



Scoping Study

Enabling Environment for Pay-as-You-Go in Ethiopia

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Abbreviation Table

ACSI	Amhara Credit and Savings Institution
AEMFI	Association of Ethiopian Microfinance Institution
AFD	Agence Francaise de Développement
ATM	Automated Teller Machine
ATP	Ability to Pay
B2B	Business-to-Business
B2C	Business-to-Consumer
CfP	Call for Proposals
CGAP	Consultative Group to Assist the Poor
DBE	Development Bank of Ethiopia
DECSI	Dedebit Credit and Saving Institution
DFID	Department for International Development
DRE	Distributed Renewable Energy
ECA	Ethiopian Communications Authority
ECAE	Ethiopian Conformity Assessment Enterprise
EEA	Ethiopian Energy Authority
EEU	Ethiopian Electricity Utility
EFCCC	Ethiopian Environment, Forestry and Climate Change Commission
EIC	Ethiopian Investment Commission
EnDev	The Energising Development
ERCA	Ethiopian Revenues and Customs Authority
ESA	Ethiopian Standards Agency
E-SEDA	Ethiopian Solar Energy Development Association
ETB	Ethiopian Birr
EU	European Union
EUR	Euro
FFR	Financing Facility for Remittances
ForEx	Foreign Exchange
FSD	Financial Systems Development
GIZ	Gesellschaft für Internationale Zusammenarbeit (German: Society for International Cooperation)
GoE	Government of Ethiopia
GoR	Government of Rwanda
GOGLA	Global Off-Grid Lighting Association
GSM	Global System for Mobile Communications
GSMA	Global System for Mobile Communications Association
GTP	Growth and Transformation Plan
HS	HelloSolar
IEA	International Energy Agency
IEC	International Electrotechnical Commission
ICT	Information and Communication Technologies
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
LPI	Logistics Performance Indicator
M2M	Machine to Machine

MFI	Microfinance Institution
MIS	Microfinance Information System
MNO	Mobile Network Operator
MoA	Ministry of Agriculture
MoFEC	Ministry of Finance and Economic Cooperation
MoTI	Ministry of Trade and Industry
MoWIE	Ministry of Water, Irrigation and Energy
MRO	Maintenance, Repair, and Operations
MTF	Multi-Tier Framework
NBE	National Bank of Ethiopia
NEP	National Electrification Program
NGO	Non-Governmental Organization
OCSCO	Oromia Credit and Saving Cooperation
OGS	Off-grid Sector
OSS	Operational Self-Sufficiency
PAYGo	Pay-As-You-Go
pct	Percentage
PESTEL	Political, Economic, Social, Technological, Environmental and Legal
PoA	Program of Activities
PSE	Private Sector Enterprises
PSNP	Productive Safety Net Programme
PUE	Productive Use of Energy
PV	Photovoltaic
RBF	Results-based Financing
REB	Renewable Energy Bureaus
R&D	Research and Development
SACCO	Savings and Credit Cooperatives
SEF	Solar Energy Foundation
SFPI	Specialized Financial and Promotional Institution
SHS	Solar Home Systems
SMFI	Somali Micro-Finance Institution
SMS	Short Message Service
SPV	Special Purpose Vehicle
STM	Solar Technologies Manufacturing
ULAB	Used Lead Acid Batteries
UNFCCC	United Nations Framework Convention of Climate Change
USAID	United States Agency for International Development
USD	United States Dollar
USSD	Unstructured Supplementary Service Data
VAT	Value-added Tax
VTC	Vocational Training Centre
WB	World Bank
Wh	Watt hour
Wp	Watt-peak

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EnDev Ethiopia Team

Executive summary



EnDev Ethiopia's Financial Systems Development (FSD) component is supporting the creation of an enabling environment for off-grid renewable energy and energy efficiency investments. Pay-as-You-Go (PAYGO) technology and business models are a key component for the promotion of off-grid energy technologies. The following scoping paper introduces ICT-enabled PAYGO systems for energy access and explores the reasons for its low penetration in Ethiopia by providing:

- 1) a comprehensive overview of the PAYGO sector, including the status-quo of the supply, demand and regulatory environment;
- 2) a stakeholder mapping;
- 3) a country comparison with Rwanda;
- 4) recommendations on interventions.

To collect data for the scoping paper, a desk research was conducted followed by interviews with stakeholders in order to identify key hindrances in the supply, demand and regulatory environment. These outputs were compiled in a **Policy Economy, Social, Technology, Environment and Legal** analysis framework (PESTEL) specifically adapted to characterize and compare the PAYGO environment in each country and between countries.

ICT-enabled PAYGO has been one of the main drivers for the scale up of standalone solar systems in the African continent. Compared to other business models in the off-grid-sector (OGS), the PAYGO business model is determined by **four main characteristics**:

1. **Capital Intensive**, referring to leasing-based finance setups which allow end-customers to either purchase a clean energy generation asset (i.e., lease-to-own) or perpetually use the energy service delivered by it (i.e., lease-to-use);
2. **ICT-driven**, referring to remote control and monitoring of systems, integrated mobile money channels or proof-of-payment codes via SMS and a software that processes and manages the communication with products, end-customers and agents;
3. **Growth and Replication Oriented**, referring to the control and streamlining of supply chains, the development of simplified and replicable distribution channels and a dependency on customer retention to ensure return on investments;
4. **Product-Service Systems**, referring to the bundling of a hardware product with technical and financial services to a compact offer. This new type of business model combines procurement, distribution and finance and requires an adapted regulation and tax regime.

With almost 110 Million inhabitants, Ethiopia is the second largest African country in terms of population. With a GDP per Capita of 772 USD and an annual GDP growth of 6.8 percent, it is the 8th biggest economy on the continent.

The Government of Ethiopia (GoE) is currently implementing the second phase of its Growth and Transformation Plan II (GTP II), which aims for Ethiopia to achieve lower middle income and carbon-neutral status by 2025. Along with Ethiopia's ambitious poverty reduction strategies and targets, the government has released its National Electrification Program 2.0 (NEP 2.0), which strives for universal electrification by 2025 through a mix of on- and off-grid energy solutions. The Ministry of Water, Irrigation, and Energy (MOWIE) is the overall governing body of the energy sector. In Ethiopia, overall access to main-grid electricity is estimated at 34 percent (2018). However, rural and urban access to the main grid differ

drastically, with urban grid access between 80 percent and 90 percent while rural grid access ranges from five percent to 20 percent.

GoE with support from the International Finance Corporation (IFC) has recently developed a favourable regulatory environment for leasing and first activities are taking place. Leasing is the only financial sector in Ethiopia open to foreign investors. However, it is yet not clear if and how leasing can be applied in the off-grid sector (OGS) and for PAYGO companies.

Microfinance networks in Ethiopia have a comparable high outreach and have proved that their rural finance practices are profitable. In some countries such as Senegal, Bangladesh and Uganda, Microfinance Institutions (MFI) created own PAYGO spin-off companies in order to gain experience in digitization and to increase their outreach to vulnerable and remote populations. The MFI spin off BAOBAB+ in Senegal offers PAYGO solar systems, tablets, access to digitized financial education services and internet. After finishing their pay plan, PAYGO clients of BAOBAB+ can qualify for a loan from BAOBAB's microfinance services. In other countries, MFIs develop partnerships with PAYGO companies. This is also the case in Ethiopia, where MFIs give PAYGO companies access to their networks, provide consumer finance or support in the vetting and collection process. In Benin, two approaches to integrate PAYGO in MFIs' financing models have been piloted:

The **Direct Sell of PAYGO Solar Products by MFI** scheme, in which the MFI collects the initial payments from own clients (pre-screening), activates the product at the branch and earns a commission from the distributor. The latter collects the following payments from clients directly through the platform. This model is an additional source of revenue for the MFI (or its' clients who can act as promoters) and enables a gradual familiarization with PAYGO technology without taking credit risk.

In the **MFI Solar Credit with PAYGO Guarantee** scheme, the credit risk is transferred to the MFI, which uses the PAYGO platform to remind customers to pay their instalments. In the case, the partnering PAYGO company focuses on the distribution and the Maintenance, Repair, and Operations (MRO) services.

Recently Ethio-telecom started offering partner agreements to PAYGO companies. Beside integrating the PAYGO platform, the Telco company offers to warehouse, distribute and sell the solar products across its network. Furthermore, customers will be able to pay their monthly instalments through airtime from their mobile number.

The market potential for PAYGO systems is huge in Ethiopia. The energy access report based on the Multi-Tier Framework reveals that 56% of the households are still in Tier 0 but report a high willingness to pay for a Tier 1+ quality on credit. Large potential is also assumed for productive uses. Private Sector Enterprises (PSE) and PAYGO companies report testing e.g., PAYGO enabled solar irrigation pumps.

According to GOGLA 2019's reporting on the status of the off-grid sector, in Ethiopia, more than one million standalone units have been sold, out of which about 110,000 were earmarked as PAYGO. However, based on the desk research and stakeholder interviews, less than 8,000 systems could be identified and confirmed as sold with a PAYGO pay plan. The PAYGO players in the Ethiopian market are local start-ups, private sector enterprises, NGOs, and microfinance institutions (MFIs).

The exercise of comparing the enabling environment for PAYGO in Ethiopia and Rwanda revealed that, although both countries are very similar in the characterisation of their demand side and the design of their national electrification plans, key differences can be found in the general business and investment environment. Access to hard currency, low barriers for

international investors, results-based finance subsidies and risk mitigation facilities supported the development of a vital PAYGO industry in Rwanda which became a key stakeholder for reaching the off-grid electrification targets of the Government of Rwanda.

The well-developed GSM network and the high penetration of mobile money in Rwanda can be counted as additional factors, particularly in the early days, but meanwhile, the PAYGO industry has developed strategies to further overcome the limitations of mobile money e.g. by agent-based networks and SMS codes for payments.

Considering the special needs and requirements derived from the characteristics of PAYGO business models, an enabling environment consists of different **Political, Economic, Social, Technical, Environmental and Legal** factors. The compilation of these factors and the comparison with Rwanda in the framework of a PESTEL analysis has supported the identification of following key hindrances:

- Limited access to finance, particularly with regard to the need for hard currency, equity, debt but also credit lines to cover the gap between asset financing and end-user receivables for PAYGO companies.
- Low ability to pay off the main target group requiring subsidies and an effective organisation of the demand.
- Improvable policy and regulatory environment, particularly with regard to possibilities for foreigners to invest into distribution and to repatriate their returns, vertical integration of supply chains and the replication of distribution channels, adapted licenses for product-service integration, PAYGO regulations and PAYGO tax regime.
- Weak stakeholder engagement and skills to compensate the low mobile money penetration and weak GSM coverage through agent-based networks.

To address the key hindrances, following recommendations are made:

1. **Access to Finance for Supply Side Actors:** Finance for the whole supply chain: Improve access to FOREX, equity, debt, SPVs, risk mitigation facilities for PAYGO companies, targeted finance for start-ups, NGOs, local retailers, MFIs, and cooperatives. Develop financial vehicles combining remittances with targeted development activities through public co-funding and guarantees.
2. **Effective Organisation of the Demand and Consumer Financing:** Encourage a data-driven organization of the demand, facilitate the use of existing infrastructures from other sectors for distribution and after-sales and support their digitization. Focus on Tier 1 category technology and link the digitized Warranty Tracking System of the Development Bank of Ethiopia (DBE) with PAYG technology and Microfinance Information Systems (MIS).
3. **Improvement of the Policy and Regulatory Environment:** Improve the environment for business and investment, particularly the access to foreign currency, the re-patriation of return of investments for foreigners. Furthermore, remove barriers to reach a vertical integration of the supply chains and replication of distribution channels across the regions. Clarify how the recently developed regulatory environment for leasing supports the status of PAYGO and develop a framework for lease-to-own and perpetual leasing for MFIs and PAYGO companies in the OGS.
4. **Capacity Building and Stakeholder Engagement:** Public and private Ethiopian stakeholders as well as the civil society can be engaged to profit from PAYGO technologies, strategies and lessons learned. Process can be streamlined to become more

transparent and efficient for Renewable Energy Bureaus (REBs), MFIs, and PSEs. New markets can be explored by TELCOs and Utilities, flagship projects combining energy, finance and digital inclusion can be developed. Financial vehicles combining remittances with targeted development activities can be piloted and implemented.

Below follows an overview of quick wins, mid- and long-term actions that can be taken to improve the enabling environment for PAYGO in Ethiopia:

- I. Stakeholder Engagements, including the support of public stakeholders to adapt and develop regulations, harmonize their requirements across the regions and integrate a PAYGO strategy in their OGS tenders. Private stakeholders should be supported to share their experiences and develop their business models
- II. Studies compiling PAYGO opportunities for different target groups (TELCOs, Utilities, MFIs, etc.), developing criteria for inclusive PAYGO pilot regions and exploring strategies for remittance-based finance in the energy and microfinance sector.
- III. Capacity building through workshops and trainings on the use of PAYGO platforms, mobile money integration, data analytics and data-based management in the OGS and the digitization of processes in the inclusive energy and finance sector
- IV. Technical Assistance: Support of on-going pilots to move to a scale up phase, the development of data collection and analytics project to improve demand and supply management, e.g., in the preparation of the tenders planed in the NEP and development of a software linking the interface between the Warranty Tracking System of DBE, PAYGO platforms and microfinance information systems.
- V. Financial vehicles combining remittances with targeted development activities through public co-funding and guarantees and on a longer term, development of an SPV for PAYGO re-financing in combination with a minimum electricity demand voucher
- VI. Communication campaigns promoting PAYGO activities and examples adapted to the different target audiences, informing about on-going PAYGO initiatives, particularly the flagship project and popularise investment opportunities in the OGS in Ethiopia and among Ethiopian diasporas. Support on-going PAYGO pilots through capacity building, technical assistance, grants and guarantee funds in order to develop an adapted and attractive investment vehicle for the sector.

