and Tikikil stoves per month; when receiving bulk orders, sales may even reach a 1,000," says Genete.

Indeed, as a result of the ongoing partnership with EnDev Ethiopia and the regional government, Genete's working capital has reached close to one million Birr (EUR 45,400). She has managed to create job opportunities for more than 20 people. Genete considers herself as a role model to other women who strive to change their lives. With my earnings, "I have also constructed some rental rooms in my compound which bring me around 10,000 Birr (EUR 453) of additional income per month," she complemented.

Genete aspires to produce the highest quality energy-efficient stoves, and to be the best supplier of renewable-energy technology in the whole of Amhara Region. EnDev Ethiopia continues to train and support producers like Genete around the country, providing households with efficient, health and environment-friendly cooking.

Workload

Women often have a high workload as they have to shoulder the double burden of field work and the bulk of household responsibilities. Therefore, women can often spend less time than men on education. Their workload also reduces women's opportunities to engage in productive activities, condemning them to economic dependence. The improved cookstove activities help to address these issues. Almost all interviewees of a survey in EnDev Kenya's improved cookstoves project claim to have saved time on wood collection and cooking. Half of the respondents who saved time use this additional time to carry out their productive activities. About a third of the respondents saving time were doing leisure instead (going to the church, visiting family members, etc.).

In some countries women have become stove entrepreneurs, thus improving their social position, and enhancing their roles within families and villages.

Electric light gives women the freedom to do some of their housework after dark, so they have more time to relax, to study or to do other work during the day.

Increase the efficiency of the use of the primary energy source

a) Stoves: In 2014, EnDev tested the efficiency and safety of several promoted stoves. Stoves not saving at least 40% of energy compared to the baseline technology in the "Water Boiling" and "Controlled Cooking" test or not fulfilling basic safety standards were not included in the adjusted number of outcomes. However, they are not necessarily excluded from project activities because they often have positive impacts on indoor air pollution and work load, even if they don't reach 40%.

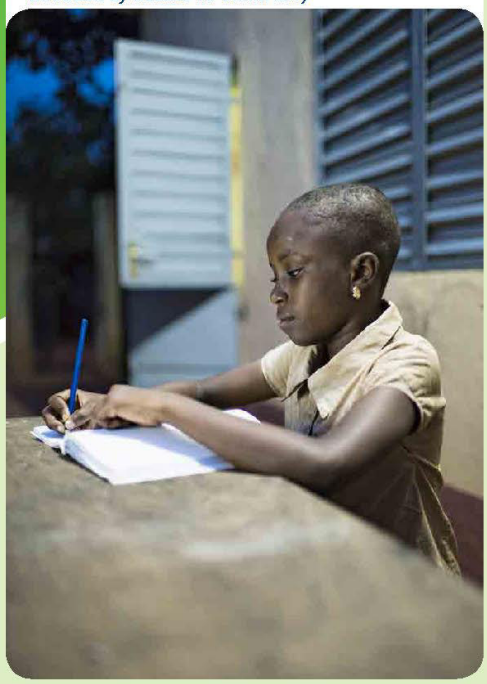
Several field studies have shown that households quite often do not fully realise the energy-saving potential of the improved cookstoves. The main reasons are that **a)** households tend to cook more (more often or bigger meals), **b)** do not use the appropriate cooking pots and **c)** do not use the stove in an optimal way, e.g. do not extinguish the fire in the stove but let it smoulder for a longer period of time. It is a general phenomenon of many innovative technologies that the benefits achieved under controlled conditions are frequently offset by human behaviour and traditional habits. As a consequence of these findings, EnDev uses only an average reduction of fuelwood consumption of 30% per improved cookstove in its outcome calculations and reporting regarding CO_2 emission savings.

