GAIA
IMPACT FUND

IMPACT REPORT 2019

About us

Gaia Impact Fund is a French venture capital fund created by a team of entrepreneurs which specialized in renewable energies and impact investing. Our goal: support sustainable and innovative initiatives dedicated to energy access.

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Foreword

It was in the early 2000s, after many voyages, that we started to realize the social and environmental challenges faced by our planet. We realized the extent of our responsibility as ordinary citizens of the world, but also as entrepreneurs. We thus decided to enter a new field of activity and create a company that would produce renewable energy (solar and wind) in France. Willing to push further our commitment toward a new inclusive energy transition, we also chose to create an endowment fund, Synergie Solaire (Solar Synergy), open to all companies in the renewable energy sector.

Supporting energy access projects in developing countries through grants and subsidies is necessary in some cases such as at the beginning of entrepreneurial projects or in certain fields like education and health. However, we quickly figured out that this system alone would fall short of initiating a self-sustained model, we thus started contemplating how to operate differently. We sought to find a sustainable and inclusive economic model with projects that would promote local economic development. As we witnessed the emergence of young ventures specializing in energy access, particularly in Sub-Saharan Africa and South-East Asia, we decided to create Gaia Impact Fund in 2016 to support entrepreneurs in emerging countries.

We are convinced that small and medium-sized enterprises (SMEs) play a critical role in fostering economic activity worldwide, and especially in emerging markets where they are responsible for generating more than 50% of the overall job creation while contributing to 35% of the gross domestic product. SMEs help diversify a country's economic base, they promote innovation, bring goods and services at the best price to those at the bottom of the pyramid, and are a powerful force in favour of gender and youth integration into economic life.

However, despite their multiple economic, social and political benefits, small and medium-sized enterprises remain significantly under-served by financial institutions. Several business climate surveys conducted around the world have shown that difficulty in obtaining financing is generally one of the three main factors impeding SMEs' development.

Creating Gaia Impact Fund is a way for us to tackle this challenge. We believe in the key role companies play against poverty by supporting economic growth and job creation. We believe in the role of the entrepreneur as a catalyst for change.

We have chosen to place entrepreneurs at the center of our mission and support them on any issue they face, be it related to strategy, financing, accounting, HR, marketing, business development, data, or anything else. This form of collaboration is greatly appreciated by entrepreneurs who, in our opinion, should be able to consider their funder as a real partner.

The adventure that began almost 3 years ago, and the experience which was acquired by investing in eight companies, has comforted us in our choices and strengthened the initial vision of Gaia Impact Fund's project: to be an investor partner that can catalyze the global emergence of renewables for the benefit of populations, to be active and responsive in the crucial startup phase of a company, and to support entrepreneurs' ambitions towards a model of profitable, sustainable growth that generates jobs and opportunities with a high social and environmental impact component.

As we prepare to open our capital to new investors, it is time to analyze and disseminate the experience of our early years. Our ambition for Gaia Impact Fund - to become a major player in a sustainable and inclusive transition - must be judged by the facts. Measuring and reporting on our activity and impact is a central objective. The distribution sector of Solar Home Systems, which Gaia has supported through five companies over the past three years, is now facing the challenges of maturity in many markets. This first impact report, which merely focuses on this sector, seeks to explore with greater depth how these companies can pursue their momentum in this new environment and answer questions such as: who are my customers? What real value am I in a position to bring them? Have I built a brand and a sustainable footprint in my community? And above all: what is my impact?

Hélène DEMAEGDT, President of Gaia Impact Fund

Table of figures

Executive Summary

This impact report reflects the progress made by Gaia and its partners during our first two years of existence.

We have combined the experiences of our partners in the field with the conclusions provided by academic research to achieve a deeper understanding of the impact of renewable energy. We have focused on two levels of impact: the impact of the fund on the companies it supports, and the impact of the companies themselves on end-users. Finally, we have backed this data with targeted studies on subjects which have emerged as central and yet under-explored in our discussions with entrepreneurs.

Our results are revealing of our progress so far as well as what remains to be done. The deployment of solar kits is based on the pay-as-you-go payment system, which is already well established in East Africa (thanks to the strong penetration rate of mobile money) but has yet to be consolidated in West Africa. Decentralized energy companies themselves have a catalytic effect on development by supporting the energy transition while enabling job generation and professional training.

Access to energy shapes the life of a population. Solar kits allow users to save up to $144 in energy costs over the lifetime of a solar kit. They create economic opportunities, which are seized by more than a third of customers. Solar kits can also allow students to study up to three extra hours per week. However, they cannot remove all the constraints that limit access to education. They significantly improve the eye and respiratory health of users, as domestic pollution from kerosene and biomass combustion is responsible for four million deaths every year. Other outcomes are less quantifiable: the feeling of security, the comfort provided by better lighting, or the possibility of a more flexible schedule are all benefits reported by customers.

During our reflections and dialogues with entrepreneurs, other subjects that rarely appear in related literature have appeared central to us, including questions about climbing up the energy ladder, the transformation of energy expenditure patterns, and the development of productive uses. We have decided to explore these topics through targeted case studies.

Finding energy sources and recharging your phone has a cost, but it also takes time. Among Oolu Solar customers in Senegal, up to 52% had to travel long distances, travel to the neighboring village or pay a fee just to charge their phones. These elements are not always included when computing money savings.

Kerosene is often used as a benchmark in the solar industry. While many customers still use kerosene lamps, our case studies provide evidence of a more nuanced situation. In many cases, and after several years of decentralized solar power development, the transition to other energy sources is already well underway.

The effect of small-scale solar energy on productive activities is more incremental than transformational. It complements existing traditional activities and helps overcome basic obstacles such as the impossibility of keeping a shop open in the evening. With the development of more powerful solar roofs and the diversification of productive uses, the contribution of solar energy to the energy transition can be even greater. Domestic kits are only the beginning of this era of change.

Definitions :

What do we mean by ...

Social and environmental impact

Social and environmental impact refers to the overall consequences of an activity on society[1]. These effects include both the direct benefits to end-users and the indirect economic and environmental impacts. Impact measurement doesn't only focus on the immediate outcomes of the activity; it attempts to capture the longtern consequences of a project, which are harder to assess.

Impact fund

As an impact fund, we place these benefits at the center of our concerns. We use private investment to finance market-based solutions when they represent a viable and sustainable solution to a social and environmental problem.

Assessing and reporting on impact

Impact assessment seeks to identify, quantify, and attribute changes to the activities of the stakeholders. We gain more insight when impact assessment goes beyond this factual approach to focus on the value attributed to changes made by end-users and society. Finally, impact assessment can be used to identify the most effective means of action and how the impact of an activity can be improved.[2]

Access to energy

The International Energy Agency defines access to energy for a household as a gradual process: it refers to «a household having reliable and affordable access to both clean cooking facilities and to electricity, which is enough to supply a basic bundle of energy services initially, and then an increasing level of electricity over time to reach the regional average[3]». Access for all to clean and affordable energy has been defined by the United Nations as one of the Sustainable Development Goals to be achieved by 2030.

Decentralized solar energy

efers to the production of electricity through small or medium-sized solar installations which may or may not be connected to the grid. The companies in which we invest offer several types of solutions, adapted to several levels of need in various local situations :

• *Pico-scale solar kits. These small solar devices include a battery, a solar panel, one or more bulbs and often a telephone charging port. They are used as a direct replacement for kerosene or battery-powered lamps.*

• *Solar Home Systems (SHS). With a power typically ranging from 5Wp and 200Wp, these kits are installed on the roof of a building and can power several light bulbs, recharge phones, and sometimes be connected to other devices such as televisions or refrigerators.*

• *Solar installations for commercial and industrial use. These installations can reach several hundred kWp and significantly reduce the carbon footprint of industrial or commercial activities.*

• *Minigrids. These small-scale distribution systems, ranging from 10 kW to 10 MW, provide local electricity supply to a group of customers, alongside or independently of the national grid.*

Pay-as-you-go

Pay-as-you-go refers to a credit mechanism through which the customer pays a down payment to benefit from the product, followed by a regular payment on a weekly or monthly basis until the product is fully paid, thus lowering the upfront cost of SHS and making them more affordable to low-income customers.

Off-grid households

Access to energy is a central issue for households that are not connected to the national grid. Most of these households live in rural areas. They have to rely more expensive, often polluting, energy sources. Households with unreliable access to the grid face similar concerns.

Productive uses

Productive uses can be defined as «agricultural, commercial or industrial activities relying directly on electricity to produce goods or services[4]». While more powerful devices offer more opportunities, the entire range of off-grid solar devices can be used in a productive way. Solar Home Systems and pico-scale solar kits allow end-users to work longer or undertake new activities, such as a phone charging business. More powerful products can be used to power a wider range of activities at the household level (including refrigeration, storage, irrigation systems and solar mills), the community level, or on a different scale for industrial and commercial customers.

[1] Thierry Sibieude and Céline Claverie, "La mesure de l'impact social" (CSESS, 2011), https://www.avise.org/sites/default/files/atoms/files/20140204/201112_CSESS_Rapport_ImpactSocial.pdf.
[2] Ibid, p.14.
[3] International Energy Agency, « Energy Access Outlook 2017: From poverty to prosperity », World Energy Outlook Special Report, 2017, p.21.
[4] Benjamin Attigah and Anna Brüderle, "Productive Use of Energy – PRODUSE, A Manual for Electrification Practitioners" (GIZ, 2011), http://www.euei-pdf.org/sites/default/files/field_publication_file/150907_euei_productive-use-manual_rz_04_web.pdf.

Gaia Impact Fund Key figures

2017
First investment of the fund.

8
Early stage Investments.

4
Segments in energy access :
Solar Home Systems
Commercial & industrial customers
Minigrids
Solar tech

11
Countries in which we operate.

467
Full-time jobs created localy.

11
Contribution to 11 of the Sustainable Development Goals :
ODD 1 : No poverty
ODD 3 : Good health and well-being
ODD 4 : Quality education
ODD 5 : Gender equality
ODD 7 : Affordable and clean energy
OOD 8 : Decent work and economic growth
ODD 9 : Industry, innovation and infrastructure
ODD 10 : Reduced inequalities
ODD 11 : Sustainable cities and communities
ODD 12 : Responsible consumption and production
ODD 13 : Climate action

In the SHS segment only :

177 863
People benefitting from an improved access to energy.

44 178
Tons of CO2 avoided.

Part 1
Impact of the fund

Energy access: an essential lever for development

Access to energy has been identified as a critical issue by the Sustainable Development Goals. Providing everyone with access to clean, reliable and affordable energy is a strategic matter when it comes to enabling an efficient energy transition, economic opportunities, access to education and better living conditions.

We have created Gaia Impact Fund to support the entrepreneurs dedicated to this project.