1. Introduction to the scope of paper

1.1 Scope of paper

EnDev Ethiopia's Financial Systems Development (FSD) component is supporting the creation of an enabling environment for off-grid renewable energy and energy efficiency investments. Financial instruments, such as Pay-as-you-Go (PAYGO), are a key component for the promotion of off-grid energy technologies, as they can increase end-user's affordability. Based on its track record in Sub-Saharan Africa, PAYGO technology has a large potential to facilitate the uptake of off-grid solar systems in Ethiopia as well. However, the uptake of PAYGO enabled solar solutions in Ethiopia was so far low.

Micro Energy International (MEI) was commissioned by EnDev Ethiopia to investigate the reasons for the low penetration of PAYGO enabled solar systems in Ethiopia and develop a scoping paper which includes:

- i. a comprehensive overview of the PAYGO sector in Ethiopia, including the status-quo of the supply, demand and regulatory environment;
- ii. a mapping of and the subsequent interviewing of main stakeholders;
- iii. a country comparison with other African countries where PAYGO has been successfully disseminated;
- iv. points of intervention for FSD in particular and EnDev Ethiopia in general.

1.2 Methodology

The PESTEL (**P**olitical, **E**conomic, **S**ocial, **T**echnological, **E**nvironmental and **L**egal) analysis was defined as the framework to guide the literature research (own consultant's documentation and publicly available information) for the status-quo of PAYGO in Ethiopia and develop indicators for country comparison. For each of the PESTEL dimensions, guiding questions were developed. These questions framed the different components of a successful environment for the implementation of PAYGO. The literature review included, Ethiopia's National Electrification Program (NEP 2.0), reports on the country's off-grid market, mobile money market, GSM coverage, pilot experiences with PAYGO and electricity access, among others (an overview of the reports and documentation utilized is provided under References). The initial findings of the literature review were adapted as answers to the proposed guiding questions, with the objective of understanding the status-quo of PAYGO in Ethiopia, identifying additional stakeholders and providing the necessary information for the stakeholder mapping.

Based on the guiding questions and the results of the preliminary literature review, a gap analysis was conducted. The resulting gaps were the base for the specific in-depth literature research and the interaction with stakeholders. As a parallel process the guiding questions were refined into indicators for a PAYGO enabling environment, providing the criteria for country comparison. Once the specific indicators were defined, an additional literature review was conducted to frame the PAYGO environment of the country of comparison (Rwanda) into the list of indicators, so the comparison with Ethiopia's status quo could be developed. The interaction with the key stakeholders to fill-in the gaps from the literature review took place in a step-by-step interaction, where the stakeholders were interviewed directly. The analysis of the information provided by the stakeholder interviews and the country comparison provided a clear understanding of the current environment for PAYGO in Ethiopia, how a potential

environment would look like, which interventions are required to achieve this environment and which stakeholders could support this process. These findings were incorporated in the recommendations section of the paper and divided in demand side interventions, supply side interventions and regulatory side interventions.

2. Pay-As-You-Go for Energy Access

ICT-enabled PAYGO has been one of the main drivers for the scale up of standalone solar systems in the African continent. The technology and the associated business model attracted many investors to the OGS. Understanding the characteristics of PAYGO is crucial for the development of an enabling environment.

Compared to other business models in the OGS, PAYGO is determined by four main characteristics from which special needs and requirements towards the **P**olitical, **E**conomic, **S**ocial, **T**echnical, **E**nvironmental and **L**egal factors are derived. They are described in depth in Section 3.3 PESTEL, influence the enabling environment.



Figure 1. Characteristics of PAYGO Business Models

Capital Intensive

In financial terms, PAYGO refers to leasing-based finance setups which allow end-customers to either purchase a clean energy generation asset (i.e., lease-to-own) or perpetually use the energy service delivered by it (i.e., lease-to-use). While the former allows end-customers to eventually gain ownership through incremental payments, the latter is comparable to a typical utility service, whereas the asset ownership remains with the energy service provider.

Although PAYGO suggest high repayment flexibility, the capital costs in most developing countries, including Ethiopia, pushes the PAYGO companies to enforce a payment plan with regular instalments, close to those of MFIs.

The majority of PAYGO systems are manufactured in China. In order to buy the assets in bulk, PAYGO companies need access to loan in hard currency. To cover the gap between the asset financing and end-user receivables, which in the case of Ethiopia can take up to 3 years, PAYGO companies need access to an adapted credit line. In absence of such a credit line, they have to use own capital, which has limitations, or collaborate with MFIs and cooperatives.

3 years
to cover the
gap
between.

Raising debt requires equity. PAYGO companies typically use this capital for the development of their distribution infrastructure.

In technological terms, PAYGO has been enabled by a combination of ICT-technologies, including embedded remote controls for switch-off and usage monitoring. The lockout technology turns borrowers' lighting (or lack thereof) into an immediate and tangible reminder to repay their debt, making clean energy a manageable, as-you-go experience, akin to a prepaid mobile phone plan.

PAYGO solar solutions have three basic parts to how digital payments are used:

- a) End-customer payments are digitized, either via
 - i) **formal mobile money channels** - software platforms integrate with mobile money platforms to receive payments, update customer accounts, and deliver proof of payment data that is transferred to the solar device to unlock for the prepaid usage, often via direct data or SMS messages. In Rwanda, Bboxx and ENGIE Mobisol send proof of payment directly to the solar devices over the cellular network to unlock services, and also receive product performance and customer usage data from each unit. In Uganda, Fenix International sends an SMS, which includes a unique code that is then transferred to the solar device through a hard-held keypad, to the end-user upon receipt of mobile payment.
 - ii) or in the absence of mobile money, through **proof-of-payment codes via SMS** - end-users pay cash to an agent appointed by the PAYGO solar company to vend prepaid energy credits (in the form of vouchers with unique 8 - 12-digit numeric codes) which are later entered into the solar product via a keypad.
- b) Software that processes digital payments and manages automated communication with products, end-customers and agents: Data plays an important role in PAYGO solar businesses, with many companies collecting hundreds of data points weekly from each customer. In the past, PAYGO solar companies have been developing their own proprietary software, often hosted in the cloud, to track data related to end-customers and payments. These software platforms often include an SMS or data gateway for automated communication with products, customers, and agents, and some integration with a digital payment platform to receive mobile payments from customers. Some PAYGO solar products (MKOPA, ENGIE Mobisol) track information on product performance (i.e., solar panel and battery voltage) and customer usage, sending data back to the central software hub on regular intervals via the GSM network.
- c) Proprietary hardware is used to tie the usage of energy services to payments: Once the proof-of-payment is transferred to the PAYGO solar device either through a.i) or a.ii), a circuit board within the solar device regulates the usage by controlling how and when electricity is sent from battery to appliances. PAYGO hardware can be initially divided into two groups based on whether or not the solar device is directly connected to the cellular network – on-network and off-network (see Table 7. PAYGo On- and Off-Network Differentiation). Reliable GSM/M2M (Machine-to-Machine) chips are currently more expensive on a per-unit basis than off-network hardware, though these prices continue to drop. For lower-cost products such as pico PV, it is not yet cost effective to add a GSM/M2M chip to allow for two-way communication via the cellular network.

All these features call for data-based management systems, which are typical for PAYGO companies and make their business models close to those of modern Telecommunication Companies and Electricity Utilities.

Growth and Replication Oriented

The first PAYGO companies operating in the OGS such as ENGIE Mobisol, M-KOPA and Bboxx were covering and controlling all aspects of the supply chain, from R&D, hardware and software manufacturing to distribution and consumer finance in different countries. Due to the high operational expenses and low cash-inflow from the local business activities, PAYGO companies started disintegrating their supply chains; currently the market sees a more specialized approach with manufacturers of PAYGO solar mainly based in China being able to integrate different PAYGO platforms/software from companies often based in the US, UK and the EU. Local distributors can choose a Solar Home System (SHS) brand such as BioLite, OmniVoltaic or SunKing, combine them with a PAYGO platform such as Angaza or Paygee and develop their own local distribution network. However, some fully vertically integrated companies such as Bboxx still exist.

The following figure gives an overview of international PAYGO players and value chains:

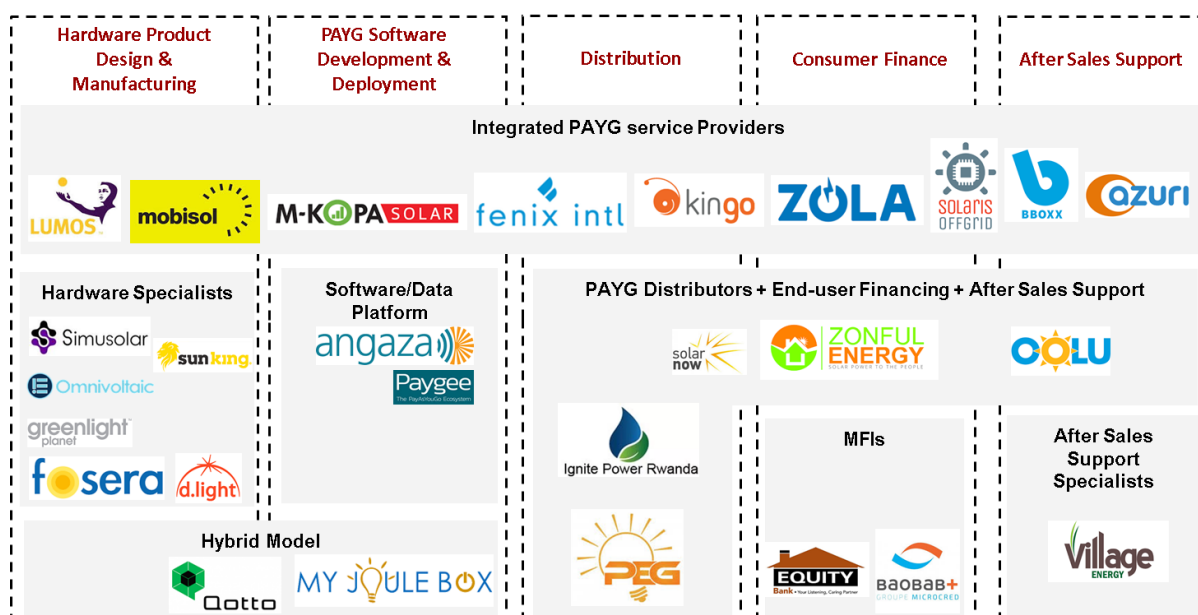


Figure 2. International PAYGO Players and Value Chains

Lithium-ion (Li-ion) batteries were first introduced in the 1990s and have rapidly grown to become a key technology in mobile consumer electronics. They provide much improved performance (number of cycles) compared to lead-acid and can support a depth of discharge ranging from 80 to 100% with round trip efficiencies of 92-96%.

The challenge faced by Li-ion batteries is that they have much higher costs than lead-acid batteries. However, because of the higher depth of discharge they make economic sense in some cases due to high number of cycles possible and reduced storage needs compared to lead-acid. This is particularly the case for solar lanterns and Tier 1 SHS, who became this way portable and easy manageable products.

The portability and manageability of Li-Ion based solar products enabled the development of highly efficient and replicable distribution infrastructures based on proprietary channels as well as partnerships with 3rd parties such as MFIs, TELCOs, gas stations etc. The PAYGO sector, e.g. in Rwanda, developed reverse supply chains based on swap strategies for repair and overhaul and collection strategies for proper disposal and recycling.

The development of these distribution channels is time and capital intensive. Accordingly, customer retention for the commercialization of further products is key for many PAYGO companies in order to reach breakeven and become profitable. Typically, upgrades to Tier 2 SHS or further appliances are offered after the customer has paid the last instalment. In some cases, PAYGO companies do also offer other products such as smart phones, tablets, water filters or financial services. MFIs have used PAYGO solar as a starter-product for vulnerable non-clients to qualify for a larger micro-credit.

Product Service Systems

A characteristic of PAYGO companies is the bundling of a hardware product with technical and financial services to a compact offer. This new category of business model, which compiles importation, warehousing, distribution and finance requires an adapted regulation and tax regime.

3. Status-quo of PAYGO in Ethiopia

In the following chapter, an overview of PAYGO systems in Ethiopia is provided, followed by the map of relevant stakeholders. The results of the literature research and the conducted interviews are compiled in an adapted PESTEL framework. The chapter concludes with an overview of the key hindrances for the needs of PAYGO companies.

3.1 PAYGO Systems in Ethiopia

In order to understand the status quo of PAYGO in Ethiopia, several sources of reporting (GOGLA, WB) were corroborated and interviews with local actors were conducted. Additionally, an overview of the systems available in Ethiopia, per type of systems and their distributors was created:



A detailed Table can be found in Annex 3 - Status Quo of PAYGO in Ethiopia.

Table 1. Overview of PAYGO Systems gives an overview of the OGS in Ethiopia and the number of PAYGO systems, which differ in their units, depending on the reporting source:

Table 1. Overview of PAYGO Systems in Ethiopia

Lanterns, pico-PV, SHS	H1	H2	H1+H2	% of PAYGo
Total units sold in 2019 (GOGLA)			1.011.537	
Units sold in Cash (GOGLA)	251.597	658.982	910.579	
PAYGo Units (GOGLA)	42.181	58.777	100.958	10%
PAYGo Units (Stakeholder Interviews)			5.500	1%
Total units sold in 2020			235.401	
Units sold in Cash	209.601		209.601	
PAYGo Units	25.800		25.800	11%
PAYGo Units (Stakeholder Interviews)			2.500	1%
Total SHS units imported through DBE since 2013			167.000	
Total Pico PV units imported through DBE since 2013			1.100.000	
Number of MFI Loans for RE and EE since 2013			214.000	

To interpret the above numbers and particularly understand the differences between the PAYGO units indicated by GOGLA and those reported by the main stakeholders during the interviews, it is important to note limitations to GOGLA's reporting for the years 2019 and 2020. Firstly, the reported data is collected from companies affiliated to GOGLA and IFC Lighting Global, whose sales are estimated to cover only 28% [28] of the overall off-grid solar market, with a remaining 72% of non-affiliates distributing both Lighting Africa approved and other products. Secondly, the numbers presented cover products sold both business-to-business (B2B) and business-to-consumer (B2C); however, for the B2B sales, products are sold to

distributors, government agencies or any other intermediary before they reach their intended end-user, meaning that although the products are reported as sold in a country, they may not have reached yet the consumer. Thirdly, specifically for the case of Ethiopia, although these products are PAYGO enabled, they are rarely sold in instalments and hence not PAYGO activated. Lastly, GOGLA does not differentiate between the different types of PAYGO systems, which can be on- or off-network.