In several countries, households cook on various types of stoves in parallel, a phenomenon called stacking. They do not immediately switch from one stove to another or from one fuel to another, but they add the new stove or fuel to the already existing ones.[9] Thus, an improved cookstove will not necessarily completely replace the three-stone fire. The different stoves and fuels are used for different purposes. The traditional fire is often used especially for small meals, like breakfast. Only over time traditional cooking technologies are abandoned if they are not needed anymore. For our impact analysis we assume that on average improved cookstoves will be used for 80% of the meal preparation.

b) Lighting systems: EnDev is almost exclusively promoting Compact Fluorescent (CFL) and LED lamps for lighting that produce a brightness of 60 or more lumen per Watt. These lighting systems are 300 times more efficient than a candle and a kerosene wick lamp (0.2 lm / W).

[9] See also Renewable Energy: Access and Impact, IOB study 376, www.government.nl/foreign-policy-evaluations.

Benin: Children are able to study at night because of access to electricity



Bolivia: Due to grid densification like here in the department of La Paz, over 270,000 persons gained access to electricity in Bolivia

Bolivia: The shop of Rosemary Rivero Pereyra in the community Monte Sinaí can improve its sales during hours in the evening thanks to the **Phocos picoPV system**

Madagascar: **OLI stoves**, *the improved cookstoves for charcoal and firewood as promoted by ADES*

D. Lessons learnt from failures and challenges

Internal disputes in private companies can seriously affect already achieved results and positive outcomes of minigrids: Developing micro hydropower projects is a long and tedious process. Relationships between the project developer and banks, government, and even with EnDev can get strained. But especially the shareholders of the companies operating the power plants themselves, so called special purpose vehicles (SPV), have to keep all their wits together to make it through the ups and downs of their partnership. There might be different opinions on technical matters, on how to organise work flows, but most difficult to handle are disputes about power and money. One example of how tricky it is to keep partnerships between local and international investors alive comes from Rwanda. Stakeholders of ENNy, a SPV that successfully built the MHPP Mazimeru and operated the power plant since commissioning in April 2012, are no longer talking to each other. Due to some internal conflicts, the Rwandese shareholders unilaterally convened a board meeting in mid-2013 in which they dispelled the German shareholder from all rights. As equal shareholders to the SPV, none of the parties is legally able to take such a decision unilaterally. Thus, the two parties are in a stalemate position and ended up suing each other in court. Suggestions by EnDev to intervene or at least to support with an external mediator were not accepted. Since ENNy was paying neither staff nor liabilities any more, the turbine supplier was not paid on time and deactivated the turbines. Hence, Mazimeru is no longer producing electricity since October 2014. Repairs are waiting to be done as well, but with ENNy in no position to take any decision, the only way ahead for saving the investment is to hope for a swift take-over by a new investor.

There is strong concern that installation of solar systems on health centres and other social institutions may not be sustainable in the medium and long run despite clear agreements regarding maintenance and repair: So far EnDev has supported the electrification of more than 500 health centres, the majority of them with photovoltaic systems. Right from the beginning it was clear that achieving sustainability will be the major challenge of these installations. EnDev selected high quality components for the photovoltaic systems that are long lasting and require little maintenance. In addition, installation was generally linked to an agreement with local, regional or national health authorities which defines the transfer, the rules and responsibilities for operation, and maintenance and repair of the systems. Nevertheless, rough surveys conducted by EnDev to assess the sustainability of the installations indicate that several photovoltaic systems are currently not operational. Main reasons are in some cases the limited lifespan of key parts such as the batteries, which is not replaced, in other cases technical failures. Both are the result of poor maintenance or a failure to handle problems and initiate repairs and replacements at an early stage. EnDev addresses these challenges by providing training to health centre staff and by reminding the health authorities of their responsibility. Nevertheless, the success of these measures depends on individual initiative and commitments of authority members. The financial capacity of the health centres and the local health authority is generally too low to invest into maintenance, repair and replacement of components. And regional and national authorities are often not giving any kind of priority or even attendance to a maintenance, repair and replacement budget. Strengthening ownership for the photovoltaic system proved to be more difficult than anticipated.