Ensure access to affordable, reliable and sustainable energy for all

Reliable access to affordable energy is an opportunity for the one billion people still living without any access to a local power grid, but also for those with an unreliable access to it. Overall, two billion people are experiencing energy poverty. Ironically, they pay for energy at its highest price. Energy can represent up to 10% of their expenditures[5]. They have to rely on energy sources which are often polluting, sometimes dangerous, such as kerosene lamps, candles, flashlights, diesel generators, and so on. This situation has a considerable environmental cost. It also impacts the economic opportunities and quality of life of end-users, resulting in worsened health as well as the inability to study or devote more time to productive activities, all of which constitute major obstacles to development. Renewable energies can help pave a way out of this poverty trap.

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> ***In 2019, nearly a billion people still lack access to the grid. 95% live in South-East Asia or Sub-Saharan Africa, with 80% living in rural areas.***

[5] *Adina Rom, Isabel Günther, et Kat Harrison, « The Economic Impact of Solar Lighting: Results from a Randomised Field Experiment in Rural Kenya », 2017, https://acumen.org/wp-content/uploads/2015/10/Report-The-Economic-Impact-of-Solar-Lighting.pdf.*

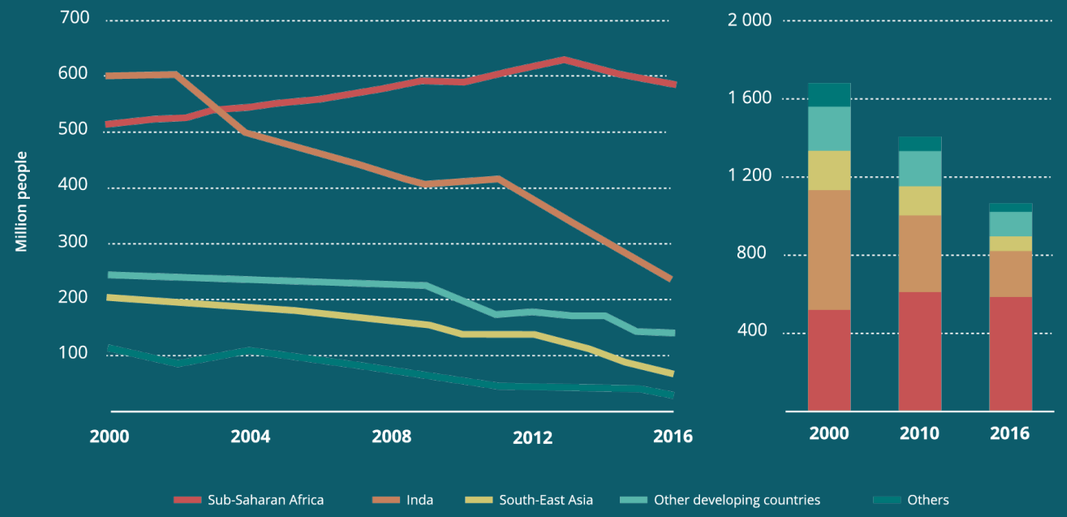


Figure 1 : Population without access to electricity in the world from 2000 to 2016

The number of people without access to electricity has decreased by 100 million every year since 2012. This progress has been dampened by high population growth in the least connected areas; in Sub-Saharan Africa, electrification efforts offset population growth for the first time in 2014.

In 2017, the number of people without access to electricity fell below one billion. Renewable energy has provided 34% of new connections since 2012; 6% of connections were achieved through decentralized solutions, through off-grid systems or minigrids. This trend is expected to expand as decentralized renewable energy is now deemed as the cleanest and most efficient way to bring electricity to rural populations. Despite this progress, only 43% of the population currently has access to electricity in Sub-Saharan Africa.

Renewable energy is a key actor for energy access

Renewables represent a sustainable and competitive solution to the challenges faced by developing countries, especially since recent technological innovations have significantly reduced their cost.

Through the development of innovative financial models, such as pay-as-you-go, renewables are increasingly accessible to rural families and small and medium enterprises. Their adoption is even more essential in developing countries, where the use of low-carbon energy paves the way for inclusive and environmentally friendly growth. According to IEA forecasts, solar panels will account for 30% of electricity generation for energy access throughout Africa by 2030, while decentralized solutions, such as Solar Home Systems and minigrids, will account for 27% of new connections[6]. In order to provide access to energy for all of Africa by 2030, more than half of the new connections must be decentralized. Solar energy would therefore account for 58% of the additional electricity generation capacity[7].

[6] *International Energy Agency, « Energy Access Outlook 2017: From poverty to prosperity », p.88. New policies scenario.*
[7] *Ibid. Energy for all scenario.*

Gaia Impact Fund : a catalyst for impact

We have designed Gaia as an impact catalyst. As an early stage investor, we give SMEs and startups at the beginning of their entrepreneurial adventure the means to achieve their full social and environmental potential.

[11] *Ibid, p.11*

« In many countries, decentralized solar solutions are now more competitive than their carbon-based alternatives.

© Solaris

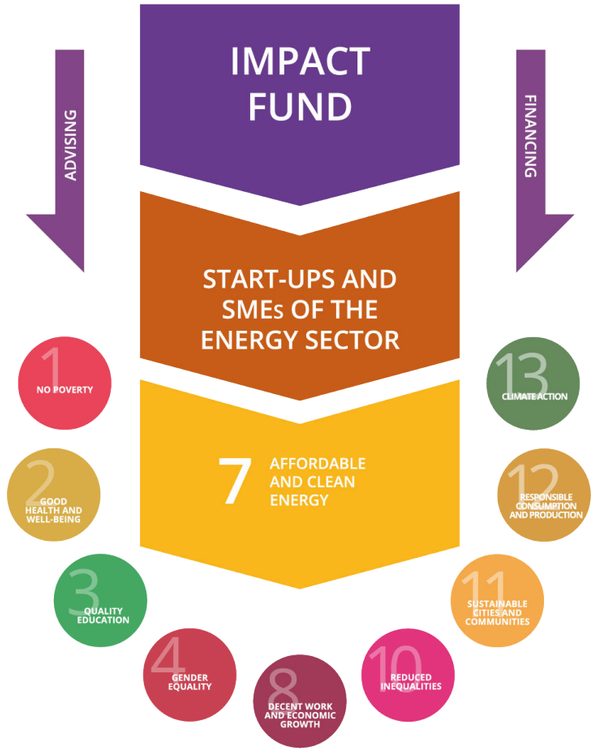


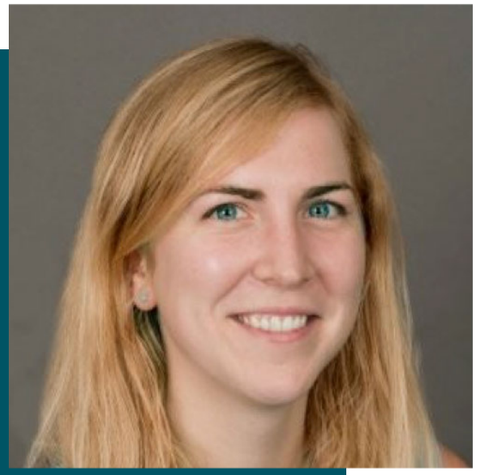
Figure 2 : Two levels of impact

Closing the financing gap through private sector investment

Access to energy, and more generally to renewables, can bring sustainable and inclusive growth to developing countries and remove the barriers that these countries face in their development. However, this opportunity poses a major investment challenge, since reaching a 70% electrification rate in Africa by 2040 represents an annual investment of $7.5 billion. Private sector engagement is an effective way to fill this financing gap.

Direct resources to startups and SMEs in energy access to drive sustainable and local development

We focus our financing on startups and SMEs in the energy access sector. They are the ones that create the most local jobs and represent the most opportunities for growth, yet they are too rarely financed. While startups and SMEs represent 90% of companies and 75% of jobs on the African continent, half of them do not have access to credit. However, energy is a particularly capital-intensive sector. Our specialization in energy access allows us to invest effectively in these emerging markets and to better meet the needs of entrepreneurs.



« There is a real need for early stage investors, especially investors interested in impactful projects with an international dimension. During the first years of upOwa, we found extremely few organizations that could help us with this level of development. Impact funds are useful for channeling funding to companies which have riskier business models but more interesting projects. »

Caroline Frontigny, President of upOwa

Advising energy entrepreneurs

We apply our strategic vision of the energy sector and our expertise towards the companies in which we invest. Our entrepreneurial experience allows us to understand the needs of entrepreneurs and help them overcome the challenges they face in order to shape resilient companies with sustainable impact.

« Entrepreneurs look for investors who encourage and challenge them. For me, Gaia succeeds on both fronts. Their passion for building impact companies shines through in our frequent conversations, but they also understand the need to ask hard questions, constantly test our hypotheses, and question assumptions. I've learned a lot in one year of working together, and I'm excited to continue this journey! »

Dan Rosa, CEO of Oolu Solar

Advising energy entrepreneurs

The companies in which we invest are located in Sub-Saharan Africa and South-East Asia, two regions that account for the majority of people in situation of energy poverty. These areas also have a significant and yet largely under-exploited solar potential, which facilitates a transition to reliable, renewable and easily accessible energy.

Oolu Solar

Founded in 2015 by Dan Rosa and Nilmi Senaratna

Sector : SHS

West Africa

Easy Solar

Founded in 2015 by Nthabiseng Mosia, Alexandre Tourre, and Eric Silverman

Sector : SHS

Sierra Leone

upOwa

Founded in 2015 by Kilien de Renty and Caroline Frontigny

Sector : SHS

Cameroon

Solaris

Founded in 2016 by Siten Mandalia

Sector : SHS

Tanzania

Candi

Founded in 2017 by Philippe Flamand

Sector : Commercial and industriel

South-East Asia

Hybrid Solution

Founded in 2010 by Jim Ayala

Sector : SHS

Philippines

Canopy Power

Founded in 2015 by Sujay Malve

Sector : Commercial and Industriel

South-East Asia

Mascara
Desalinisation Solaire

Founded in 2014 by Maxime Haudebourget Marc Vergnet

West Africa
Southern Africa

Figure 3 : Map of Gaia Impact Fund's partner companies

Part 2
Impact of the portfolio

© Solaris

Methodology

To write this report, we relied on….

A literature review on the impact of energy access:

• **Econometric studies to measure the impact of decentralized solar energy on households.** *These studies isolate the impact of energy access by controlling the effect of socio-demographic and temporal variables (income level, gender, location, passage of time, poor harvest season, etc.).*

• **Qualitative and quantitative studies which assess the different stages of the theory of change associated with decentralized solar energy.** *Based on questionnaires or interviews, these studies put the impact of solar energy back in the context of the daily lives of end-users, identifying how they use the product and the value that they give to it.*

• **Studies and impact reports from energy practitioners.** *These reports complement the academic literature thanks to practitioners' privileged access to sources and their operational approach to the main stakes of the sector.*

The GOGLA methodology for the impact assessment of off-grid solar

The off-grid solar sector has a strong focus on impact assessment. Since 2013, researchers, impact assessment experts and practitioners have gathered in a working group, initiated by GOGLA (the global association of the off-grid solar energy industry) to reflect on the impact of off-grid solar energy. To determine the impact of our partner companies, we have used metrics drawn from version 3.0 of the «Standardized Impact Metrics for the Off-Grid Solar Energy Sector,» published by this group in 2018[8]. These indicators provide a conservative and standardized estimate of the impact of off-grid solar energy on end-users, covering improved access to energy, savings on energy expenditures, impact on economic activity and environmental impact. However, «many critical social development benefits from off-grid solar also remain difficult to track, such as improvements in health and safety, for example. Therefore, these metrics should be seen a starting point, not an end, to the analysis of socioeconomic impacts by the off-grid sector."[9] We have therefore conducted additional studies to complete these perspectives.