According to the desk research and interviews conducted with key stakeholders in the sector, HelloSolar has distributed in the last two years about 7,000 PAYGO systems out of which 95% are activated and paid in instalments. A number of other companies claim having a few hundred activated systems, at a pilot stage. As of October 2020, roughly 8,000 activated PAYGO systems can be confirmed, representing less than 1% of the total number of systems reported to GOGLA.

MFIs play a crucial role in the Ethiopian OGS sector. PSEs collaborate with them to finance particularly Tier 1+ SHS. This applies also to PAYGO companies, who partner with MFIs not only for consumer financing but also for the identification of solvent clients and to get support with the collection of instalments.

3.2 Stakeholder Mapping

The following Figure 3 gives an overview of the relevant stakeholders identified for a conducive framework for PAYGO in Ethiopia. They are segmented in public and private sector stakeholders as well as in civil society and development partners.

Stakeholders close to the inner circle are considered key stakeholders, followed by primary and secondary stakeholders. In dark red are the stakeholders interviewed for this study (detailed list in Annex 1 - Introduction and scope of the paper

in the annex). In light red and orange are the stakeholders conducting PAYG pilots in Ethiopia.

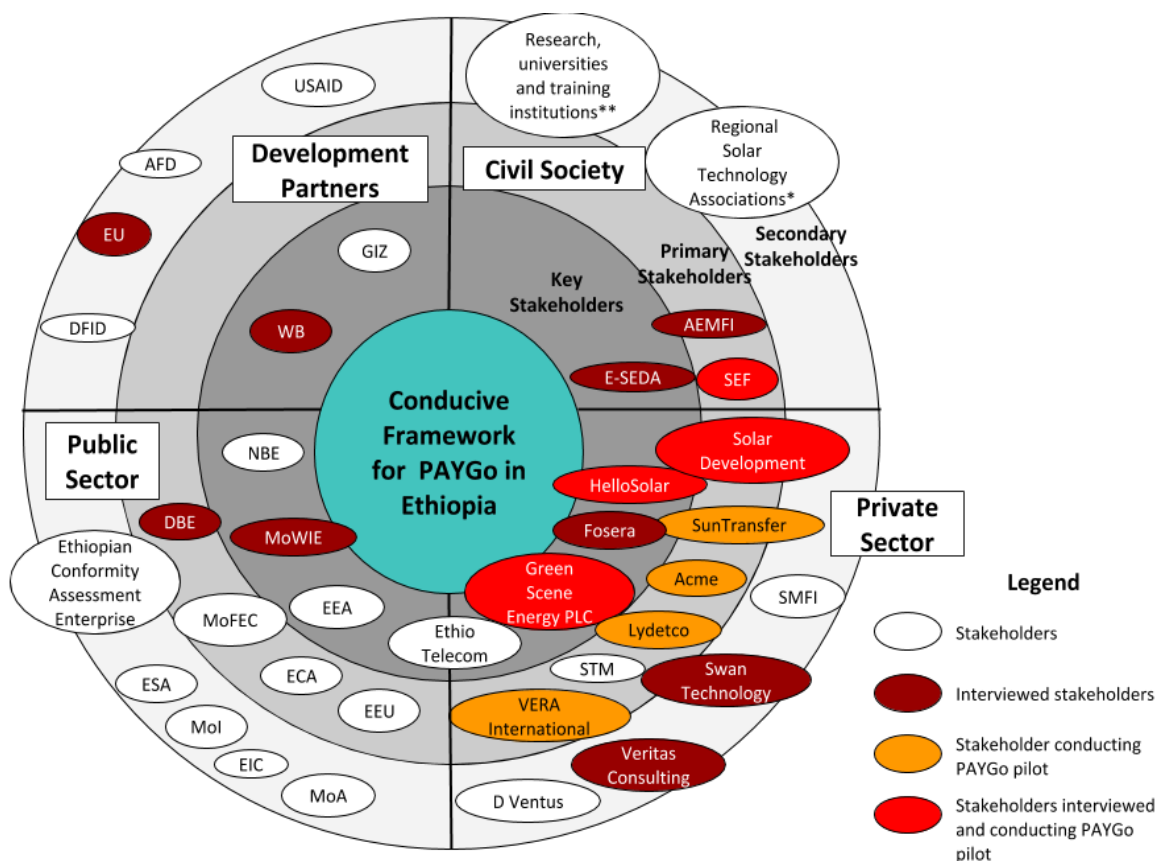


Figure 3. Stakeholder Mapping

3.3 PESTEL

As described in Chapter 02. Pay-As-You-Go for Energy Access, the PAYGO business model is determined by four main characteristics from which special needs and requirements towards the **P**olitical, **E**conomic, **S**ocial, **T**echnical, **E**nvironmental, and **L**egal factors are derived.

The following Table 2 gives an overview:

Table 2. PAYGO Business Model Characteristics

PAYGo Business Model Characteristic	Special Needs and Requirements	P	E	S	T	E	L
Capital intensive	Hard currency debt for bulk acquisition of systems						
	Customer financing up to three years covering inflation, depreciation and other risks						
	Equity finance for the development of the supply chain						
ICT driven	Remote control of the systems						
	Remote monitoring						
	Data driven management						
	Mobile money						
Growth and replication oriented	Control of the supply chain						
	Development of simplified distribution channels						
	Development of replicable distribution channels						
	Customer retention						
Product - Service System	Technical product offer (Hardware)						
	Technical service offer (MRO)						
	Financial service offer						

To gain a deeper understanding of Ethiopia's enabling environment for PAYGO and to make it comparable with other's country environment, results of the desk research and insights from interviews with key stakeholders are compiled in the following adapted PESTEL analysis. To conduct the analysis, a set of guiding questions were developed, from which indicators for the country comparison are derived (see Table 12. PESTEL Guiding questions). In the following,

the results of the analysis are presented. Marked in “+” are those factors which can be considered supportive of a PAYGO solar environment, while in “-” are factors which can be discouraging.

3.3.1 Political

This section is focused on the governmental and civil society’s support for off-grid electrification in general and PAYGO in particular.

(+) GoE acknowledges and supports national electrification through decentralized solar technologies

The Government of Ethiopia (GoE), through its national electrification programme, aims to achieve universal access to electricity by 2025 and become a power hub in Eastern Africa [3]. According to NEP 2.0, this goal is supported, by off-grid electrification. The mid-term pre-electrification program acknowledged for a private sector led, off-grid electrification which targets those communities that will take longer to receive a grid connection but are residing between 2.5 and 25 km away from the existing grid [NEP 2.0, p22]. It is expected that 6 million new off-grid connections will be added by 2025, which represents a target of 35% off-grid access rate by then (see Figure 7. NEP 2.0 Electrification targets).



6 Million new
off-grid
connections
until 2025

(-) The NEP 2.0 considers Distributed Renewable Energy (DREs) only as a bridge technology, which will be replaced gradually with grid connections

The projections in NEP 2.0 indicate that grid service delivery will remain the primary delivery modality while off-grid electrification is expected to reach a peak in 2025 serving 35% of the population and then tapering off to be a relative marginal supply solution for less than one million households by 2030. PAYGO companies would have to adapt their offers, accordingly, praising their systems as complementary to the grid or shift to other types of offers such as PAYGO roof top solar, PAYGO smart phones, TV, tablets etc.

(-) Policies are not uniform across the different regions, requirements differ e.g. with regard to the quality standards

Regional Energy Bureaus (REBs) are playing a central role in defining and implementing regulation for off-grid solar companies on a regional level. Whenever a company enters a new region, it needs to obtain a license to operate from the REB. Procedures and rules to obtain such a license are not harmonized across regions, adding substantial administrative costs to companies seeking to operate across several regions.

Following are three examples:

- Amhara REB only accepts Lighting Global certified products,
- Oromia accepts Lighting Global or any other third party approved solar systems,
- Tigray accepts either Lighting Global or Ethiopian Conformity Assessment Enterprise (ECAE) certified products only.

(-) Restrictions apply to vertically integrated supply chains and foreign investments

Under the current proclamation (980/2016), companies need separate licenses for import and retail. According to key stakeholders, this leads to high mark-ups of around 30%. Furthermore, the trade is restrictive for foreign investment; in the field of OGS, this means that foreign companies are not allowed to be involved in the distribution of solar systems[4].

(-) The financial and telecommunication sectors are not liberalized and are restrictive

The financial sector is not liberalized and is restrictive for international stakeholders. Mobile and Agent Banking Regulations were published in 2012 outlining a financial institution-led policy. Technology service providers must partner with a financial institution to provide e-wallet services. Despite all the restrictions, there are some companies with foreign owners operating in Ethiopia as technology service providers for mobile or e-wallet banking. Because these technology service providers are not regulated by the NBE, these foreigners are allowed to provide the technology as long as an Ethiopian financial institution accesses the accounts and handles agent recruitment [4].

GoE with support from IFC has recently developed a favourable regulatory environment for leasing and the Development Bank of Ethiopia (DBE) and some companies such as Ethiolease have launched operations.

Leasing is the only financial sector in Ethiopia open to foreign investors. However, it is yet not clear if leasing can be applied by PAYGO companies under these regulations and if this opens up new opportunities for foreign investment [45].

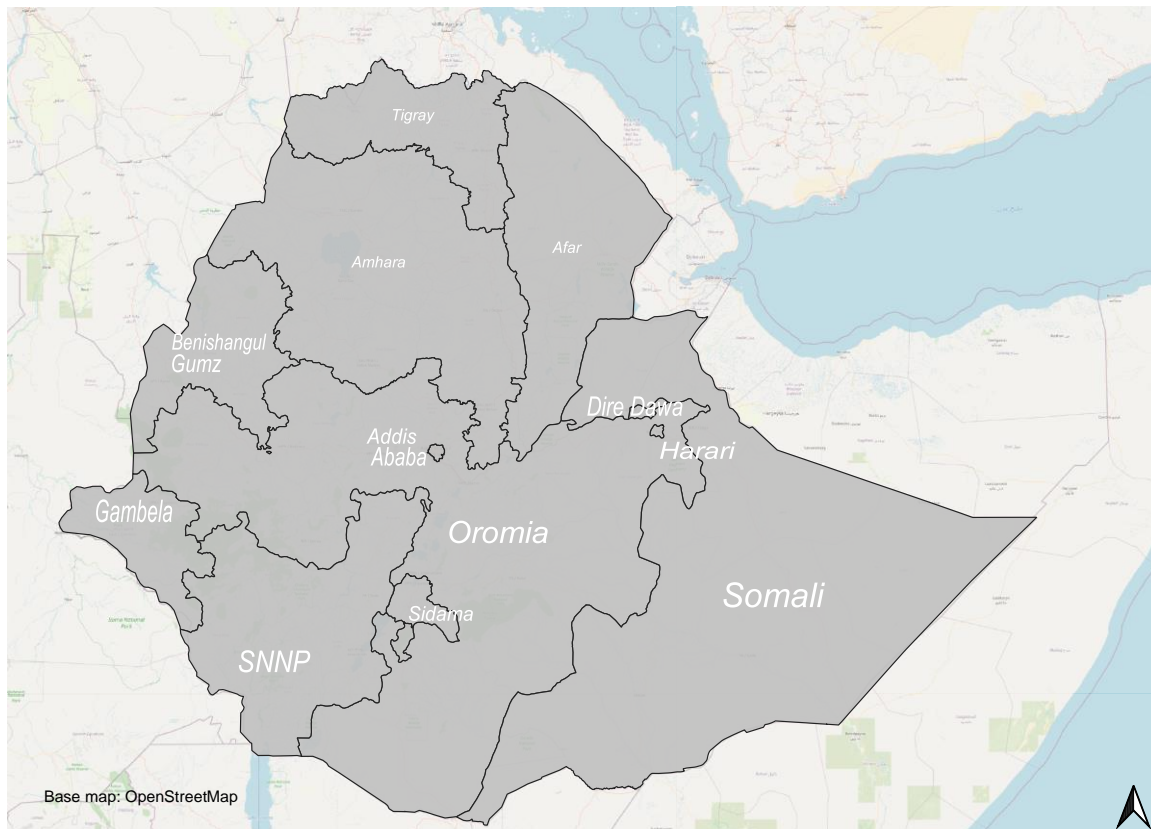
Mobile services are provided by a state-owned telecom, Ethio telecom, which is in a process of liberalization [5]. Recently, the PAYGO start-up Green Scene announced a partnership with Ethio telecom. The latter will provide its customers with the option to pay for energy through its branch offices and every airtime store across the country [46].

(+) National and regional civil society actors raise awareness, improve skills and contribute to coordinating diverse stakeholders

The Ethiopian Solar Energy Development Association (ESEDA) is a non-profit association that facilitates the growth of the solar energy business in Ethiopia, by promoting the interests of the solar energy industry among the public sector. Besides ESEDA, four regional solar energy associations exist:

- Oromia Region Solar Technology Association,
- Amhara Region Solar Technology Association,
- SNNPR Solar Technology Association and
- Tigray Region Solar Development Association.

Figure 4. Ethiopia Administrative Map



Furthermore, a scientific community researching off-grid electrification was identified. The Energy Technology Programme of the Addis Ababa Institute of Technology does research on feasible options for rural electrification, while promoting capacity building and networking. Specific research on PAYGO has not been identified so far. Other scientific organizations promoting research in off-grid electrification are the Adama University, Solar Technologies Manufacturing (STM), the Institute of Energy of the Mekelle University, and Hawassa VTC.

3.3.2 Economic

This section focuses on resources and economic conditions necessary for the establishment of PAYGO operational models in Ethiopia.