Attribution of outcomes to EnDev activities is sometimes difficult to demonstrate and prove: EnDev has been promoting the dissemination of picoPV products (solar lanterns, small solar home systems) since 2007. Activities have included strengthening the supply side (importers, retailers, marketers) and the demand side (households, small enterprises and social institutions). EnDev has applied a broad range of instruments comprising capacity development of stakeholders, general marketing activities, financial incentives, public campaigns, awareness activities, and quality assurance and consumer protection measures. Meanwhile the market for picoPV products has been developing very dynamically in many countries and several organisations are actively contributing to increasing sales of these devices including IFC/World Bank, private companies, private financial institutions, and NGOs. In this setting it becomes more and more difficult to identify the specific value of certain supportive activities of EnDev and to attribute outcomes to these activities. As a consequence EnDev has defined certain preconditions that must be fulfilled in order to count

outcomes of solar companies and certain criteria that influence the percentage of sales that are considered attributable to EnDev. Preconditions are a regular business development service provided by EnDev to solar companies and a proven responsibility of the cooperating companies regarding warranty. Additional outcome relevant criteria are whether companies already sold solar products prior to the contact with EnDev or initiated this business as a result of EnDev advice. EnDev generally tries to avoid double or triple counting if other organisations are involved by quantifying its contribution in relation to those of others. However, validation of this approach is not easy as data of the contributions of others is lacking or insufficient. In addition, the contributions of the different organisations are often not easily comparable. Furthermore there is a need for better understanding of the markets to help determine up till what point EnDev interventions are still additional to general market dynamics and other actor's interventions.

Private Investment into Promotion of Renewable Energy for Rural Rwanda

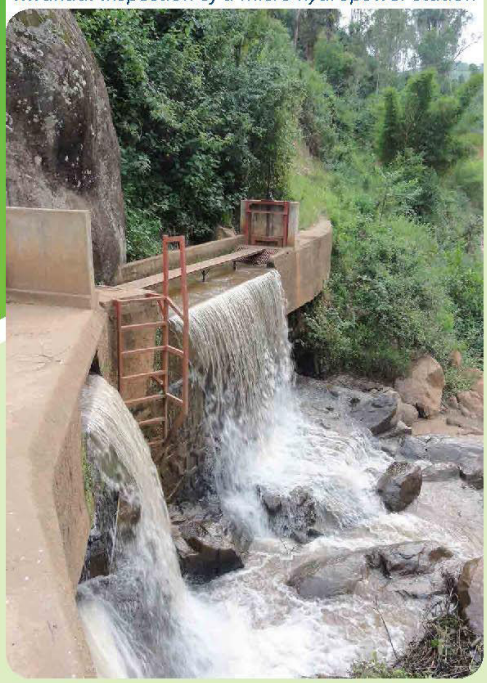
EnDev Rwanda has produced a video clip presenting the impact of its work in the Private Sector Participation in Hydro Power component (PSP-Hydro). One of the Rwandan success stories is the company REPRO.

The entrepreneur Gregory Tayi developed the first privately run micro hydropower plant in Rwanda with support from EnDev. In the video, he tells the story of how he overcame many obstacles and how businesses can help to solve the energy problem in rural areas.

Since the installation of the company's 96 kilowatt power plant at the river Rwishywa in the municipality of Murunda, Western Province, REPRO has been steadily feeding sustainable electricity into the Rwandan national grid.

