Progress Report 2017

Energising Development – Phase 2

energising development

Partnership between

The Netherlands Ministry of Foreign Affairs

The German Federal Ministry for Economic Cooperation and Development

The Norwegian Agency for Development Cooperation

The UK Department for International Development

The Swiss Agency for Development and Cooperation

The Swedish International Development Cooperation Agency

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Deutsche Gesellschaft für
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Registered offices: Bonn and Eschborn, Germany
P.O. Box 5180
65726 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15
E info@giz.de
I www.giz.de

Contact:
Energising Development
Dr Carsten Hellpap

T +49 6196 79-6179
F +49 6196 79-806179
E endev@giz.de
I www.endev.info

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Wolfgang Diederich

Responsible:
Dr Carsten Hellpap
Signature:

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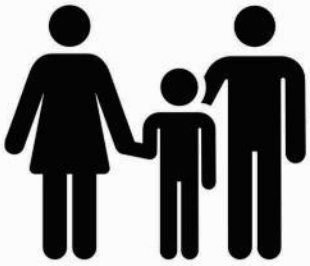
Key Achievements since 2005



Energy access for

19.2 million

people accomplished

14.4

million
household members
with improved
cooking solutions

4.8

million
household members
with electricity

Broader Impact

Indirectly, EnDev supported – together with others – access to sustainable energy for at least

83

million people

2.0 million t of CO_2 saved per year – equivalent to planting of more than 4.9 billion trees

7.0

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

41,300

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

A total installed power with renewable energies of MW

60.7

40,500

trained technicians, stove producers, sales agents

21,900

social institutions with a modern form of energy: among them 11,400 schools and 1,300 health centres

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 2017 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 21 million people worldwide by 2021 (5 million in phase 1 from 2005 to 2009; additional 16 million in phase 2 from 2010 to 2021) with a currently planned total budget of EUR 329 million. The strategy of EnDev is geared towards developing and promoting sustainable pro-poor markets for energy services and off-grid products, and sustainable social welfare measures ensuring energy access for those people and cases that cannot be reached through market activities.

By December 2017, **EnDev in its second phase** has facilitated sustainable[1] access to modern energy services[2] to 14.14 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 14,397 schools, health stations and community centres got access to improved cooking energy or electricity, or other modern energy carriers. Furthermore, 29,360 small and medium enterprises gained access to modern forms of energy for productive use.

Table A-1: Adjusted number of people with sustainable access to modern energy services (EnDev 1 + 2)

	lighting / electrical appliances	cooking / thermal energy	total household members
EnDev 1	0.82 million	4.19 million	5.01 million
EnDev 2	3.97 million	10.17 million	14.14 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 251 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.

The expenditures for EnDev 2 activities in 2017 reached EUR 34 million.

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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).

Replacing a diesel mill in Nepal

Mr. Janak Bahadur Magar from Kamalamai-12, Sindhuli district, is employed as an operator of Jirgha Khola Integrated Watermill (IWM) Electrification Project. Before this project was set up, he used to operate a diesel mill in the area that he purchased about 8 years ago. Mr. Janak operated the diesel mill for about 5-6 years and then sold it. After the IWM project was implemented, he was interested in using the improved water mill as it was easier to operate and cheaper than the diesel mill. He says "The diesel mill was expensive and tedious to operate. Transportation of diesel and its maintenance was a headache. I am glad to operate this mill now." Today, he earns around NPR 8,000 (EUR 65) per month. He says "I am happy to serve the people of my village. It gives me peace, satisfaction and happiness for helping others."

Nepal

B. Overview of current status of the EnDev 2 programme

B.1 Outcomes in the period 2009 – December 2017 (EnDev 2)

This chapter provides information on energy access outcomes, health impacts and CO_2 emission reduction for phase 2 starting in 2009. Since the beginning of 2015, EnDev also reports on specific job creation, leverage and gender indicators. At the end of 2017, the EnDev partnership comprised 29 projects in 25 different countries, with side activities in additional 5 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 17, access to mini-grids (solar/hybrid or hydropower) in 10 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/ electricit...
country projects	Bangladesh	●				●				
	Benin	●				●			●	
	Bolivia	●		●	●	●			●	
	Burkina Faso	●								
	Cambodia		●							●
	Ethiopia	●			●	●		●		
	Ghana	●							●	●
	Indonesia						●	●		
	Indonesia biogas		●							
	Kenya	●				●	●			
	Liberia (with Sierra Leone and Guinea)	●		●		●	●			
	Madagascar	●								
	Malawi	●				●				
	Mali				●	●	●			●
	Mozambique	●			●	●		●	●	
	Nepal	●						●	●	
	Peru	●		●	●	●			●	
	Rwanda (with Burundi and DRC)	●	●			●		●		●
	Senegal	●			●		●		●	
	Tanzania	●				●				
	Uganda	●			●	●		●	●	
	Vietnam		●							
multi-country projects	BD, KE, RW, TZ, UG[3]				●					
	Central America (Hon, Nic)[4]	●		●	●	●		●	●	
	Kenya, Tanzania, Uganda		●							
	Mekong (Cambodia, Laos, Vietnam)	●								
	Sub-Saharan Africa (MOZ, UG)								●	
	Cooking sector support and coordination in BD, GH, KE, UG	●								
	Refugee context (MA,KE, SO, TZ, UG)	●				●			●	

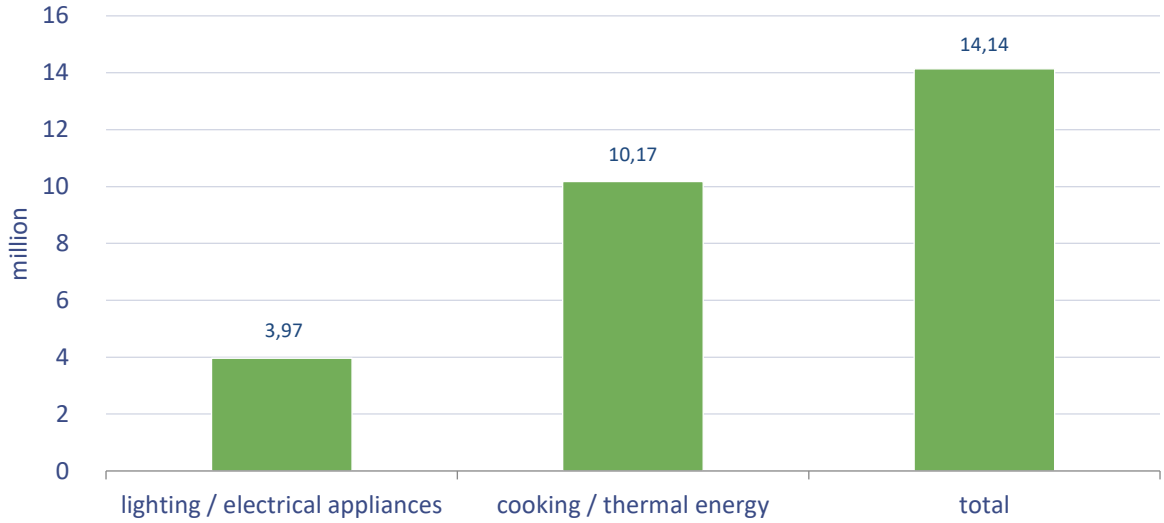
[3] focus is on off-grid appliances

[4] with some activities in Guatemala

Outcome figures

By December 2017, **EnDev 2** facilitated sustainable access to modern energy services and technologies for about **14.14 million people**. Of these, 3.97 million people (28 %) were connected to the central grid or a mini-grid, or used standalone electric systems. 10.17 million (72 %) are now using improved cooking technologies, such as improved firewood and charcoal stoves or biogas plants (Figure B.1). In addition, **14,397 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: Adjusted number of household members provided with modern energy services in a sustainable manner (EnDev 2)



The focus of the EnDev programme is on Sub-Saharan African countries. Around 62 % 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.3).

Figure B.2: Funding by region

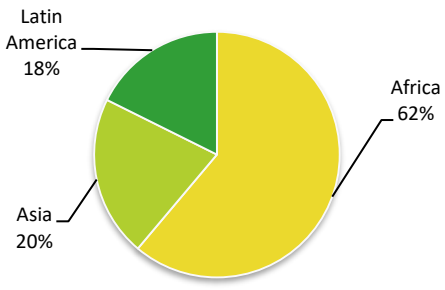
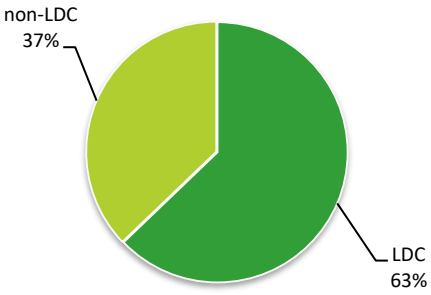


Figure B.3: Funding by countries



The majority of the target achievement on household level comes from access to modern cooking solutions (72%) while households with access to electricity contribute 28% to the overall target achievement (figure B.4). 41% of the country budgets are used for activities to promote modern cooking, 59% to promote access to electricity (figure B.5). Especially the sales of picoPV systems experienced the highest growth rate.

The cost efficiency of cooking technologies (stoves and biogas) is currently 8.9 EUR / person on average and 32.5 EUR / person in the case of electrification (figure B.6).