Targeted case studies to complement existing data

These case studies have been designed in collaboration with our partner companies. These collaborations have enabled us to leverage our partners' resources in terms of call centers, customer knowledge and databases to develop impact studies closely linked to their needs and concerns. We have gathered data and insights from Solaris and Easy Solar to better understand the typology of end-users, and from Candi to analyze the environmental impact of solar roofs. In partnership with Oolu Solar, we have studied the effects of solar kits on energy expenditures and time savings related to the purchase of alternative energy sources in Senegal. With upOwa, we have developed a survey on the productive use of Solar Home Systems among Cameroonian households - a subject which has yet to be explored in depth by the literature.

The impact of Solar Home Systems

Improving access to energy results in many economic, social and environmental changes. The impact of a product is not limited to the end-user; rather, new products impact society as a whole, particularly through job creation and greenhouse gas reduction. The replacement of expensive, dangerous and polluting energy sources (and particularly kerosene) has a positive impact on both the savings and health of users. Improving the quality and duration of lighting allows households to take on more economic activities. It also gives children more time to study.

Some impacts are less obvious. By avoiding kerosene accidents and providing light at night, solar energy gives users a sense of security, which is one of the first benefits they attribute to Solar Home Systems. A solar kit allows end-users to save time on purchasing alternatives and recharging phones, which often require long journeys. The impact of a solar kit is often not limited to the customer's home; rather, the customer's neighbours can also indirectly benefit from better access to energy and its multiple fallouts. In a bar, a shop or a health center, solar kits can finally facilitate the production of goods and services at the local level.

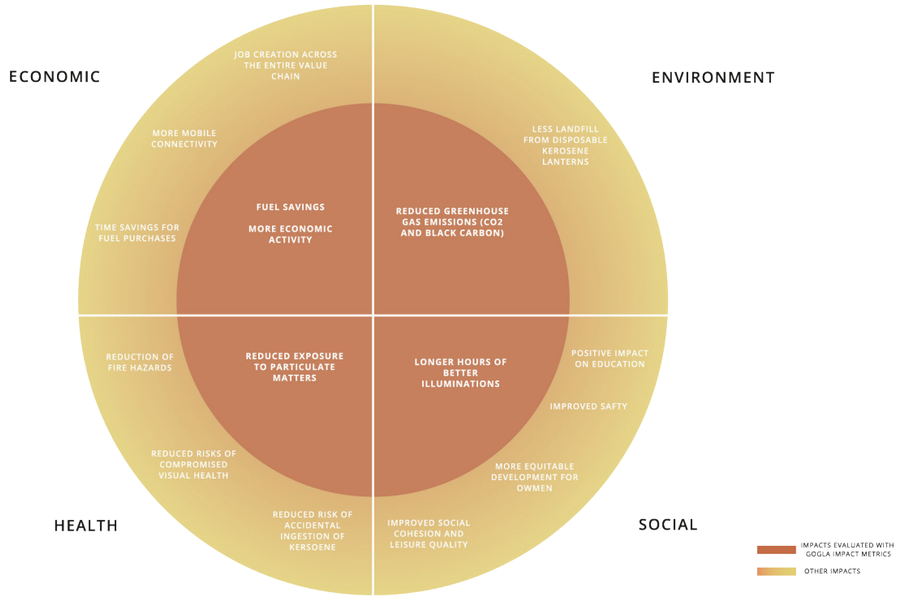


Figure 4 : Direct and indirect impacts of Solar Home Systems[10]

[8] GOGLA, « Standardized impact metrics for the Off-grid Solar Energy Sector », 2018. https://www.gogla.org/sites/default/files/resource_docs/gogla_impact_metrics.pdf.
[9] Ibid, p.6.
[10] This figure was inspired by: World Bank. « Off-grid Solar Market Trends, Report 2016 ». Lighting Global, Bloomberg New Energy Finance, 2016, p.40. https://www.energynet.co.uk/fr/webfm_send/1690.

I. Presentation of the end-users and their needs

Who are the end-users?

End-users who have little or no access to the network

An estimated 89 million people currently have access to clean energy in Africa and Asia thanks to decentralized solar energy. Among these, 21 million are benefiting from access to electricity for the first time.[11]

The main beneficiaries of off-grid solar energy are off-grid households. This situation is closely related to geographical location: 84% of people who do not have access to a power grid live in rural areas[12]. The electrification rate and the quality of the network vary considerably from region to region. Households with unreliable access to a power grid also use Solar Home Systems to benefit from a better access to electricity.

In Cameroon, 93% of the urban population is connected to the grid. This figure drops to 21% for the rural population. 16% of our sample of solar customers have access to the grid, slightly less than the overall rural population.

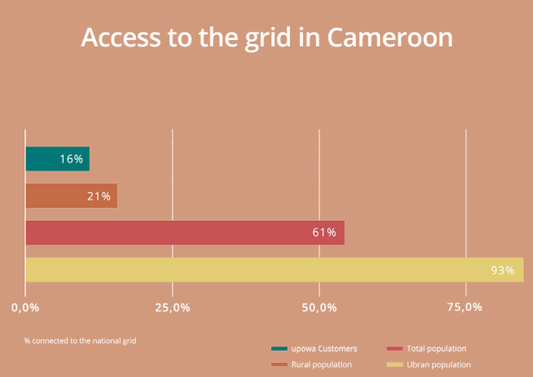


Figure 5 : Access to the grid in Cameroon
Data: Representative sample (N >1000) of upOwa customers, Cameroon; World Bank data, Access to electricity in Cameroon, 2017[13]

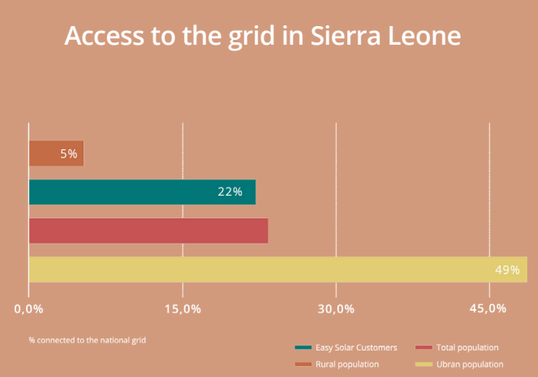


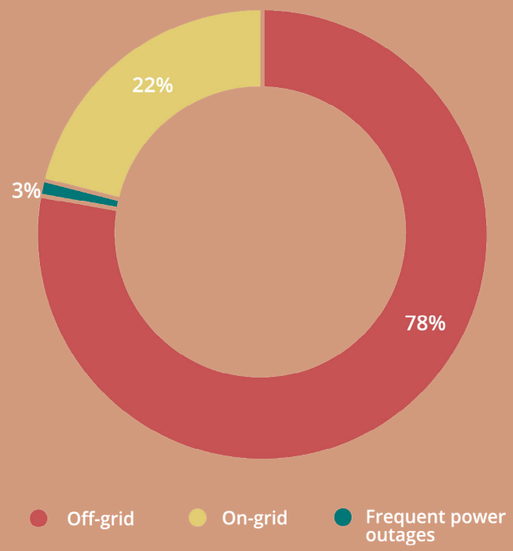
Figure 6 : Access to the grid in Sierra Leone
Data: Representative sample (N >1000) of EasySolar customers, Sierra Leone[14]; World Bank data, Access to Electricity in Sierra Leone, 2017[15]

[11] Bloomberg New Energy Finance, Lighting global, 2016
[12] IEA database, Energy outlook, 2017
[13] World Bank, World Bank Open Data, 2019, https://data.worldbank.org/
[14] Acumen et Easy Solar, « Lean Data baseline results » (Unpublished data, December 2018).
[15] World Bank, World Bank Open Data, 2019, https://data.worldbank.org/

Various income levels and high energy expenditures

Technological innovations and pay-as-you-go financing have made SHS more affordable to low-income households. Among our sample of customers in Senegal[16], 82% lived below the poverty line of $2.5 per day. However, the income profile is highly dependent on the operating country, as well as the type and cost of the product. Certified solar products often reach the rural middle class, or even rural elites for more powerful products. According to a SolarAid study of 3 500 users in Kenya, Tanzania and Zambia, customer incomes were generally above the local average, by 11%, 47% and 208%, respectively.[17]

For these off-grid households, lighting, phone charging and cooking constitute major expenditures. The 240 million off-grid phone users charge their phones for between $0.15 and $0.25 per charge, which is equivalent to a cost of between $30 and $50 per kWh[18]. Among Solaris customers in Tanzania, lighting and phone charging alone account for more than 5% of customer income[19].



Access go the grid and grid reliability among customers in Sierra Leone

Beneficiaries of solar products are not limited to off-grid households. 78% of participants in our sample of solar kit users in Sierra Leone were not connected to the grid. This figure is close to the national average. Among the 22% of customers connected to the grid, 93% experience frequent power outages, hence why they resort to SHS.[20]

Figure 7 : Access to the grid and grid reliability among customers in Sierra Leone[21]

[16] Acumen and Oolu Solar, "Lean Data" (Unpublished data, 2017).
[17] Kat Harrison, Andrew Scott, and Ryan Hogarth, "Accelerating Access to Electricity in Africa with Off-Grid Solar," 2016, https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10229.pdf.
[18] World Bank, « Off-grid Solar Market Trends, Report 2016 ».
[19] Representative sample of Solaris customers (N > 1000)
[20] Ibid.
[21] Acumen and Easy Solar, "Lean Data Baseline Results."

Methodology

Estimate the income of SHS customers

The income levels of SHS customers are difficult to estimate accurately. Earnings are sometimes seasonal, especially for farmers who make up a large part of the customers. They do not always come in monetary form and can stem from different sources. To obtain better estimates, households are sometimes asked to estimate their expenses and weekly incomes, which are considered more reliable than annual income. When enough data are available, the Poverty Probability Index (PPI) can be used to assess the probability of a household being below the poverty line using observable criteria, such as the number of people in the household or house characteristics.