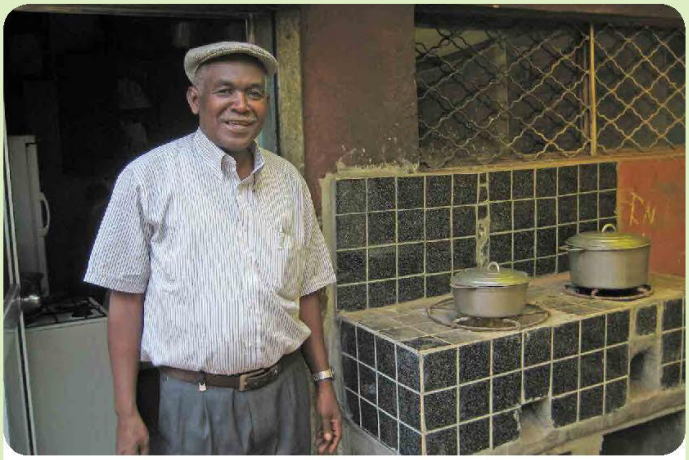
REPRO started training local people to work for the company and Gregory Tayi is now looking for new business opportunities in the renewable energy sector. The company currently develops a biomass power plant and is in negotiations with the Rwanda Energy Group (REG) for three more hydropower sites.

Rwanda: Inspection of a micro hydropower station



Benin: Improved cookstoves on sales at a store

Peru: A home benefiting from safe electrical connections in Cayasbamba, Ancash



Madagascar: This teacher constructed his kitchen with two improved cookstoves at his home

E. Overview about general EnDev activities in 2014

Cooperation with other organisations and initiatives

EnDev has established a broad network of partnerships and cooperation with other organisations and initiatives in the field of energy access to coordinate and synergise the work as much as possible. EnDev contributes actively to **the Sustainable Energy for All Initiative (SE4ALL)**. In 2014, staff members of EnDev participated in several conferences and working groups and provided background information and experiences of the programmes to delegates of the donor countries of the EnDev partnership. EnDev played a major role in incorporating picoPV systems in the definition of access to electricity and the different tier levels for the update of the SE4ALL Global Tracking Framework. Intensive discussion on the indicator for access to modern cooking with World Bank, WHO, NGOs, and other started late 2014. A harmonized concept was developed in March 2015 and will be presented at the Vienna Energy Forum in June 2015. EnDev tested a draft version of the SE4ALL survey methodology for measuring access in Ethiopia. Results and lessons learnt were fed into the revision of the survey questionnaire.

The cooperation with **Lighting Global (Africa/Asia)** focused on supporting market research, networking between international and local entrepreneurs, financing facilitation, developing standards, certification and labelling, aggregating market demand, knowledge sharing and capacity building on international and on country level. EnDev is currently coordinating several country projects such as Bangladesh, Ethiopia, Kenya, and Tanzania with Lighting Global. EnDev also supported the **Global Off-Grid Lighting Association (GOGLA)** to take over certain tasks in developing further the certification system for solar lanterns and the labelling of products.

EnDev is a partner organisation of the **Global Alliance for Clean Cookstoves (GACC)**. EnDev has been participating in several fora and working groups of the alliance including the group developing ISO norms for quality and testing of stoves. In addition, EnDev participated in relevant conference and international discussions on how to develop sustainable markets for stoves. EnDev is regularly reporting its outcome figures to GACC and is currently the main contributor to the GACC figures on global access to clean cooking. On country level EnDev is supporting test and quality laboratories equipped by GACC. In addition, EnDev is participating in creating clean cooking associations and in developing country action plans.

EnDev is also in close contact with **WHO** especially the *Public Health, Social and Environmental Determinants of Health Department* to exchange concepts and findings how to reduce indoor air pollution.

EnDev has been in regular information exchange with **The European Union Energy Initiative-Partnership Dialogue Facility (EUEI-PDF)** regarding the energy access situation in individual countries, project activities, innovative approaches and access indicators. Both sides support each other in the preparation of missions and in general policy dialogue issues concerning energy access. EnDev participated in the “Second High Level Meeting of the Africa-EU Energy Partnership (AEEP)” and presented several lessons learnt and case studies from country projects.

EnDev and **Practical Action** have both been part in the international discussion on defining access and indicators. Both sides were regularly exchanging their views and concepts on energy access.

