Progress Report 2016

Energising Development – Phase 2

Draft Version for the Governing Board

energising development

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Content

Tables and Figures

RBFs

endev

Key achievements since 2005

Broader Impact: indirectly, EnDev supported, together with others, access to sustainable energy for at least

70 million people

Directly attributed to EnDev activities, energy access for

17.3 million

people was accomplished since 2005.

13.3 million

household members with improved cooking solutions

4.0 million

household members with electricity

endev

Key achievements since 2005

1.8 million t of CO_2 saved per year – equivalent to planting of more than 4.3 million trees

A total installed power of **51.9 MW** with renewable energies

38,600 small and medium enterprises with a modern form of energy for productive uses

More than **40,000** technicians, stove producers, sales agents etc. trained

19,400 social institutions with a modern form of energy: among them 13,400 schools and 1,200 health centres

6.6 million men, women and children with drastically reduced exposure to indoor air pollution

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 2016 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 UK Department for International Development (DFID),
- the Swiss Agency for Development and Cooperation (DEZA / SDC) and
- the Swedish International Development Cooperation Agency (SIDA).

EnDev aims to achieve sustainable access to energy for minimum 20 million people worldwide by 2019 (5 million in phase 1 from 2005 to 2009; additional 15 million in phase 2 from 2010 to 2019) with a currently planned total budget of EUR 373 million. The strategy of EnDev is geared towards developing and promoting sustainable pro poor markets for energy services and off-grid products.

By December 2016, EnDev in its second phase has facilitated sustainable[1] access to modern energy services[2] to 12.26 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 19,388 schools, health stations and community centres got access to improved cooking energy or electricity, or other modern energy carriers. Furthermore, 38.600 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)

lighting / electrical appliances	cooking / thermal energy	total household members
3.17 million	9.09 million	12.26 million

Facilitating access to modern energy service is a key requirement to reduce poverty, to improve the standard of living, and is 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 245 baseline, impact and sustainability studies. Major results of the studies are presented in the impact report "Empowering people" of EnDev which is annually updated (http://endev.info/content/Downloads). In the present progress report key findings of household surveys in four countries are summarized.

Financially, EnDev developed as scheduled. The expenditures for EnDev 2 activities in 2016 reached EUR 30 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 cleaner and advanced cookstoves for solid fuels that have higher combustion efficiency (at least 40% in comparison to traditionally used stoves).

Ghana: ICS for gari roasting in the Tsormenyo Gari Processing Centre, Mafi Kumase Community, Volta Region. EnDev cooperates with SNV in Ghana to introduce improved Gari roasting stoves for SME so that agro-processing industries become familiar with the financial and health benefits of improved cookstoves.

Ghana: SNV conducted a study, according to which an ICS for Gari processing can reduce fuelwood consumption by 30%, and hence induce cost savings. SNV estimated a market potential for up to 50,000 improved institutional Gari cookstoves. The new option is the burro, Gari Elephant. It is expected to augment the net income by at least 20% and a payback time of under 6 months.

B. Overview of current status of the EnDev 2 programme

This chapter provides information on energy access outcome, health impacts and CO_2 emission reduction for phase 2 starting in 2009 and/or the entire phase EnDev 1 plus EnDev 2 starting in 2005. Since the beginning of 2015, EnDev also reports on specific job creation, leverage and gender indicators.

At the end of 2016, the EnDev partnership comprised 30 projects in 26 different countries, with side activities in additional 4 countries. EnDev supports access to improved cooking systems in 21 of the 30 projects, access to off-grid solar technologies (solar home systems and solar lanterns) in 15, access to mini-grids (solar/hybrid or hydropower) in 11 projects, grid extension in 11 projects and biogas in 5 projects (see table B.1).

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

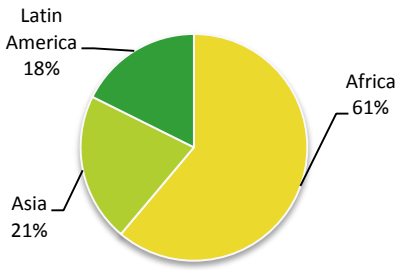
		stoves	biogas	other cooking/ thermal	SHS	picoPV	solar mini-grid	hydro mini-grid	grid	other lighting/ electricity
country projects	Bangladesh	●				●				
	Benin	●				●			●	
	Bolivia	●		●	●	●			●	
	Burkina Faso	●								
	Burundi[3]	●				●				●
	Cambodia		●							●
	Ethiopia	●			●	●		●		
	Ghana	●							●	●
	Indonesia						●	●		
	Indonesia biogas		●							
	Kenya	●				●	●			
	Liberia[4]	●		●		●	●			
	Madagascar	●								
	Malawi	●				●				
	Mali				●	●	●			●
	Mozambique	●			●	●		●	●	
	Nepal	●						●	●	
	Peru	●		●	●	●			●	
	Rwanda		●			●		●		
	Senegal	●			●		●		●	
	Tanzania	●				●				
	Uganda	●			●	●		●	●	
	Vietnam		●							
multi-country projects	Bangladesh, Kenya[5]				●					
	Central America (Hon, Nic)[6]	●		●	●	●		●	●	
	Kenya, Tanzania, Uganda		●							
	Malawi, Mozambique	●								
	Mekong (Cambodia, Laos, Vietnam)	●								
	Sub-Saharan Africa (MOZ, UG)								●	
	Cooking sector support and coordination in BD, GH, KE, UG	●								

[3] with some activities in Congo
[4] with some activities in Guinea and Sierra Leone
[5] focus is on off-grid appliances
[6] with some activities in Guatemala

Outcome figures

By December 2016, EnDev 2 facilitated sustainable access to modern energy services and technologies for about **12.26 million people**. Of these, 3.17 million people (26%) were connected to the central grid or a mini-grid, or used standalone electric systems. 9.09 million (74%) are now using improved cooking technologies, such as improved firewood and charcoal stoves or biogas plants (figure B.3). In addition, **11,887 social institutions** gained access to electricity or improved cooking systems and **26,643 small and medium enterprises** now have access to a modern form of energy for productive use.

Figure B.1: Funding by region

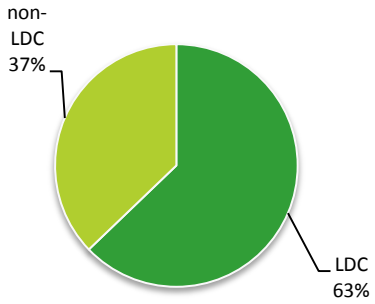


The focus of the EnDev programme is on Sub-Saharan African countries. Around 61% of the committed EnDev 2 funds are currently allocated to this part of Africa (figure B.1). The share of least developed countries (LDC) supported by EnDev is 63% (figure B.2).

The outcome figures reported in this report are verified in the field through detailed lists of customers of energy services and products, and/or sales figures of energy companies and retailers. In cases when not only EnDev but other international partners have been involved, only a part of the outcomes are counted according to the financial share of EnDev in the total cost of a measure. EnDev does also not simply sum up outcomes achieved in the course of the programme but tries to capture those processes which **reduce outcomes** through so-called adjustment factors. Thus, figures of six-month reporting periods are adjusted downwards before the total number of beneficiaries is presented to donors and the public.

EnDev applies four adjustment factors:

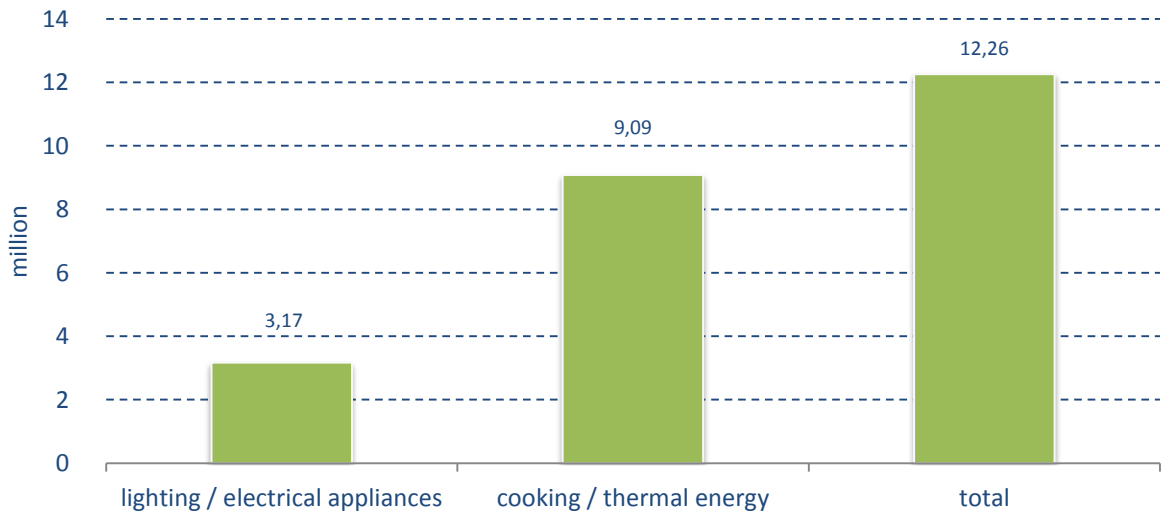
Figure B.2: Funding by countries



- 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 whose access to both cooking energy and electricity is facilitated by EnDev are only counted once in the aggregate figure.

In addition, the EnDev figures already include a discount for **replacement** which reflects the limited life span 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 project period. Some of the later-stage sales will go to beneficiaries reported before. It would therefore be wrong to simply add up all sales numbers. Only sales beyond replacement generate new access.

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



In the past, EnDev has subtracted 100% of the systems after their estimated life span. However, evidence emerges that this approach may be overly conservative. Not all systems registered in EnDev's monitoring require replacement: 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.