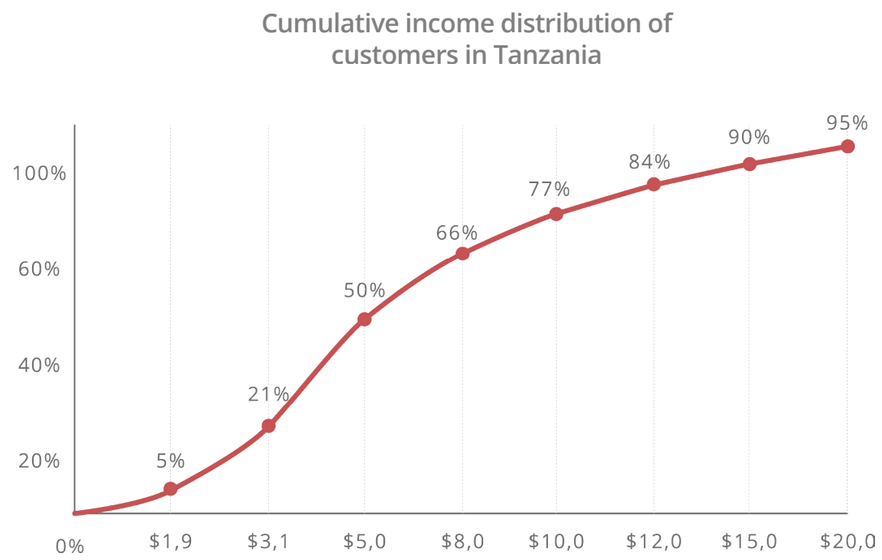


Figure 8 : Cumulative income distribution of customers in Tanzania sample > 1000, representative of Solaris customers.

Among Solaris' clients in Tanzania, 5% of users were below the first poverty line of $1.9 per day, 21% below $2.5 per day, and 50% below $3.1 per day. Less than 10% of users had an income superior to $15/day.

Beyond a rather male clientele: a variety of users

Although the proportion of female buyers is not negligible, SHS are more often purchased by men. According to data from our partners in Sierra Leone, Cameroon, and Senegal, women made up 14% to 28% of all customers[22]. This difference is partly due to a reporting bias: men usually provide their contact details and therefore their gender as they purchase a kit, probably because of their better access to credit and their leading role in managing household finances.
However, the purchase of a SHS has a considerable impact on the women of a household: in our sample in Cameroon, for example, nearly 94% of clients are married or in a household[23]. Since they spend most of their time at home, women and children benefit the most from the impact of SHS.

A majority of farmers

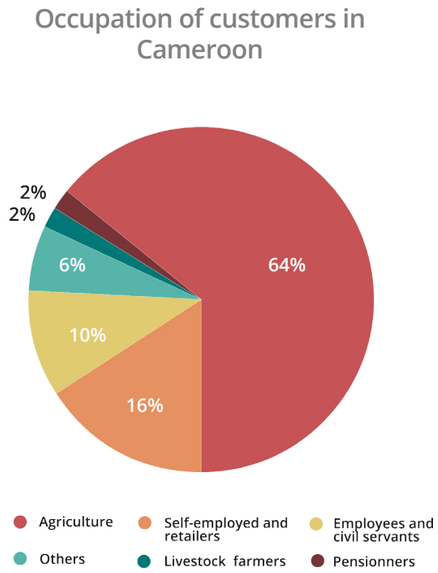


Figure 9 : Profession of customers in Cameroon; sample > 1000, representative of upOwa's customers

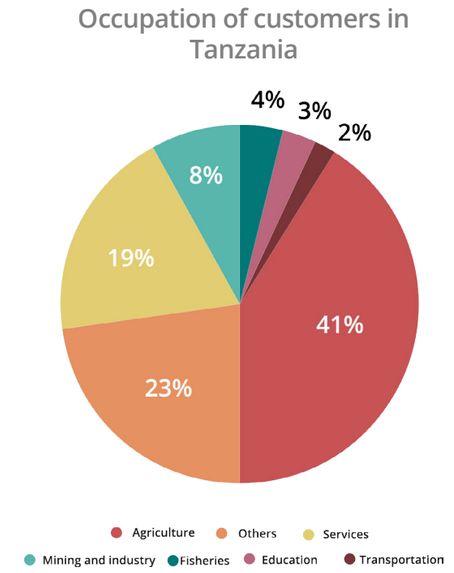


Figure 10: Profession of customers in Tanzania; sample > 1000, representative of Solaris' clients

Agriculture accounts for the majority of jobs (64%), followed by self-employed and shopkeepers (16%), then employees and civil servants (10%).

In Tanzania, agriculture is also the first job for SHS customers, with 41% of the sample employed in the sector. Services are the second most frequently reported profession (19%), followed by mining and industry (8%).

22% of customers reported a secondary activity. Among them, agriculture was again the first additional activity declared (45% of respondents). There were particularly strong connections between the fishing and agriculture sectors.

[22] *Sample of customers from Sierra Leone, Senegal and Cameroon.*
[23] *Sample of customers from Cameroon.*

Most customers are between 30 and 50 years old

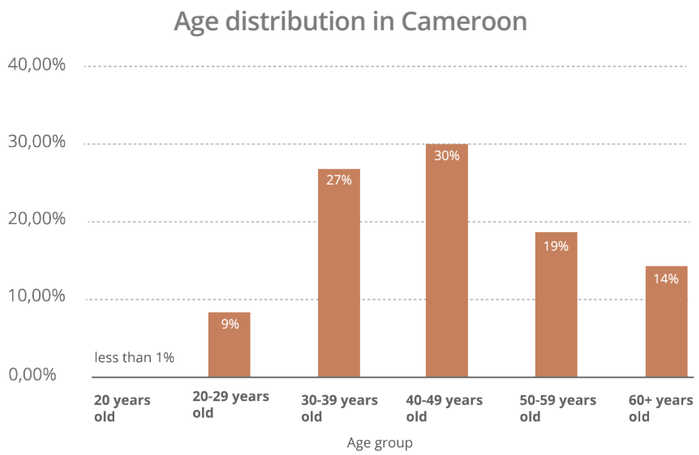


Figure 11 : Age distribution of customers in Cameroon; sample > 1000, representative of Solaris' clients

On our sample in Cameroon, the average age of the clients is 40 years. About 10% of the clients are under 30 years of age. Most clients are between 30 and 50 years old: 27% of them are between 30 and 39 years old, with 30% between 40 and 49 years old. More than a third of the clients are over 50 years old: 19% are between 50 and 59 years old, and 14% are over 60 years old.

What are the impacts expected by end-users?

Customers have various expectations when purchasing access to solar energy. Exploring the motivations of end-users is important for understanding the local context and identifying customer priorities. An improved access to energy is the most frequently cited impact[24][25][26]. Financial savings, better access to mobile phones, better education, an improved sense of security and a positive impact on health are among the most important impacts for end-users[27]. These aspirations vary depending on the product purchased. Because they are more powerful than solar lanterns, Solar Home Systems generally open more possibilities and are more frequently associated with business opportunities, communication and access to information for end-users[28].

> ***Savings, better access to mobile phones, education through extra lighting hours, a sense of security and a positive impact on health are among the most important impacts for end-users.***

[24] *Stephanie Hirmer et Peter Guthrie, « The benefits of energy appliances in the off-grid energy sector based on seven off-grid initiatives in rural Uganda », Renewable and Sustainable Energy Reviews 79 (1 novembre 2017): 924-34, https://doi.org/10.1016/j.rser.2017.05.152.*
[25] *IDInsight, « d.light Solar Home System Impact Evaluation », 2015, https://www.dlight.cappom/wp-content/uploads/2018/08/20151028_d_light_impact_report_FINAL.pdf.*
[26] *GOGLA, « Powering Opportunity, The Economic Impact of Off-Grid Solar », 2018, https://www.gogla.org/sites/default/files/resource_docs/gogla_powering_opportunity_report.pdf.*
[27] *Hirmer and Guthrie, "The Benefits of Energy Appliances in the Off-Grid Energy Sector Based on Seven off-Grid Initiatives in Rural Uganda."*
[28] *Ibid.*

Key figures

For four companies in Gaia's portfolio specializing in pico-scale solar kits and SHS segments since the beginning of Gaia's investments :

177 863

People have benefited from better access to energy

X 3

We estimated that the purchase of a solar kit has increased the brightness in end-users' homes by three

144 $

On average, the purchase of a solar kit has helped households save $144 throughout the lifetime of the solar kit

6 165

An estimated 6 165 people have taken on more economic activity thanks to solar kits

II. An impact analysis of solar kits at the household level

These estimates were calculated using GOGLA methodology[29] for the solar kit segment of Gaia's portfolio. They cover the impact from the beginning of each investment to the end of 2018.

Access to energy

Solar kits do not only increase the duration of lighting. They replace various alternatives, which are often more expensive and sometimes more polluting: flashlights, candles, kerosene lamps, or simply darkness. The improvement in terms of brightness is cited by end-users as one of the major impacts of solar kits[30]. Since 2017, Gaia's investments in solar kits have directly helped 177 863 people benefit from improved access to energy. On average, the brightness in the home of end-users has increased threefold[31].

While the use of solar kits generally leads to a cessation or reduction in kerosene consumption, households often continue to purchase other complementary energy sources for needs that solar kits do not meet. Many users keep using batteries for radios and flashlights, which are often not compatible with solar kits[32].

[29] GOGLA, « Standardized impact metrics for the Off-grid Solar Energy Sector »
[30] Ognen Stojanovski, Mark Thurber, and Frank Wolak, "Rural Energy Access through Solar Home Systems: Use Patterns and Opportunities for Improvement," Energy for Sustainable Development 37 (April 2017): 33–50, https://doi.org/10.1016/j.esd.2016.11.003
[31] We used GOGLA metrics for these estimates. See GOGLA, « Standardized impact metrics for the Off-grid Solar Energy Sector ».
[32] Stojanovski, Thurber, and Wolak, « Rural Energy Access through Solar Home Systems ».

"Gaia's investments in solar kits since 2017 have directly helped 177 863 people benefit from improved access to energy.

From carbon energy sources to solar energy: a linear process?

The concept of the «energy ladder» implies that households make a transition from more polluting, labour-intensive energy sources to more expensive, efficient and less polluting energy sources as their socio-economic status increases. Solar kits allow households to engage in this transition while lowering the costs of clean and efficient products. Theoretically, the savings made by households could allow them to further their transition by investing in more powerful products. In practice, this process is neither linear nor automatic. Some households keep relying on other energy sources, which are used in the event of solar product failure or for complementary uses; generators are often used to operate products that are not chargeable with small solar products, while torch lamps are used for their portability.


© Easy Solar

Case study : the different energy sources used by Oolu Solar customers in Senegal

Methodology

This survey was conducted on 218 customers based in Senegal in collaboration with the team of Oolu Solar. The questionnaire was formulated to understand how purchasing a solar kit changed the end-users' energy consumption behaviors, and specific attention was paid to the impact on savings, time use and the replacement of previous energy sources. The questions were reworked with Oolu Solar to better reflect local expressions and realities.