(-) Restrictive business environment impacting international supply chains

Ethiopia is perceived as a high-risk business environment and is placed 159 out of 190 countries on the World Bank's 2020 Doing Business Index [5]. The same report states that, in order to start a business, 32 days are required, which is longer than the average for Sub-Saharan Africa (21.5 days), and the costs represent 45.4% of the population's income per capita (against 36.4% in Sub-Saharan Africa)[10]. The main barriers for investment are the difficulties and delays to access foreign exchange (FOREX) and to repatriate it in the case of foreign investors [4]. The Ethiopian government exercises control over the services sector, including a virtually full control over the local banks. However, the impending privatization of state-owned logistics, electricity and telecommunication sectors is expected to boost private investments [11].

(-) Access to FOREX is the main issue for providers of solar off-grid solutions

It translates into delays and general unpredictability in delivery times for both, new purchases and warranty replacements. It also disables local businesses to continuously rebuild stocks and scale business using economies of scale that can result in lower priced products for end-customers. Last but not least, the cost burden of 1.5% fee that the National Bank of Ethiopia charges for all foreign exchange transactions can be significant for relatively small businesses. Providers can experience 3-12 months delay from placing an order with FOREX bureaus of local banks for exchanging ETB to hard currency to receiving their import order. In addition, the exact timing is often very hard to predict, posing a challenge on business continuity and customer relations. Different mitigation strategies are pursued by PSEs in the sector, such as applying for grants in hard currency, engaging Ethiopian diaspora as funders/founders and applying to the DBE WB credit line for Market Transformation. This credit line was available until 2019. An extension is in negotiation between GoE and the World Bank but currently retarded because of the COVID-19 pandemic.

(-) Access to targeted finance for enterprise development and business scale-up

The private sector has different financial needs that over time change in size, type of and most fitting source of financing. Availability of grants and targeted equity finance are instrumental in the early growth stages of PAYGO companies. Debt becomes more relevant when operations have proven that they scale, and companies are seeking to grow and expand their models. Due to the strong limitations on investment in the local financial sector, international equity for PAYGO is particularly non-existent. Furthermore, limited working capital access means no benefits from economy of scale of bulk orders, limited stocks locally, limited investment in branding and changing sales modalities to widen customer bases. Currently, Ethiopian commercial banks request **100% collateral** on borrowed funds as well as international guarantees for certain lending purposes such as for clean energy business development purposes. The high collateral requirements ultimately preclude many local PSEs (especially those in the early stages of development such as start-ups) to access local financing. It is often tedious to obtain those guarantees, which also come at an annual cost. It should be noted that PAYGO companies working with end-user finance schemes need access to on-lending for end-customer finance, which is often cited as the biggest obstacle to growth for SMEs working in the space. For the moment, PSEs are either using their funds or collaborating with MFIs to overcome this gap.

(-) Weak infrastructure combined with a high level of remoteness

Geographical remoteness results in high costs that are hard for off-grid businesses to absorb. In general, trade logistics' time and costs are still high in Ethiopia even with increasingly improving road and railway infrastructure. In 2016, the World Bank Logistics Performance Indicator (LPI) ranked Ethiopia 126 out of 160 countries. Logistics related to procurement, shipment, delivery, and maintenance of imported materials to remote areas as in the majority of Ethiopia result in significant delays, added costs for end-customers, low attractiveness for general investment in the market segment, and hardships for PSEs in reaching scale. PAYGO companies must recover sufficient revenue to pay for operating costs and unless they engage

in a partnership with an existing network, they must also collect sufficient revenue to recover the cost of the investment in infrastructure. However, the PAYGO characteristic simplified and replicable distribution channels, described in Section 0 Growth and Replication Oriented, can help to overcome this barrier.

(+) Ethiopia has a well-developed and profitable micro- und rural finance sector, however, its outreach is limited and generally, it lacks modern tools for loan appraisal, disbursement, monitoring and portfolio diversification

There are 35 MFIs in Ethiopia that hold 6% of all financial sector assets. The five largest MFIs are state-owned and have 11.4 million accounts [4] serving a relatively broad market with a focus on the ones better off [19]. The MFIs in Ethiopia, according to MixMarket, have an average Operational Self-Sufficiency (OSS) of 145%, implying that they can easily cover their operational expenses and are relatively profitable. Nevertheless, a lack of digitization and product diversity can be observed. Government-supported MFIs such as OCSCO, Wasasa Microfinance, DECSI, ACSI, and OMO Microfinance have started getting involved in solar off-grid lending since 2012. This trend can be attributed mainly due to the first/preferential access they were given to the DBE credit line whose first tranche/inception dates back to 2013. At the same time, smaller institutions such as Buusaa Gonofaa, Harbu Microfinance, SFPI, and PEACE Microfinance, all private MFIs which have span off from local NGOs, have also been active in the field of solar lending. Today, 14 MFIs have access to the DBE off-grid business support programs for MFIs and have been involved in different capacities in green lending. Typically, local MFIs gather demand from their existing clientele. Once minimum order quantities are achieved, orders are placed with their pre-selected/chosen providers/PSEs, channelling a down payment/prepayment from their end-customers to the provider. The rest of the payment to the provider is executed upon installation. Warranty, maintenance and after-sales are usually calculated in the price offered by the provider. End-users have to pay an interest fee varying between 12 and 25%. Although MFIs play a central role in financing OGS products in rural Ethiopia, it is observed that their interest and motivation could be improved. Whilst the risk of credit and technology default is carried by the MFIs, the PSE gets 100% of its system paid after installation. Small pilot projects of local MFIs and NGOs using mobile money, digital vouchers and PAYGO exist, even within the very vulnerable target groups such as PSNP beneficiaries. AEMFI reports such experiences from Peace MFI, ACSI and OCSSCO in collaboration with AZURI.

(+) Experiences and instruments to leverage investments from Ethiopian Diaspora

According to the International Fund for Agricultural Development (IFAD), 30 to 40% of remittances go to rural areas and more than 20% of the people within the reach of an MFI receive remittances through MFIs [3]. Projects such as the Financing Facility for Remittances (FFR) have supported the integration of money transfer systems between MFI clients and Ethiopian migrants through an online, real-time remittance processing system. PAYGO companies in Ethiopia are pioneering International Remittance Payment to allow Ethiopian Diaspora to pay for their off-grid relatives from abroad. Furthermore, the role of the Ethiopian diaspora supporting particularly importers of off-grid technology to overcome their challenges accessing hard currency was underlined by many of the interviewed stakeholders.

3.3.3 Social

The social environment presents the context of the society in which a project or organisation operates, including factors such as demographics, cultural attitudes, values and lifestyle.

(+) According to the Ethiopian Multi-Tier Framework (MTF), 55,7% of the households are still in Tier 0. Furthermore, 26.000 schools and 15.000 health posts are un-electrified

The market size for the OGS is closely linked to the current access to electricity and the reliability of its supply. The energy access report based on the Multi-Tier Framework (MTF) (see

Figure 8. MTF 2018 Distribution of Tiers) shows that 57% of Ethiopian households have at least one source of electricity. In the context of the MTF, 55.7% of the households either have no access to electricity sources or rely on grid or off-grid solutions that do not manage to provide even basic electricity services (lighting the house and charge cell phones for at least four hours a day) [15]. PSEs report that it is very difficult to sell Tier 1+ quality Solar Home Systems (SHS) without credit in Ethiopia. This reveals a huge potential for PAYGO solutions. 65% of the total employment in Ethiopia takes place in the agriculture sector [16], the country's exports depend mostly on agricultural commodities. 95% of the agricultural production comes from about 12 million smallholder farming households[17]. A considerable number of these farmers live and work in long-term off-grid areas but are deemed to have the highest growth potential under the agriculture policies of the Government [NEP 2.0]. PSEs report plans to test PAYGO enabled and activated productive use applications, such as solar irrigation pumps [18].

(+) Productive Safety Net infrastructure has a wide outreach and broader development objectives

The NEP 2.0 defines several priority beneficiaries such as those belonging to the Productive Safety Net Program (PSNP). To ensure adequate access to lighting products, the Government has set in place a supply-side financial support mechanism. Ethiopia's PSNP is one of the largest social protection schemes in Sub-Saharan Africa and has been implemented since 2005. It has broader development objectives beyond fulfilling income shortfalls: smoothing household consumption, facilitating investment in human capital and other productive assets, protecting household assets, and strengthening the agency of those in poverty to overcome their predicament. All regions of Ethiopia, except Gambella and Benishangul Gumuz, are covered by the program and the number of beneficiaries has increased to around eight million people. PSNP uses a mix of geographic and community targeting criteria to choose vulnerable households (see PSNP outreach in Figure 6. PSNP Outreach). AEMFI reports that some MFIs (Peace MFI, ACSI and OCSSCO) are piloting PAYGO systems with PSNP clients.

3.3.4 Technological

The technological environment describes the available enabling infrastructure for the set-up of PAYGO technologies. Relevant topics which characterize the technological environment are the following:

(-) Low ICT use and literacy and limited mobile phones usages

In 2020, the GSM coverage of Ethio telecom is very limited (see Figure 5. GSM coverage in Ethiopia) and the internet usage not very widespread in Ethiopia. In 2019, there were 46.75 million mobile phone connections (41% of the population), with 7.2 million new connections added between 2019 and 2020, and 21.14 million internet users (an internet penetration of 19%)[23]. 96% of the mobile connections are pre-paid. Recently, Ethio telecom started offering partner agreements to PAYGO companies. Beside integrating the PAYGO platform with Ethio telecom systems, the Telco company offers to warehouse, distribute and sell the solar products across its network. Furthermore, customers will be able to pay their monthly instalments through airtime from their mobile number [46].

(-) Low penetration of mobile money

Due to underdeveloped telecommunications infrastructure, almost entirely absent in rural areas, and the monopolistic control of the government-owned mobile operator company, mobile phones penetration is remarkably low in Ethiopia if compared to other African countries. This is one of the reasons, why Ethio telecom decided to collaborate with PAYGO companies. The sector is heavily regulated, and the government has control over the communication networks. Mobile money services have started to emerge after receiving slow approvals. They are being offered in consistent strides in various regions through a handful of financial institutions, which may contribute to greater penetration of mobile money.

Belcash Technology Solutions PLC (BTS) launched Hello Cash in February 2015 as the first mobile money service provider. The system is designed for multi banks and MFIs to be interconnected and offer the mobile money service to their respective customers, targeting especially rural communities in order to drive financial inclusion. In 2018, BTS launched Hello Solar to pilot PAYGO in Ethiopia, which is so far the leading PAYGO company in the country.

M-BIRR launched in March 2015 is provided by the five largest MFIs in Ethiopia (ACSI, DECSI, OCSSCO, OMO and ADCSI) and focuses primarily on poor households in rural areas. A detailed list of mobile money provider is in the annex in Table 10.

As of November 2020, as little as 0.3% of the population aged 15+ years reports having a mobile money account, while 0.6% make online purchases and /or pay bills online [23]. All digital payment accounts must be linked to the possession of a banking account, either from a bank or an MFI, limiting digital payments. Even in the on-grid sector, 99% of the electricity payments take place in cash, and only 2% of the households use mobile money. The GoE has established a goal of 5% adoption of mobile money by 2025 [3]. Some PSNP beneficiaries receive their money via mobile payments, however, according to interviewed PAYGO companies, this does not yet mean, that they are capable to use the technology to make payments. Regarding other possible payment infrastructure that could eventually be used for the payment of off-grid electricity, there are less than 15,000 financial service access points in the country [4], and more than 100,000 airtime resellers, established by Ethio telecom to serve its more than 60 million subscriptions [3], accordingly, the announced partner agreements with PAYGO companies are a promising opportunity to increase the outreach.

(+) National and regional solar energy literacy

Apart from the training provided through the regional solar associations, local knowledge of solar energy has been gradually built through initiatives of EnDev, IFC, the World Bank and other development organisation. UNFCCC's "Solar Lighting in Rural Ethiopia" for example, established solar centres across Ethiopia to promote technology spreading; this project included setting up a central solar school and competence centres to train people in the solar trade and provide finance. The program established 11 solar centres and installed 22000 SHS. This program also established an international solar energy school in Addis Ababa, where solar engineers are trained, in particular in the area of rural electrification and are capacitated to set up their own small solar businesses in villages [24].

(+) A product warranty tracking program and a customer information system is currently developed and will be implemented in the upcoming months

In support of different quality assurance strategies, a Warranty Tracking and Customer Information System are being developed by the World Bank to locate the distribution of imported technologies with a web-enabled warranty tracking and customer information system. The system will create warranty tracking mechanism to replace defective products during the warranty period.

3.3.5 Environmental

This adapted PESTEL factor investigates end-of-life management issues. The increased implementation of solar products will require the enforcement of proper collection and recycling practices for electronic waste, lead-acid batteries and lithium-ion batteries, but in a way distributor, manufacturers are not burdened by a too complex supply chain.

(-) Lack of regulation on e-waste management and recycling of batteries

The Electrical and Electronic Waste Management and Disposal Council of Ministers Regulations No. 425-2018 has been issued in 2018. However, NEP 2.0 does not cover the topic of recycling and disposal yet. The battery recycling industry is still highly informal. GIZ aims to promote the implementation of solutions to promote sustainable and environmentally solutions for battery recycling [25], and in this sense, working with the Ethiopian Ministry of Environment, Forestry and Climate Change Commission (EFCCC)[26] on setting up a proper framework.

(+) Battery Disposal Provisions under the Ethiopian Off-grid RE PoA (PoA 10285)

The Ethiopia Off-Grid Renewable Energy Program is a 2014 UNFCCC CDM registered Program of Activities (PoA) coordinated and managed by the Development Bank of Ethiopia (DBE). The Component Project Activity (CPA) included in this PoA is operated by DBE, who is also a project participant. To make the repair and replacement of solar batteries more affordable to households purchasing solar products, the purchaser of the credits generated from the PoA (Ci-Dev) has stipulated that part of the revenues from the program's carbon

credit sales should be used to partially offset the costs of battery replacement. Around 40% of the battery replacement costs are supposed to be subsidized through carbon revenues.