Figure B.4: Target achievement - People with access to energy - EnDev 2

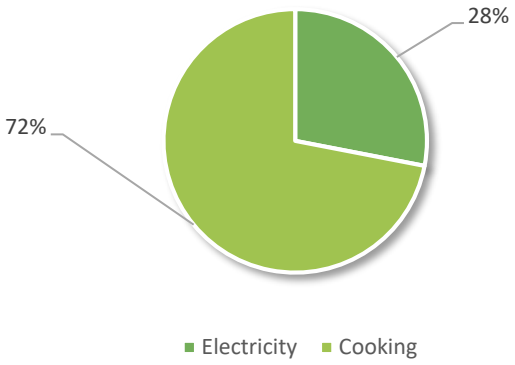


Figure B.5: Expenditures EnDev 2

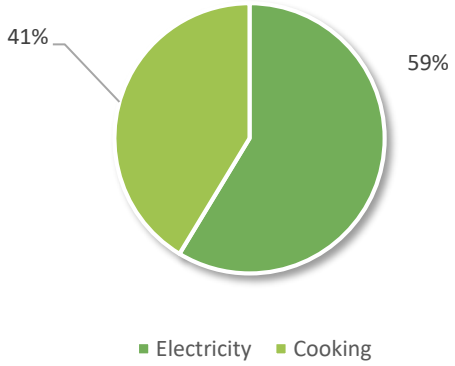
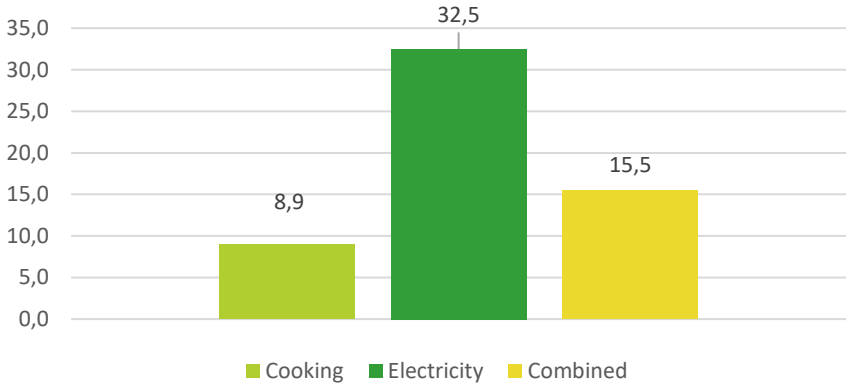
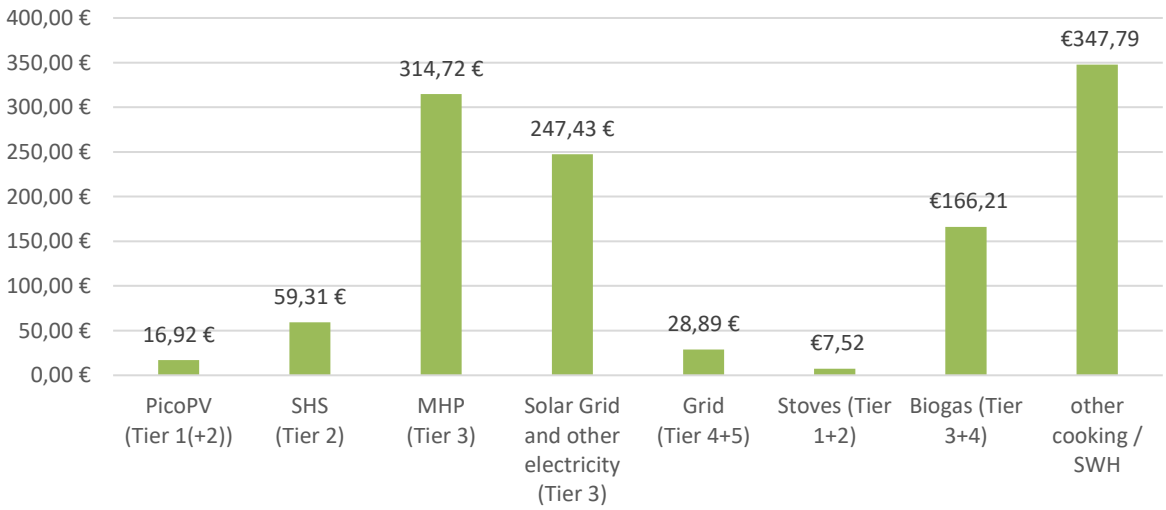


Figure B.6: Cost efficiency in EUR/person reached - EnDev 2



Within EnDev projects, a set of different energy technologies is promoted (figure B.7). Only the cost efficiencies of stove and picoPV activities are below the overall EnDev benchmark of 20 EUR / person.

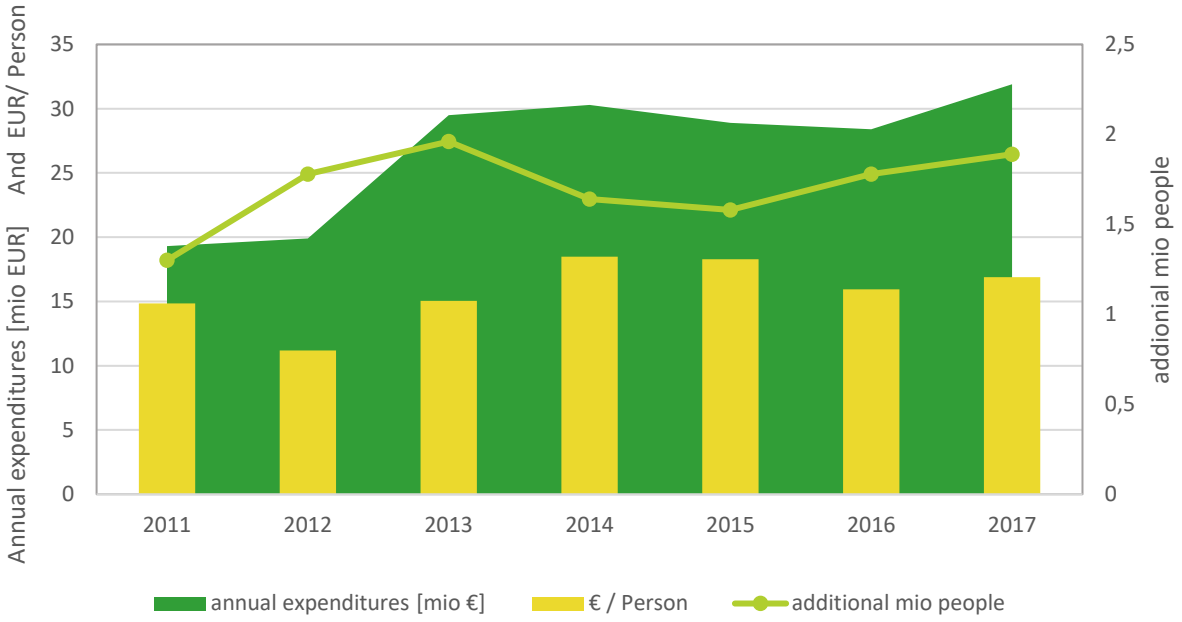
Figure B.7: Cost efficiency per technology - EnDev 2



Overall, since 2013 there is a slight trend related to the above analysis. While projects expenditures within this period were on average around EUR 32 million per year, the achievement of additional targets as well as the overall cost efficiency show a slightly increasing trend. These trends reflect that

EnDev is targeting its activities increasingly to people that are living in remote areas, and to higher tiers which are more expensive. Part of the additional costs are compensated through learning processes that improve the cost efficiency of activities (Figure B.8).

Figure B.8: Overview development Targets/expenditures in projects/cost efficiency



The outcome figures reported in this report are verified in the field through basic data from customers, who got access to energy services and products, and/or through sales figures of energy companies and retailers. In cases, where other international partners have been involved in addition to EnDev, 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. Up to now, EnDev applies **four adjustment factors** concerning sustainability, windfall gain, double energy and double EnDev counting. The background for each factors was described in previous progress reports.

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 adding up all sales numbers. Only sales beyond replacement generate new access.

The adjustment factors described above were reviewed in 2017 and are currently replaced by new factors based on some methological improvements. Hereby EnDev aims to keep the high accuracy of its monitoring data while reducing the complexity and the efforts that are required to keep it progressing.

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 the supply of energy and a device turning the energy into a useful service are required. As it is often difficult to directly monitor electricity services, access can be claimed by demonstrating access to the respective device and the required energy. Alternatively, access can be claimed on the base of electricity consumption.

The EnDev tier system is aligned with the Multi-Tier Framework (MTF) of SEforALL presented in the Global Tracking Framework (GTF). Based on this, the EnDev electrification outcome figures in the different tiers for the EnDev 2 phase are:

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

Tier	Services	Typical system	Number of people	%	Trends regarding share
5	tier 4 services plus use of devices typically requiring a few kilowatt like air conditioners	grid	738,233	19%	→
4	tier 3 services plus use of devices typically requiring a kilowatt like water heaters, irons	limited grid	305,365	8%	→
3	tier 2 services plus use of devices typically requiring a few hundred watt like rice cookers, refrigerators	mini-grid	146,605	4%	→
2	bright light, radio, telephone plus use of devices typically requiring tens of watts like TV, video, fan	solar home system	1,650,723	42%	→
1	medium bright light and, if possible, limited radio use and telephone charging	picoPV, battery charging station	1,123,665	24%	↗
		total	3,964,591		

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)	%	Trends regarding share
5	Access to needed quantity of energy source: ≥ very good Health protection: ≥ very high Convenience: ≥ very high	0	0%	→
4	Access to needed quantity of energy source: ≥ good Health protection: ≥ high Convenience: ≥ high	101,856	1%	→
3	Access to needed quantity of energy source: ≥ fair Health protection: ≥ fair Convenience: ≥ fair	83,940	1%	→
2	Access to needed quantity of energy source: ≥ limited Health protection: ≥ sufficient Convenience: ≥ sufficient	5,390,288	53%	↑
1	Access to needed quantity of energy source: ≥ deficient Health protection: ≥ low Convenience: ≥ low	4,582,562	45%	↓
0	Access to needed quantity of energy source: ≥ highly deficient Health protection: ≥ very low Convenience: ≥ very low	15,698	0,2%	→
		10,174,344		

Personalised PAYGo schemes for solar home system customers in Benin

The company ARESS is the first company to introduce the PAYGo model to Benin, partnering with mobile operator MTN and supported by EnDev. ARESS is also a participating company in EnDev Benin's RBF project and receives incentives for the sale of their solar systems. What makes ARESS remarkable is that they not only sell small solar systems with this approach (specialising on GreenlightPlanet's Pro and Home series), but even developed their own PAYGo technology to cater for larger customers and customised solar systems.