Lighting source before the purchase of the solar kit

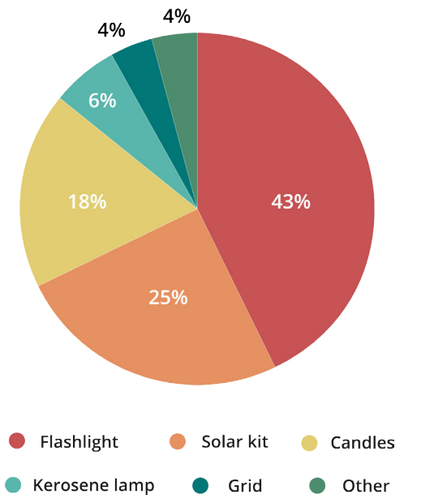


Figure 12 : Lighting source before the purchase of the solar kit; sample of 218 customers with simple solar kits or solar kits with a compatible television.

Households in transition

In our sample, 6% of respondents used kerosene lamps as their main source for light; 18% used candles. Many households have already made a transition to battery-powered products, which are now common among rural African households[33], but also to solar energy: 43% used flashlights, and 25% already used a solar system.

In our sample, 6% of respondents used kerosene lamps as their main source for light; 18% used candles. Many households have already made a transition to battery-powered products, which are now common among rural African households, but also to solar energy: 43% used flashlights, and 25% already used a solar system. Not all solar kits are equivalent: buying a kit which is more powerful or of better quality can represent an improvement in the scale of energy access[34]. In comparison, 86% of Solaris' customers already used a solar system as their main source of light before their purchase. This difference can be explained by the segmentation of the solar market. Oolu's solar lanterns manage to reach households who are new to solar energy, or who are ready to make a transition from informally sold lanterns to better quality products. On the other hand, Solaris' product range reaches customers who are already very familiar with solar kits, which is why they are ready to invest in more powerful products.

> ***The purchase of a more powerful kit represents a climb up in the energy ladder.***

Replacement of previous lighting sources

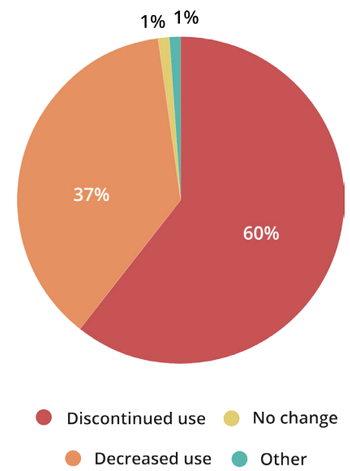


Figure 13 : Replacement of previous lighting sources; sample of 218 customers with simple solar kits or solar kits with a compatible television.

Solar kits have replaced alternatives for 60% of respondents. The consumption of alternative lighting sources has decreased for 37% of them. Among households who reported using kerosene lamps, 83% have stopped using them after purchasing their solar kit. Of the 18% who still report using their oil lamps, all have reduced their consumption.

[33] *Jörg Peters and Maximiliane Sievert, "Impacts of Rural Electrification Revisited – The African Context," Ruhr Economic Papers (Essen, 2015), https://pdfs.semanticscholar.org/9924/4a86923f992bef1427655900a384525493f7.pdf?_ga=2.192242218.1482600123.1564503912-2136408935.1564043410.*
[34] *Harrison, Scott, and Hogarth, « Accelerating Access to Electricity in Africa with Off-Grid Solar ».Home Systems ».*

Economic impact

Purchasing a solar kit, which replaces often more expensive energy sources, allows households to save on average $144 over the lifetime of the kit[35]. This figure does not take into account the costs associated with phone charging or the transport costs incurred when purchasing other energy sources for households that do not have solar kits.
By eliminating these costs, the switch to decentralized solar energy allows households to make additional savings, both in terms of time and money.

> ***Purchasing a solar kit saves households an average of $144 over the life of the kit.***

[35] *We used GOGLA metrics for this estimate, which compares the savings made on alternative energy sources over the lifetime of the kit. This only applies for solar kits below 11 Wp, as data for other kinds of products are not available. See also: GOGLA, « Standardized impact metrics for the Off-grid Solar Energy Sector ».*

© Solaris

Case Study : Saving time and money for Oolu Solar customers (Senegal)

Charging your phone: a real challenge

Charging phones is certainly not easy for the millions of people who do not have reliable access to a power grid. Before purchasing a solar kit, 30% of respondents travelled long distances to recharge their phones, with 11% being forced to travel to a neighbouring town. At least 11% paid between 100 and 250 CFA francs to charge their phones, or 15 to 45 cents in USD.

The purchase of a solar kit has not only relieved end-users from these expenses and trips, but it also made them reference points for phone charging in their neighborhood. Sharing energy sources with relatives and neighbors occurs frequently, although it is generally not addressed in the literature. Before the purchase, 23% of respondents went to their neighbors' homes to charge their phones. Now, more than half of them (53%) share their solar kit with their neighbors. Among them, 89% do so to charge their phones.

> ***The purchase of a solar kit has not only saved users from these expenses and trips but has also made them reference points for phone charging in their neighbourhood.***

Phone charging mode before purchasing the solar kit

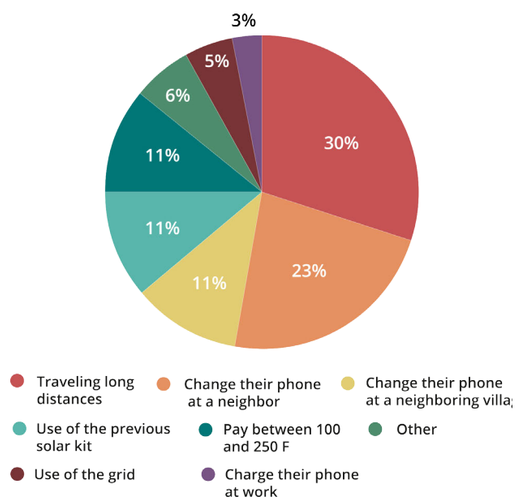


Figure 14: Phone charging mode before purchasing the solar kit; sample of 218 customers with simple solar kits or solar kits with a compatible television.

Pay-as-you-go is transforming energy expenditure patterns

Most of Oolu Solar's customers purchase their Solar Home System through the use of a pay-as-you-go payment plan, an innovation facilitated by the emergence of mobile money. For many customers, this purchase is their first access to credit. However, given the low incomes of customers, some can only charge small amounts of money to their mobile money account, which results in frequent trips to the nearest mobile money point. Although the solar kit allows customers to avoid traveling long distances to charge their phones, 64% of respondents still make trips exclusively to recharge their mobile money accounts, while 37% of customers combine this trip with other errands. At Oolu Solar, due to low payment frequency, this change is nevertheless a significant improvement compared to the pre-purchase situation.

Neighbor's use of Solar Home System

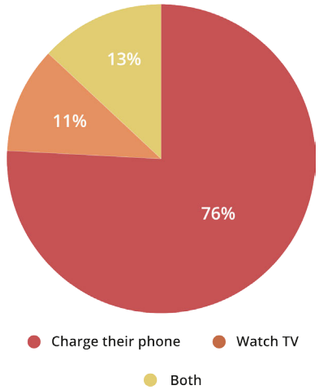


Figure 15 : Neighbors' use of Solar Home System; sample of 218 customers with simple solar kits or solar kits with a compatible television.

Is recharging the mobile money account associated with other activites ?

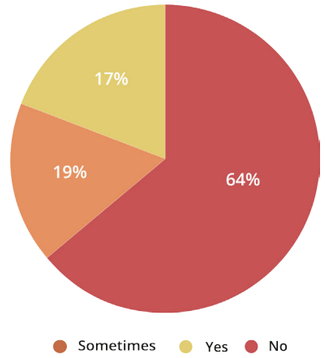


Figure 16 : Is recharging the mobile money account associated with other activities? Sample of 218 customers with simple solar kits or solar kits with a compatible television.

Case Study

Productive uses

According to GOGLA estimates, between 15 and 38% of customers use their solar kits for productive purposes, depending on the power of the purchased system. Thanks to companies supported by Gaia, it is estimated that 6 165 people have taken up more economic activity since the beginning of the fund's investments: 3 019 people spend more time working, 2 779 people use the product to support their business, and 1 310 people have opened a new business.[36]

The correlation between the use of small off-grid solar products and a direct increase in economic activity is not entirely clear. Other factors can affect a person's ability to begin a new economic activity, including a lack of capital to invest in productive tools, a lack of training, or difficulties in selling products outside the village. Market access is another one of the main factors limiting a person's transition from agricultural to non-agricultural employment[37]. Finally, households are often already engaged in professional or domestic activities, leaving little time for some to start a new business[38]. Furthermore, a person's increase in productivity is correlated to the size of the system. According to GOGLA estimates, the rate of consumers who generate additional income after purchasing their solar product varies from 10 to 30% depending on the power output of the product.

to reschedule daily activities. Some activities can be more easily postponed to the evening, increasing the flexibility of a user's schedule[39]. This is particularly important for women, who can perform more domestic tasks at night. Increased brightness creates a more practical and comfortable setting for typical activities such as sewing or food processing[40].

> ***It is estimated that 6 165 people have undertaken more economic activity since the beginning of the fund's investments.***

[36] *See GOGLA, « Standardized impact metrics for the Off-grid Solar Energy Sector ».*
[37] *Peters and Sievert, "Impacts of Rural Electrification Revisited – The African Context."*
[38] *Michael Brossmann, « Off---grid Rural Electrification and Fighting Poverty A Comparative Impact Assessment of Solar Home Systems and Small Solar Home Systems in Rural Bangladesh », 2013, https://publikationen.uni- tuebingen.de/xmlui/bitstream/handle/10900/50005/pdf/Brossmann_2013_SSHS_Impact_Study_GSWP_19.pdf ?sequence=1&isAllowed=y.*
[39] *Peters and Sievert, « Impacts of Rural Electrification Revisited – The African Context »*
[40] *Brossmann, « Off---grid Rural Electrification and Fighting Poverty A Comparative Impact Assessment of Solar Home Systems and Small Solar Home Systems in Rural Bangladesh ». p.60*

Case Study : Professional use of Solar Home System by upOwa customers in Cameroon

Methodology

This study was based on a desire to identify and describe the professional uses of small solar kits, a subject which has so far remained under-explored. In partnership with upOwa, we interviewed 45 clients who reported using their SHS outside their homes. The questionnaire was designed to focus on the use of solar kits and the changes they had brought to respondents' lives. The questions were then rewritten with the upOwa team to better reflect local expressions and realities. 25 respondents reported that they actually use the solar kit in professional settings. They used 6 watt-peak models. The survey also featured in-depth interviews with three users whose activity was representative of the different locations in which solar kits were used: a health center, a bar and a shop.

Various places of use

Most respondents were the managers of their establishment or their associates. While bars and shops were the most common establishments, we also found that solar kits were used in hair salons, cafés, restaurants, and health centers.