3.3.6 Legal

The legal framework considers the influence of regulatory authorities, policy stability and legal norms for the context of PAYGO in Ethiopia.

(-) PAYGO has no clear status in Ethiopian policy

At present, two regulators in Ethiopia have different views on PAYGO: According to the NBE, only financial institutions are legally able to offer credit. However, Ethiopian Energy Authority (EEA) has expressed the opinion that PAYGO conforms to their regulations. This gap in regulatory provision needs to be investigated and resolved.

(-) Technology providers have limited possibilities to offer financial services and MFIs have limited possibilities to stock and distribute products

Classical PAYGO companies run a product-service system model in which the customer gets the technology and the financing from the same entity (See section 0.Product Service Systems). This is also the default model in Bangladesh, where MFIs create new entities to offer SHS with credit in a one-hand model. Due to the existing legal framework, the default model applied in Ethiopia up to date is the multi-enterprise business model. It refers to cases where two or more entities enter into formal agreements to provide the financed energy technology to the end-users. Typically, a technology supplier and an MFI enter into a contract where the former is providing financing, whilst the latter provides the hardware, conducts installation and after-sell services. The end-user has to deal with two entities to access electricity and services. To be effective, this model requires: a clarity in responsibilities, roles, as well as steps, procedures and process alignments between all participating parties.

(+) Quality approved solar products are tax exempt

The Ethiopian Revenues and Customs Authority (ERCA) usually charges up to 35% duty and an excise tax of up to 100% on imported products. However, importers of solar products under 15Wp have been exempted from both thanks to the proclamation from the Ministry of Finance and Economic Cooperation (MoFEC) on renewable energy. Larger SHS with quality certificates (Lighting Global, IEC) are also benefiting from this exemption. They are exempted from custom duties (but 15% VAT and 3% withholding tax are applicable) [3]. Moreover, to streamline importation of off-grid solar products, the Council of Ministers has approved certification of products before shipment (Pre-Verification of Conformity, or PVOC). The Ministry of Trade has eliminated the practice of taking of samples from every shipment, related testing fees, and a previous 0.5% deposit based on shipment value.

(+) Quality framework is standardized based on international standards

Quality standards for solar products set by the Ethiopian Standards Agency (ESA) based on the Lighting Global quality assurance framework are implemented for solar systems below 15 Wp; for systems up to 350Wp, the International Electro-technical Commission (IEC) standards are in place, but their adoption is voluntary[3].

(-) Restrictive and strong oversight on financial services diversification

The use of mobile money is restricted to banks and MFIs, as they must hold the money in any mobile banking transaction. Financial services can only be provided by financial institutions and not by other parties such as mobile network operators (MNO) [5]. The regulations on financial services are changing, and since April 2020 non-financial service companies are allowed to offer certain services such as cash-in/cash-out, domestic remittances, bill payments, retail payments and inward international remittances if they obtain a license from the National Bank of Ethiopia (NBE). Some of the requirements are a minimum capital deposit of 50 million ETB (1.46 million USD), central bank approval of key product executives, a five year business plan, a geographical rollout schedule and security policies, new services could also be subject to a three months pilot phase assessed by authorities [27].

3.4 Country comparison

For the country comparison, Rwanda was chosen as a showcase because it has on the one side an electrification strategy closes to the NEP, on the other side the country achieved to attract many PAYGO investors. Today, the five Rwandan PAYGO companies play a central role in supporting the Government in reaching its goal of universal electrification by 2024. Table 3 summarizes the key indicators comparing the two countries:

Table 3. Key Indicators for the Country Comparison [4],[20], [48]

Indicators	Ethiopia	Rwanda
Demographics		
Total Population	109.224.559	12.301.939
Area in km ²	1.104.000	26.338
Population Density per km ²	109	499
GDP per Capita	USD 772,3	USD 773
GDP Growth	6,80%	5,80%
Energy Access Deficit		
National Electrification Rate	44,30%	34%
Urban Electrification Rate	96,60%	85%
Rural Electrification Rate	31%	24%
Number of households without power	12,6 million	1,7 million
% of quality verified (QV) vs non-QV products in the market (H1, 2019)	QV: 68%, Non-QV:32%	QV:90%, Non-QV: 10%
Electrification Planning		
Electrification Targets	Universal access by 2025 65% OnGrid, 35% OffGrid	Universal access by 2024 52% OnGrid, 48% OffGrid
Key Differences		
WB Doing Business Index	159	38
Nr. of PAYGo Companies	2	5
Implemented business models	Lease to own pilots	Lease to own, perpetual lease
3G GSM Coverage in 2019 (Towers per km ²)	0,01%	0,2%
Access to mobile phone (2019)	37%	76%
Access to mobile money (2019)	0,30%	31%
Impact		
People currently accessing Tier 1 energy services (2018)	2.451.734	1.192.261
	2%	10%
People currently accessing Tier 2 energy services (2018)	25.004	544.045
	0,02%	19%
People currently living with improved energy access (2018)	4.975.341	2.375.297
	5%	19%

When it comes to electrification, the most important similarities are:

- Both countries are committed to achieving universal access to electricity, through a mix between on-grid and off-grid electrification through decentralized renewable energy systems
- Both countries have similar regulations for quality standards of off-grid solar systems, based on Lighting Africa' framework
- In terms of financial inclusion, banks, microfinance institutions and SACCOs represent the main type of organizations that cover remote areas and who are also included in the supply chains of off-grid systems
- GDP per capita, the Ability to Pay (ATP) and the price sensitivity of end-users are similar in both countries and represent key barriers for the uptake of off-grid solar systems

The differences of Rwanda's better PAYGO ecosystem performance, compared to Ethiopia, are:

- Rwanda has an investment and business friendly environment
- Access to Forex in Rwanda is liberalized, and moreover, the process of setting up a new business, whether by an international or a national, is highly simplified and incentivized
- Due to its lack of Forex restrictions, there is a wider presence of international development aid in Rwanda, which carry extensive technical and financial support activities, which include subsidising procurement, training and capacity building
- Although both countries provide financial institutions (MFIs, banks and SACCOs) and private enterprises (manufacturers, distributors, importers) with guarantee and loan facilities, with the Forex barrier eliminated in Rwanda, the subsidies are reflected better in the price of the solar systems, rather than dispersed on exchange risks for the actors along the supply chain
- To encourage the inclusion of more households, GoR has set up a Risk Mitigation Facility for collaborating PAYGO companies, MFIs and cooperatives [47]
- Depending on the income level of households, the GoR provides up to 90% subsidies for Tier 1 energy access. There is no 100% subsidization. EnDev and other development partners have set up an RBF program for this purpose
- The telecom sector in Rwanda is liberalized, with more than five mobile network operators active in the market, and almost 90% of the population being covered by 3G networks. Additionally, the Rwandan population has an increased penetration and usage of mobile phones and internet services
- In terms of the supply chain for off-grid systems, Rwanda has published the National E-Waste Management Policy which is in force since 2018 and is highlighting the need for extend producer responsibility. According to GOGLA, some companies already have e-waste recycling facilities in Rwanda. Ethiopia also has a regulation (No. 425-2018) but concrete activities in the OGS could not be identified in the scope of this study. However, the Project of Activity (PoA 10285) bears potential once the Warranty Tracking System developed in collaboration with the World Bank is operational (PoA and Tracking System are both described above in the PESTEL in section 3.3.5)

Despite having a more permissive enabling environment, sales of PAYGO systems in Rwanda have been declining in 2019, when GoR published a more stringent set of rules for the minimum standards for imported products. The guidelines created un-clarity and legislation voids. In the first half of 2020, as the Ministerial guidelines have been clarified, sales started

increasing, with 78,000 units between January and June, the largest increase in East Africa [28]. However, distribution and after-sales services were affected by the COVID-19 pandemic; off-grid solar was unfortunately not designated as an essential service and by complying with lockdown restrictions, PAYGO companies had to reduce to a minimum in field activities and support for end-users.

It can be concluded that the most critical, non-geographical aspects differentiating the two countries are access to hard currency and the liberalized mobile network sector.

4. Conclusions & Recommendations

As described in Chapter 02. Pay-As-You-Go for Energy Access, the PAYGO business model is determined by four main characteristics from which special needs and requirements towards the **P**olitical, **E**conomic, **S**ocial, **T**echnical, **E**nvironmental and **L**egal factors are derived. After discussing these factors in the PESTEL in section 3.3.5 Environmental and comparing the enabling environment for PAYGO in Ethiopia and Rwanda in Section 3.4 Country comparison, following key hindrances and fields of action have been identified:

Table 4. Key Hindrances and Fields of Action

PAYGo Business Model Characteristic	Special Needs and Requirements of PAYGo Business Models	Key Hindrances for an Enabling Environment for PAYGo	Fields of Action
Capital intensive	Hard currency debt for bulk acquisition of systems	Limited access to hard currency in general	Access to Finance
		Ethiopian Commercial Banks require 100 % collateral	
	Customer financing up to three years covering inflation, depreciation and other risks	Limited access to credit lines to cover the gap between asset financing and end-user receivables	
	Equity finance for the development of the supply chain	Limited possibilities for foreigners to invest into distribution and to repatriate their returns.	Policy and Regulatory Environment
ICT driven	Remote control of the systems	Unqualified agent networks	Capacity Building and Stakeholder Engagement
	Remote monitoring	Weak GSM Network	Effective Organisation of the Demand
	Data driven management	Limited skills in ICT and data analytics	Capacity Building and Stakeholder Engagement
	Mobile money	Limited skills and use of mobile money	Capacity Building and Stakeholder Engagement
Growth and replication oriented	Controll of the supply chain	Legal barriers for vertical integration	Policy and Regulatory Environment
	Development of simplified distribution channels	Technological dependence on Li-Ion batteries	Policy and Regulatory Environment
	Development of replicable distribution channels	REB's non-harmonized regulations	Policy and Regulatory Environment
	Customer retention	Low ability to pay	Access to Finance
		The NEP 2.0 considers off-grid systems as pre-electrification	Effective Organisation of the Demand
Product - Service System	Technical product offer (Hardware)	Required licences, missing PAYGo regulations, tax regime	Policy and Regulatory Environment
	Technical service offer (MRO)		
	Financial service offer		

4.1 Recommendations

In the following recommendations are clustered according to the fields of action identified in Table 4 and the targeted actors

4.1.1 Access to Finance for Supply Side Actors




Target Finance for the Whole Supply Chain

- Improve access to FOREX, equity, debt, SPVs, risk mitigation facilities for PAYGo companies, targeted finance for Start Ups, NGOs, local retailers, MFIs, and cooperatives
- Develop financial vehicles combining remittances with targeted development activities through public co-funding and guarantees. Learn from IFADs FFR and Hello Solar's SOLARDARITY

- The Development Bank of Ethiopia (DBE) Market Transformation Programme has proven of being effective but not sufficient and yet not inclusive enough, e.g. for start-ups or smaller regional retailers. More available hard currency, funds and targeted facilities to import PAYGO systems are required.
- The microfinance sector and PAYGO companies in Ethiopia have already demonstrated how remittances can be mobilized for targeted development activities. Pilot initiatives based on the PAYGO technology are promising and should be strengthened with public co-funding and guarantees.
- Although Ethiopian MFIs have a comparably good outreach in rural areas, PSEs and PAYGO companies underline that there are limits, particularly as MFIs do not focus on electrification needs when developing their networks. The possibility to offer consumer finance can support PSEs developing their own distribution network focused on electrification purposes.
- Although MFIs play a central role in financing DREs in rural Ethiopia, it is observed that their interest and motivation could be improved. Some MFIs in Benin, Senegal, Madagascar and Uganda have used PAYGO to modernize and digitize their organisations.
- Special Purpose Vehicles (SPVs) and risk mitigation facilities for PAYGO companies, MFIs and cooperatives would increase available liquidity for end-customer financing and enable the private sector and particularly PAYGO companies to support NEP 2.0 reaching the set targets.
- Even if mobile money is not a prerequisite for PAYGO, it still represents an important driver for potent and solvent investors such as telecommunication and mobile money companies as well as power sector utilities who regard mobile money enabled solar PAYGO as a door opener for the inclusion of customers with low ability to pay and residents of remote areas. The digitization of the money flow processes would help address efficiency and reported corruption issues by streamlining collection and increasing transparency.

4.1.2 Effective Organization of the Demand and Consumer Financing



Encourage a data-driven organisation of the demand

- The low ATP of a substantial part of the population together with their remoteness needs a lean and effective approach
- PAYGo voucher for minimum electricity access for vulnerable citizens in deep rural and non-commercial viable areas can guide the supply.

- Local stakeholders generally state that demand for solar off-grid products is not an issue in Ethiopia (see Figure 9. Willingness to Pay measurement). Companies report that they even have to limit daily sales numbers to make sure stock is available and to avoid “dry seasons”.

- To support the PAYGO companies developing their market by focusing on rural and deep rural areas, a further segmentation of the population in the MTF and mapping is recommended. Segmentation should be complemented with more detailed geographic, socio-economic and financial data. A segmentation considering also peri-urban and deep rural areas, location of off-grid schools and health centres, access to credit or PSNP in general and willingness to take a loan for a Tier 1 SHS in particular. Relevant is also the ability of local populations to pay instalments monthly or seasonally. Supportive distribution infrastructure such as GSM, mobile internet, scratch-card retailer coverage and gas stations should be mapped and regularly updated.
- Comparable to pro-poor tariffs for vulnerable grid-connected households, PAYGO technology allows to sponsor a minimum electricity consumption through vouchers which are regularly distributed to the target group. Digitized monitoring with PAYGO platforms facilitates RBF. An approach which is recommended is to pilot and implement in combination with the different subsidised programs foreseen in the NEP 2.0 for deep rural and non-commercial viable areas.
- PAYGO technology can support the digitalization of the REBs and thus support them managing data and monitoring effectively the sustainable electrification of households, institutions and SMEs in their area. REBs can also support logistically an upgrading and a swap strategy. An important role can also be played in the sustainable end of life management of batteries and electronic waste strategy. EnDev Ethiopia has already developed an MS Excel based tool with four REBs (Amhara, Oromia, SNNPR and Tigray) that could serve as a starting point for this effort.