Cyrille Nobime is such a customer from the village Gbégoudou of the Tori-Bossito commune, benefiting from a PAYGo plan for his 1.5kW solar system. A nurse by profession, Cyrille uses the system to power his private health centre, a small shop next door and his own living quarters. The solar system offers lighting and powers a refrigerator in which he stores vaccines and medicines; a TV at the entrance of the health centre to welcome customers; and a copy machine, printer and computer in the shop.

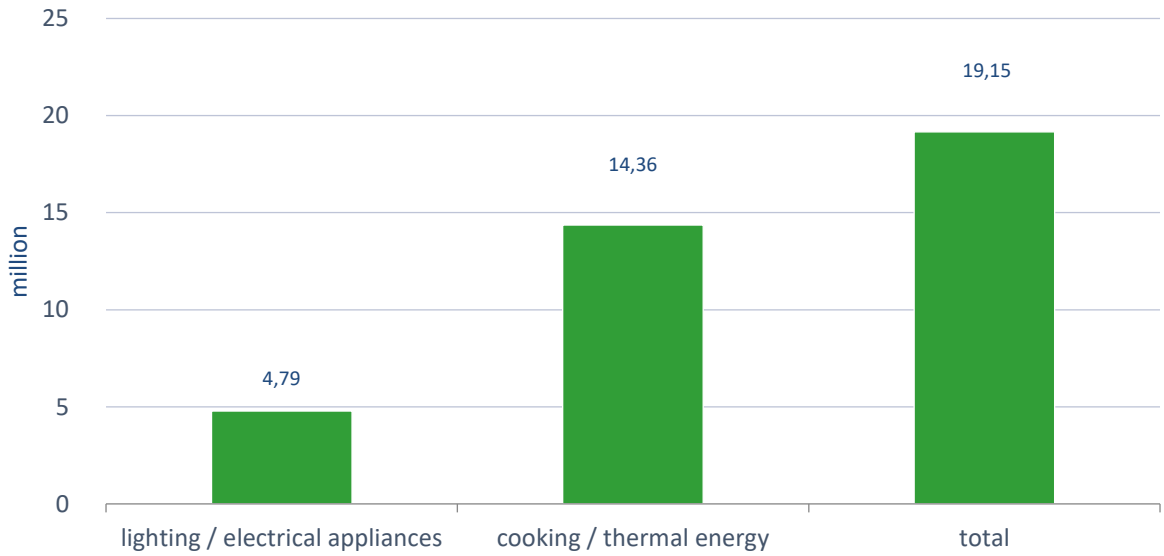
His main source of income is the health centre, where he receives on average four patients per day, mostly children. Additionally, he drafts, copies or prints documents in his shop. After an advance payment of 800,000 CFA (approx. EUR 1,200), his payment plan foresees monthly payments of 65,000 CFA (approx. EUR 100) for three years. The system comes with a three-year product and service guarantee, since the remote monitoring technology makes it possible for ARESS to track the performance of the system and intervene in case of problems.

Benin

B.2 Overall outcomes in the period 2005 – June 2017 (EnDev 1 + 2)

Looking at the overall EnDev programme, starting from phase 1 in 2005 up to December 2017 in phase 2, the **total number of people** having gained sustainable access to modern energy services on household level amounts to **19.15 million** (figure B.9). The total number of **social institutions** is around **21,900**; the total number of **small and medium enterprises** is more than **41,300**, respectively.

Figure B.9: 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 25.1 million for EnDev 2 and 34.0 million for EnDev 1 and EnDev 2 combined.

In addition to the main objective of the partnership to facilitate access to modern energy technologies and services, EnDev has four impact targets: **a)** climate mitigation, **b)** health prevention, **c)** improved gender balance, **d)** job creation, and two 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 1,662,772 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 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 3.2 million stoves and access to solar home systems, mini-grid connections or solar lanterns for 1.0 million households supported by EnDev are 2,037,000 t of CO_2.

For comparison: this amount corresponds to

- CO_2 emissions of all intra-European flights during 14 days, or
- Norwegian car traffic during 146 days, or
- the yearly emissions of 424,000 inhabitants of Sweden: that is around two third of Göteborg, the second largest locality of Sweden, or
- planting of more than 4.9 million trees on an area as big as 6,200 soccer fields.

Health

As a result of EnDev 2 activities the exposure level of indoor air pollution could be drastically reduced for more than 5.5[5]million household members (particularly women and children). The improvement of the health protection was achieved by:

1. 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;
2. removing pollutants from the cooking site through chimneys, flues, hoods or ventilation;
3. 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

This paragraph presents data and findings on gender impacts in the period of EnDev 2.

The review of EnDev impact studies concerning gender-related effects provide ample evidence that access to modern energy improves:

1. **employment of women and income generation:** Studies from Ethiopia and Kenya, inter alia, demonstrate that women trained by EnDev started successful stove businesses (production/retailing) both as secondary business and even full-time, created employment for assistants, and generated profit. In Kenya, the share of women among active entrepreneurs both in solar and cooking technologies is slightly above 50%. However, women have less income sources, lower sales in both technologies, and work fewer hours on income generation. They eventually earn 25 and 40% less than male solar and stove entrepreneurs, respectively. Further, males are 70% more likely to have customers beyond their county borders. This adds to the evidence from international studies[6] that the success of women entrepreneurs depends very much on the amount of household duties additional to their business endeavours. Nevertheless, even with small additional income, women contribute to the household earnings and spend it for the benefit of the whole family.

[5] 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.

[6] See, e.g. Bradshaw, Castellino and Diop, 2013, Women's role in economic development: Overcoming the constraints, Background paper for the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda, page 8 ff., retrieved from: http://unsdsn.org/wp-content/uploads/2014/02/130520-Women-Economic-Development-Paper-for-HLP.pdf

2. **medical services especially for women in health centres:** Electrified health centres in Ethiopia, Liberia, Sierra Leone and Guinee now provide service also during night time which is specifically important for women in the final stage of their pregnancy;
3. **indoor air quality in kitchen areas:** In most cases women are responsible for cooking and thus benefit most from improved cookstoves that emit fewer pollutants. Considering the above figure on the number of people with access to tier 2 cooking solutions and assuming that 1/5 of the household members are women and 2/5 young children it can be concluded that around 1,1million women and 2.2 million young children benefit from improved health protection;
4. **safety against sexual harassments,** due to electric light that provides safety both inside homes by decreasing the number of burns and house fires and outside homes in public spaces, and the reduction of collection time for firewood;
5. **working conditions and comfort** due to improved cookstoves that are easier to use and the replacement of kerosene lamps with PV-powered lamps (e.g. studies in EnDev Bolivia and Ethiopia).

Gender-disaggregated monitoring data about full time job creation is presented below.

Installed generation capacity with renewable energies

The total power capacity based on renewable sources installed since the start of EnDev 2 is 43.2 MW.

SHSs contribute 22.4 MW to the total result, which is the biggest share amongst the technologies with 51.8%. The share of mini-grids is 17.7 MW (MHP: 12.6 MW, PV: 5.1 MW). PicoPV systems up to now have a total installed capacity of 3.1 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 58.2 MW.

Job creation

This paragraph presents data on employment effects for the period from January 2017 until December 2017.

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 250 working days per year with 8 working hours per day, it can be calculated that 3,444 full-time equivalent jobs existed in the process steps of the production, assembly and installation of 1,521,168 stoves from January 2017 until December 2017. During the same period it is calculated that at least 564 full-time equivalent jobs existed in the biogas sector by installation of biogas digesters. Both figures sum up to 4,008 full-time equivalent jobs in the installation and assembly of cooking energy technologies.

Most of these work steps are not done by full-time labour. About 2/3 of the EnDev stove projects captured additional data about the number of people working in the production of stoves. These captured values (which include part-time labour) can be compared to the calculated full-time equivalents. The comparison reveals that on average 3.4 persons are involved for each full-time equivalent. Based on this ratio a total of 13,627 people worked in the production and installation of EnDev stoves during the last 12 months.

EnDev applied the methodology published by UNEP[7] for calculating the number of jobs created along the distribution chain. It resulted in additional 697 full-time equivalent jobs exist in the distribution chain for stoves. For picoPV systems, which are mainly produced in China, and for SHS the number of full-time equivalent jobs along the distribution chain was 1,493.

[7] Light and Livelihood: A Bright Outlook for Employment in the Transition from Fuel-Based Lighting to Electrical Alternatives; UNEP 2014.

The mini-grids projects supported by EnDev also create jobs. Temporay jobs that exits during the construction of the minigrid sites have not yet been considered. During the operational phase there are jobs in operation of the plant, administrative and managerial tasks and security service. It is calculated that by end of 2017 in total 2,748 full-time equivalent jobs existed that were related to these work profiles at the mini-grids.

In addition to direct employment effects described above, EnDev also created indirect employment effects. Within the SMEs that got access to energy through EnDev it is estimated that 2,936 full-time equivalent jobs were created.

Altogether, 11,882 full-time equivalent jobs existed in the supply chain for energy access technologies as well as in companies benefitting from new energy access in our partner countries that can be assigned to EnDev.

Table B-4: Employment effect of EnDev

	Type of employment effects			
	Direct			Indirekt
Type of Technology	Production	Distribution/ Sales	Operation	SMEs Application of Technologies
Cooking Energy	4,008	697		2,936
Solar light		1,493		
Mini-grids			2,748	
Total 11,882				

Leverage

This paragraph describes leverage effects since 2015.