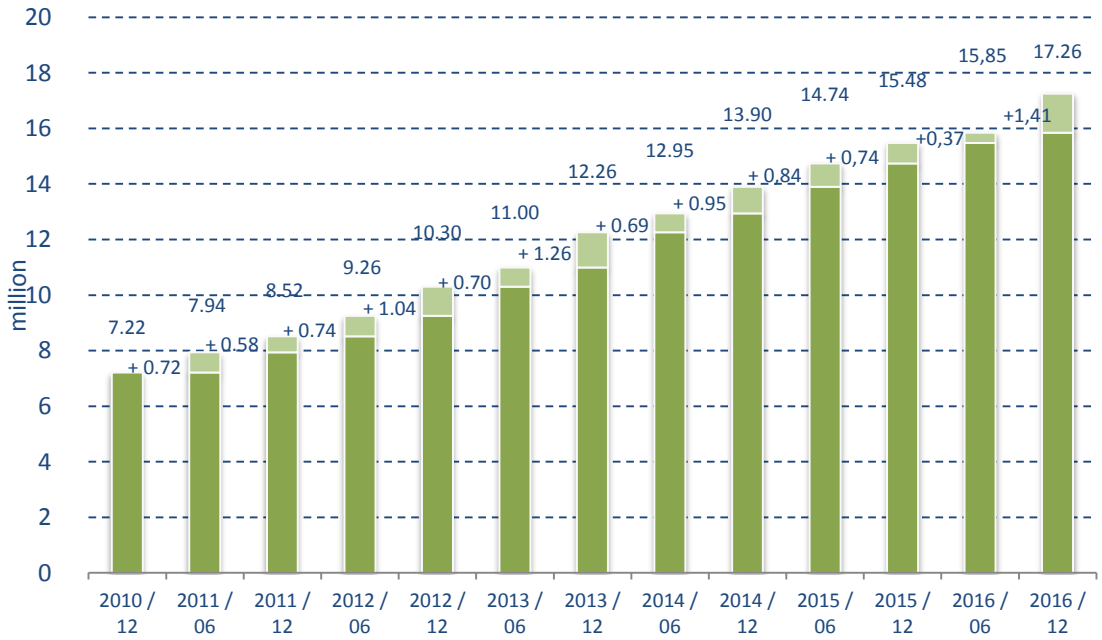
Magdagascan entrepreneurs invest in the energy sector

In Madagascar, EnDev through ADES promotes the improved metal-clay stoves called OLI. There are numerous resellers that offer OLIs at their stands on local markets and at their hotely, a small Madagascan eatery often found at roadsides. Per sold piece, they earn 3,000 Ariary (approximately EUR 0.86).

In the city of Antsirabe, located on the high plateau around 170 kilometres away from the capital, an innovative reseller built his own push cart. With his cart, he cruises through the city selling different models of the OLI. He reported he sells between five and eight stoves per day. With most Madagascans earning between 60,000 and 100,000 Ariary per month, he is able to make a lot more in a good week.

The young entrepreneur built his push cart and started selling the stoves without any intervention of or financial contribution of EnDev. He basically seized the chance of the expanding market for improved cookstoves. Although not very common until now, small entrepreneurs become more and more engaged in businesses. This is a good example of indirect impacts of the country project: beyond the 160 employees working in the direct construction chain of OLIs and further 50 people in outsourced manufacturing there are more all along the value chain investing in modern energy services.

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



Access to electricity

EnDev uses a tier system to define 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 SEforALL global tracking framework. Based on this system the EnDev electrification outcome figures in the different tiers for the EnDev 2 phase are as follows:

Table B.2: EnDev 2 outcomes according to the tier system for electrification

Tier	Services	Typical system	Number of people
5	tier 4 services plus use of devices typically requiring a few kilowatt like air conditioners	grid	642,700
4	tier 3 services plus use of devices typically requiring a kilowatt like water heaters, irons	limited grid	258,438
3	tier 2 services plus use of devices typically requiring a few hundred watt like rice cookers, refrigerators	mini-grid	134,034
2	bright light, radio, telephone plus use of devices typically requiring tens of watts like TV, video, fan	solar home system	1,589,202
1	medium bright light and, if possible, limited radio use and telephone charging	picoPV, battery charging station	550,130
		total	3,174,505

These figures reflect the number of people that had no access to electricity beforehand. Out of these 328,287 would have gotten access to electricity without the support of EnDev, but at a lower tier level.

Access to improved cooking devices

The SEforALL tier system for improved cooking systems is still not 100% developed. Especially the health indicator is difficult to define for all levels. EnDev is involved in intense discussion with WHO, World Bank and partner organisations to finalize the matrix. The tier system currently implemented

by EnDev is in line with the current state of the multi-tier framework presented in the 2015 tracking framework. EnDev outcomes are attributed to the 5 tiers as follows:

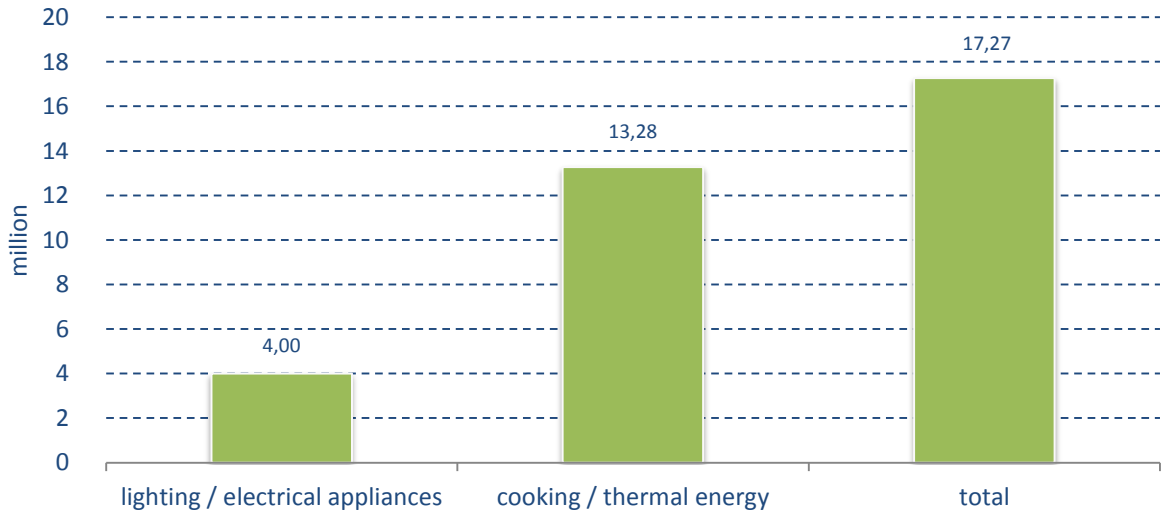
Table B.3: EnDev tier system for improved cookstoves

Tier	Services	Number of people (EnDev methodology)
5	Access to needed quantity of energy source: ≥ very good Health protection: ≥ very high Convenience: ≥ very high	0
4	Access to needed quantity of energy source: ≥ good Health protection: ≥ high Convenience: ≥ high	60,981
3	Access to needed quantity of energy source: ≥ fair Health protection: ≥ fair Convenience: ≥ fair	49,235
2	Access to needed quantity of energy source: ≥ limited Health protection: ≥ sufficient Convenience: ≥ sufficient	4,006,154
1	Access to needed quantity of energy source: ≥ deficient Health protection: ≥ low Convenience: ≥ low	4,955,072
0	Access to needed quantity of energy source: ≥ highly deficient Health protection: ≥ very low Convenience: ≥ very low	13,132
		9,084,574

Overall outcome

Looking at the overall EnDev programme, starting from phase 1 in 2005 up to December 2016 in phase 2, the **total number of people** having gained sustainable access to modern energy services on household level amounts to **17.27 million** (figure B.5). The total number of **social institutions** is more than **19,300**; the total number of **small and medium enterprises** is around **38,600**, 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 21.5 million for EnDev 2 and 30.5 million for EnDev 1 and EnDev 2 combined.

EnDev Senegal receives acclaim for its engagement for women

On International Women's Day, 8 March 2017, EnDev Senegal received a badge of honour from the Senegalese Ministry of Energy and the Development of Renewable Energies (MEDER), acknowledging its engagement for women in business. The Ministry honours that EnDev Senegal supports women in realising their opportunities in the changing work environment. Globalisation, digital innovation, and climate change, among others, are transforming factors which both pose challenges but also opportunities to improve the economic capabilities for women.

EnDev Senegal's approach incorporates women in different stages in the value chain: from production to promotion, to sales, and aftersales.

For instance, the marketing of improved cookstoves is largely ensured by women's groups, and micro-finance institutions that cooperate with EnDev addresses women, especially in rural areas. Energy access and modern energy services are not simply means to an end but help women participate in the business world.

Burkina Faso: Energy is used productively for Shea butter processing.

Uganda: Through grid electrification, this shop in Konapak offers PC, photocopying, scanning, printing, and other general secretarial services for those who do not own a computer or who are illiterate.

C. Impacts of EnDev 2

In addition to the main objective of the partnership to facilitate access to modern energy technologies and services, EnDev has 4 impact targets: **a)** climate mitigation, **b)** health prevention, **c)** improved gender balance, **d)** job creation, and 2 outcome targets: **e)** leverage of funds and **f)** increase of power generation with renewable energies.

CO_2 savings

An improved firewood cookstove, which saves 30% of firewood in practice and which is used to prepare 80% of all meals, 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 1,491,200 t of CO_2. In addition, 214,651 t of CO_2 savings are generated for which emission reduction certificates are 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 and mini-grid or grid connections replaces at minimum two kerosene lamps, thus saving at least 0.18 t CO_2 per year. A solar lantern replaces approximately one kerosene lamp, saving 0.09 t CO_2 per year.

The total CO_2 saving of 3.0 million stoves and access to solar home systems, mini-grid connections or solar lanterns for 803.746 households supported by EnDev are 1,839,872t of CO_2.

For comparison: this amount corresponds to

- CO_2 emissions of all intra-European flights during 12.0 days, or
- Norwegian car traffic during 129 days, or
- planting of more than 4.3 million trees on an area as big as 5,400 football pitches.

Health

As a result of EnDev activities the exposure level of indoor air pollution could be drastically reduced for more than 4.5 million household members[7] (particularly women and children). The improvement of the health protection was achieved by:

- reducing the quantity of emissions of particulate matters and CO through **a)** improved cookstoves 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.

The specific assessment of the health impact of promoted cooking solutions is based on the type of stove and fuel, the use of chimneys, flues or hoods, the degree of ventilation and the cooking place. Only cooking solutions classified as tier 2 or higher are considered as sufficiently safe regarding exposure of household members to indoor air pollution. These include all stoves using electricity or gaseous fuels as well as improved biomass stove (rocket stoves, gasifier stoves) used outdoor or with chimney or hood when installed or placed indoor.

Gender impact

EnDev pursues a gender-sensitive approach following the Mission Statement from its Strategy 2014-2018 which declares that EnDev is "*committed to … use the potential of modern energy services to*

[7] All members of households that use a stove fulfilling the level 2 criterion for the health attribute of the multi-tier matrix for cooking solutions.

promote gender equality". So far, when implementing measures of the EnDev programme in different countries, gender issues are addressed in a variety of ways.