Facilitate the Use of Existing Infrastructures from Other Sectors for Distribution and After-Sales and Support their Digitization

- Focus on simple Tier 1 category technology (to be installed by user, swap strategy for after-sales, etc.)
- Link the digitized Warranty Tracking System with PAYG technology

- PAYGO technology in Tier 1 category, which is operable without GSM coverage, is simple and often follows a plug and play principle. It is easy to install, i.e. by the customer himself and also easier to repair and maintain, e.g. by swapping components or the whole product that malfunction. This, in turn, facilitates the use of existing infrastructures for distribution and aftersales such as MFIs, mobile money providers, gas stations etc. With Tier 2 products, complexity grows and with it, the need for professional installation and MRO structures.
- The Ethio telecom payment system is currently integrated with the Angaza chips to enable the record of payments of PAYGO system users. This process should be supported as it will enable the use of the huge airtime retail infrastructure for PAYGO companies.
- A linkage between the digitized Warranty Tracking System, PAYGO platforms and MFIs' management information systems (MIS) can enable active and targeted coordination of action between different stakeholders, particularly those working on the last mile of off-grid electrification in Ethiopia (REBs, PSEs acting as distributors and local retailers and technicians, MFIs and youth enterprises). A digitized collaboration between all stakeholders can streamline the process and make it more transparent in order to ensure positive impact and removal of delays and bottlenecks for all participants.



Focus on moving households and social institutions from Tier 0 to Tier 1

- Encourage PAYGo actors to develop upgrading strategies to make their customers connectable to the future.

- The vast majority of rural households (and hence, the vast majority of off-grid beneficiaries) are currently in Tier 0, i.e. they have no access at all, or they do not meet the criteria of a Tier 1 energy supply access level. Hence, prioritizing off-grid solar products that enable households to move from Tier 0 to Tier 1 is likely to be a high-impact measure, particularly in rural and deep rural areas.
- A more in-depth measurement and/or validation of the existing data is needed. The MTF states that nearly 80% of households are willing to pay for a Tier 2 solar product either upfront or with a payment plan. In Tanzania, Kenya and Rwanda, Tier 2 PAYGO enabled systems can reach prices of even EUR 1,500, bundled with appliances. The example of Rwanda underlines that SHS of this size still have a very limited market in rural Africa.
- Encouraging PAYGO suppliers to provide an upgrade strategy from Tier 1 to Tier 2+ and to propose solutions for the eventuality of the national grid expanding into PAYGO areas. With its huge off-grid market size, Ethiopia can set a new standard for upgradability and compatibility of off-grid products by making this a requirement in official tenders or for accessing particular private sector subsidies.

80 % of households are willing to pay for a Tier 2 solar products

4.1.3 Improvement of the Policy and Regulatory Environment



Improve the Environment for Business and Investment

- Access to foreign currency and re-patriation of investments
- Improve possibilities for vertical integration of supply chains

- Supporting the development of a friendlier investment and business environment
- Encourage the development of a narrative which looks at DREs as an integral part of a modern electricity sector and not only as a pre-electrification technology. A sustainable OGS and PAYGO strategy should address this issue proactively by at least mentioning the role of stand-alone solar systems in an electrified context, e.g. as rooftop systems for auto-consumption and feed-in opportunities. Furthermore, civil society and private stakeholders, particularly the scientific community and start-ups should be motivated to develop technically and economically viable upgrade strategies. It is also recommended to make the presentation of upgrade strategies mandatory in calls for proposals (CfPs) and tenders.



Clarify the Status of PAYGo and Leasing in the OGS

- Develop a framework for lease to own and perpetual leasing for MFIs and PAYGO companies

- Explore the opportunities and limitations of the new leasing regulations developed by GoE with the support of the IFC for the OGS [45]
- Support NBE and EEA to clarify the regulations around PAYGO for the OGS.

- Support regulators to remove legal barriers and develop a framework that allows and supports MFIs to spin-off companies dedicated to distribute and finance off-grid and PAYGO systems comparably to the model applied in Bangladesh.



Support REBs to Harmonize their Requirements

- Harmonize REBs requirements towards PSEs across the regions
- Support digitized REBs to adapt their mandate to the new opportunities

- Support REBs harmonizing their requirements towards PSEs and PAYGO companies across the regions.
- The digitization of REBs can dramatically increase their transparency and efficiency and widen their mandate towards the bundling, organization and transparent publication of market data in a standardized manner for product neutral awareness raising, information and training of households and the control of the quality of products and services.



Develop an end of Life Strategy for PAYGo Components

- Develop a policy and regulation particularly for e-waste, Li-Ion batteries and ULABs
- Link the Warranty Tracking System with the PoA 10285

- The increased implementation of solar products will require the enforcement of proper collection and recycling practices for electronic waste, lead-acid batteries and lithium-ion batteries, but in a manner in which distributors and manufacturers are not burdened by a too complex supply chain. GIZ aims to promote the implementation of solutions to promote sustainable and environmentally sound solutions for battery recycling[25], and in this sense, working with the Ethiopian Environment, Forestry and Climate Change Commission (EFCCC)[26] on setting up the proper framework.
- Further enriching the existing e-waste regulation by EFCCC and include the into the next NEP version

4.1.4 Capacity Building and Stakeholder Engagement

The main constraints of the Ethiopian OGS, access to hard currency and legal hurdles to foreign investments into retail and distribution channels, cannot be mitigated by PAYGO companies. Accordingly, if investment and business environment remain constant, it is unlikely that classical, vertically integrated PAYGO business models can or will be implemented in Ethiopia in the short run. Nevertheless, it is worth to pick up selected strengths and lessons learned, strategies and technologies developed in the global PAYGO sector in the last decade, to adapt them to the Ethiopian ecosystem and to integrate them into a national *Digitalization Strategy for Financial and Energy Inclusion*.

Ethiopian stakeholders can profit from PAYGO technologies, strategies and lessons learned. The following Table 5 some propositions for capacity building and stakeholder engagement are outlined:

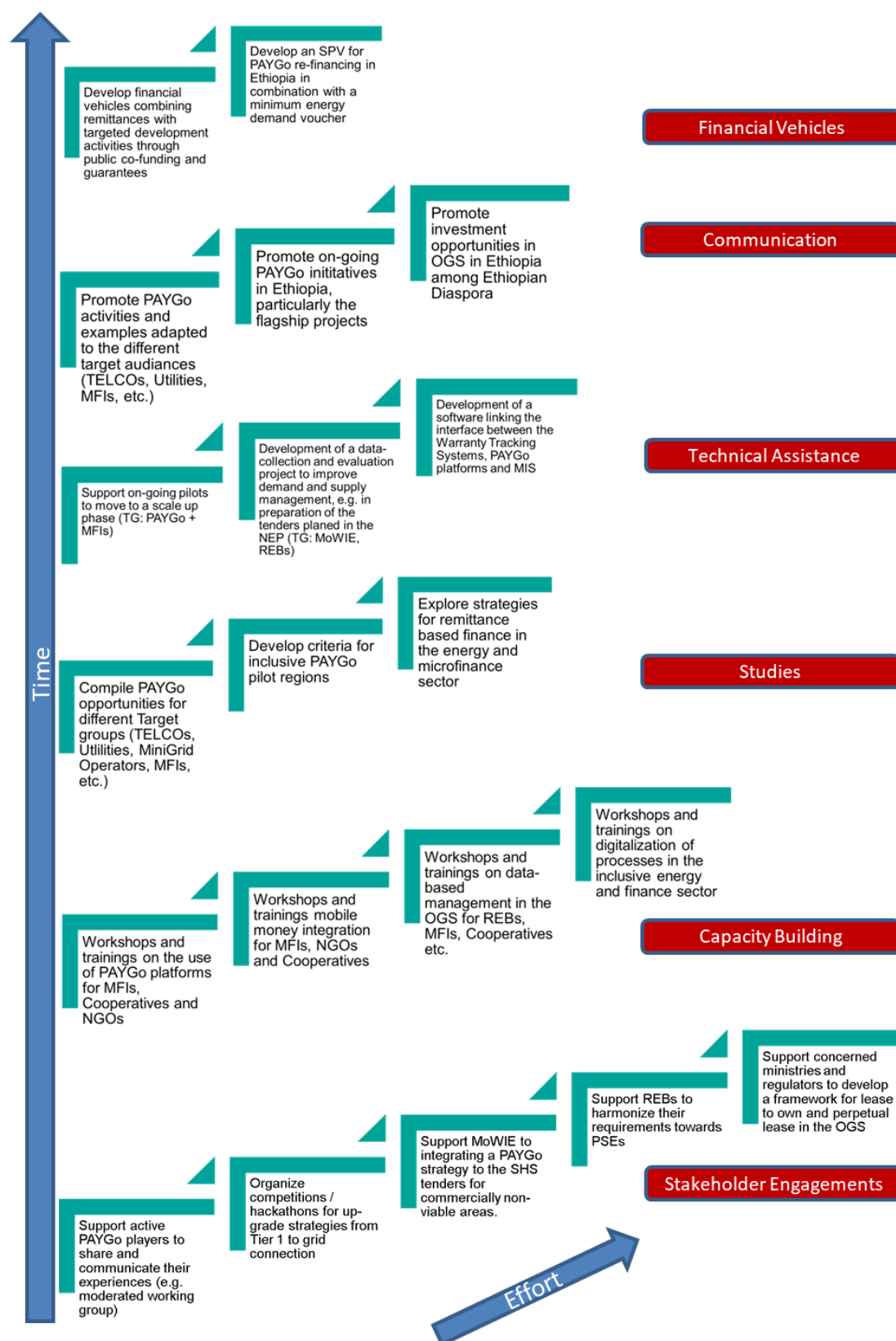
Table 5. PAYGO technology opportunities for the Ethiopian Stakeholders

Stakeholder	PAYGo technology opportunities
PSEs	PSEs can use PAYGo technology to digitize their business model and improve their after-sales through data-based MRO services. Furthermore, they can learn from classical PAYGo business models how to streamline their logistics and distribution networks.
TELCOs	PAYGo solar technology supports TELCOs in several growth & inclusion strategies: i) outreach to rural and remote clients, ii) powering mobile phones of off-grid clients, iii) promoting and educating clients to use mobile phones for multiple services, including mobile payments. Ethiopian TELCOs can profit from lessons learned by others in the field.
Utilities and Mini-grid operators	In some African countries, utilities are also involved in implementing and managing off-grid connections. Some PAYGo technologies are piloting the gradual upgrade from Tier 1 to Tier 3 and even to a grid connection. With regard to the increasing importance of DREs in the energy sector, including rooftop systems, these PAYGo innovations, in combination with a perpetual-lease business model could be interesting for EU as well as for some mini-grid operators.
Energy Bureaus	The use of PAYGo platforms and their combination with the warranty tracking program and the customer information system developed by the WB bears huge opportunities to digitize the energy bureaus and to streamline their work.
MFIs	PAYGo technology can be a driver for the MFI sector to pilot digitization, integration of mobile money and data driven management models. Lessons can be learned from i.e. BAOBAB+ (Senegal, Madagascar), FINCA (Uganda), ACFB and RENACA (Benin).
Local Manufacturers	The PAYGo technology is not very complex and also available as open source. Local smart meter manufacturers such as Dventus have already developed prototypes. which can be further adapted and also used in other sectors (on-grid connections, biogas, water pumps, appliances etc.)
PSNP	The Ethiopian PSP has already proved its efficiency, innovation and collaboration capability in many fields. The ongoing PAYGo pilots should not only be looked at as an electrification initiative for the most vulnerable citizens, but as flagship projects for energy-finance and digital inclusion.
International Investors	PAYGo business models have proven to be exceptionally attractive for public and private investors. The development of investment vehicles that work in the Ethiopian context, e.g. by combining remittances with other guarantee funds, can support overcoming particularly the barriers related to access to hard currency. International PAYGo investors might also be attracted by the subsidy programs planned for non-commercially viable areas.

4.2 Quick Wins & Chain of Activities

Below follows an overview of quick wins and a chain of activities that can be taken to improve the enabling environment for PAYGO in Ethiopia through stakeholder engagements, studies, capacity building, technical assistance, communication and financial vehicles.