The total value of all stoves and off-grid systems sold or installed by companies cooperating closely with EnDev since 2015 was EUR 209.2 million, which is a ratio of 2.2 in relation to the programme expenditures of EUR 95.2 million.

Since 2015, the total amount of investments along the market chain including intermediary products but excluding expenditures for private consumption is about EUR 512.0 million in the current semester alone, representing a ratio of 5.3 in relation to the EnDev programme expenditures.

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: A study covering 150 communities in Kenya found that grid electrification had only minimal positive impacts on economic and social indicators 18 months after connection. In general, electricity consumption of poor households proved to be very low as well as the take-up of the electrical appliances that enable electricity-consuming activities.[8] The results are in line with findings of studies in previous years. These studies found that electricity improves people's life in general by increasing lighting consumption, by increasing study time after nightfall and by facilitating information and communication through TVs, radios and mobile phones. Hence, electricity contributes directly to the well-being of households. However, consumption levels in households and enterprises are generally relatively low. Productive use and income generation does not necessarily increase. 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.[9] Thus, access to electricity is a prerequisite for development but does not guarantee that development will take place. For economic benefits to flow, electrification needs to be integrated into a broader development plan.

Off-grid picoPV: Studies on the impacts of off-grid picoPV confirm findings of previous years that households can reduce significantly their expenditures on kerosene and dry cell batteres. They are less exposed to fumes of kerosene lamps, causing coughing and cold/flu symptoms, and they were not subject to burns or home fires from the kerosene lamps. People have more time by not having to travel to purchase kerosene, and by adding a couple of extra hours of after-sunset lighting each evening.

In a randomized control trial study in rural Kenya, most households used the solar light daily for several hours as a substitute for a kerosene lamp. This allowed households to save roughly 50% of their montly expenditures on energy, which represented between 1% and 2.5% of their total cash expenditures.[10] The study also showed that poor households are quite price sensitive. Only 29% of them were willing to purchase the offered solar light at market price (9 USD) and 69% when offered at a discounted price (4 USD). However, no difference in usage was found between solar lights provided free and solar lights sold to households. The study confirmed that solar lighting improves the general welfare in rural homes including simple convenience effects, improved studying conditions for children, and more flexibility in arranging the daily housework tasks. Last year, a study found that solar lighting is used by children for studying purposes and either increases study time or flexibility (i.e. study time is shifted from daytime to nighttime). Also in this Kenya study, there was some evidence that access to solar lights increases children's light use but they do not increase adult's time use. There is no significant increase in children's study time nor shifts to more productive time use for adults. A study in Uttar Pradesh, India confirmed these results. Again, it was found that getting access to a solar lighting system had little effect on the household patterns of time spent on work, studying using the light, general expenditures, general savings or business ownership. However, households with solar lighting systems spent about Rs 47-49 less on black market kerosene per month than before.[11] Income generating effects of solar lighting systems can only be expected, when they facilitate nighttime economic

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8 Kenneth Lee, Edward Miguel, and Catherine Wolfram (2017), The economics of rural electrification: Evidence from Kenya, Policy brief 89339, International Growth Centre

9 Lenz, L., A. Munyehirwe, J. Peters und M. Sievert (2017), Does Large Scale Infrastructure Investment Alleviate Poverty? Impacts of Rwanda's Electricity Access Roll-Out Program. World Development 89 (17): 88-110.
Peters, J., & Sievert, M. (2016). Impacts of rural electrification revisited–the African context. Journal of Development Effectiveness, 8(3), 327-345;
Dinkelman, T. (2011). The Effects of Rural Electrification on Employment: New Evidence from South Africa. American Economic Review, 101(7), 3078–108.

10 http://www.dec.ethz.ch/research/solar-lighting.html

11 M. Aklin, P. Bayer, S. P. Harish, J. Urpelainen, Does basic energy access generate socioeconomic benefits? A field experiment with off-grid solar power in India. Sci. Adv. 3, e1602153 (2017).http://www.indiaspend.com/cover-story/basic-energy-access-does-not-unlock-broader-socio-economic-benefits-18793

activities or if cellphone communication is crucial for economic activities and hampered by lack of charging possibility.

Mini-grids: To learn more about the impact of mini-grids a 3-year randomized control trial was carried out in the northeastern state of Bihar in India with 3000 households divided in three groups: one with access to electricity at full price, one with access to electricity at a discount and one that served as control group with no access.[12] As it was expected, it was found that interest in electricity access as well as electricity consumption increased significantly when a 50% discount was offered showing the high price sensivity of consumers. However, unlike in other studies kerosene purchase did not fall. The authors assume that this is directly related to the government subsidies to kerosene. Families typically purchase an allotment from the government at a subsidized price. They continue to take their full share of kerosene regardless of the electricity access as they either sell the kerosene or find other uses for it, such as paint thinner or as a fuel additive. The researchers also found that electric lighting had a small yet significant effect on educational performance, as children read more at night. As a result, those children saw an increase in scores by as much as 13% in both reading literacy and math.

Two research studies from the International Institute for Environment and Development (IIED) and another study from Smart Power India (SPI) analyzing productive use aspects of mini-grids in Tanzania and India showed that to be financially successful, mini-grid operators must focus not only on existing power demand, but also on building additional demand by supporting electricity-based local enterprises.[13] Many factors proved to be critical to stimulate productive use of electricity, including capacity development, business permitting processes, access to finance and transportation infrastructure.

Electricity for health centres: In a study on the impact of powering Primary Health Centres (PHC) with solar, the authors find that 50% more patients were admitted and almost twice the number of babies delivered per month in solar-powered PHCs compared to those without a solar system in the Indian state Chhattisgarh.[14] Although, a high percentage of PHC is connected to the grid, 90% of them reported power cuts during peak hours, impeding public health services, such as births, vaccine storage, emergency services and clean water. The power needs could be met even under peak others by a combination of the grid and solar.

Impacts of improved cooking technologies

In past years, studies have been published, which did not find any evidence that the introduction of wood-burning improved cookstoves (ICS), even when they were highly energy efficient, will reduce the risk of pneumonia and other smoke related diseases.[15] On the other side, several studies show that ICS can drastically reduce indoor air pollution. Thus, in a study in Malawi the improved cookstove *Chitetezo Mbaula* used 53% of the fuel, and produced 59% of CO, and 50% of PM2.5 of the traditional three-stone fire under field conditions. A *Philips* gasifying stove used 31% of the fuel, and produces 38% of CO, and 22% of PM2.5 of the traditional three-stone fire.[16] A study by the Universidad National Autónoma de Mexico even showed that energy efficient biomass stoves with chimney, as EnDev is promoting them in Central America, could reduce CO and PM2.5 kitchen concentrations in Mexican villages to levels significantly lower that those suggested by the WHO guidelines for particulate matter (PM2.5) and carbon monoxide (CO). In the laboratory study the kitchen volume, air exchange rates

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12 https://medium.com/energy-impact-series/contextmatters-f7714335fc3f

13 Smart Power India (2017). Expanding opportunities for renewable energy based mini-grids in rural India. Best, S., Garside, B. (2016) Remote but productive: Using energy access investments to catalyse enterprises and income in Tanzania's rural communities. IIED Working Paper. IIED, London. Contejean, A. and Verin, L. (2017) Making mini-grids work: productive uses of electricity in Tanzania. IIED Working Paper. IIED, London.

14 http://www.indiaspend.com/special-reports/how-solar-powered-health-centres-could-transform-indian-healthcare-68778

15 Mortimer, K., Ndamala, C. B., Naunje, A. W., Malava, J., Katundu, C., Weston, W., ... & Wang, D. (2017). A cleaner burning biomass-fuelled cookstove intervention to prevent pneumonia in children under 5 years old in rural Malawi (the Cooking and Pneumonia Study): a cluster randomised controlled trial. The Lancet, 389(10065), 167-175.

16 Pamela Jagger, Joseph Pedit, Ashley Bittner, Laura Hamrick, Tione Phwandapwhanda, Charles Jumbe. 2017. Fuel efficiency and air pollutant concentrations of wood-burning improved cookstoves in Malawi: Implications for scaling-up cookstove programmes. Energy for Sustainable Development Volume 41, Pages 112-120

and cooking time representing a typical rural house in Michoacan, Central Mexico was taken into account.[17]

The different findings indicate that several factors have a strong influence whether or not ICS can reduce the risk of smoke related diseases. In many studies, it was observed that people use the so-called advanced stoves only occasionally and continue to cook most of the dishes with their traditional stove. This stacking phenomenon is also particularly observed in rural households, which got access to LPG. In addition, 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. Reaching indoor air pollution level with little or no risk of pulmonal and other diseases will most likely happen when stoves with chimney are used and settlement is not too dense. However, positive effects on the incidence of pneumonia can only happen, if the exposure of the household members to other air pollutants is low. In any case, the use of ICS has definitely considerable effects on wood fuel usage, energy expenditures, and collection timesavings.[18]

In sum, this suggests that 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. However, to be effective for improving health an integrated approach is required tackling fuel quality, air ventilation and ambient air pollution.

Adoption of off-grid solar and improved cooking technologies

As mentioned above, it is quite often observed that the adoption of off-grid solar products and ICS is limited even the technology is supposed to make sense from the perspective of the poor.

Findings 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 used.[19] The major demand-side barrier to adoption is affordability – given that most dissemination programmes 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.[20]

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%.[21] Consequently, 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

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17 http://cleancookstoves.org/resources/543.html

18 Adrianzén, M. A. (2013). Improved cooking stoves and firewood consumption: Quasi-experimental evidence from the Northern Peruvian Andes. Ecological Economics, 89, 135-14;
Bensch, G. and J. Peters. 2013. Alleviating deforestation pressures? Impacts of improved stove dissemination on charcoal consumption in urban Senegal. Land Economics 89(4): 676-698;
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19 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.
Beyene, A.D., R. Bluffstone, P. Martinson, and A. Mekonnen. 2015b. The Improved Biomass Stove Saves Wood, But How Often Do People Use It? Evidence from a Randomized Treatment Trial in Ethiopia. World Bank Policy Research Working Paper, No. 7297.