In countries, that are part of the **Energy+** initiative, EnDev has been in constant dialogue with partner governments and consultants of Norway to coordinate activities between the different programmes. EnDev generally follows a bottom-up approach, which is complementary to governmental measures that are part of the Result Based Aid approach of the Energy+ initiative. EnDev provides the lessons learnt of its programme and contributes to capacity development of partner organisations as part of Energy+ activities.

EnDev is cooperating with several **World Bank Group** programmes on national as well as on international level including **ESMAP**. On head-office level EnDev has been used as a case study for new programme concepts in the context of the Global Delivery Initiative (GDI) of the World Bank-GIZ partnership on 'Science of Delivery'. In addition, EnDev has been involved in conceptual discussions

how to achieve the last mile and develop sustainable business concepts for solar companies and retailers and was involved in the planning of the 'State of the Energy Access Report'.

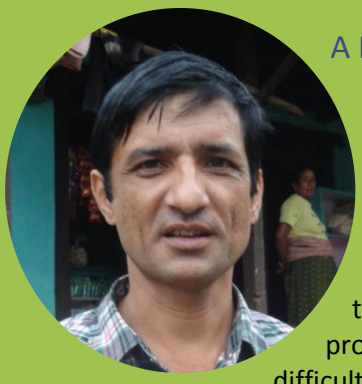
In the climate sector, EnDev participated in the **UNFCCC** COP20 conference and organised a side event, where Ban Ki-moon together with the Peruvian government cooked on an EnDev-promoted cookstove. With the **Scaling-up Renewable Energy Program (SREP)** first dialogues were initiated on country level which will be intensified in 2015.

Experience with productive use promotion – A female entrepreneur in Nepal

EnDev Nepal promotes "Productive Use of Electricity" as part of the grid extension component. Until now, 15 so-called enterprise service providers (ESP) have been trained on business development services, and around 100 enterprises are established. One of them has been created by Mrs. Poonam Bhujel, who is the pioneer in her village, running a medium sized poultry farm with 200 chicken. She decided to invest, after she attended a business orientation workshop, where ESPs presented ideas, approaches and know how on the development of a new business. She says, "I am happy with the new business and determined to continue it further. I pay NRs 1200 (EUR 11) per month for electricity, which I need for the heat lamps in my poultry farm, but I find it reasonable."

PU promotion in Nepal attracts young people to stay back in the villages

"My father has been running a small furniture enterprise for a couple of years. I was determined not to join him with his carpentry business, so I went to Qatar. When I came back, my father had prepared a business plan with the support from an enterprise service provider, and the local PU team had helped him with a credit linkage. I also recently attended a business orientation coaching on poultry farming. Now, I am confident to start a poultry farm. We already have a room for poultries. After some renovation of the room, I will soon buy chicken. Today I realize we can start enterprises within our own village. So why still going abroad?"



A PU facilitator

"I am Dolraj Poudel. I am the manager of Okobara Community Rural Electrification Entity (CREE) in Syangjha district as well as one of the members of Productive Use (PU) facilitator team. We have been providing services to the new emerging entrepreneurs in the village. Basically, a PU team consists of CREE members who are well exposed to financial and technical sectors. The PU team therefore provides assistance in overcoming technical as well as financial difficulties while starting a new business. People have begun to understand that electricity can be used not only for lighting purpose but also for productive use. We guide them through the technical issues in procuring new machines. Similarly, we ease the process of installing the necessary technical equipment, such as acquiring three phase meters by coordinating with the CREE."

Malawi: Customers of the **Chitetezo Mbaula** *ICS*

Malawi: Transportation of the **Chitetezo Mbaula** *stoves from rural production sites to the urban demand*

Liberia: Women who participate in literacy groups purchase picoPV lanterns **Barefoot firefly** *which they also use for illumination of the studyroom when attending evening classes*

Mozambique: Grid densification activities in Pemba started in 2014

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