Figure 5: Quick Wins & Chain of Activities



References

- [1] Lighting Global and International Finance Corporation, “Pay-As-You-Go Market Attractiveness Index 2019,” Jun. 2019.
- [2] “A Bottom-up Approach: Low-Carbon Energy Transition In Developing Countries.” <http://www.tradeforum.org/A-Bottom-up-Approach-Low-Carbon-Energy-Transition-In-Developing-Countries/> (accessed Sep. 28, 2020).
- [3] Ministry of Water, Irrigation and Electricity, Federal Republic of Ethiopia, “National Electrification Program 2.0 Integrated Planning for Universal Access.” 2019, Accessed: Sep. 24, 2020. [Online].
- [4] USAID - Power Africa Off-grid Project, “Off-Grid Solar Market Assessment Ethiopia,” USAID, Oct. 2019. Accessed: Sep. 24, 2020. [Online].
- [5] HelloSolar International, “HelloSolar March 2020 Learning Report,” Addis Ababa, Ethiopia, Mar. 2020. Accessed: Sep. 24, 2020. [Online].
- [6] “Ethiopia may sell majority stake in Ethio telecom,” *Mobile World Live*, Oct. 10, 2019. <https://www.mobileworldlive.com/featured-content/top-three/ethiopia-may-sell-majority-stake-in-ethio-telecom> (accessed Sep. 24, 2020).
- [7] D. Endeshaw, “Ethiopia to sell 40 percent of Ethio telecom - Minister,” *Reuters*, May 21, 2020.
- [8] “Solar Energy Development Association (SEDA-E),” *GOGLA*, Aug. 17, 2017. <https://www.gogla.org/about-us/members/solar-energy-development-association-seda-e> (accessed Sep. 29, 2020).
- [9] “Overview | Addis Ababa Institute of Technology.” <http://www.aau.edu.et/aait/academics/center-for-energy-and-technology/overview-of-cet/> (accessed Sep. 29, 2020).
- [10] World Bank Group, “Economy Profile of Ethiopia - Doing Business 2020,” World Bank Group, 2020. Accessed: Sep. 29, 2020. [Online]. Available: <https://www.doingbusiness.org/content/dam/doingBusiness/country/e/ethiopia/ETH.pdf>.
- [11] “Foreign direct investment (FDI) in Ethiopia - Investing - Nordea Trade Portal.” <https://www.nordeatrade.com/en/explore-new-market/ethiopia/investment> (accessed Sep. 29, 2020).
- [12] M. Köhler, L. Brauhardt, and C. Nettersheim, “Country Deep Dive Analysis 2019: Recommendations to include off-grid RE in the NDC update 2020 and initialize international support - Ethiopia,” The Greenwerk; Reiner Lemoine Institut, 2019.
- [13] “Ethiopia Energy Outlook – Analysis,” *IEA*. <https://www.iea.org/articles/ethiopia-energy-outlook> (accessed Sep. 29, 2020).
- [14] Ethiopia Off-Grid Energy Portal, “Demystifying Ethiopia,” Jul. 2018.
- [15] G. Padam, D. Rysankova, E. Portale, B. Bonsuk Koo, S. Keller, and G. Fleurantin, “Ethiopia Beyond Connections Energy Access Diagnostic Report Based on the Multi-Tier Framework,” Washington, D.C, May 2018. Accessed: Sep. 24, 2020. [Online].
- [16] “Employment in agriculture (% of total employment) (modeled ILO estimate) - Ethiopia | Data.” <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=ET> (accessed Sep. 30, 2020).
- [17] “Ethiopia at a glance | FAO in Ethiopia | Food and Agriculture Organization of the United Nations.” <http://www.fao.org/ethiopia/fao-in-ethiopia/ethiopia-at-a-glance/en/> (accessed Sep. 30, 2020).
- [18] E. Francis, “Panel: Productive Uses and Community Engagement,” presented at the

- Ethiopia National Off-Grid Electrification Forum, Addis Ababa, Ethiopia, Feb. 2020, Accessed: Sep. 30, 2020. [Online]. Available: <https://esmap.org/sites/default/files/Presentations/2.1%20PU%20Pilot%20Implementation%20Brainstorm.pdf>.
- [19] S. B. Wassie, H. Kusakari, and M. Sumimoto, "Performance of Microfinance Institutions in Ethiopia: Integrating Financial and Social Metrics," *Social Sciences*, vol. 8, no. 4, p. 117, Apr. 2019, doi: 10.3390/socsci8040117.
 - [20] "GSMA - Network Coverage Maps - Ethiopia." <https://www.gsma.com/coverage/#710> (accessed Sep. 24, 2020).
 - [21] "Mobile cellular subscriptions (per 100 people) - Ethiopia | Data." <https://data.worldbank.org/indicator/IT.CEL.SETS.P2?locations=ET> (accessed Sep. 30, 2020).
 - [22] "Individuals using the Internet (% of population) - Ethiopia | Data." <https://data.worldbank.org/indicator/IT.NET.USER.ZS?locations=ET> (accessed Sep. 30, 2020).
 - [23] "Digital 2020: Ethiopia," *DataReportal – Global Digital Insights*. <https://datareportal.com/reports/digital-2020-ethiopia> (accessed Sep. 30, 2020).
 - [24] "Solar Lighting in Rural Ethiopia – Ethiopia | UNFCCC." <https://unfccc.int/climate-action/momentum-for-change/activity-database/momentum-for-change-solar-lighting-in-rural-ethiopia> (accessed Sep. 30, 2020).
 - [25] "E-waste and battery recycling in Ethiopia." <https://app.leverist.de/opportunities/e-waste-and-battery-recycling> (accessed Oct. 01, 2020).
 - [26] "ILA Blog < News | ILA - International Lead Association Website." <https://www.ila-lead.org/news/ila-blog/2019-12-03/improving-battery-recycling-in-ethiopia> (accessed Oct. 01, 2020).
 - [27] "Ethiopia opens mobile money to newcomers," *Mobile World Live*, Apr. 01, 2020. <https://www.mobileworldlive.com/money/news-money/ethiopia-opens-mobile-money-option-to-newcomers> (accessed Sep. 24, 2020).
 - [28] GOGLA, "Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data (January - June 2019)," January-June 2019. Accessed: Oct. 13, 2020. [Online]. Available: https://www.gogla.org/sites/default/files/resource_docs/global_off-grid_solar_market_report_h1_2019.pdf.
 - [29] Shell Foundation, "Providing PAYGO Access to Energy and Information - Case Study HelloSolar," Aug. 2020.
 - [30] M. BERSISA, "Multidimensional Measure of Household Energy Poverty and its Determinants in Ethiopia." Jönköping International Business School (JIBS), 2016, Accessed: Sep. 30, 2020. [Online]. Available: <https://edit.ju.se/download/18.25ed6da515648599f36aed3/1520578336452/EARP-EF%202016-15%20Bersisa.pdf>.
 - [31] "Green Scene Ethiopia - Products," *Green Scene Ethiopia*. <https://greensceneethiopia.com/solar-energy-for-your-home/> (accessed Oct. 01, 2020).
 - [32] "Sundaya." <https://www.sundaya.com/#> (accessed Oct. 16, 2020).
 - [33] "Phocos Pico LED." https://www.solarwirtschaft.de/fileadmin/media/pdf/intersolar2010/Pico_LED_Light_system_12_watt_peak.pdf (accessed Oct. 16, 2020).
 - [34] "Omnivoltaic ovBeacon MB2-090." https://www.lightingglobal.org/wp-content/uploads/2013/12/LG-SSS_mar_mb2090_v4.pdf (accessed Oct. 20, 2020).
 - [35] "Sun King Eco." http://www.pptsolar.lighting/assets/documents/Greenlight_ECO_B.pdf (accessed Oct. 20, 2020).

- [36] "HelloSolar," *HelloSolar*. <http://www.hellosolarint.com/products> (accessed Oct. 01, 2020).
- [37] "HelloSolar Pioneers PAYGO and International Remittance Payment to Provide Affordable Solar Home Systems in Ethiopia," *HelloSolar*. <http://www.hellosolarint.com/solardarity/articles/HelloSolar-Pioneers-PAYGO-and-International-Remittance-Payment-to-Provide-Affordable-Solar-Home-Systems-in-Ethiopia> (accessed Oct. 01, 2020).
- [38] GOGLA, "Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data (July - December 2019)," July-December 2019. Accessed: Oct. 13, 2020. [Online]. Available: https://www.gogla.org/sites/default/files/resource_docs/global_off_grid_solar_market_report_h22019.pdf.
- [39] Y. Workie, "Sun Transfer Tech PLC Best Practices," Addis Ababa, Ethiopia, Jan. 07, 2016, Accessed: Jan. 10, 2020. [Online]. Available: <https://sustainabledevelopment.un.org/content/documents/22759Suntransfer.pdf>.
- [40] "LYDETCO Ethiopia Solar | Ethiopia Solar System & Components | Ethiopia Solar Water Heaters | Ethiopia Industrial Packing | Ethiopia Industrial Inputs & Machinery." <http://www.lydetco.com/index.html> (accessed Oct. 02, 2020).
- [41] "Dedebit Credit and Savings Institution (DECSI)," *Innovations for Poverty Action*, May 11, 2015. <https://www.poverty-action.org/organization/dedebit-credit-and-savings-institution-decsi> (accessed Oct. 06, 2020).
- [42] "Credit Services." <https://www.oromiamfi.com/index.php/services/credit-services> (accessed Oct. 08, 2020).
- [43] "Somali microfinance institution plc," *Somali Microfinance*. <http://www.somalimfi.com/> (accessed Oct. 08, 2020).
- [44] "Sun King Mobile." https://www.lightingglobal.org/wp-content/uploads/2014/02/LG-SSS_glp-sunkingmobile_products.pdf (accessed Oct. 20, 2020).
- [45] P. Kamau, "IFC helping Ethiopia expand its leasing sector, strengthen smaller businesses," *Africa Business Communities*, Feb. 03, 2020. <https://africabusinesscommunities.com/news/ifc-helping-ethiopia-expand-its-leasing-sector-strengthen-smaller-businesses/> (accessed Nov. 19, 2020).
- [46] "Solar energy within reach for all Ethiopians with simple, smaller payments under our plans with Ethio telecom," *Green Scene*, Jun. 02, 2020. <https://greensceneethiopia.com/2020/02/06/solar-energy-within-reach-for-all-ethiopians-with-simple-smaller-payments-under-our-plans-with-ethio-telecom/> (accessed Nov. 19, 2020).
- [47] Rwanda Energy Group, "Off Grid Electricity Access Expansion Programs," presented at the 5th Mini Grids Action Learning Event: Reaching Universal Energy Access in Ghana by 2020, Accessed: Nov. 19, 2020. [Online]. Available: <https://atainsights.com/wp-content/uploads/2019/06/9.-Uwera-Rwanda-Energy-Group.pdf>.
- [48] Different statistical data, Accessed: Dec. 9, 2020. [Online]. Available: <https://data.worldbank.org/>

Annexes

Annex 1 - Introduction and scope of the paper

Table 6. List of Interviewed stakeholders

Stakeholder	Name of the representative	Date of the interview
Solar Energy Foundation (SEF)	Samson Tsegaye	12.10.2020
Association of Ethiopian Microfinance Institutions (AEMFI)	Teshome Kebede	13.10.2020
Fosera	Thomas Köpke	13.10.2020
European Union (EU)	Danielle Morbin	13.10.2020
World Bank (WB)	Johanna Galan	13.10.2020
Veritas Consulting	Atsede Endegnanew	14.10.2020
Swan Technology	Mika Turpeinen	15.10.2020
Ethiopia Solar Energy Development Association (E-SEDA)	Nabil Ishak	15.10.2020
Ministry of Water, Irrigation and Energy (MoWIE)	Yisehak Seboka	16.10.2020
Development Bank of Ethiopia (DBE)	Elias Asnake	20.10.2020
Green Scene	Rekik Bekele	20.10.2020
Hello Solar (HS)	Wilhelmina Diop	21.10.2020
Ethio Telecom	Kelem Birhane	02.12.2020

Annex 2 - PAYGo for Energy Access

Table 7. PAYGo On- and Off-Network Differentiation

	On-Network	Off-Network
Summary	<ul style="list-style-type: none"> i) products are connected directly to the cellular network via embedded M2M module + SIM ii) customers pay via mobile money; software send message directly to the solar device to “unlock” prepaid services via the cellular network iii) requires tight partnership with a MNO (Mobile Network Operator) for SIM cards and access to discounted data/SMS/mobile money 	<ul style="list-style-type: none"> i) PAYGO hardware does not connect with the GSM network ii) customers pay cash to appointed agents for prepaid vouchers/scratch cards, which are validated via SMS. Software generates unique usage codes manually entered into the solar device iii) does not require a formal relationship with an MNO.
Companies	Azuri, ENGIE Mobisol, HelloSolar, Bboxx, Lumos, Greenlight Planet, M-Kopa, PEG Africa, d.light, Fosera, Niwa, Omnivoltaic	Fenix Int'l, Azuri, ENGIE Mobisol, PEG Africa, Fosera, Niwa, Omnivoltaic
Advantages	<ul style="list-style-type: none"> i) ability to communicate with solar devices in real-time, accessing data on usage/performance ii) remotely disable services anytime iii) if partnered with an MNO, can leverage its agent network and product distribution channels 	<ul style="list-style-type: none"> i) can be deployed in areas where end-customers do not have cellular coverage ii) can be sold in markets without active mobile money services iii) development cycle of the technology is often shorter and lower cost than on-network iv) not tied to a particular MNO; higher degree of autonomy in designing customer transactions and distribution.
Disadvantages	<ul style="list-style-type: none"> i) requires formal partnership with MNOs ii) distribution limited to areas with reliable cellular coverage; can require customers to carry devices to areas with stronger cellular signal to synchronize iii) limited to selling in countries with high mobile money penetration iv) M2M technology is typically more expensive than off-network 	<ul style="list-style-type: none"> i) lack of direct connectivity with the solar device makes it difficult to obtain real time usage and performance data, and to identify theft or tampering. Data is collected in-person at the customer's premises, adding transaction costs, by agents or employees, at irregular intervals, to monitor the performance of systems. ii) unable to disable energy services in real-time, if user bypass or tamper with the system iii) requires building/developing an agent network for vending vouchers/scratch cards.