20 Beltramo, T., G. Blalock, D.I. Levine, and A.M. Simons. 2015. The effect of marketing messages and payment over time on willingness to pay for fuel-efficient cookstoves. Journal of Economic Behavior & Organization 118: 333-345.
Mobarak, A.M., P. Dwivedi, R. Bailis, L. Hildemann, and G. Miller. 2012. Low demand for nontraditional cookstove technologies. Proceedings of the National Academy of Sciences of the United States of America 109(27): 10815-10820.
Lewis, J.J. and S.K. Pattanayak, S.K. 2012. Who adopts improved fuels and cookstoves? A systematic review. Environmental Health Perspectives 120(5): 637-645.

21 Grimm, M., & Peters, J. (2016). Solar off-grid markets in Africa. Recent dynamics and the role of branded products. Field Actions Science Reports (FACTS), 15: 160-163.

to adoption.[22] 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.[23] Smart payment schemes like pay-as-you-go can help, but still leave poorer households excluded.[24]

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.[25] Second, giving away technologies for free once does not automatically spoil the prospects of self-sustaining markets later.[26] 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.

[22] Bensch, G., Grimm, M., Huppertz, M., Langbein, J., & Peters, J. (2016). Are promotion programmes needed to establish off-grid solar energy markets? Evidence from rural Burkina Faso. Ruhr Economic Papers 653.

[23] Grimm, M., Lenz, L., Peters, J., & Sievert, M. (2016). Demand for Off-Grid Solar Electricity: Experimental Evidence from Rwanda. IZA Discussion Paper Series.
Rom, A., Günther, I. and K. Harrison (2016) Economic Impact of Solar Lighting A Randomised Field Experiment in Rural Kenya. Working Paper. ETH Zürich.

[24] Collings, S. & Munyehirwe, A. (2016). Pay-as-you-go solar PV in Rwanda: evidence of benefits to users and issues of affordability, Fields Actions Science Reports (FACTS), 15: 94-103.

[25] 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).

[26] 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.

Burkina Faso

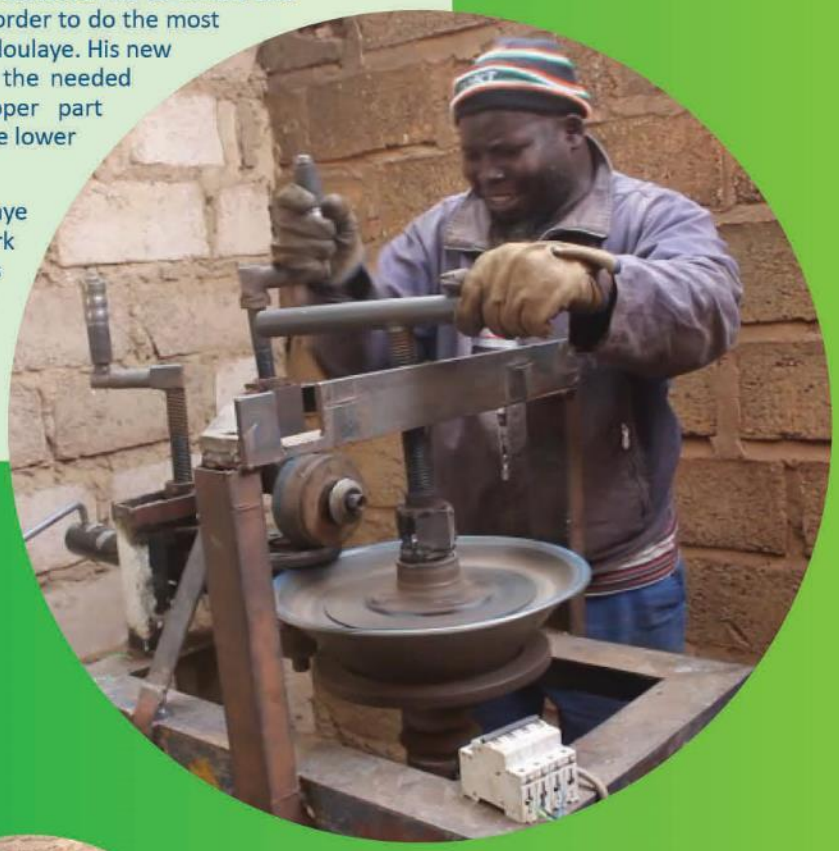
Applied innovation in Burkina Faso: The invention of an improved stove manufacturing tool

Abdoulaye Diallo is an artisan trained by EnDev Burkina Faso in stove production. In the capital Ouagadougou where he lives, like in all large Burkinabe cities, the daily wood fuel consumption is high: 2.7kg wood and 1.1kg charcoal per household.

In order to create awareness for the need of saving firewood and to promote modern energy for cooking, EnDev Burkina Faso supports stove producers in manufacturing efficient, durable and affordable stoves for the population. The improved stoves market is currently booming and demand is growing. However, almost the entire production is manual and the product does not completely satisfy the customers. Aware of this fact and with the intention to improve the productivity of his activity, Abdoulaye developed a machine that allows the mechanising of improved stoves production.

"The most complex and difficult task in the manufacturing process is creating the layers at the border of the stove's upper part. This slows down the work and makes it strenuous. That's what motivated me to invent this machine with the support of EnDev in order to do the most difficult parts of the work", explains Abdoulaye. His new tool creates layers on the borders of the needed components: particularly on the upper part which supports the cooking pot, and the lower part which is the base of the stove.

Thanks to his invention, Abdoulaye reduced the strenuousness of his work while increasing the quality of his stoves as well as increasing his production by 50%. With five employees in his workshop, he is one of the artisans who professionalise the improved stoves value chain in Burkina Faso.



C. Results from Surveys

In 2017, 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.

Benin: Verification in a changing solar market

In an RBF project, verification triggers incentive payments and is therefore a cornerstone of the approach. At the same time, verification can be used to support companies in their development, as data collection and verification strengthens their relations with their retailers, improving product tracing, customer feedback and internal accounting processes.

When EnDev started the RBF project for solar systems in Benin, the market was underdeveloped and companies imported less than a hundred products at once. EnDev developed a verification approach that was adapted to the needs of the companies at that time. The approach proved to work as companies flourished and sales increased, yet it also yielded unforeseen effects. For example, companies could submit claims containing any number of systems and could submit as many claims as they wanted. While at the beginning this approach gave companies the maximum freedom and flexibility, this turned into a challenge for implementation. It allowed for extreme situations such as a claim for only two picoPV systems sold, or submitting four claims in the same month by the same company. The new call in February 2018 will impose stricter rules to the by now more mature companies, including a minimum threshold per claim and a maximum number of claims per year.

The field verification posed similar challenges. When non-Lighting Global-certified solar home systems were included in the RBF, EnDev Benin verified 100% of systems, i.e. each claimed system had to be verified in the field by an engineer to check product conformity and installation quality. If problems were encountered, the company had the chance to revisit the installation, followed by another verification by EnDev to make sure all corrections were implemented. This meant that it was sometimes necessary to have a three-day field visit to verify just two customers of solar home systems (for the second time), due to the remoteness of clients. Several claims had to be lumped together into a field visit to avoid verification costs being higher than the incentives themselves. This approach reduced costs, but resulted in long delays in the verification process, thus frustrating companies. Increasing sales, standard of assessment, and attempts to externalise the verification to independent consultants, which took months to implement and resulted in only one candidate being fit for the task for the moment, quickly turned the technical field verification into a bottleneck.

EnDev Benin tackled these process challenges twofold. In the short term, the percentage of systems that were physically inspected were reduced to 50%, while the remaining 50% were verified through a 15-minute phone verification. EnDev also trained a junior engineer, who temporarily verifies systems in the field. In the medium-term, the new call significantly reduces incentives for non-Lighting Global-certified solar home systems to push for more certified plug-and-play systems on the market, which reduce the need to technically inspect the products. Additionally, further externalisation to more verification consultants based in different regions of the country will lead to faster processing of claims.

Peru: Sustainable ICS maintenance through local technicians

Background: Since 2012, EnDev Peru has provided technical assistance to the National Cooperation Fund for Development (FONCODES) of the Ministry of Development and Social Inclusion, for the mass

dissemination of improved cookstoves (ICS). As part of this assistance, EnDev conducted trainings with the objective to develop the skills of local technicians (so-called Yachachiq) so that they are able to install and repair ICS. In order to find out the current situation of these local technicians, a telephone poll was carried out in coordination with FONCODES, targeting technicians trained between 2012 and 2014.

Methodology: The methodology used is based on telephone surveys, carried out with the EnDev Surveys app. The database consisted of 166 local technicians located throughout the country. The objective was to assess if trained local technicians provide the service of installation, maintenance and/or repair of improved cookstoves even after their work with FONCODES is finalised.

Results: Out of the 166 technicians, about one third could be reached via telephone (49 technicians). 61.2% Yachachiq (i.e. 30 technicians) of the respondents indicated that they installed or repaired ICS independently in the previous year. Out of these Yachachiq, 28 (93.3%) indicated that they had carried out the complete installation of an ICS while 14 (46.7%) had repaired ICS parts, i.e. 12 technicians did this additionally to the full ICS installation. The most common parts of an ICS, which had been repaired, were: chimney (26.7%), combustion chamber (13.3%), metal grill (6.7%) and ferro-cement tile (6.7%). Another 7 Yachachiq stated that they carried out only maintenance work (cleaning of the stove).