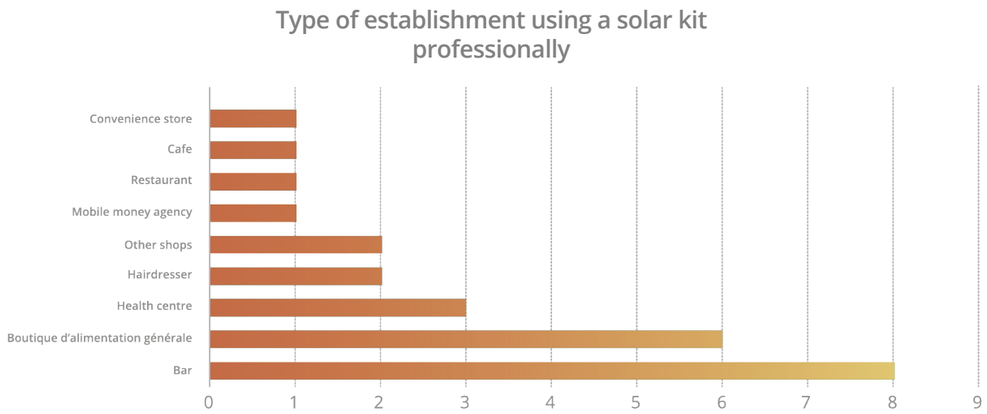


Figure 17: Type of establishment using a solar kit professionally

Case Study

Amadou Abdou, shopkeeper at Nsan Mendouga : Saving on energy bills

Amadou Abdou Abdou's shop is dark. The shopkeeper, based in the village of Nsan Mendouga, bought his solar kit ten months ago. Even in the early afternoon, one of the lamps of the kit remains on in the back shop. Another is located in the central room; the third one only comes out at night to light the front.

His shop remains open late at night, until 10pm. Before purchasing a solar kit, Amadou used a generator to light up his shop in the evening, costing him up to 1000 francs a day. The purchase of the kit has saved him a lot of money. Using the generator every day would have cost him up to 25 000 extra francs per month.

In addition to lighting, Amadou charges a few customers' phones in the morning for free. Since the purchase of the kit, he is less concerned about the safety of his shop: to avoid theft, he leaves a light bulb permanently on in the room to suggest that someone is always present.

Better lighting over longer periods of time

Customers primarily used the kit to light up their place of work. Respondents who were already connected to the power grid used the kit to prevent power shortages. For the others, the solar kit provided better lighting in the evening and in the morning, with some respondents reporting staying later in the evening. 21 respondents also reported using their kit to charge their phone. Among them, 12 respondents were providing this service to their customers. No respondent reported charging phones for a fee. This is a surprising result, as phone charging is one of the most common opportunities started with solar kits.

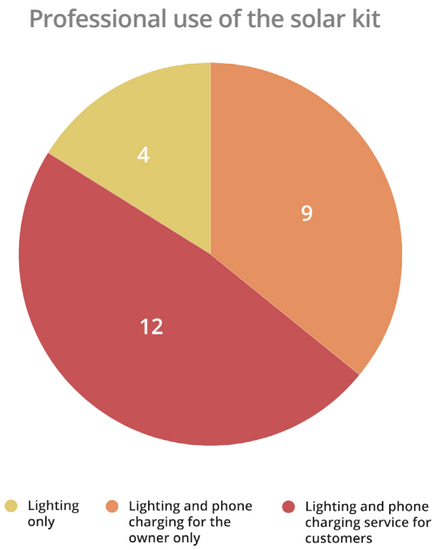


Figure 18 : Professional use of the solar kit

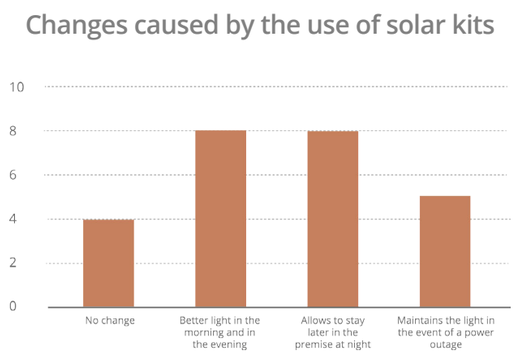


Figure 19 : Changes caused by the use of the kit

Of the 25 people surveyed, 10 reported that the changes brought about by the solar kit were very important, 10 quite important, 2 not very important, and 3 did not notice any change. Most customers reported an increase in revenue, particularly among those who remained open later after purchasing the kit.

For most users, the kit has elicited reactions from customers who reported enjoying the brightness and the possibility of staying later in the evening.

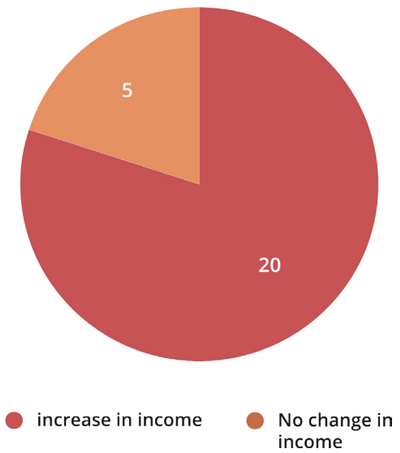


Figure 20 : Changes in income since the purchase of the solar kit

"The majority of customers reported an increase in revenue, especially those who remained open later since the kit was purchased.

Case Study

Marie Jeanne, bartender in Nsan Mendouga: Lighting the village bar

Marie Jeanne has been running a bar in Nsan Mendouga for over twenty years. The electricity was cut off for good in her village four years ago. Before purchasing upOwa's kit ten months ago, she generally closed the bar at 7pm. Marie Jeanne owned a generator, but due to its price she used it only on special occasions.

The bar now remains open until 10pm every evening, and Marie Jeanne says that the solar kit saves her 5000 Francs per month. Her bar now operates as the party hall of the village. As the only bar in the village to be equipped with electricity, it has become the favorite spot for every celebration: Christmas, Easter, birthdays... The bar remains open until morning and the kit is on all night long.

Replace or supplement existing lighting sources

End-users previously used a variety of lighting sources: kerosene lamps, connections to the power grid, generators, other solar products, torch lamps, and so on. Of the 25 clients interviewed, 12 respondents stopped using other lighting sources after purchasing a solar kit. Previous lighting sources were often kept as backup sources of energy or to operate other devices that were not compatible with the kit. Respondents who were connected to the power grid, and sometimes those with generators, continued to use them (e.g. to play music in bars).

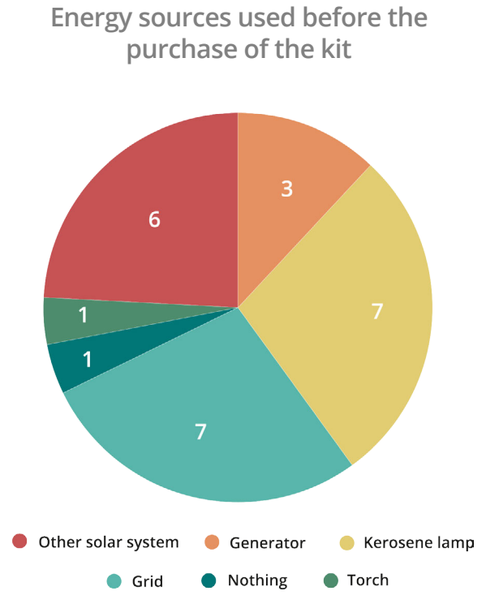


Figure 21 : Energy sources used before the purchase of the kit

"Previous lighting sources were often kept as backup sources of energy or to operate other devices that were not compatible with the kit.

Brigitte Niété, doctor in a rural hospital: Solar energy for health

Founded more than 20 years ago, the health center in which Brigitte Niété works has long been awaited to be connected to the grid. However, the neon strips installed on the ceiling have never worked, and the refrigerator that is supposed to keep the vaccines cool is still wrapped in its package. Access to reliable electricity is a real challenge for this center, which must remain open all night.

For Brigitte (the doctor who has been running the center for four years), the arrival of the solar kit was a relief. Until then, doctors and nurses used solar torches or rechargeable lamps when on duty. These devices provide only limited lighting and their can only provide light for up to three hours.

These lighting sources were replaced three months ago by an UpOwa kit. The four lightbulbs were divided between the client waiting area, the consultation room, the operating room and the delivery room. The constant and reliable lighting ensures 24-hour service.

The center expects much more from solar energy. A refrigerator would allow for more independence. The vaccines are currently picked up every morning in the nearest town, 16 km away, and brought back in the evening to keep them cool. Television is also highly anticipated. It would allow patients, who spend a lot of time in the waiting room, to distract themselves from their problems. For the center, which operates on its own budget, the cost of these additional products remains an obstacle.

Case Study

Education

In 2013, more than 140 000 schools in Africa lacked access to the grid[41]. By generating several hours of additional and better-quality lighting per day, solar kits provide additional study time for children.

The lack of high-quality light is frequently cited by children as a barrier to education[42]. The impact of solar kits on education is, however, mixed: while several studies report an increase in study time and school attendance, this increase does not necessarily translate into higher grades or longer schooling[43]. Sometimes, solar kits simply allow children to postpone their study time to the evening and engage in more recreational activities during daytime[44]. Although the lack of access to quality lighting is a limiting factor for the democratization of education, access to energy is only one of many conditions that must be met to significantly improve learning opportunities in developing countries[45].

The lack of quality light is frequently cited by children as a barrier to education

Democratizing education through solar kits: A case study conducted by Hybrid Solutions in the Philippines

In the Philippines, where 20 million people live without connection to the power grid, island geography makes electrification difficult (I.e. the country has 7 107 islands).

Hybrid Solutions, which Gaia has been supporting since 2016, relies on partnerships with microfinance institutes, cooperatives and local organizations to provide electricity to rural and isolated populations. Gaia Impact Fund has been specifically supporting a programme aimed at equipping the Palawan islands with solar panels. Overall, 162 solar lanterns have been distributed to students in Coron, Buyot, Camanga and Bucatan; 8 bigger solar panels have also been installed in schools. To prepare for these installations, 10 teachers and 13 technicians have been trained to install and maintain solar panels.

Children in households that had purchased a solar kit from Hybrid Solutions reported working an average of 3 hours and 25 minutes more per week. 84.6% of beneficiaries surveyed reported an improvement in study time for their children, and 47.5% of respondents reported using only solar energy for children's studies[46].

84.6% of beneficiaries surveyed reported an improvement in study time for their children, and 47.5% of respondents reported using only solar energy for children's studies.

[41] Matthew S Orosz, Sylvain Quoilin, and Harold Hemond, « Technologies for Heating, Cooling and Powering Rural Health Facilities in Sub-Saharan Africa », Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy 227, no 7 (1 novembre 2013): 717‑26, https://doi.org/10.1177/0957650913490300.
[42] Harrison, Scott, and Hogarth, « Accelerating Access to Electricity in Africa with Off-Grid Solar ».
[43] Yuya Kudo, Abu S Shonchoy, and Kazushi Takahashi, "Impacts of Solar Lanterns in Geographically Challenged Locations: Experimental Evidence from Bangladesh," IDE Discussion Paper (Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO), 2015), http://hdl.handle.net/2344/1414.
[44] Michael Grimm et al., « A First Step Up the Energy Ladder? Low Cost Solar Kits and Household's Welfare in Rural Rwanda », Discussion paper series, 2015.
[45] World Bank, « Off-grid Solar Market Trends, Report 2016 ».
[46] The Noun project, « Social impact evaluation for Hybrid Social Solutions » (Jackson Institute for Global Affairs, Yale University, 2016).