Gender impacts of energy access measures on households: Women and children benefit the most from the promotion of improved cookstoves as proven in numerous studies and acknowledged by international organisations. In rural households women and children are extensively exposed to smoke and fumes of the fireplace. They are generally also responsible for collecting firewood which is a very strenuous and time-consuming task. The use of improved cookstoves helps reduce the burden of collecting biomass fuels and simultaneously reduce the health risks caused by traditional cooking practises. The time saved on firewood collection is also reinvested in household activities, family and child care, agricultural work and – though to a lesser extent – in income generating activities by female household members. Electricity access for households is beneficial for both sexes.

Gender impacts of income generating activities within the value chain and of productive use of energy through sustainable access: Two EnDev studies finalised in 2016 support the evidence that women in Kenya being capacitated for business activities in the energy sector by EnDev still face difficulties to be empowered running large-scale businesses. The studies show that there is a good scope of gender equality between male and female entrepreneurs in picoPV and stove businesses, and that customers do not discriminate between male and female vendors. Income numbers, on the other hand, reveal a sizeable gender gap: on average women earn significantly less than men. Amongst top earners, there are more men than women, whereas in the group of low-income earners most are women. With regards to the reach of sales activities of vendors, both studies from Kenya come to the same conclusion: women are somewhat bound to their close proximity and hence do not manage the same outreach. The stove and picoPV businesses with the widest outreach are run by men. So while women entrepreneurs benefit by many EnDev interventions, there are still market and cultural barriers that hinder them to expand their businesses in the same way as male entrepreneurs do.

Additional income generation of households that is facilitated by energy access interventions of EnDev are also observable. Women report that they use electricity for additional household chores, processing crops and engaging in new income generating activities such as sewing. Their earnings are usually additional income for the household. In some countries such as Senegal this additional income is managed by the women themselves. Ownership by women of this additional income is acknowledged by international organisations to accelerate the human development, as women habitually invest a higher proportion of their earnings in their families and communities than men.

Gender impacts of energy access on social institutions: Both EnDev data and gender studies reveal that investing in modern energy access for health institutions serve largely as a benefit for women and their children. There are more female patients treated in health care facilities like hospitals, rehabilitation centres, and rural health centres. Health care facilities with access to energy services are particularly relevant for women and infants pre-birth and in the postnatal phase reducing the risk of infant mortality. EnDev's interventions to facilitate access to electricity and lighting in schools, however, do not have a gender-specific impact as both boys and girls benefit equally.

Job creation

Each EnDev project captures information about the time required for production of stove parts as well as for assembly and for installation. Based on the available data and the assumption of 240 working days per year with 8 working hours per day it can be calculated that 3,246 full-time equivalent jobs existed in the process steps of the production, assembly and installation of 1,455,506 stoves from January 2016 until December 2016.

Most of these work steps are not done by full-time labour. According to monitoring data on average 3.4 persons are involved for each full-time equivalent. Based on this ratio a total of 11,038 people worked in the production and installation of EnDev stoves during the last 12 months.

For calculating the number of jobs created along the distribution chain EnDev applied the methodology published by UNEP[9]. It was calculated that an additional 463 full-time equivalent jobs exist in the distribution chain for stoves. For PicoPV systems, which are mainly produced in China, the number of full-time equivalent jobs along the distribution chain was 577.

Altogether, 4,287 full-time equivalent jobs existed in the supply chain for stoves and picoPV in our partner countries.

The data presented in this chapter are still a preliminary description on the job creation impact of EnDev. EnDev is still working on an elaborate methodology to capture more comprehensively the job situation along the value chains for energy products and services. In addition, EnDev will analyze the number of jobs that is created as a result of the use of modern energy technologies and services.

The local bottom-up approach supports the long-term development of the energy access sector in Peru

Tito Cerna Izquierdo is standing in front of his market stand, explaining to a group of people how this solar lamp works and how to mount it to the ceiling of a room. He even drops the lamp in order to show his customers how robust this model is. On the stand next to him, there are more solar lamps in various shapes and sizes – and with different solar modules.

Tito (30) is the manager of EnerChignol EIRL, a company selling solar products directly to the end customers, almost exclusively in rural areas. Born in the district of Cachachi, region Cajamarca, he was trained as an electrician by the EnDev country project. He was part of a group of young people who were trained to install grid connections during a grid electrification project. After the end of the project, only a few of them remained in the sector, starting to sell picoPV lamps, thus expanding their target audience to households that had not benefited from grid connection and other hard-to-reach areas.

Not only does Tito provide clean energy solutions to an underserved market, he is also a big advocate for quality. He pioneers high-quality lamps there before large suppliers of cheap, low-quality products swamp the market in his region. Until today, it has worked well: his clients trust him and do not focus primarily on the price. For more than three years now, Tito has been successfully supplying solar lamps in his region. At present, EnerChignol has more than five points of sales, through which it manages to provide products to more localities. In the last quarter, the company entered into the sales of wood-burning improved cookstoves and ovens, trading them in the provinces of Cajabamba and San Marcos.

Leverage

The total value of all stoves and off-grid systems sold or installed by companies cooperating closely with EnDev since 2015 was EUR 123.6 million, which is a ratio of 2.03 in relation to the programme expenditures of EUR 60.8 million.

Since 2015, the total amount of investments along the market chains for all EnDev supported access technologies including intermediary products but excluding expenditures for private consumption is about EUR 324.9 million, representing a ratio of 5.3 in relation to the EnDev programme expenditures.

Installed generation capacity with renewable energies

The total power capacity based on renewable sources installed since the start of EnDev 2 is 36.9 MW. The biggest share amongst the technologies is contributed by mini-grids. Mini-grids contribute 47.1% to the total result (MHP: 10.5 MW, PV: 6.8 MW). The share of SHS is nearly the same with 17.6MW, while picoPV systems up to now have a total installed capacity of 2.0 MW. It is estimated that an additional 15 MW have been installed in the first phase of EnDev resulting in a totally installed capacity of 51.9 MW.

Impact of energy access according to recent scientific studies

This chapter summarizes recent findings of research in the energy access literature with an emphasis on topics of particular relevance to the EnDev programme: Impacts of access to grid and off-grid electricity, impacts of improved cookstoves, and adoption of off-grid electricity and cookstoves. The focus is on empirical studies that employ strategies which are able to approximate **causal** relationships.

Impacts of electricity access

Grid electricity: In a comprehensive study on the impacts of electricity in rural Africa the authors find for Rwanda that while electricity improves people's life in general and hence contributes directly to their well-being, consumption levels in households and enterprises are extremely low.[8] Productive use and income generation does not increase. This is also confirmed in other studies.[9] According to these studies, electricity is not the only and often not the major bottleneck to stimulate new economic activities in rural Africa. As long as the demand for products and services is only coming from the same area and no access to supra-regional markets exists, an expanding production will not be absorbed.

Off-grid solar and PicoPV: Studies on the impacts of off-grid solar, in particular picoPV, confirm the positive impact expectations, though on a lower level than for on-grid electrification. For obvious reasons, off-grid solar cannot be used for high-wattage applications and thus, already in theory, productive use is limited to improved lighting facilitating nighttime activities. So far, however, research has not confirmed usage of off-grid solar for income generating activities in a somewhat systematic way.[10] Instead, studies find that off-grid solar improves quality of life in rural homes including simple convenience effects, improved studying conditions for children, and more flexibility in arranging the daily housework tasks. More specifically, it was found that off-grid solar is used by children for studying purposes and either increases study time or flexibility (i.e. study time is shifted from daytime to nighttime).[10; 11] While this is an improvement as such, there is so far no indication that this translates into better ultimate educational outcomes, for example school attendance or grades. There is some evidence for positive health effects, yet not measured by disease prevalence but by a reduction of smoke exposure.[11] On a monetary level, the most important observed effect (in the absence of notable income generation effects) are savings in terms of energy expenditures. Most studies observe effects that reduce expenditures.[10] Taking into account the investment cost, amortization periods are often in the range of 12-24 month and thus quite long, though.

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9 Peters, J., & Sievert, M. (2016). Impacts of rural electrification revisited–the African context. Journal of Development Effectiveness, 8(3), 327-345;
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Improving maternal and child health in Ethiopia: one health centre at a time

In Ethiopia's rural areas, where around 85 percent of the population lives, it can be extremely difficult to access health care facilities. Despite the progress Ethiopia made in recent years, the availability of maternal, newborn and child health (MNCH) services is still very limited.

In order to enhance access to health services in rural areas, EnDev Ethiopia has electrified more than 145 health centres and 6 health posts with PV solar energy. The centres, located in the four main regions of Ethiopia, provide improved health services to off-grid rural populations living in a radius of 10 km from the installations. Co-financed by Irish Aid, the project improves MNCH by facilitating modern health services through solar electrification and water provision. In order to guarantee the sustainability of the service and maintenance structure, solar technicians from installation companies, operators and end users are trained by EnDev. In addition, the installation and construction work is done by national companies who are trained to take care of maintenance and repair in the future.

Mebaneh Germaye, health worker at Azeba health centre (in Central Tigray) admits the working condition were very difficult before the electrification. "In the past I had to use a flashlight, squeezed between my neck and shoulder when I was delivering during the night. Now I only have to turn on the switch", he says with an excited voice.

Abeba Bayelegn, another health worker at Gebaba health centre (in SNNPR region), is also full of praise for the improved service thanks to access to energy and drinking water provision. "We can treat our patients so much better now that we can actually provide appropriate services. We can even warm up clean water for deliveries!"

The PV systems allow for the operation of microscopes, sterilisers and vaccine fridges, improving the reliability and quality of the health centres tremendously. Due to the intervention, over a million people in SNNPR and Tigray gained access to improved health services. In some of the health centres, the generated power also pumps clean water to the clinic and to surrounding villages. Irish Aid's final evaluation report concluded that the solar power systems in all of the assessed health centres were functional or easy to bring back to functionality and were well maintained. Furthermore, access to and quality of MNCH services greatly increased and the working conditions of health workers and services received by clients improved. The high staff turn-over is identified as one of the key challenges in rural health centre electrification. This issue will be addressed with the Ethiopian health authorities as part of a plan to improve health centre maintenance in general.