Conclusions: The results of the survey show that the trainings in installation and repair of ICS have supported the development of skills of local technicians. Even 1-3 years after their participation in the FONCODES project, the majority (of the reached) Yachachiq continued to work as service providers for the installation, repair and/or maintenance of ICS in their local scopes. Therefore, we assume that local technicians contribute to the sustainability of ICS in their regions.

New low-carbon technologies for cooking tested in Peru

Background: In Peru, clean cooking programmes in rural households are implemented in a joint effort of the state and the private sector. However, many families continue to use traditional cookstoves. Therefore, within the framework of the design of a NAMA project for Universal Access to Sustainable Energy led by the Ministry of Energy and Mines with the support of EnDev Peru, alternative technologies for cooking that are sustainable, effective and innovative are being investigated and validated.

Methodology: A pilot field study with nine households was carried out. Three households each from the Coast, Highlands, and Jungle were interviewed using entry and exit surveys as well as continuous monitoring to evaluate the operation, acceptance, usage preferences, recommendations for improvement and impacts of new low-carbon technologies for cooking. Tested cookstoves were: (I) GoSun Solar Cooker (adapted to the local context), (II) TLUD Champion Servals Gasifier, and (III) FINCA Gasifier (adapted to the local context). The data collection period was from November 15 to December 20, 2017.

GoSun Solar Cooker

TLUD Champion Servals Gasifier

FINCA Gasifier

Results: The following results were obtained after analysing the aspects of acceptance of the three types of cookstoves. (I) GoSun Solar Cooker: on the Coast, the households were satisfied with the performance of the cookstove 44% of the times used (for some meals, the stove did not work as expected), while in the Highlands, the households accept it in three quarters of cases, and in the Jungle two third of times it is accepted. (II) The TLUD Champion Servals Gasifier was accepted least by users:

on the Coast, households accept the performance of the cookstove in 27% of the times used, in the Highlands, is was accepted in 31% of cases, while in the Jungle, households were satisfied in 42% of cases. (III)The TLUD FINCA Gasifier had slightly higher acceptancy rates: on the Coast, 20% of the times used households accepted the new cookstove, whereas in the Highlands 43% and in the Jungle 37% of the stove performance was satisfying to the households testing the model.

Conclusions: Although the households mostly accepted the new cookstoves, they proposed adjustments to be made to improve their operation. In the case of gasifiers, for instance, some improvements are required for recharging the fuel supply, for stability and safety because it can cause burns. One of the most outstanding results is the acceptance, which the GoSun Grill solar cooker has achieved, households highlight its versatility for cooking various types of food. However, it is subject to weather conditions. In general, it is concluded that it is necessary to continue improving the adaptability of the technologies to the cooking practices of households in different areas, as well as to continue developing new pilots to know the perception and expectations of users.

Selected user feedback: (I) GoSun Solar Cooker: "It is easy to use, it is much more efficient when there is high solar intensity, it allows other activities, it can be used better when there is more sunlight intensity, it allows to save firewood, I would like to have a device to boil water" Sara Guerrero Mundaca, Coast region. (II) TLUD Champion Servals Gasifier: “It consumes less firewood compared to a traditional cookstove. For fried meat, it is excellent. Easy to use, however, it is important that the supports have a better stability, because it could cause turning of the pots. In addition, it is important to place an accessory that allows to feed the firewood without removing the pots. The burner should be a little wider in such a way that it allows placing pots with larger diameter” Nancy Cervera Pérez, Highlands region. (III) TLUD FINCA Gasifier: “The gasifier is very fast, consumes little wood, some arrangements mainly in the supply of firewood and the overheating of the outer cylinder are necessary. I am willing to buy one of these” Eufemia Perez Olano, Jungle region.

Nepal

Nepal
- Family duties have become more comfortable at night with electricity

Bishrupa Rai, a 70-year-old grandmother from Tulsingtar is happy to see her village lit up with electric bulbs at night. Just a year back there was no electricity in her village and the people had to depend on kerosene lamps for lighting purposes. Since the installation of the Rawa Khola Integrated Water Mill Electrification Project in April 2016, people in Tulsingtar have access to reliable electricity services. Mrs. Rai says "Electricity has helped me in my daily chores, especially at night. I can see properly and this helps me take care of my four grandchildren with ease. Children wake up at odd hours at night and the electricity made it easier for us to take care of them even at those times."

D. Lessons learnt from failures and challenges

Peru: How can we leave no one behind?

The urgent need of understanding energy access (especially clean cooking) as a public energy service for profitable operation and maintenance models

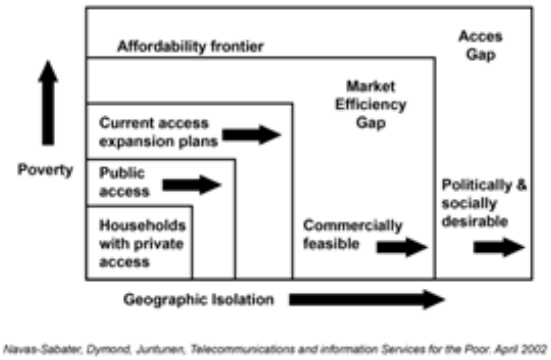


FIGURE 1: MARKET VS ACCESS GAP IN PUBLIC SERVICES

"Ensuring access to affordable, reliable, sustainable and modern energy for all" is one of the targets of SDG7 related to energy. EnDev contributes to this goal, striving through a market-based approach to reach the "last mile" with modern energy services like electrification or cooking technologies. However, this work implies different challenges depending on how far this last mile is. Since in highly electrified Latin American countries like Peru, the very last electrification gap matches the extreme poverty rate, the very last mile implies in addition to very complicated logistics and disperse population, low power demand and daily income levels below USD 2 per capita. These conditions prohibit that market forces alone ensure sustainable energy for all, as already argued in the literature of public services.[27]

The higher the electrification rate, the higher not only the challenges related to the technology and the business models to provide access to "the last mile", but also the need for government involvement with specific sector regulation (Figure 1). Therefore, the operation and maintenance (O&M) costs of recent electrification projects in Peru with stand-alone technologies like solar home systems, rely partially on cross-subsidies from big energy consumers.[28] Since 2010, a specific sector regulation ("rural photovoltaic tariff") supports providing access to electricity to nearly one million people, which is 3% of the total Peruvian population. It is the government's main tool for closing the electricity gap off-grid. Due to EnDev´s support to utilities and contractors in these projects, we learned on the ground that for some of those poor families, this was the only way to get access to the technologies and most important, to an O&M service for them. In addition, we learned that these families are just the peak of the electricity-gap iceberg, hence leaving the most isolated and poorest households for the future. So why should we expect that those still lacking access should buy themselves a solar system or a picoPV lamp, while richer citizens in urban areas pay only for an electricity service? Leaving no one behind still may imply supporting markets, but maybe not a technology-market, but rather a service-market, just like other public services such as water, telecommunications or even energy.

On the other hand, despite several efforts of the Peruvian government investing in modern cooking devices, still one third of the population cooks at least partially on open fire. In the same line, globally the electricity access gap is falling while the inefficient cooking with solid fuels is increasing. Therefore, in the framework of the global climate agenda, EnDev Peru in alliance with the Energy Ministry are proposing specific sector policies for closing the electrification and clean cooking gap. This includes the comprehension of clean cooking as an energy public service like electrification, hence integrating an O&M scheme driven by private companies for clean cooking technologies like improved improved cookstoves.

[27] Navas-Sabater, Dymon & Juntunen, 2002.

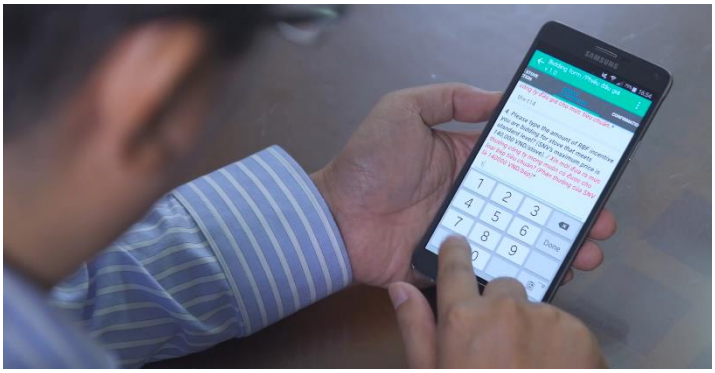
[28] Current cross-subsidy regulation covers at least 50% of O&M costs for households consuming monthly less than 30 kWh, from a specific fund feeded monthly by 3% of all electricity bills outstriping 100 kWh

Mekong Region: Listening to partners and beneficiaries is vital for improving the project set up, and a little patience is needed for success

SNV, the implementing partner of EnDev's Mekong Region RBF project, which supports the up-take of Advanced Biomass Cookstoves (ABC), carried out several studies in Vietnam, Cambodia and Laos and gathered feedback from companies taking part in the *Stove Auction*. Three vital lessons from the studies and the implementation of the project are presented below.

A challenge observed in Cambodia and Vietnam was the issue of durability of some of the stoves despite an overall satisfaction with durability. Users reported this when interviewed. SNV took the feedback seriously and started looking into this matter. They found that all of the interviewed people who experienced a stove failure made use of the warranty service, showing high consumer education and well-working after-sales service. A very essential feedback from the private sector was that the strict application of the verification system led to discouragement of companies to report claims for incentives. In the Mekong Region project, the whole claim will be rejected if just one customer cannot be verified. It seems that the companies decided to not report customers of which they are unsure if they can be reached rather than including them in the claim and not receive the incentive for a whole badge of customers. Hence, the reported market effect is actually much smaller than the overall market of the stoves truly is.