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Health

According to the World Health Organization, close to 4 million people die prematurely each year from illness resulting from household air pollution, often caused by kerosene.

Solar kits can significantly improve this situation, especially for women who spend more time inside the home, where kerosene pollution is concentrated. This effect is even more pronounced in South-East Asia, where solar energy is often used to replace kerosene lamps[47]. Because they spend a lot of time at home, children also benefit greatly from a reduction in kerosene use[48].

The impact on health is particularly strong for women who spend more time inside the home, where kerosene pollution is concentrated.

The interest of solar energy for health in the Philippines with Hybrid Solutions

The use of kerosene lamps can also cause accidents and eye problems. In the survey conducted by Hybrid Solutions, customers felt 11.75% safer since purchasing a solar kit due to a reduction in kerosene-related skin burns (59.5% to 71.2%)[49].

[47] Peters and Sievert, "Impacts of Rural Electrification Revisited – The African Context."
[48] Brossmann, « Off-‐‑grid Rural Electrification and Fighting Poverty A Comparative Impact Assessment of Solar Home Systems and Small Solar Home Systems in Rural Bangladesh », p.61
[49] Planète d'entrepreneurs, « Social Impact Assessment - Final report » (Stiftung Solarenergie & Hybrid Social Solutions (HSSI), 2011).

III. Decentralized solar energy, a source of sustainable development :

an analysis of the impact on society and the environment

A job-intensive sector

The decentralized energy sector is particularly intensive in terms of local employment, particularly due to the low mechanization of distribution processes[50]. The companies in which Gaia has invested currently support 467 full-time local jobs. These figures correspond to a higher employment density per product in the field of solar kits than for carbon-based energy sources. One million lanterns correspond to 17 000 workers for solar LED lanterns, or one worker for every 59 products sold annually, according to estimates made on companies operating mainly in Africa[51].

« La densité d'emploi par produit est plus élevée dans le domaine des kits solaires que pour les sources d'énergie carbonées.

This figure varies according to the geographical context and the power of the systems. For Solar Home Systems, employment opportunities have been estimated at one worker for every 30 systems sold annually, according to Grameen Bank programs in Bangladesh. Another study in Ethiopia on the potential employment generated by small-scale solar power estimated this figure to be 50 systems per worker[52]. Under the assumption that each household buys three lanterns and replaces one each year, the LED lantern sector alone could create up to 2 million direct jobs[53]. The transition to solar energy also has many indirect impacts on local employment: increased savings for households, removal of obstacles for businesses and organizations, increased educational opportunities and reduced health problems are all positive impacts of solar power on a local economy.

Thanks to Gaia's entire portfolio

467

the total number of full-time local jobs created in Sub-Saharan Africa and South-East Asia is 467.

[50] Evan Mills, « Job Creation and Energy Savings through a Transition to Modern Off-Grid Lighting », Energy for Sustainable Development 33 (août 2016): 155□66, p.2. https://doi.org/10.1016/j.esd.2016.06.001.
[51] Ibid. The study surveyed companies operating in Ethiopia, Haiti, India, Kenya, Malawi, Tanzania, and Zambia.
[52] Ethio Research Group, « Solar Energy Vision for Ethiopia, Opportunities for creating a solar industry in Ethiopia ».
[53] This estimate is based on the job intensity of 17000 jobs for one million lanterns.

From kerosene lamps to solar lanterns: opportunities for career changes

By replacing other less efficient and sometimes more polluting energy sources such as kerosene lamps, batteries or candles, solar kits create jobs in the same value chain. Jobs with a similar profile in the same sector (particularly in distribution) can therefore be maintained through the transition from carbon-based energy sources to solar products.

The decentralized solar energy sector is thus replacing carbon-related jobs while creating new ones. The energy sources currently used by households likely to supply themselves with solar lanterns correspond to about 150 000 jobs[54], a lower density than solar energy. On top of being a net contributor to the job sector, off-grid solar energy also helps to keep jobs in rural areas, which is not the case with centralized power grid jobs.

[54] Mills, « Job Creation and Energy Savings through a Transition to Modern Off-Grid Lighting ».

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Salamatu, sales team at EasySolar

Salamatu joined the EasySolar sales team in 2017, which he does alongside his teaching activities. He established the local EasySolar branch in their chiefdom with his brother.

« My relationship with our customers is very cordial. I tell them about the importance of solar kits, and I tell them to stop using poor quality lamps, especially because of their battery problems. Having high quality lamps is much better for their children's education.

Most of the people I sell products to come from neighboring villages, who are aware of the advantages of solar lamps. People are admiring our solar lamp models and their brightness. Even the people in our village who moved to the capital have come back to buy solar products for their homes or communities. For people in my village, however, buying solar kits still proves difficult.

I am proud of myself and the role I have within my community. I am happy and proud to have this opportunity to work with EasySolar. People trust me because I am a teacher and I do my job rigorously. »

Part 2
Impact of the portfolio

Training in solar energy professions

« We have put an emphasis on training from the beginning. You want to have people on the ground who are very well trained. We really need to send autonomous people who will know what to do without the support of the management team. All the people we sent to the field went through a training phase, a training day and then field experience. »
Caroline Frontigny, co-founder of upOwa

© Humana people to people_Fondation Ensemble

A sector with a strong environmental impact

Decentralized renewable energy sources have the potential to advance the energy transition in developing countries. The companies supported by Gaia are working in this direction on two levels, combining sustainability and affordability.

The environmental impact of solar home kits

The release of an estimated 24 914 tons of CO2 equivalent and black carbon have been avoided through the replacement of polluting energy sources at the household level since the beginning of Gaia's investments[55]. However, this estimate is based on the assumption of a high substitution rate of kerosene by solar energy. Our samples seem to reflect a more complex reality. When buying a solar kit, many customers already report owning a solar kit or rechargeable lamp that does not use kerosene. These results show the complexity of climbing up the energy ladder. A possible explanation is that for a part of the population we serve, rechargeable lamps and solar kits sold informally may have already replaced kerosene lamps. Further research is required to better understand the place of solar kits in the energy ladder and how they are used in conjunction with other energy sources. A better understanding of this substitution process would require a detailed history of household energy sources, including the exact number of kerosene lamps used per household and data on secondary lighting sources.

Reconciling universal access to energy and environmental performance

In the long term, access to better energy services means increased consumption but also increased energy efficiency. Renewable energies play a central role in minimizing the environmental impact of progress by allowing households with better access to energy to leapfrog the energy ladder through directly access to clean energy. According to the International Energy Agency's Energy for All scenario, universal access to energy would have an impact of less than 1% on CO2 production by 2030 compared to current forecasts. By reducing greenhouse gas emissions from biomass combustion, the use of cleaner energy helps to offset the impact of an increase in consumption.[56]

For four companies supported by Gaia offering pico-scale solar kits and Solar Home Systems:

44 178

It is estimated that the replacement of polluting energy sources at the household level has avoided the release of 44 178 tons of CO2 equivalent and black carbon into the atmosphere.

These estimates were made using the GOGLA methodology for the solar kit segment of Gaia's portfolio. They cover the impact from the beginning of each investment to the end of 2018.

For the commercial and industrial segment supported by Gaia:
- The current total capacity installed by Candi avoids the release of roughly 101 tons of CO2 per month thanks to the use of roof-based solar panels.

[55] *This is the quantity of carbon dioxide and black carbon avoided by the substitution of solar to kerosene lamps, on the lifetime of the solar kit. See GOGLA, « Standardized impact metrics for the Off-grid Solar Energy Sector ».*
[56] *IEA, World Energy Access Outlook, 2017, p.107*

Candi : Decarbonizing industrial and commercial energy supplies in India

Decentralized solar energy achieves most of its environmental impact through high-power installations, such as solar roofs and minigrids. Investing in solar energy for the commercial and industrial sector is a way to effectively decarbonize electricity consumption. Candi has tackled this challenge by offering solar roofs to Indian companies and institutions that want to free themselves from an unreliable power grid. Coal still accounts for 58% of electricity production in India, and the industrial and commercial sector is the country's largest consumer of electricity. In 2016-2017, the industrial and commercial sector was responsible for almost half of the country's electricity consumption.

Candi's customers include manufacturers, offices, commercial spaces, and schools. The incentive to switch to solar power is threefold: solar roofs allow an organization to operate better while reducing its energy expenditure and improving its environmental footprint. Unreliable power grids are cited as a major constraint among small and medium-sized enterprises in developing countries[57]. In the event of a power outage, these organizations must rely on expensive diesel generators. By providing for 20 to 30% of their consumption, a solar roof allows organizations to reduce their energy bills by about 10%. We estimate that Candi's solar panel installations up to June 2019 avoided the release of about 101 tons of CO2 emissions per month.

Composition of the Indian electricity sources, by installed capacity (2019)

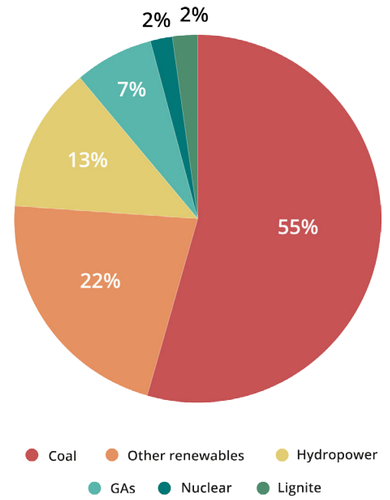


Figure 22: Composition of the Indian electricity mix, by installed capacity (2019)[58]

Coal remains the most important source of electricity in India (55%). Renewables make up 22% of national electricity sources.

[57] *Yao Wang, « What Are the Biggest Obstacles to Growth of SMEs in Developing Countries? - A Picture Emerging from an Enterprise Survey », Borsa Istanbul Review 16-3 (2016) 167-176, 2016, 38.*
[58] *Central Electricity Authority, « All India installed capacity (in MW) of power stations », 2019, http://www.cea.nic.in/reports/monthly/installedcapacity/2019/installed_capacity-03.pdf.*

New horizons for decentralized solar energy

Combining impact assessment and strategic analysis

The field of energy access provides a particularly fertile environment for research and innovation in impact measurement. The strong synergies between startups, impact funds and local partnerships are particularly favorable to a collaborative and cumulative approach to impact assessment. Throughout this report, we have focused on studying under-explored areas of impact regarding energy access. We have designed our impact methodologies to strengthen the capacity of our partners, convinced that better understanding a product's impact enables companies to improve their operational efficiency and better prepare themselves to meet the challenges inherent to the energy sector.