Costs (and benefits) of electrification: The role of electrification – be it via off-grid technologies or through grid extension – for improving welfare of the hitherto unconnected population in developing countries is still debated in the literature. It is generally agreed that access to electricity is necessary but not sufficient to produce welfare effects. Thus, welfare increases are smaller than widely expected, at least in the short term. A recent paper comes to the conclusion (Grimm et al. 2016) that long-term impact potentials are clearly lower for off-grid solar; their medium term cost-benefit balance is much more convincing.[12]

Impacts of improved cooking technologies

In 2016, a study on the impacts of improved cookstoves (ICS) received much attention in the popular press. In a nutshell, the study finds no evidence that an intervention comprising a gasifier stove, which reduced smoke emissions by around 90% compared with the open fire in laboratory testing, reduced the risk of pneumonia in young children in rural Malawi.[13] However, the ICS was used only for less than 40% of the cooking events. This may not have been enough to produce a positive effect on the incidence of pneumonia. In addition, the lack of effect on pneumonia might also be the result of the exposure of the household members to other air pollutants from rubbish burning and tobacco smoke. The authors of the study conclude "*that tackling any individual source of air pollution exposure in isolation is unlikely to be effective for improving health; an integrated approach to achieving clean air that tackles rubbish disposal, tobacco smoking, and other exposures, as well as robust cleaner cooking solutions (eg, cleaner stoves and fuels) that achieve a high rate of acceptance is probably needed to deliver health benefits*". In a report on a systematic review of 42 studies on the effects of different improved and clean cookstoves on smoke exposure and kitchen concentration it was found that while exposure and concentrations do decrease, for most ICS types levels still exceed WHO standards.[14] Thus, additional measures such as proper drying of wood fuel and sufficient air ventilation are needed to achieve positive health effects in wood or charcoal burning cooking systems. The use of ICS has definitely considerable effects on wood fuel usage, energy expenditures, and collection time savings.[15]

In sum, this suggests that in particular simple biomass ICS yield a promising cost-benefit balance because of their low cost and comparatively high effects on woodfuel consumption and related poverty and environmental dimensions.

Adoption of off-grid solar and improved cooking technologies

Another important topic that has received much attention in the academic literature is the adoption of off-grid solar and ICS. It picks up the discussions that practitioners have been leading for many years, especially for ICS: if a technology is supposed to make sense from the perspective of the poor, why is not it taken up?

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Addressing the water-energy-food nexus: solar pumping system in Nsakyir, Ghana

In Nsakyir near Nsawam in the Eastern Region of Ghana farmers grow fruit and vegetables. Although only about 40 kilometres away from the capital, access to the electricity grid is not available.

Joshua Farm in Nsakyir had so far grown pineapples, mainly for local consumption and processing. In 2014, the decision was taken to diversify the production and to cultivate vegetables as well. However, in order to sustain good yields, the cultivation of vegetables requires irrigation. Hence, the farmer was determined to invest in a borehole, fitted with a solar pumping system – the first solar irrigation pump in the area has been installed. Additionally, a drip irrigation system was introduced, allowing for reliable and adequate irrigation in a water-saving manner, increasing the yields, and limiting the risk of harvest losses due to droughts.

In line with priorities set by the Ghanaian government in the Ghana National SEforALL Action Plan, and along with high and seasonably stable solar irradiation country-wide, solar water pumps are a highly appropriate solution providing a sustainable source of energy for agriculture for productive use of energy (PUE) in Ghana.

In spite of a well-developed market for conventional electric, diesel and petrol pumps that are affordable and can be accessed in all district capitals, the demand for solar pumps for PUE in off-grid areas increases. The high cost of diesel and petrol on the one hand, and the falling capital expenditure of PV on the other hand, are seen as main potential drivers for this tendency. This is particularly important in the Northern regions where electrification rates are low and most communities are not within the reach of the grid. Very low rainfall as well as variability in rainfall patterns make irrigation a 'must' to ensure food security and sustain and increase crop yields.

EnDev Ghana started solar water pumping activities in 2014, building up on the experience from the first phase of the project, with a clear focus on access for PUE. As such, EnDev Ghana provides business development services as well as technical advice and training to both, providers and users of (solar) irrigation systems. Ghana is the first EnDev country project to concentrate on a nexus approach, combining water, energy and food.

EnDev Ghana proposed to upscale the project and to support 300 small scale farmers to access and use solar pumping systems for irrigation, and to facilitate access for grid irrigation for 375 farmers.

The recent evidence on improved cookstoves suggests that, for starters, non-adoption is not so much due to cultural traits, habits, and education (although these factors obviously can play a role). If an ICS is in fact improved (i.e. saves fuel) and adapted to the cooking patterns in the respective region it is also used.[16] The major demand-side barrier to adoption is affordability – given that most

[16] Bensch, G. and J. Peters. 2015. The intensive margin of technology adoption – experimental evidence on improved cooking stoves in rural Senegal. Journal of Health Economics 42: 44-63.

dissemination programs aim at establishing markets in which customers have to pay cost-covering prices. Uptake of ICS is low because people are chronically short on cash and credit constraint.[17]

The major difference between ICS and off-grid solar is that unlike ICS solar home systems and PicoPV kits are making inroads to households in rural areas without further promotion activities – at least to the somewhat wealthier strata. In many countries take-up rates are remarkably high at 10-30%.[18] As a consequence, interventions by governmental or non-governmental agencies are not required to establish markets per se, but rather to also reach the poorer strata. For these poorer strata the picture is actually quite similar to ICS: affordability issues and liquidity constraints are the major bottlenecks to adoption.[19] Even though the investment into a PicoPV kit pays back within its life span the amortization period is too long. As a consequence, the willingness to pay of most rural households is considerably lower than the market price.[20] Smart payment schemes like pay-as-you-go can help, but still leave poorer households excluded.[21]

Subsidies and adoption: Both for ICS and off-grid solar the state of research suggests that universal access will not be achieved without direct subsidies. Beyond the normative universal access goal, external effects provide an economic justification for subsidies. While some open questions remain on sustainability and the source of funding, two classical concerns about subsidization have been rebutted by recent findings in the literature: First, also if ICS and off-grid solar are given away for free the technologies are used intensely.[22] Second, giving away technologies for free once does not automatically spoil the prospects of self-sustaining markets later.[23] It is important to emphasize that there is a growing consensus on these two points in the development economics community with evidence coming from the dissemination of different technologies such as malaria-bednets or water disinfectants.

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22 Grimm, M., A. Munyehirwe, J. Peters, and M. Sievert. 2017. A first step up the energy ladder? Low cost solar kits and household's welfare in rural Rwanda. World Bank Economic Review (forthcoming).

23 Meriggi N., Bulte, E. and Mobarak, A. Subsidies for Technology Adoption: Experimental Evidence from Rural Cameroon. Mimeo. Published and presented at CSAE Conference 2017, Oxford.

Senegal: Thomas Silberhorn, Parliamentary State Secretary to the Federal Minister for Economic Cooperation and Development (BMZ), visited EnDev Senegal in January 2017. He met with Massaer Gueye, the most successful and largest ICS producer in Senegal, located in Dakar, at the production site.

Cambodia: The multi-country RBF Project in the Mekong region promotes the market development for higher tier improved cookstoves, e.g. the Mimi Moto and Ace1 model. They are highly energy-efficient and emit few emissions. Before the Cambodia Stove Auction, products are held in the warehouse. Here, a woman uses her ICS for cooking.

D. Results from Surveys

In 2016, EnDev carried out several household surveys to capture the view of the beneficiaries about the energy technologies and services that EnDev promotes in the different country projects. The results – positive as well as negative – of three of the surveys are presented in this chapter.

Kenya – Social institutions reduce fuel consumption with ICS

Background: Energising Development Kenya facilitates access to clean cooking for social institutions and small enterprises since 2006. In 2015, a study was conducted about the effect of Institutional Rocket Stoves (IRS) in social institutions (SI) and small and medium enterprises.

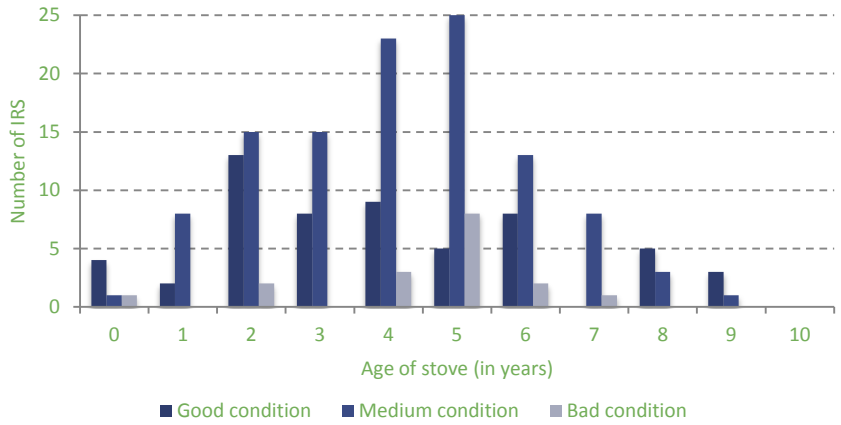
Methodology: A total of 63 social institutions and 33 enterprises were interviewed across three clusters (Central, Western and Lake Victoria Cluster). The general objectives were to examine the life span of the IRS, fuel consumption, rate of usage, maintenance costs, safety and ease of operation.

Results: 72% of the IRS in enterprises were in use throughout the day. Concerning social institutions 38% of the IRS were operating all day, 24% three times a day and 27% were used twice a day.

The observed conditions of the IRS in the field were overall satisfactory. Almost a third (31%) of the inspected stoves had no visible damages and a great number (59%) of them were in medium condition while only 10% were in bad condition. Examining the year of construction and the current condition of the stoves, a majority of 53% of the IRS found to be in good condition were older than 3 years. Additionally, of the IRS in medium condition almost two thirds (63%) were 3 years and older.

Conclusion: In light of the estimated life span of 3 years, the survey proved that IRS remain in good or medium condition for much longer than 3 years. The average life span of an IRS until replacement is due was discovered to be 5.8 years despite being used to its full capacity, throughout the entire day and six days in a week. The survey confirmed that the IRS consumed far less firewood compared to the stoves the institutions had used before. The rate of maintenance and costs were very low with most stoves operating efficiently.

Kenya study: condition of IRS in interviewed SI and PU



Tanzania – Market development study demand/supply

Background: Since late 2013, EnDev has been operating a RBF fund for pico-solar in Tanzania's Lake Zone with strong private sector response and consumer uptake of products. In 2016, a study was carried out to analyse strength and weaknesses of the supply side as well as consumer knowledge about solar products.