A general lesson learnt from the past few years implementing the project is that RBF works best in markets that already exhibit certain pre-conditions and readiness for the uptake of an RBF mechanism. The three countries in the Mekong Region required significant up-front preparation for the ABC market to reach the point where RBF schemes could take hold. Higher levels of 'traditional' technical assistance were required, for instance, to support stove technology development, and to prepare market actors for participation in the RBF project. A well-functioning RBF project with disbursement and verification mechanisms is no easy feat and takes time. It is important to plan realistic timeframes, and to have endurance, as markets require time to mature.



Vietnamese ABC producer participating in phone-based RBF auction. Photo: © SNV Vietnam

Integrated planning for electrification – lessons learnt in Mali

In early 2017, EnDev Mali changed its approach by focusing its activities more on a geographical area (a 'cercle' or sub-province). The activities include a full range of PV technologies to serve various demands in the vast rural area of Mali. More than 44 villages in the cercle of intervention were visited to identify the best technical approach. About five of those villages were sufficiently large so that a mini-grid was expected to be suitable, and a feasibility study was carried out in the most dynamic one. The study, which considered consumption profiles, showed promising findings, yet doubts about the sustainability were raised.

When the Malian president visited the village, he promised electricity access and the construction of a paved road to the village. The EnDev project was pushed to continue with the installation of a mini-grid, however, it decided to first compare the stand-alone solution with a connection to the national grid as the grid is only about 30 km away from the village. A connection to the national utility EDM would generally be preferred in a political context (more flexible, lower tariff) and could complicate sustainable exploitation of a mini-grid if executed.

In its study, EnDev compared the scenario of installing a mini-grid in the village and hybridising another village close by through AMADER with World Bank funding with the alternative scenario of extending the grid over 30 km thus connecting both villages to the national grid. The study concluded that connecting both villages to the grid was overall the preferred option, being more economical and offering a better long-term perspective.

EnDev shared its findings with AMADER and the World Bank who were already preparing the hybridisation. The project contacted multiple stakeholders and after intensive communication, the World Bank revised its budget towards a grid-connection plan. Discussions on governmental level are ongoing. It is a sensitive subject as the ministry without proper compensation-measures has forced the transfer of some of the AMADER networks to EDM. Instead of reinforcing the sector in which both structures are complementary, this tends to separate visions.

The most important lesson learnt is to consider all options for electrification and choose those that are most suited and sustainable, and to do so from the start. EnDev Mali got delayed in the process, however, has launched the discussion for grid connection of multiple villages through AMADER/ World Bank. Meanwhile, the mini-grid study of EnDev continues in other villages further away from the national grid (70km), where standalone networks are expected to be the proper solution for 15+ years to come.

EnDev thereby seeks to include the national grid as a solution for rural electrification in specific cases, and use its lesson learnt to improve exchange on sustainable electrification on a national level. Among donors, this experience is used to encourage collaboration between executing parties and further push a mapping of (rural) electrification.

Mali

How a village mini-grid became a model of success nationwide: N'Tjiba in Mali

An EnDev installed hybrid mini-grid with 50KWp PV capacity in the municipality of N'Tjiba in Mali is boosting the already dynamic 3,000+ inhabitants village of Faladié. The village is situated at about 60km distance off the grid along an unpaved road. It is home to an innovative project since hybrid mini-grids, prepaid metering, 24/7h service and commissioning by the communal office were all new in Mali. Exploitation of the network is delegated to a private operator. Hybrid mini-grids with prepaid metering are getting common practice in Mali now. The 24/7 service level and communal commissioning are getting more and more interest as well and multiple donors actually visited the network.

The financial contribution and active involvement of the communal office has led to a high ownership in the village. Transparent management is combined with a control system engaging themunicipality, operator, village representatives and clients. A separate fund for replacement of equipment is put in place. While impact of ownership can only really be evaluated in the mid- to long term, other impacts are evident already.

The population multiplied their productive activities since gaining access to 24h electricity supply. They are aware that they pay more for electricity as people in Bamako do, yet on village level it is considered an economical option. Several people actually came back from Bamako to N'Tjiba due to the electrification; multiple new shops and services opened. An IT service came available, more complex tailoring and embroidery formerly only done in Bamako became available at two places in the village, barbers now use electric equipment, a welder announced he wants to come to the village and 52 fridges/freezers are installed for cooling, with more to come. The cooling is mostly used for drinks, locally produced juices, some fish and medicines/vaccines. The three or four fridges on gas that had existed are no longer being used.

Though the availability of energy-efficient equipment is limited, the first clients have started to optimise their installations, especially those using electricity for productive use. In general, the development of the village due to the electrification is surpassing expectations.

While the effect on productive use is important, social services evidently also profit from the electrification, like the local clinic, pharmacy and a school, which aims to integrate IT in its operations. The municipality contributed financially in the project, and today in turn receives free public lighting as well as increased revenues from taxes of entrepreneurs who use electricity. Further extension of the capacity will be necessary to service the whole village as requested by the residents.

E. Global trends and EnDev's cooperation with other players

Global trends

In 2017 the findings of various studies under the SE4All agenda made it clear that the ambitions of SDG7, including access to energy, will not be reached at the current pace. The 2017 Global Tracking Framework showed that without additional efforts a maximum of 92% of people will have access to electricity and 72% to modern cooking services in 2030. SE4All's Energizing Finance report revealed a significant annual financing gap to be closed by public and private actors collectively. At the same time progress on providing energy access did progress considerably, but very skewed in technologies, regions, countries, and in particular in the case of cooking energy, insufficient to keep pace with population growth. On the global lighting agenda it was observed that the increase in market share for Lighting Global certified high quality products (through cash sales) is slowing down, in part also due to quality improvements in the non-Lighting Global segment of the market. PAYGO business models are growing strong with many new entrants. On the other hand the limitations of the model are becoming more clear, in terms of obtaining working capital, high final consumer investments, and the challenges of a complex business model (mixing financial and technical services), increasing default rates while going into weaker segments of the market (bad debt ratios), and an increasing competition in a weak market. In addition, the call for more attention for reverse logistics, i.e. E-waste, becomes stronger. PAYGO companies take an increasing interest in providing higher tier services where the business model is more profitable, but client base is much lower. Cash sales still dominate the lower tiers.

Global efforts to develop the mini-grid sector have so far not resulted in an overall acceleration of the construction rate of sites. In spite of large funds, meanwhile partially reallocated, available for implementation developing this sector, its policy and enabling environment, proves very complex. Some good examples can nevertheless be found. It will require a long breath and even more coordination between public and private sectors, and development partners to successfully role out mini-grids on a large scale. EnDev's role in the sector needs focus as well, which will be reflected in its 2018 strategy revision.

Efforts in the clean cooking sector have increased modestly in 2017. The World Bank has stepped up its engagement by exploring investment programs in several countries, in Bangladesh e.g. through a submission at the GCF (approved March 2018). New business models are being developed mainly based on a combined tools and fuel approach. Focus in the sector has further increased towards higher tier solutions, driven by a strong health perspective. Countries with large LPG programs dominate progress on the clean cooking agenda and the push for intensifying LPG access for cooking increased further in 2017. The Global Alliance (for Clean Cookstoves), on the basis of an elaborate stakeholder investigation, has presented the design of their third phase which also focuses (also for lack of resources) on the industrial segment of the market, i.e. LPG, ethanol, and biomass pellets fuels. The larger donor community seems to however be searching for a renewed position in the sector. In spite of the multidimensional impact of clean cooking, international funding comes from the energy and climate agenda, and engaging e.g. donors on a health agenda proves difficult.

Lately the discussion, with a pioneering role for EnDev, on whether or not the focus on the cleanest fuels is justified is getting stronger. Two perspectives broaden that discussion; on one hand the definition of "clean" in cooking, as promoted by WHO and others is considered as too narrow since it does not consider important factors as ventilation, fuel preparation, and exposure. Looking at cooking from a non-binary perspective, i.e. beyond the emission of the stove, as is being done by EnDev (in its cooking energy system approach) and ESMAP (in the further elaboration of the MTF for cooking energy) offers a much broader suite of solutions for clean cooking energy, including –as an intermediate solution- quality artisanal stoves. Second, a leapfrog to cleanest solutions only is unrealistic on the basis of current technology and business models. Transitioning the sector will go through a broad spectrum of better and less good temporary solutions, technically and business models, which are also influenced by fuel availability, behavioral changes, and economic development at country or even sub-country level. The Netherlands Environmental Assessment agency has started

a modeling study into transition scenarios for clean cooking towards 2030 providing input to that discussion.

EnDev well placed in focal themes in the run-up to the SDG7 review

In 2017, the preparations for the UN-HLPF review of SDG7 (July 2018) started. An elaborate stakeholder process preparing a series of policy briefs on various SDG7 subtopics and regions took place towards the end of the year. The discussions and the draft briefs underline the need for accelerating efforts to achieve universal energy access. EnDev is well positioned to contribute to many of the themes addressed in the policy briefs, especially considering the importance that is given to closing the large local human and institutional capacity gap, and the need for on-the-ground innovations, as well as the urgency to act on clean cooking. EnDev is operating at the heart of these topics, working with local companies and entrepreneurs, local NGOs and government institutions on both the national and subnational level. Other topics, like solutions for leaving no one behind, strengthen the enabling environment and for economic development through productive use of energy are on EnDev's agenda for strengthening in its current strategy considerations as well. In addition, the lack of data on energy access, from policy and investors sides, is identified as a major bottleneck in the sector. Through its contributions to the MTFs, the Cooking Energy System, and in general its monitoring system, EnDev already contributes that topic.

Bangladesh – growing a stove business and achieving prosperity

Mr. Khaled Md. Abdullah is a person who has overcome difficult circumstances and is now a perfect example for all the Bondhu Chula entrepreneurs to follow. He is the owner of Grameen Sanitation, which is located in Ashulia near Dhaka.