Towards a better understanding of environmental impact

The actors in access to energy have focused above all on studying the social and economic aspects of decentralized solar energy. The environmental impact of these new products remains an under-explored area in research on the impact of access to energy. In the solar kits segment, it is interesting to note that the environmental impact varies considerably depending on the type of energy source replaced: the replacement of carbon-based energy sources such as kerosene lamps or diesel generators has a particularly significant impact in terms of reduced CO2 emissions, and when solar kits replace batteries, they can also reduce the production of toxic waste, a problem related to insufficient battery recycling[59].

At the same time, the way in which a solar kit is used plays a decisive role in its sustainability. Leaving the kit on all night outside the house and set to the highest brightness is a common practice. This practice contributes to the feeling of security provided by solar kits, one of the impacts most frequently cited by users. For example, among Oolu Solar's customers in Senegal, 96% felt safer due to their solar kit[60]. However, doing so considerably reduces a battery's life expectancy.[61] The question of sustainability is even more pertinent as some kits are reaching the end of their lifetime expectancy. Given the relative youth of the industry, this subject is only starting to be addressed. Lifecycle environmental impact assessments highlight the importance of collecting and recycling solar kits, especially since the informal recycling of lead-acid batteries, used in some solar kits, can have negative consequences both on health and on the environment.[62]

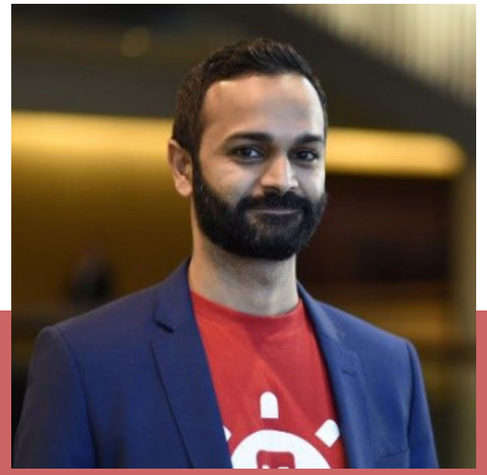
Towards productive uses of solar energy

While solar kits allow end-users to increase their income, this effect is limited by the power of the product. With the recent diversification of solar kits, the emergence of products specifically dedicated to the production of goods or services could multiply this impact[63]. In agriculture, which accounts for up to 70% of jobs in Sub-Saharan Africa, solar pump irrigation can be a more efficient alternative to rainwater irrigation while avoiding the pollution associated with using diesel pumps. Refrigerators, which are among the most desired products cited by current SHS customers, would help to minimize food loss and increase the quality of health services by facilitating the refrigeration of vaccines. The impact of these products on entrepreneurship, income growth, gender equality and health is promising and requires the development of new impact methodologies.

Similarly, the impact of solar energy on commercial, industrial and institutional players has yet to be explored in depth. By creating an industry that functions independently of the power grid at a lower cost, decentralized solar energy has the potential to provide more than a direct economic impact on energy initiatives. Rather, reducing pressure on local power grids allows local populations to benefit from better access to electricity and all the advantages that come with it.

On a larger scale, the idea of a carbon-free commercial and industrial sector, less dependent on a grid which often generates significant greenhouse gases, opens up particularly promising opportunities. This idea, which relies on the coexistence of largely private equipment efforts and a centralized effort to extend the grid, raises questions about the new forms of cooperation that should be set up between public and private economic actors. The emerging decentralized solar industry for industrial customers will have to address the issue of its «net» impact. Exciting debates are coming up.

Gaia Impact Fund intends to assume its role as a pioneer and catalyst by responding to these new challenges when it comes to energy access, leading the discussion on questions related to productive uses, industrial solar power, medium-powered community solar energy uses, and the net contribution to the reduction of greenhouse gas emissions. These challenges will be collective. The value chain - from access to energy to production, financing, installation and maintenance - is global. It will continue to evolve as new financial, industrial and political players build opportunities. Integrating the challenge of access to energy into national traditions, in consultation with users and citizens, will be a new stage of maturity on the road to universal electrification. Let's stay focused and work together.



As an impact fund, Gaia has been interested in defining and measuring its impact from day one. The team collaborated with Solaris Off-grid to analyse this impact effectively, without adding to the monitoring processes.

Siten Mandalia, co-founder of Solaris Off-grid

[59] *Brossmann, « Off---grid Rural Electrification and Fighting Poverty A Comparative Impact Assessment of Solar Home Systems and Small Solar Home Systems in Rural Bangladesh ».*
[60] *Drawn from the survey conducted with Oolu Solar.*
[61] *Stojanovski, Thurber, and Wolak, "Rural Energy Access through Solar Home Systems."*
[62] *ENEA Consulting, « L'accès à l'énergie. Etat des lieux, enjeux et perspectives » (Paris, 2014), https://www.enea-consulting.com/wp-content/uploads/2015/05/ENEA-Consulting-Lacc%C3%A8s-%C3%A0-l%C3%A9nergie.pdf.*
[63] *Attigah and Brüderle, « Productive Use of Energy – PRODUSE, A Manual for Electrification Practitioners ».*

References

Acumen, and Easy Solar. “Lean Data Baseline Results.” Unpublished data, December 2018.

Acumen, and Oolu Solar. “Lean Data.” Unpublished data, 2017.

Attigah, Benjamin, and Anna Brüderle. “Productive Use of Energy – PRODUSE, A Manual for Electrification Practitioners.” GIZ, 2011. http://www.euei-pdf.org/sites/default/files/field_publication_file/150907_euei_productive-use-manual_rz_04_web.pdf.

Brossmann, Michael. “Off-grid Rural Electrification and Fighting Poverty A Comparative Impact Assessment of Solar Home Systems and Small Solar Home Systems in Rural Bangladesh,” 2013. https://publikationen.uni-tuebingen.de/xmlui/bitstream/handle/10900/50005/pdf/Brossmann_2013_SSHS_Impact_Study_GSWP_19.pdf?sequence=1&isAllowed=y.

Central Electricity Authority. “All India Installed Capacity (in MW) of Power Stations,” 2019. http://www.cea.nic.in/reports/monthly/installedcapacity/2019/installed_capacity-03.pdf.

ENEA Consulting. “L’accès à l’énergie. Etat des lieux, enjeux et perspectives.” Paris, 2014. https://www.enea-consulting.com/wp-content/uploads/2015/05/ENEA-Consulting-Lacc%C3%A8s-%C3%A0-l%C3%A9nergie.pdf.

Ethio Research Group. “Solar Energy Vision for Ethiopia, Opportunities for Creating a Solar Industry in Ethiopia.” Freiburg, Addis Ababa, 2012. https://www.sun-connect-news.org/fileadmin/DATEIEN/PV-Industry-ET-04-09-12_final.pdf.

GOGLA. “Powering Opportunity, The Economic Impact of Off-Grid Solar,” 2018. https://www.gogla.org/sites/default/files/resource_docs/gogla_powering_opportunity_report.pdf.

———. “Standardized Impact Metrics for the Off-Grid Solar Energy Sector,” 2018. https://www.gogla.org/sites/default/files/resource_docs/gogla_impact_metrics.pdf.

Grimm, Michael, Anicet Munyehirwe, Jörg Thomas Peters, and Maximiliane Sievert. “A First Step Up the Energy Ladder? Low Cost Solar Kits and Household’s Welfare in Rural Rwanda.” Discussion paper series, 2015.

Harrison, Kat, Andrew Scott, and Ryan Hogarth. “Accelerating Access to Electricity in Africa with Off-Grid Solar,” 2016. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10229.pdf.

Hirmer, Stephanie, and Peter Guthrie. “The Benefits of Energy Appliances in the Off-Grid Energy Sector Based on Seven off-Grid Initiatives in Rural Uganda.” Renewable and Sustainable Energy Reviews 79 (November 1, 2017): 924–34. https://doi.org/10.1016/j.rser.2017.05.152.

IDInsight. “D.Light Solar Home System Impact Evaluation,” 2015. https://www.dlight.com/wp-content/uploads/2018/08/20151028_d_light_impact_report_FINAL.pdf.

International Energy Agency. « Energy Access Outlook 2017: From poverty to prosperity ». World Energy Outlook Special Report, 2017. https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

International Energy Agency. Energy Access Database, 2019. https://www.iea.org/energyaccess/database/.

Kudo, Yuya, Abu S Shonchoy, and Kazushi Takahashi. “Impacts of Solar Lanterns in Geographically Challenged Locations: Experimental Evidence from Bangladesh.” IDE Discussion Paper. Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO), 2015. http://hdl.handle.net/2344/1414.

Mills, Evan. “Job Creation and Energy Savings through a Transition to Modern Off-Grid Lighting.” Energy for Sustainable Development 33 (August 2016): 155–66. https://doi.org/10.1016/j.esd.2016.06.001.

Orosz, Matthew S, Sylvain Quoilin, and Harold Hemond. “Technologies for Heating, Cooling and Powering Rural Health Facilities in Sub-Saharan Africa.” Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy 227, no. 7 (November 1, 2013): 717–26. https://doi.org/10.1177/0957650913490300.

Peters, Jörg, and Maximiliane Sievert. “Impacts of Rural Electrification Revisited – The African Context.” Ruhr Economic Papers. Essen, 2015. https://pdfs.semanticscholar.org/9924/4a86923f992bef1427655900a384525493f7.pdf?_ga=2.192242218.1482600123.1564503912-2136408935.1564043410.

Planète d’entrepreneurs. “Social Impact Assessment - Final Report.” Stiftung Solarenergie & Hybrid Social Solutions (HSSI), 2011.

Rom, Adina, Isabel Günther, and Kat Harrison. “The Economic Impact of Solar Lighting: Results from a Randomised Field Experiment in Rural Kenya,” 2017. https://acumen.org/wp-content/uploads/2015/10/Report-The-Economic-Impact-of-Solar-Lighting.pdf.

Sibieude, Thierry, and Céline Claverie. “La mesure de l’impact social.” CSESS, 2011. https://www.avise.org/sites/default/files/atoms/files/20140204/201112_CSESS_Rapport_ImpactSocial.pdf.

Stojanovski, Ognen, Mark Thurber, and Frank Wolak. “Rural Energy Access through Solar Home Systems: Use Patterns and Opportunities for Improvement.” Energy for Sustainable Development 37 (April 2017): 33–50. https://doi.org/10.1016/j.esd.2016.11.003.

The Noun project. “Social Impact Evaluation for Hybrid Social Solutions.” Jackson Institute for Global Affairs, Yale University, 2016.

Wang, Yao. “What Are the Biggest Obstacles to Growth of SMEs in Developing Countries? - A Picture Emerging from an Enterprise Survey.” Borsa Istanbul Review 16-3 (2016) 167-176, 2016, 38.

World Bank. “Off-Grid Solar Market Trends, Report 2016.” Lighting Global, Bloomberg New Energy Finance, 2016. https://www.energynet.co.uk/fr/webfm_send/1690.

———. World Bank Open Data, 2019. https://data.worldbank.org/.

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