Methodology: 304 households (242 by phone and 62 onsite) were interviewed in 3 regions of the Lake Zone. For phone surveys the standing data of RBF companies was used while onsite interviews were randomly selected. In addition, 47 entrepreneurs at supplier, retail and technician levels were interviewed along with a series of semi-structured interviews amongst selected enabling environment actors.

Results and conclusion: The results indicate that the Lake Zone market for picoPV is expanding. Products continue to gain popularity and new companies (competitors) enter the market. Further, turnover increases at a very high rate, and the PV business starts generating high profits. On the other hand there is a need to strengthen consumer awareness and protection, and to improve diversification of financing and market information access. Based on the results of the study, EnDev Tanzania will provide tailored technical assistance to companies participating in the programme and enhance its consumer information activities.

Uganda – Cooking energy system – Stacking of stoves

Background: It is often observed that household continue to use their traditional stoves even if they have purchased an improved cook stove. This phenomenon called stacking was analysed more in detail in a study in Uganda.

Methodology: In total, 73 rural households, which are all beneficiaries of EnDev Uganda, were interviewed. While the visited communities were selected by the focal person, households within these communities were visited at random. Due to the season, it was not possible to select households beforehand. As many women were working in their gardens, the enumerators went to the villages and visited any household that had received a cooking stove and where the main cook was at home. The questionnaire referred to the following topics: general information, information on stoves, information on fuels, cooking habits, health impacts, information on house and kitchen.

Results: 75% of the interviewed households use a second stove, but only 14% use a third stove regularly. The study shows that 93% of the households use an improved cook stove as their first stove, while only 7% continue to use self-built stoves and 3-stone fire as their primarily used cooking technology. With regard to the second and third stove, 60% of all households use an improved cooking stove, but 40% use self-constructed stoves or the traditional 3-stone fire additionally. Fortunately, none of the users have continued to use the 3-stone fire exclusively. In total, 86% of the beneficiaries use the ICS for at least 75% of their cooking activities.

Conclusion: The study emphasises the fact that stove stacking is one important aspect in the impact evaluation of ICS interventions and provides interesting first insights from one country. Based on these results and experiences from other countries, EnDev currently develops a new assessment tool which is able to take the households' whole cooking energy system into account. In doing so, EnDev is able to take the monitoring of its ICS projects to the next level within the next year.

Kenya: Okoa Kuni Wood Stove, Cook'n Lite Ltd

Central America: Between 2009 and 2016, the grid was extended to 52 communities.

E. Lessons learnt from failures and challenges

The „threat of non-sustainability"– the case of mini-grids in Senegal

When EnDev started in Senegal in 2006, off-grid electrification was practically non-existent. The government created a regulation to allow for small scale electrification in rural areas, but there were no actors in the sector with the experience, the resources and the confidence to make use of it. EnDev developed the technical concept, the business model and the implementation approach for building solar-diesel hybrid mini-grids in rural villages of Senegal. Under EnDev 1, a total of 18 mini-grids were installed by local companies which were assigned by the rural electrification agency ASER to operate them afterwards. Based on the success of this pioneering phase, another 68 mini-grids were established under EnDev 2. The first few years, the operators were facing only few technical problems. However, in 2016 about 50% of the 18 mini-grids of EnDev 1 were out of service. A field mission detected a large variety of reasons for this dismal situation.

There are a number of **technical challenges** limiting the functioning of the systems. Due to high temperatures far above 30°C, the life span of batteries is much shorter than anticipated. The equipment supplied by EnDev for the regulation of the electricity is of high quality and is proving well in the field. Unfortunately, there is no direct representation of the supplier in Senegal available for repairs. In real life this means that mini-grids are out of service for long time until the equipment has been repaired in Germany or being replaced by sub-standard but locally available equipment.

The **financial sustainability** is even stronger limited. The current provisional tariffs are sufficient to pay for the costs of operation, but insufficient to cover the real production costs of mini-grids if the replacement of the equipment is factored in. Due to the current payment system based on a flat rate payment with a limit on Watt, there is no incentive for the users to limit their consumption as "it is already paid for". When operators are adding further clients, the available kilo-Watt-hours available per client are decreasing. This is frustrating the old clients who are reducing or even stop paying in protest for the perceived reduced quality of access to electricity.

Even **institutionally** the **sustainability** of the mini-grid sub-sector is very weak. Even 10 years after starting with mini-grid installations, only 1 operator has a licence. All other operators are still operating with uncertainty over their business. Any time they can be chased away. On this base they have difficulties to access loans and are not willing to invest large amounts of money.

In agreement with the Ministry in charge of Energy (MEDER), EnDev is now focusing on resolving these challenges to ensure long-term sustainability of mini-grids. Once again EnDev is pioneering for the rest of the sector in Senegal.

Providing Solar Light to Health Stations – failures due to time pressure

During the Ebola crisis, EnDev was commissioned to equip 750 medical facilities in Liberia, Sierra Leone and Guinea with Solar Home Systems. To introduce different manufacturers to these countries and to avoid supply bottlenecks it was planned to contract at least 2 suppliers per country delivering 125 SHS each. After delivery the systems should be installed by EnDev project staff within a short period. Because appropriation of funds came late the tender process had to be done within a tight schedule leading to weak tender documents. As a result all 750 SHS were provided by the same supplier. Since this company had limited resources the delivery anticipated in January was completed in April. In addition to the delayed delivery the batteries had been produced in summer before, so these batteries were 9 months en route without recharging in between. The installation process itself was slow as well because of limited access to the regions due to Ebola. Furthermore, installation of additional solar components (fridges and solar roofs) that had been bought from the same funds had to be executed with priority. When starting installation process of SHS it turned out that a significant amount of batteries were not working because of the long storage period and possibly a lack of quality. According to the manufacturer, it is possible to store batteries for 1.5 years but harsh climatic conditions as in Liberia may reduce this period. This information was not given on delivery. It

turned out to be difficult to prove a failure from company's side, moreover the companies assumed wrong treatment of batteries by the project although any attempted repair had been discussed before. The interference of persons neither working for the company nor the project complicated the overall situation. In order to avoid a loss of reputation within the countries because of non-functioning solar systems in health stations, EnDev accepted, that the batteries were only replaced partly by the manufacturer, transportation, additional batteries and installation was paid by the project. EnDev did not reach its original target to introduce systems from different suppliers and provide solar light to health institutions within the anticipated period. The installation was far slower than expected, the result not sufficient. It took a lot of time and extra money to repair the defective systems and achieve the promised results.

Promotion of energy efficient TVs – the problem of improper use

EnDev is supporting the dissemination of energy efficient DC appliances such as TVs and fans through a Result Based Financing project. An off-grid solar company in Bangladesh participating in the project that added super-efficient televisions to its SHS bundle encountered an unexpected issue related to customer behavior. In an attempt to extend the run time of the TVs, customers shorted the battery and charge controller and connected the TV directly to the PV array. Apparently in some communities this had been common practice with older cathode ray tube TVs, but it caused the flat screen LED TVs being sold by the company to burn out. The company was forced to develop a new technology solution that made it impossible for customers to bypass the battery, which required a costly development and testing process and caused significant delay in sales of the TVs.

The example shows that technologies disseminated through a RBF mechanism alone without consumer education and information measures may result in improper use of the technologies and affect market development. Consumer must have sufficient knowledge about a technology or the technology must be extremely robust against improper use to make RBF an effective tool.

Sierra Leone: the roadshow took place in Kambia and Prtloko in December 2016. The solar vehicle publicly promotes renewable energy and solar products in rural Sierra Leone as part of the Energy Revolution launched in 2016 by the Government of Sierra Leone.

Ethiopia: Girls in the Tigray region studying at night due to the solar PV lamp

F. Global trends and EnDev cooperation with other organisations and initiatives

Global trends

In 2016, meaningful steps were undertaken internationally to operationalize the Paris climate accord, and to intensify activities for achieving the SDGs including SDG 7 to ensure access to affordable, reliable, sustainable and modern energy for all. The **NDC partnership** was launched November 2015, during COP22 and the Green Climate Fund approved its first projects including some renewable energy projects (though only one specifically targeting decentralized energy provision). The Africa Renewable Energy Initiative, initiated COP21, was formally institutionalized and developed its implementation plan. The UK Energy Africa Campaign moved forward on its country compacts, and launched two call for proposals for supporting countries in their policy and regulatory environment for off-grid solar, and for technical and financial support to companies in the sector. The Power Africa initiative supported the further development of larger generation and grid role out projects and expanded its (partners') off grid support to mainly individual companies in SHS and mini-grids.

The SEforALL secretariat published its **Strategic Framework for Results 2016-2021** to provide strategic direction to the Sustainable Energy for All platform and its partners that operate on a global basis. It describes how SEforALL wants to move further, faster in the coming five years towards the delivery of the SEforALL objectives. One key element is the promotion of partnerships and the creation of accelerator working groups such as the last mile accelerator. EnDev is in discussion with SEforAll to become an official partner as well as to be a key player in the accelerator working group.

The SEforALL Global Tracking Framework 2017, presented at the SEforALL Forum in New York early April, shows that progress being made towards universal access in 2030, is significant but insufficient. Population growth, in particular in (Sub Saharan) Africa is outpacing the increase in energy access. As a consequence, the number of people without electricity dropped only a little and the number of people without clean cooking event went up. Efforts (and funding) have to be sped up 4 (electricity) or 5 (cooking) times. At current pace 2030 only will show access rates of 91% and 72% for electricity and clean cooking respectively (IEA, global average). The bulk of the funds and efforts directed at renewable energy, both climate related and ODA, focus investments on grid connected generation and larger mini-grids. Decentralized energy receives only a limited funding envelope, with clean cooking seeing only minor investments. In addition there seems to be a widening divide between countries and between regions within countries, with (SSA) African countries significantly lagging, and within these countries growth occurs predominantly in urban and better off markets, favouring the business models of the private sector. The risk of the poor in LDC's in general, and in rural remote areas, slum areas, refugees and conflict areas to be left behind will only increase towards 2030 unless efforts are significantly stepped up[24].