Khaled is originally from Gaibandha district of northern Bangladesh, where he had a small sanitary shop. After he came in contact with Bondhu Chula staff in 2012, he started his own stove business. Bondhu Chula programme has been supported by EnDev since 2006. Its activities were later taken over by Bangladesh Bondhu Foundation (BBF) after its establishment in 2015.

In the beginning, Khaled used to install domestic Bondhu Chula stoves and soon became popular because of his good quality stoves. A divisional manager of BBF asked him to join the training on Commercial Bondhu Chula in Joypurhat district, which he did. After having attended the training, Khaled started a new journey of installing commercial stoves in different hotels, restaurants, tea-stalls, community centers and many more small firms.

A good business opportunity opened up for him as he was invited to an Engineers' Forum in Rangpur, where he received several stove orders. This was the beginning of orders from different regions of the country. After initially installing five commercial stoves in Ashulia, he got more and more orders from the regions of Ashulia and Dhaka. Finally, he decided to shift his business to Ashulia and moved there with his family. He received considerable help from BBF.

After a lot of hard work, Khaled is now an established Bondhu Chula partner. His monthly income is between BDT 120,000 and 160,000 through the stove sales. He employs four staff and bought a motorcycle and a pickup van for quick delivery of stoves. His two sons and his daughter attend reputable schools and achieve good grades in their exams. Khaled says, "All this has become possible because of my Bondhu Chula business".

Bangladesh

Sensitisation of women on the benefits of improved cookstoves makes an impact in Bangladesh

EnDev Bangladesh has been promoting the use of improved cookstoves under the brand name 'Bondhu Chula' since 2006. Bondhu Chula is an efficient improved cookstove that saves fuel and prevents indoor air pollution by using a chimney. So far, EnDev has helped install 2.5 million Bondhu Chulas in Bangladesh. Since February 2015, Bangladesh Bondhu Foundation (BBF) has been managing the activities of the Bondhu Chula programme.

Dipali Rani is a user of Bondhu Chula who lives in the railway settlement of Netrokona district in the northern part of Bangladesh. Netrokona is densely populated and narrow, and the way inside is muddy and slippery. All residents of this neighbourhood are very poor.

Dipali is a housewife and mother of two daughters, Puja and Shima, who both attend local schools. Dipali's husband is a day labourer and they do not have much money. The family lives in a small room where all their daily activities, such as sleeping, cooking and the children's homework, take place.

Dipali became interested in the Bodhu Chula after being informed about the disadvantages of traditional inefficient stoves from the staff of BBF. She received information about medical conditions like asthma, headache, cancer and eye diseases. Dipali's left eye is sensitive to kitchen smoke. She has been suffering from eye problems since childhood. She and her daughters faced serious health problems, especially eye irritation, when cooking with traditional stoves. It was impossible for them to study inside the room when the old stove was used. They had to spend a lot of time to collect fuel for cooking, and they used to miss school often.

The family decided to buy the improved cookstove and today, a chimney of the Bondhu Chula can be seen on the roof of their house. When cooking, the indoor air remains pollution free because the smoke goes out through the chimney. Dipali says that over the last year she saved BDT 2000 (approx. EUR 20) in fuel costs. She does not have any eye problems anymore and her daughters can study inside the house at all times.

Just as Dipali, numerous other women and their families have benefited from energy-efficient, clean cookstoves in Bangladesh.

Bangladesh

Mali

Improved security and governance through streetlights in conflict-prone northern Mali

Since the installation of streetlights in Gao, northern Mali, people gather in the street at night to meet friends and neighbours and to conduct economic activities after dark.

Stakeholders of the local community such as officials, traditional authorities and youth and women groups were consulted to determine the streets to be illuminated. Local entrepreneurs from Gao were trained and involved in the works to set the foundations and install the streetlights.

Abbreviations

ABC	advanced biomass cookstoves
ABPP	Africa Biogas Partnership Programme
ADES	Association pour le Développement de l'Energie Solaire, Switzerland
ADES	Association pour le Développement de l'Energie Solaire, Madagascar
AEPC	Alternative Energy Promotion Centre, Nepal
AHPROCAFE	National Coffee Growers Association, Nicaragua
AMADER	Agence Malienne pour le Developpement de l'Energie Domestique et de l´Electrification Rurale, Malian Agency for Household Energy and Rural Electrification, Mali
ASS	After Sales Service
BBF	Bangladesh Bondhu Foundation
BCE	Biogas Construction Enterprise
BCE2B	Business-to-Business
BIRU	BIogas RUma indonesian for Household Biogas
BMZ	the German Federal Ministry for Economic Cooperation and Development
BO	beneficiary organisations
CDM	Clean Development Mechanism
CfP	Call for Proposals
CLASP	Collaborative Labelling and Appliance Standard Programme
CPO	Construction Partner Organisations
CREDELEC	Word creation out of „crédito" and „electricidade", Mozambique
CREE	Community Rural Electrification Entities, Nepal
CRRF	Comprehensive Refugee Response Framework
CSC	Customer Service Centre
CSI	Credit Sanctioning Incentive
DELAPAZ	Electricity Distribution Company of the Department of La Paz, Bolivia
DEZA / SDC	the Swiss Agency for Development and Cooperation
DFID	the UK Department for International Development
DJEBTKE	Directorate General for New and Renewable Energy and Energy Conservation
DRC	Democratic Republic of the Congo
EDCL	Energy Development Company Limited
EDM	Electricidade de Moçambique/ Energy Public Utility, Mozambique
ELCOM	ELectrification COMmunale, Mali
EnDev	Energising Development programme
EOI	expression of interest
EPC	engineering, procurement, construction
ERC	Energy Regulatory Authority, Kenya
ERSEN	The Rural Electrification Senegal Programme

ESMAP	Energy Sector Management Assistance Programme
FASERT	Fund for Sustainable Access to Thermal Energy
FOCAEP	Central American Fund for Access to Sustainable Energy and Poverty Reduction
FONCODES	National Cooperation Fund for Development, Peru
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GOM	Government of Mozambique
HEP	national household energy platform, Bangladesh
HH	households
HIVOS	Humanistisch Instituut voor Ontwikkelingssamenwerking
ICS	improved cookstove
IDCOL	Infrastructure Development Company Limited
IDCOL	Infrastructure Development Company Limited
iQC	independent quality control
IVA	independent verification agent
IVA	independent verification agent
IWME	improved water mills electrification
KESDM	Ministry of Energy and Mineral Resources, Indonesia
KOSAP	Kenya Off-grid Solar Access Programme
KPI	key performance indicator
KPT	kitchen performance test
KWFT	Kenya Women Finance Trust
LDC	least developed countries
LMEs	last mile entrepreneurs
LWF	Lutheran World Federation
MARD	Ministry of the Agriculture and Rural Development, Vietnam
MCC	Millenium Challenge Corporation
MCF	Mully Children's Family
MEMD	Ministry of Energy and Mineral Development, Uganda
MEMR	Ministry of Energy and Mineral Resources, Indonesia
MFA / DGIS	the Netherlands Ministry of Foreign Affairs Directorate-General for International Cooperation
MFA-NOR	the Norwegian Ministry of Foreign Affairs
MFI	micro finance institution
MHP	micro hydropower
MINEM	Ministry of Energy and Mines
MININFRA	Ministry of Infrastructure, Rwanda
MME	Ministry of Mines and Energy, Cambodia
MOAP	Market Oriented Agriculture Programme, GIZ/EU, Ghana

MoEF	Ministry of Environments and Forests, Bangladesh
MOEn	Ministry of Energ, Ghana
MoEP	Ministry of Energy and Petroleum, Kenya
MoF	Ministry of Finance, Vietnam
MoU	Memorandum of Understanding
MPE	Ministry of Energy, Senegal
MTE	mid-term evaluation
MTF	Multi-Tier Framework
MZM	Mozambican Metical
NAMA	Nationally Appropriate Mitigation Actions
NAPE	GIZ nutrition and education project
NDCs	Nationally Determined Contributions
NEA	Nepal Electricity Authority
NIBC	Nepal Interim Benchmark for solid biomass Cookstoves
NIS	Nordic International Support Foundation
O&M	operation and maintainance
ODA	Official Development Assistance
PASES	Projet d'accès aux services électriques des localités de petite taille dans la région de Sédhiou / EU-co-funded electrification project, Senegal
PAYC	Pay-As-You-Cook
PAYG	Pay-As-You-Go
PHC	Primary Health Centres
picoPV	pico photo voltaic
PICS	portable improved coostoves
PMU	Production and Marketing Unit, Vietnam
PO	Partner Organisations
PO	partner organisation
PPP	public private partnership
ProCEAO	Programme pour l'Energie de Cuisson économique en Afrique de l'Ouest/ Cooking energy in East-Africa
PU	productive use of energy
QPI	Quality Plant Incentive
RBF	results-based finance
REA	Rural Electricification Authourity
REG	Rwanda Energy Group
RF	Revolving Fund
RISE	Regulatory Indicators for Sustainable Energy
RUMI	Rural Mini-grid Management Model, Indonesia
RVO	Rijksdienst voor Ondernemend Nederland

SACCOs	savings and credit cooperative societies
SAFE	Safe Access to Fuels and Energy
SBEE	Société Béninoise de l'énergie électrique/ Benin Electric Energy Society, Benin
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
SIF	Special Initiative for Refugees (GIZ)
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
SSIC	Student Stove Innovation Challenge
SWC	Social Welfare Council
SWH	solar water heaters
TICS	Tanzania Improved Cook Stove programme
UNACC	Uganda National Alliance for Clean Cooking
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Human Rights
VGS	voluntary gold standard emission reduction certificates
VMEEA	Vice Ministry for Electricity and Renewable Energy, Bolivia
VSLA	Village Savings and Loan Associations

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Energising Development

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
Registered offices Bonn and Eschborn, Germany

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
E endev@giz.de
I www.endev.info