The Africa EU Energy Partnership[25] mapped 58 major high level initiatives, operative programs and delivery mechanisms in the energy sector in Africa, along with a substantial increase in ODA for the sector over the last years (USD 4,7 billion in 2013) although largely in North and East-Africa. Many of these initiatives have their focus on large scale investments in grid extension, grid connected (renewable energy) generation projects and larger isolated grids. When assessing initiatives actually active and delivering in EnDev's sphere of interest, i.e. in the Last Mile, decentralised electricity provision, cleaner cooking, markets for the poor, only a few remain.

[24] In July 2016 the high-level political Forum of Sustainable Development highlighted the need to "reach out to the most vulnerable in order to leave no one behind and implement the SDGs in their entirety".

[25] *Mapping of Energy Initiatives and Programs in Africa,* AEEP, May 2016.

AEEP analysed the initiatives and ODA funding streams according sectors and sub-sectors covered, types of financing and types of technical assistance provided and identified the following gaps:

- Lack of focus on Central Africa – scope for more regional programs
- Relatively low level of engagement of civil society in the energy sector
- Scope for expanding support for clean cooking
- Increased role of mini-grids and off-grid requires further development of tailor-made support schemes
- Skill development is the least common form of technical assistance

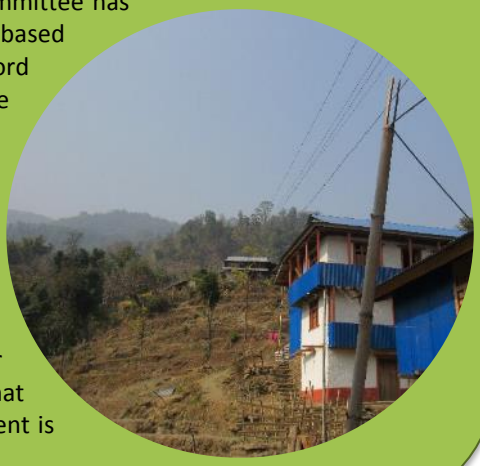
Micro Hydro transforms rural lives in Nepal

Mr. Purna Bahadur Rai from Jalpa VDC, Khotang district now enjoys electricity generated from the Lumju Khola Micro Hydro Project. He, as father and a farmer, is also the chairman of the user committee managing this plant.

Just three years back, Mr. Purna and other villagers depended on kerosene and firewood for lighting purposes. He had to walk six hours to the nearest city of Diktel to buy kerosene for his home and had to spend NPR 95 per liter of fuel (EUR 0.85 per liter). One liter of kerosene only lasted for about a week. Now he pays around NPR 100 per month (EUR 0.88 per month) for the electricity service; saving NPR 300 (EUR 2.66) a month. "…It was very difficult, especially for women and children because they had to spend long hours in the dark and smoky environment, which had adverse effect to their health… we no longer have to stay in smoky homes, thus stay healthy…" says Mr. Purna. "Also, we use less firewood now and this is helping to save our forest…" he adds, while showing the LED light he installed in his house.

The access to electricity enabled the community to have a Computer Institute at school, so teachers and children use it for developing their learning horizons. "…with the increasing use of mobile phones and television people have gained access to information…as a hidden benefit of electricity utilising these modern facilities villagers are much aware and empowered." adds Mr. Purna. Women formed Aama Samuha (Mother Groups) and conduct women literary classes. They also encourage others to engage in income generating as well as social activities.

Currently the site has 195 families benefiting from a strong management committee. The management of the site is based on an adaptation of the tariff collection system managed in NEA. The committee has established proper tariff rates based on fixed based tariff and per unit consumption. With a proper billing system, and a record book of individual households, the management has built trust among the villagers. The tariff collection is done through a local financial cooperative; and to encourage early payers, the community awards households with a pay back on their bill. Villagers are aware of the need of operation and maintenance of their power plant. For this purpose, they created a separate maintenance and repair fund which proved to be very crucial after the damages suffered by earthquakes in April 2015 and May 2015 and numerous landslides triggered during the monsoon season. Despite substantial damage to the plant, villagers came together to rehabilitate the plant with their available resources. This site proves that with a real and strong commitment of local villagers, the MHP development is not only feasible but sustainably successful.



Against this background, EnDev is currently developing its **vision towards 2030**.

Although the overall progress towards universal access in 2030 falls short some trends are encouraging, especially in electrification. In some countries in Eastern Africa the off-grid sector has developed dynamically. Technical and business innovations (esp. PAYGO) have laid a foundation for growth in the solar energy sector, where impressive growth figures are being reported for companies like Mobisol, M-Kopa, Azuri, Off-Grid Electric. The RISE index, launched by the World Bank, shows that in many countries the enabling environment for investments in such decentralized renewable energy companies is still weak and needs further attention. In addition, EnDev observes that these companies are active in the most attractive rural markets and not so much in the remote and fragile areas where economic interests are low.

In the field of cooking energy, developments are low and a real game changer still has to be found, whereas for mini-grids political and regulatory issues are still preventing successful implementation at scale, in spite of considerable funds allocated for support.

The Global Tracking Framework and the Multi-tier Framework and Regulatory Indicators for Sustainable Energy (RISE) offer the basis for assessing and discussing progress towards SEforALL and for identifying the shortcomings in the agenda. Countries address these shortcomings top-down through national policies and regulation in their national policies, supported by SDG (SEforALL) and NDC processes to which international community and development partners align their activities and investments. Concrete results on the ground from programmes such as EnDev, can further inform these national policies and processes bottom-up, and prepare the ground for investments of public and private partners to scale these approaches up to sector level. To date this happens on an incidental level; development partners informing each other, cooperate occasionally, but sometimes also provide uncoordinated and even conflicting support to governments or market processes. There is need for further cooperation between partners on the ground, as EnDev is piloting in some countries already, and to take that beyond a country by country approach.

Taking the above into account EnDev may develop its future activities in the direction of

- A regional/country focus on (Sub Sahara) Africa and LDC countries with lowest access growth rates, such as the ring of countries from the Sahel, through East Africa into the horn of Africa.
- Designing and implementing coordinated (other DP's, MDB's, governments) approaches, leveraging increased public and private finance to accelerate towards scale, at country levels
- Delivering dedicated public finance (and instruments) to reach out to the poorest, and to take initial high investment risks in non-commercial areas.
- Expressing leadership in delivering concrete results, (in particular in clean cooking), on international level through:
    - Bringing together major implementing instruments and organizations under a coordinated implementation and joint monitoring and reporting initiative

In its vision 2030, EnDev is currently repositioning itself in the international initiatives, continuing and expanding on the current cooperation with other players, and exploring its agenda for refugees and conflict stabilization.

Progress in cooperation with other players

In 2016, EnDev intensified its cooperation with key players in the energy access market, both on country level and on the international level. In cooperation with World Bank/ESMAP and other partners like KfW the Multi-Tier Framework (MTF) for tracking energy access was further refined with EnDev providing its practical experiences with applying the framework in the field. In the detailing of the MTF EnDev exchanged with other key partners in the sectors like GOGLA for picoPV electrification, while the program participated intensively in the discussions around the ISO certification process of cookstoves. Especially the latter proved to be a very sensitive and tedious

process where EnDev's field experience added significant input to the debate. In parallel to this discussion, EnDev developed its own cooking energy system framework which will be ready for sharing and input into the global discussion first half of 2017. On the agenda of cooking energy and health EnDev worked closely with WHO to reach an agreement on exposure levels for cooking technologies at different access levels.

On the ground, EnDev firmed up its cooperation with WB/SREP in Rwanda, where EnDev's due diligence and technical assistance to mini-grid developers in combination with a RBF contract triggers an SREP supported investment loan from Rwanda's UOB Bank for the project. The SREP investment plan for Rwanda was approved April 2017. Further cooperation with WBG is explored in Mali and in Myanmar where WB has expressed its interest for EnDev's RBF expertise. Coordination on the country level with IFC/Lighting Global in f.i. Kenya further continued.

In December 2016, a concept note was submitted to the Green Climate Fund for a programmatic multi-country cooperation between World Bank, Global Alliance for Clean Cookstoves and EnDev partners, GIZ, RVO and SNV, transforming the clean cooking sector in Bangladesh, Lao, Indonesia and Uganda. The feedback received from the GCF secretariat confirmed the difficult match between climate funding channels such as the GCF and the specific challenges of decentralised energy provision that require high grant shares for technical assistance and market development, and are unable to leverage large upfront private investments. In addition the GCF's approach towards programmatic investments had not yet crystallised. The consortium decided to change its strategy towards one of submitting a series of individual country proposals (also per individual accredited entity) under a joint chapeau paper defining the ratio of the cooperation and the general transformative change theory. The first proposals are aimed to be submitted to the GCF mid-2017.

EnDev is also evaluating its position with respect to the EUEI-PDF as the mutual complementarity of both programs seems so far underexploited. EUEI's network into national governments and international initiatives maybe well positioned to include EnDev's lessons into national and international policy making.

EnDev has actively discussed with the independent delivery unit of the Africa Renewable Energy Initiative to be recognized as "an AREI initiative" and thereby contribute to reaching the objectives of AREI. EnDev currently awaits the continuation of this discussion, while the IDU is getting restaffed and moving into more operational mode.

Refugee and conflict areas

Towards the end of 2016 (and the beginning of 2017) EnDev's activities in the refugee context started to firm up. In Kenya the cooperation with the GIZ's SIF (Special Initiative for Refugees), already working in Kakuma camp, has been initiated. A MoU between the two programs was elaborated and signed in early 2017. Field assessments were done and detail activities in both cooking and electrification subsectors are under design. Discussions with DFID Uganda about a co-financing of activities in Rhino camp as well as possibly other refugee locations are, early 2017, closing in on an agreement too. Here too, both cooking energy and solar lighting solutions, are under consideration. Both projects aim to include the local private sector in the delivery of products, next to local production of improved cookstoves. Cooperation with UNHCR is being explored, in order to avoid conflicting approaches where possible, and to look for opportunities to combine at best. In Tanzania EnDev was approached, by the GIZ-SIF program, to implement an energy access component both, for host communities as well as for refugees, again looking at solar and cooking technologies, also in cooperation with UNHCR, who also expressed strong interest into EnDev's technical and delivery expertise. This component would be considered a pilot activity to support the **Comprehensive Refugee Response Framework** (CRRF), which is a follow up initiative of the UN Summit in September 2016 in New York. At this summit, both, Tanzania and Uganda have been selected as pilot countries for the implementation of the CRRF.

All three country activities are aimed to start quickly during the second quarter of 2017. Main objective is to identify concrete opportunities to deliver energy to refugees and host communities on

a transitional/long term development agenda, as well as the limitations these particular settings provide.

At the suggestion of Norway's special envoy for Somalia, EnDev explored cooperation with the Norwegian International Support foundation (NIS) for activities in Somalia. NIS has a strong presence on the ground through Somalian nationals and a proven track record of implementing projects, including energy projects, in conflict areas. EnDev and NIS are developing a concept and contract for strengthening and expansion of existing private local mini-grids in the towns of Luuq or Kismayo. Public infrastructure is being seen as a (c.q. one of the) critical element(s) in easing conflict situations, to be proven by concrete pilots. In parallel of the Somali discussions NIS and EnDev meanwhile successfully reached an agreement (and contract) for installing a series of solar streetlights in Gao, a fragile region in Northern Mali.

In order to expand EnDev's cooperation on the refugee and energy agenda the program opened discussions with UNHCR, joins the monthly calls of the UN SAFE (Safe Access to Fuels and Energy) initiative, and has accepted to become a member of the Moving Energy Initiative advisory committee.

Burundian cookstove producers trained by EnDev Tanzania

The EnDev cookstove teams from Burundi and Tanzania met during the regional East African EnDev Cooking Energy meeting in Kampala in April 2016. The Burundi team showed high interest in the Tanzanian Matawi stove, since an improved wood stove of this quality was not yet available in Burundi. Ongoing communication ensured the dispatch of 20 Matawi stoves (10 metal cladded and 10 ceramic stoves) to Bujumbura, for a first field testing. Consumer tests in Burundi showed that the participating households were very satisfied with the performance of the stove. Additionally, the stove had been given to local Burundian stove producers for further examination and testing. After the very positive feedback from consumers – rural households – and producers, the team decided to introduce this stove also in Burundi. In order to ensure a sufficient supply of high quality Matawi stoves in Burundi a training for local producers was planned.

Due to the currently politically difficult situation in Burundi and the challenging working conditions for the local EnDev team, the technical training on Matawi stoves was organized in Mwanza, Tanzania, which is located only 250km from the Burundian border. The training took place in November 2016 and was facilitated by EnDev Tanzania's Technical Lead Hassan Bussiga alongside two Tanzanian ICS 'champion producers'. It was a five-day intensive training which incorporated both practical sessions at one of the producer's workshop and theory classes at the EnDev office in Tanzania. Nine stove producers from three locations in Burundi (Bujumbura, Gitega, and Ngozi), previously selected by EnDev Burundi, participated. The training was given in Swahili and English and even translated to Kirundi for some producers who did not understand either of these languages.

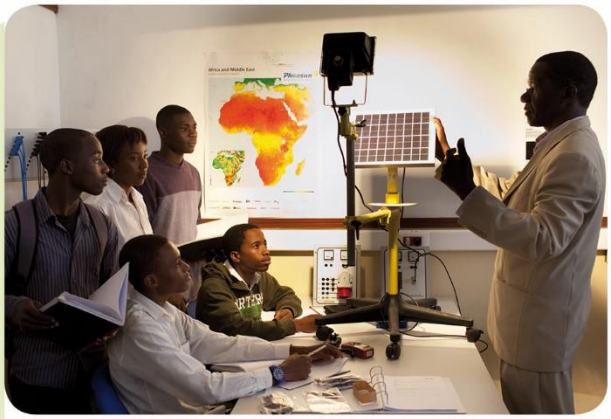
The Burundian stove producers at the training site in Mwanza, Tanzania.

During a concluding session, the participants expressed their appreciation for the training and were eager to start producing Matawi stoves upon returning to Burundi. As a reward for their dedication, all producers received a signed certificate of clean cooking excellence from the EnDev Tanzania team. Both EnDev teams agreed to continue this cooperation and to jointly follow up on trainings and knowledge exchange.

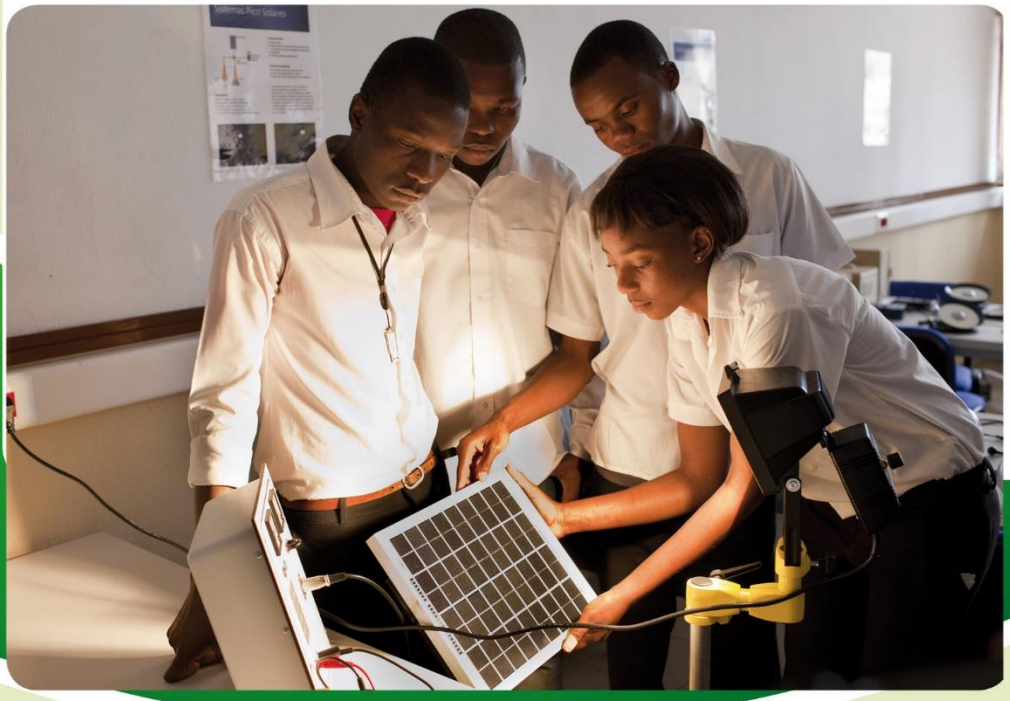
Benin: PV Solar Home System and a TV satellite dish on a family compound in rural Benin.

Mozambique: Monitoring is essential to get carbon credits for improved cookstoves..

Malawi: „A real Star uses Solar“ the Slogan for the solar Christmas Campaign 2016 presented by one of the most famous Malawian football stars.



Mozambique: At the Instituto Induytrial de Maputo a training program for renewable energies was created. This included the set up of a laboratory for PV technology. These are electricians in training.



G. Budget allocation and expenditures

EnDev 2 global budget

Out of the total budget of EUR 312,555,081 an amount of EUR 282,947,000 has been allocated to activities in the different countries.

Allocation of EnDev 2 Total Budget	
allocated to projects based on EnDev 2 Annual Planning	282,947,000
allocated to projects based on EnDev 1 Annual Planning	495,000
allocated to programme level activities	21,405,000
not allocated	7,708,081
Total	**312,555,081**

not including Annual Planning 2017 Update

The total expenditures of EnDev 2 until December 2016 amount to EUR 201,873,506.

The total expenditures in 2016 amount to EUR 29,842,154.

G.1.1 EnDev 2 budget for core activities (non RBF activities)

Out of the core budget of EUR 261,579,081 an amount of EUR 257,672,240 has been allocated to activities in the different countries and on programme level.

Allocation of EnDev 2 core budget	
allocated to projects based on EnDev 2 Annual Planning	236,801,515
allocated to projects based on EnDev 1 Annual Planning	495,000
allocated to programme level activities	20,375,725
not allocated	3,906,841
Total	**261,579,081**

not including Annual Planning 2017 Update

G.1.2 EnDev 2 RBF facility

Out of the budget for the RBF facility of EUR 50,976,000 an amount of EUR 46,184,485 has been allocated to RBF round 1, 2 and 3 projects.

Allocation of EnDev 2 RBF budget	
allocated to projects based on EnDev 2 Annual Planning	46,184,485
knowledge and preparation budget	1,029,472
not allocated	3,762,043
Total	**50,976,000**

Annual Planning 2017 Update not included

Donor funding and expenditures until December 2016

Donor funding		EnDev 2 funding	Expenditures
Governing Board donor funding			
BMZ funds		72,800,000	48,986,777
DGIS funds		100,629,138	81,416,407
MFA Norway funds		28,733,000 [d)]	23,225,200
DFAT funds		15,844,000 [c)]	15,858,257
DFID RBF funds		50,976,000 [d)]	12,628,720
DEZA funds		7,700,000 [d)]	3,572,388
SIDA funds		12,850,000 [d)]	5,462,077
RVO		2,000,000	12,337
additional donor funding			
Irish Aid	for Ethiopia	3,644,943	2,773,879
European Commission	for WestAfrica/ Senegal/ET	13,210,000	7,598,055 [b)]
DFID	for Bangladesh	3,260,000 [d)]	339,409
KoFIH	for Ethiopia	908,000	0
EnDev 2 programme		**312,555,081** [a)]	**201,873,505**

Notes a) – d):

a) Interest accrued will be considered only at the end of the global programme and added to the respective donor contribution in the final financial report.

b) Accounts of EC co-financed projects in West Africa will be balanced with the country projects involved (Burkina Faso, Senegal and Benin) in the course of 2017.

c) based on real currency exchange rate of date of income booking on our bank account

d) based on both real and estimated future currency exchange rates.

Use of donor funding over project duration

G.1.3 Expenditures

	2010	2011	2012	2013	2014	2015	2016	2009-2016 total
EnDev global funding								
BMZ	1,473,122	12,023,606	2,227,018	5,865,145	7,753,966	16,126,509	3,227,785	48,986,777
DGIS	22,136,387	9,031,088	13,941,117	6,818,371	11,501,760	-2,194,305	10,936,217	81,416,407
DFAT			1,222,851	12,531,755	2,201,682	-825,527	727,496	15,858,257
MFA NOR			2,500,934	4,537,530	5,141,562	10,518,938	526,236	23,225,200
DEZA					1,296,564	1,130,124	1,145,700	3,572,388
DFID RBF			45,040	523,556	2,168,395	3,252,762	6,638,967	12,628,720
SIDA							5,462,077	5,462,077
RVO							12,337	12,337
EnDev additional funding								
EU			1,447,321	1,083,370	3,031,261	2,016,132	19,971	7,598,055
IA			311,223	224,193	489,891	905,586	842,986	2,773,879
DFID BD						37,027	302,382	339,409
Total	**23,609,509**	**21,054,694**	**21,695,504**	**31,583,920**	**33,585,081**	**30,967,246**	**29,842,154**	**201,873,506**

G.1.4 Funding

	2015	2016
EnDev global funding		
BMZ	52,800,000	72,800,000
DGIS	100,629,138	100,629,138
DFAT	15,844,000	15,844,000
MFA NOR	27,748,000	28,733,000
DEZA	7,700,000	7,700,000
DFID RBF	50,976,000	50,976,000
SIDA	14,400,000	12,850,000
RVO		2,000,000
EnDev additional funding		
EU	4,360,000	13,210,000
IA	2,974,943	3,644,943
DFID BD	3,260,000	3,260,000
KoFIH		908,000
Total	**280,692,081**	**312,555,081**

Funding and expenditures of country activities

Country / activity	EnDev 2 funding (EUR)	Expenditures
EnDev 2 programme	312,555,081	201,873,505
Programme management	21,105,000	13,930,323
Harmonised support to clean cooking sectors	2,000,000	12,337
Refugee Activities	1,285,000	0
Benin, rural electrification	8,260,000	4,441,478
Benin, stoves	7,300,000	4,622,131[b)]
Burkina Faso	6,650,000	4,610,733[b)]
Burundi	3,200,000	2,189,589
Ethiopia	up to 29,393,000	17,139,748
Ghana	3,150,000	2,739,704
Kenya	21,435,000	11,832,319
Liberia	4,428,000	2,912,992
Madagascar	800,000	327,592
Malawi	2,500,000	1,542,506
Mali	4,500,000	1,797,739
Mali old	2,000,000	2,241,900
Mozambique	14,500,000	11,986,125
Rwanda	15,440,000	7,055,391
Senegal	up to 16,170,000	13,464,272[b)]
Tanzania	5,660,000	2,341,076
Uganda	12,250,000	8,655,730
EU West Africa	up to 1,990,000	2,786,970[b)]
Bangladesh	25,250,000	18,068,259
Cambodia	2,550,000	2,100,271
Indonesia, biogas	2,500,000	1,379,508
Indonesia, solar / hydropower	11,960,000	11,283,964
Nepal	7,915,000	4,246,264
Vietnam	3,740,000	2,204,496
Bolivia	15,000,000	13,154,885
Central America	16,790,000	14,447,109
Peru	16,920,000	15,441,811
Regional activity (RBF3)	**EnDev 2 funding (EUR)**	**Expenditures**
Bangladesh, Kenya	4,110,000	1,219,655
Kenya, Tanzania, Uganda	3,870,000	88,470
Malawi, Mozambique	1,258,000	5,153
Mekong (Cambodia, Laos, Vietnam)	4,096,000	828,948
Mozambique, Uganda	4,421,000	0
Expenditures of projects on 31.12.2014 already approved under EnDev 1		
Mongolia	495,000	486,618

Notes a) – d):

a) Interest accrued will be considered only at the end of the global programme and added to the respective donor contribution in the final financial report.

b) Accounts of EC co-financed projects in West Africa will be balanced with the country projects involved (Burkina Faso, Senegal and Benin) in the course of 2017.

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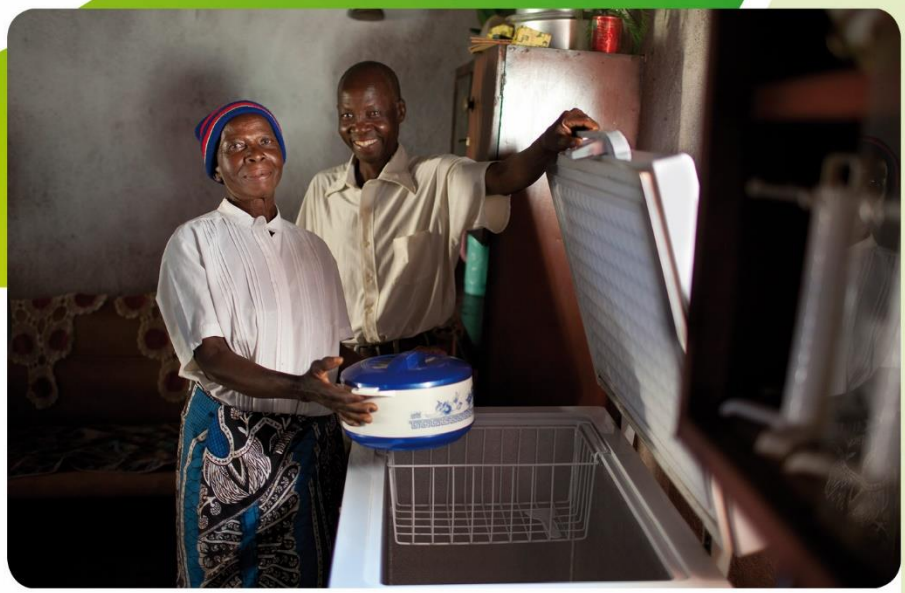

Mozambique: Ester Enoque and Filimoni Ngulai live in a small village and currently purchased a freezer. This is thanks to the German-Dutch Programme AMES (Access to Modern Energy Services) which supports the operators of small, off-grid hydro power plants.

Cambodia: Disposed LPG stove with old containers that produce a lot of waste. The familiy now can cook with biogas after installation of biogas in their home.

Uganda: installation of a solar panel on the roof of a hood. The PPP project 'Light Up A Village' in cooperation with Barefoot Power, uses picoPV to provide energy to the village of Fofo in the Moyo region, northern Uganda.

Uganda: A customer purchasing an ICS in the new packaging at the EnergyWeek

Abbreviations

ABC	advanced biomass cookstoves
ADES	Association pour le Développement de l'Energie Solaire, Switzerland
ADES	Association pour le Développement de l'Energie Solaire, Madagascar
BBK	Barclays Bank of Kenya
BCE	Biogas Construction Enterprise
BCS	battery charging station
BMZ	the German Federal Ministry for Economic Cooperation and Development
BP	biogas programme in Vietnam
BRD	Rwandan Development Bank
CA	ICF
CCAK	Clean Cookstoves Association of Kenya
CDM	Clean Development Mechanism
CLASP	Collaborative Labelling and Appliance Standard Program
CLASP	Collaborative Labelling and Appliance Standard Program
CRED	Community Rural Electrification Department, Nepal
CREE	Community Rural Electrification Entities, Nepal
CREEs	Community Rural Electricity Entities
CSC	Customer Service Centre
CSI	Credit Sanctioning Incentive
DEZA / SDC	the Swiss Agency for Development and Cooperation
DFAT	the Australian Department of Foreign Affairs and Trade
DFID	the UK Department for International Development
DGNREEC	Directorate General for New and Renewable Energy and Energy Conservation, Indonesia
EDCL	Energy Development Company Limited
EdM	Electricidade de Mocambique
ELCOM	ELectrification COMmunale, Mali
EnDev	Energising Development programme
ESMAP	Energy Sector Management Assistance Program
FIE	Fonds d'Intervention de l'Environnement, Burkina Faso
FOCAEP	Central American Fund for Access to Sustainable Energy and Poverty Reduction
GACC	Global Alliance for Clean Cookstoves
GCF	Green Climate Fund
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GOGLA	Global Off-Grid Lighting Association
GTF	Global Tracking Framework
HH	households
HIVOS	Humanistisch Instituut voor Ontwikkelingssamenwerking

ICS	improved cookstove
IDCOL	Infrastructure Development Company Limited
INDCs	Intended Nationally Determined Contributions
IRS	Institutional Rocket Stoves
IVA	independent verification agent
IWME	improved water mills electrification
KNES	Kenya National Electrification Strategy
KOSAP	Kenya Off-grid Solar Access Programme
KPI	key performance indicator
KPT	kitchen performance test
LDC	least developed countries
LG	Lighting Global
LIZ	light industrial zones
LMEs	last mile entrepreneurs
MDB	multilateral development bank
MEDER	Ministère en charge de l'Energie, Ministry of Energy, Senegal
MEEM	Ministre de l'Energie, de l'Eau et de Mines / Ministry of Energy, Water and Mines, Benin
MEMD	Ministry of Energy and Mineral Development, Uganda
MEMR	Ministry of Energy and Mineral Resources, Indonesia
MFA / DGIS	the Dutch Ministry of Foreign Affairs Directorate-General for International Cooperation
MFA-NOR	the Norwegian Ministry of Foreign Affairs
MFI	micro finance institution
MHDF	Micro Hydro Debt Fund, Nepal
MHE	Ministry for Hydrocarbons and Energy, Bolivia
MHP	micro hydropower
MINEM	Ministry of Energy and Mines
MININFRA	Ministry of Infrastructure, Rwanda
MME	Ministry of Mines and Energy, Cambodia
MNCH	maternal, newborn and child health services
MoEF	Ministry of Environments and Forests, Bangladesh
MoEP	Ministry of Energy and Petroleum, Kenya
MoP	Ministry of Power, Ghana
MoST	Ministry of Science and Technology, Laos
MoU	Memorandum of Understanding
MoWIE	Ministry of Water, Irrigation and Energy, Ethiopia
NBP	National Domestic Biogas Programme
NCSC	National Cookstoves Steering Committee, Malawi
NEA	Nepal Electricity Authority

NIS	Nordic International Support Foundation
PAYG	pay as you go
PE	polyethylene
picoPV	pico photo voltaic
PICS	portable improved coostoves
PPP	public private partnership
PU	productive use of energy
RBF	results-based finance
REA	Rural Electrification Agency, Uganda
REG	Rwanda Energy Group
RVO	Rijksdienst voor Ondernemend Nederland
SCT	social cash transfer
SDG	sustainable development goals
SEforALL	Sustainable Energy for All initiative
SHS	solar home system
SI	social institutions
SIDA	the Swedish International Development Cooperation Agency
SME	small and medium enterprise
SMSS	solar multi service stations
SNV	Stichting Nederlandse Vrijwilligers / Netherlands Development Organisation
SREP	Scaling Up Renewable Energy Programme
SSHS	small solar home systems
SWC	Social Welfare Council
SWH	solar water heaters
TICS	Tanzania Improved Cook Stove programme
UNEP	United Nations Environment Program
VMEEA	Vice Ministry of Electricity and Alternatives Energies
VMEEA	Vice Ministry for Electricity and Renewable Energy, Bolivia
VSL	Village Savings and Loan
VWU	Vietnamese Women's Union
WHO	World Health Organization

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