Annex 3 - Status Quo of PAYGO in Ethiopia

Figure 6. Solar Importers/Manufacturers Active in the Ethiopian Market

1	Acme Engineering	17	Power Green Plc
2	Auto Truck	18	Ofsed PLC
3	Beta Engineering	19	RenSys Engineering
4	Blaze Light Importer	20	Sinoware Solar Technology Manufacturer
5	Crystal Light	21	Solar 23
6	Dubai Air Star	22	Solar Woman
7	Eliya's General Importer	23	STANFORD TRADING PLC
8	ET Solar Tech	24	STM Solar Tech manufacturing
9	Eternum Energy Ventures	25	Sun Transfer Tech PLC
10	Ethio Addis Trading	26	Temesgen Belachew
11	Everbright Plc	27	TIGIST IMPORT AND EXPORT
12	Hay Energy Solution	28	Tonase solar importer
13	Kedir Saund System	29	Uni Sound General Trading
14	Little Sun	30	Universal Electronics
15	Lydetco	31	Vera International
16	Mehari Redai Importer Exporter	32	Yung Zung Solar Company

Figure 7. Solar Distributors Active in the Ethiopian Market

1	Abasel	21	Hidase Telecom	40	Tera Distributors
2	ABC Trading	22	Janf Jonfer Importer	41	Tesema Wholesaler
3	Alfurat Distributors	23	Kasim Electronics	42	Tigist Tadase
4	Ali solar distributor	24	Mafuse Importer	43	Timerga Atraga Wholesaler
5	Allur Place	25	Matimino trading	44	Total Petrol Station
6	Alternative Engineering	26	MATY TRADE / Mara Solar	45	Tsega Electronics
7	Aman Electronics	27	Mensu Business Group	46	Ummer Solar Wholesaler jimma
8	Amen Solar	28	Mohamed Solar Distributor	47	Village Power
9	Amir Electronics & Solar distributor	29	Mohammed Electronics	48	Wafa trading plc
10	Aromatic trade connection plc	30	Muna Electronics	49	Wefra Trading Place
11	Capital Electronic	31	Negasi Solar Distributor	50	Wuchale Distributor
12	Dama Trade	32	Nuredin Distributor	51	Yuasa company
13	Dani Electronics Importer	33	Rising Place		
14	Ecotoriyal Business Group	34	Robi Solar		
15	Emahus Solar & Ghion gas distributor	35	Schneider Electrical		
16	Embet Distributor	36	Shemsu Awel		
17	Ethiopian Postal Office		Sinidu Anteneh and Friends Cooperative		
18	Fiesel Importers	37	Association		
19	Gidabo Trading	38	Solar development plc		
20	Habiba Electronics Mechanical	39	Soliana Electronics		

Table 8. PSEs involved in PAYGO distribution

Organisation	Type of product	Other relevant information
HelloSolar[36] [37] [5]	Four different types of SHS ranging from 2.2 Wp panel and 9.3 Wh battery to 50 Wp solar panel and 128 Wh battery	Strategic partners: BelCash, Shell Foundation and USAID PAYGO instalment credit plan in partnership with the HelloCash mobile banking platform, 10-month rollout pilot project, sold more than 7000 SHS in the Somali and Amhara regions in partnership with the Somali Microfinance Institution (SMFI) As of January 2020, HS reached 5,000 customers, operating 37 sales points across Ethiopia HS is finalizing the setup of an assembly plant in Addis Ababa
FOSERA		Products are manufactured in Thailand and locally assembled in Bahir Dar, Ethiopia
SunTransfer[38]	SHS: 20 - 80 Wp	Solar lanterns and SHS with PAYGO options Partnership with STM Two years warranty on solar products
Solar Technologies Manufacturing (STM)[39]		Solar Technologies Manufacturing, local assembly of solar lanterns and SHS
Green Scene[31]	SHS: 6 - 100 Watt 3,300 - 32,000 ETB (115 - 1,067 USD) Solar lanterns: 0.6 - 5.5 Watt 350 - 1,800 ETB (12 - 65 USD)	Lighting Global-certified solar home systems and solar lanterns Two-year warranty PAYGO mobile payment or loans through micro finance partners
Lydetco[40]	Sales of SHS and solar lamps	Represents BP Solar and Phaesus GmbH, Solar systems and Off-grid manufacturers





Table 9. List of MFIs distributing solar PAYGO


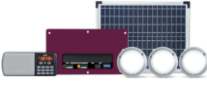


Organisation	Type of service	Other relevant information
Amhara Credit and Saving Institution (ACSI)	M-BIRR mobile money service provider	Established in 1997 18 branches and 180 sub-branches Location: Bahir Dar/Amhara
Dedebit Saving and Credit institution (DECSI)	M-BIRR mobile money service provider	Established in 1997 22 branches and 102 sub-branches 460,000 customers[41] Location: Mekelle/Tigray
Oromia Credit and Saving Share Company (OCSSCO)[42]	Solidarity Group Based Loan (SGBL) Micro, Small and Medium Enterprise Loan (MSEL) Youth Loan MSE Targets Business Loan (BL) Women Entrepreneurs Development Program Loan (WEDP) General Purpose Loan (GPL) Housing Loan (HL) M-BIRR mobile money service provider	Established in 1997 194 branches/sub-branches Location: A.A./Oromia
Omo Microfinance Institution	M-BIRR mobile money service provider	Established in 1997 14 branches and 147 sub-branches Location: Awassa/SNNP
Somali Microfinance Institution (SMFI)[43]	Partnered with BelCash for the HelloSolar PAYGO pilot	Established in 2011
Peace MFI	Saving and loan services Partnered with M-BIRR and AZURI	Established in November 1999 22 branches

Table 10. Mobile money operators

Organisation	Type of service	Other relevant information
CBE Birr	Deposit, withdraw, transfers, payments, buy mobile airtime	Transaction channels: USSD and mobile application Number of agents: 6,000 agents and 1,350 merchants Able to transact in ForEx
M-BIRR (Moss ICT Consultancy)	Transfer money, pay bills, buy goods, repay loans, check balance, get a statement	Transaction channels used: USSD Number of agents: 7,000 Partnership with 6 MFIs: ACSI, OCSSCO, DECSI, Addis Credit and Saving Institution, Omo Microfinance Institution and Poverty Eradication and Community Empowerment MFI Relevant signed-up businesses: Lyderco, GreenScene and Rensys (with Angaza and ENGIE Mobisol platforms) Not able to transact in ForEx
Hello Cash (Belcash)	Send cash, withdraw cash, pay for bills, airtime purchase, business advisory services	Transaction channels: USSD and mobile application Number of agents: 7,000 Able to transact in Forex
Amole (Fettan Dashen Bank)	Utility bill payments, person-to-person transfers, electronic mobile top-up, cash-in and cash-out	Transaction channels: USSD, mobile application and web-based platform Number of agents: 3,000 merchants and 1,000 agents Partner financial institution: Dashen Bank Services: Utility bill payments, person-to-person transfers, electronic mobile top-up, cash-in and cash-out Able to transact in Forex
Kifiya (Kifiya Financial Technologies)	Utility payments through public-private partnerships with government (water, electricity and telecom), bus tickets, mass transit, crop insurance and airtime sales	Number of agents: 50 bill payment collection centres
HIBIR (United Bank)	Cash-in, cash-out, person-to-person money transfers, business, business-to-people transfers, account opening, customer registration	Transaction channels: USSD Number of agents: 460 Able to transact in Forex
Awash Bank Mobile Banking	Money transfer, withdraw cash, money sending	Able to transact in Forex
Yene Pay	Account-based online payment platform for businesses to sell and collect payment electronically	Transaction channels: Web platform Relevant partner institutions: Hello Cash, Amole and CBE Birr No agents Able to transact in Forex

Table 11. Main Solar Products (Solar Lighting and SHS) Distributed in Ethiopia

Name	BioLite 620	Fosera PSHS	SunKing Home ¹	OmniVoltaic M400
Picture				
Short system description	Separate solar panel 3.9 W 4 lighting points - 430 lumens 1 Radio Mobile phone charging PAYGO available	Flexible SHS panels 2.5 - 10 W Different configurations available for: Lighting Radio Phone charging 4 outlets, 1 with night-light function PAYGO available	Separate solar panel, 4, 6 or 12 W power 3 lighting points Mobile phone charging PAYGO available	Separate solar panel 5.5 W 3 lighting points 1 radio Mobile phone charger 1 torch PAYGO available
Organization/Distributor	Green Scene	HelloSolar Fosera Green Scene	HelloSolar Green Scene	HelloSolar

Name	Niwa Energy 50 TV	Niwa Energy 20	MobilSol Family SHS	Solar TV (Non-Lighting Africa certified) [31]
Picture				
Short system description	Separate solar panel 50 W 3 Fixed Lamps 1 Radio 1 TV 32 Inch 1 Fan 16 Inch 2 USB Port To	Separate solar panel 20 W 3 LED lamps 1 Mp3 radio PAYGO available	Separate panel 80 W 4 LED lamps 1 TV 19" with satellite decoder Mobile phone charging	Separate panel 100 W 4 hanging lamps Inbuilt decoder 1 TV 19" 1 Satellite dish USB output

¹ Models distributed: 40z, 60 and 120

	Charge Mobile Phone PAYGO available		1 Radio 1 lamp PAYGO available	device charger
Organization/Distributor	HelloSolar Sun Transfer	Sun Transfer	Sun Transfer	Green Scene





Name	d.Light D20 (discontinued)			
Picture				
Short system description	Separate solar panel 5.0 W 2 hanging lamps Mobile phone charger 1 portable lantern			
Organization/Distributor	VERA International			





Pico solar/solar lanterns:

Name	SunKing Pro ²	Niwa M300 XL	Niwa UNO50	OVPilot X
Picture				
Short system description	Separate solar panel 2.35 - 5.5 W 1 Lighting point Mobile phone charging PAYGO available	1 LED 300 lumens Mobile phone charging	1 LED 50 lumens Lighting Global compliant	Separate solar panel 1.8 W 1 Lighting point Mobile phone charging

² Models distributed: 200 and 400

Organization/Distributor	Lydetco Green Scene Dama Trade	Sun Transfer	Sun Transfer	Dama Trade
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Name	Little Sun	SunKing Boom	Sundaya T-Lite [32] (Non-Lighting Africa certified)	Sundaya Ulitium [32] (Non-Lighting Africa certified)
Picture				
Short system description	Portable LED 0.6 W inbuilt solar panel	Portable LED lamp with detachable stand 2.7 W solar panel USB output device charger Inbuilt radio MP3 player	LED light 180 lumen output	LED light 240 lumen output
Organization/Distributor	Green Scene Solar Development	Green Scene	Lydetco	Lydetco

Name	Phocos pico system [33] (Non-Lighting Africa certified)	Omnivoltaic Power MB2 [34] ³	SunKing Eco [35] (discontinued)	SunKing Mobile [44]
Picture				
Short system description	2 LED lamps Panel 12 Wp 120 lumen	LED lighting 1 - 4 lighting points	LED lighting 1 Lightning point 0.5 W solar	LED lighting 1 Lighting point 1.6 W solar

³ Models distributed: 090, 200, 290 and 380

	Mobile phone charging	depending on the model Mobile phone charging 1.3 - 4.9 W solar panel	panel PAYGO available	panel
Organization/Distributor	Lydetco	Dama Trade	Lydetco Universal	Dama Trade Lydetco

Name	SunKing Solo	SunKing Pro 2	d.Light S2 (discontinued)	d.Light S20 (discontinued)
Picture				
Short system description	LED lighting 1 Lighting point 0.78 W solar panel	Separate solar panel 3.0 W 1 Lighting point Mobile phone charging	Personal use LED Integrated solar panel	LED lighting Mobile phone charging
Organization/Distributor	Lydetco	Lydetco	VERA International Rensys	VERA International Rensys


Name	d.Light S300			
Picture				
Short system description	Separate solar panel 1.6 W 1 Lighting point Mobile phone charging			
Organization/Distributor	VERA International			

Table 12. PESTEL Guiding questions

	PAYGO Guiding Questions	Indicators for comparison
POLITICAL	Governmental and Civil Society support to off-grid electrification and the PAYGO industry in Ethiopia	
	Is bottom-up energy transition a priority to the Government?	Existence of a national electrification targets
	Are concrete targets for stand-alone-systems set?	Existence of national targets for off-grid electrification
	Is the solar industry organized in associations?	Presence of Solar Industry Associations
	Is there a scientific community working on the topic bottom-up energy transition?	Presence of a scientific community doing OGS research
	<i>How liberalized are the mobile phone markets?</i>	Is there competition in the market?
	<i>How liberalized are the mobile money markets?</i>	Is there competition in the market?
	What kind of national programs exist to promote the adoption of off-grid solar systems?	Is there public sector support for the OGS?
ECONOMIC	Necessary resources and economic conditions for the establishment of PAYGO operational models in Ethiopia	
	How is the business environment	World Bank's Ease of Doing Business index
	How is the environment for local and foreign investment?	Environment for local and foreign investment
	Overview of international development aid // technical assistance	Number of ODA partners in the off-grid energy sector
	What specific financial mechanisms exist to support private sector?	Is there financial support for off grid electrification?
	Consumer access to finance (particularly microfinance)	Global Findex
	How is the transportation of goods and people organized?	World Bank Logistics Performance Indicator (LPI)
	What is the market size for stand-alone-systems?	Size of market for stand-alone off grid systems
	How much electricity do typical schools and health centres in rural areas need?	MTF for Access in Community Infrastructure
	What is the role of energy in the economic sectors in which off-grid and low-income population is predominant (e.g. agriculture, commerce)?	MTF for Access to Productive Applications of Energy" and "Access in Community Infrastructure
SOCIAL	The social context of the target population for PAYGO systems in Ethiopia	
	What is the ability and willingness to pay among the different income groups, particularly within off-grid populations	Ability and willingness to pay for an off-grid system
	What aspects of energy poverty are relevant for the PAYG industry?	Ability and willingness to take a loan for an off-grid system
TECHNICAL	Available enabling technology for the set-up of PAYGO systems	
	How is the coverage and quality of the GSM Network in Ethiopia?	Degree of GSM coverage

	PAYGO Guiding Questions	Indicators for comparison
	How are mobile phones and smartphones used in Ethiopia across the different segments of the population?	Penetration of mobile phones and smart phones among rural population
	How popular is mobile money across the different segments of the population?	Penetration of mobile money use among rural population
	Electricity literacy among the target population	Number of trained electricians / Training centres for electricians
ENVIRONMENTAL	End of life of PAYGO enabled solar product	
	Is there a national (or regional) plan for End-of-Life management of ULABs	National End-of-Life Management Strategy for ULABs
	Is there a national (or regional) plan for End-of-Life management of Li-Ion batteries	National End-of-Life Management Strategy for Li-Ion batteries
LEGAL	Legal framework, regulatory authorities, standardization and norming processes relevant for the PAYGO industry in Ethiopia	
	Is the status of PAYGO clarified in a policy and do regulations exist?	Is the status of PAYGO clarified in a policy and regulated
	Can retailers offer products on credit to their customers?	Can retailers offer products on credit to their customers
	What tax exemptions exist for solar components?	Do Tax exemptions exist for solar product components?
	What subsidies and tax exemptions exist for solar products?	Do subsidies for solar products exist?
	Which minimum performance standards and quality standards apply for PAYGO Systems?	Lighting Global Certified Products is set as standard



Figure 5. GSM coverage in Ethiopia

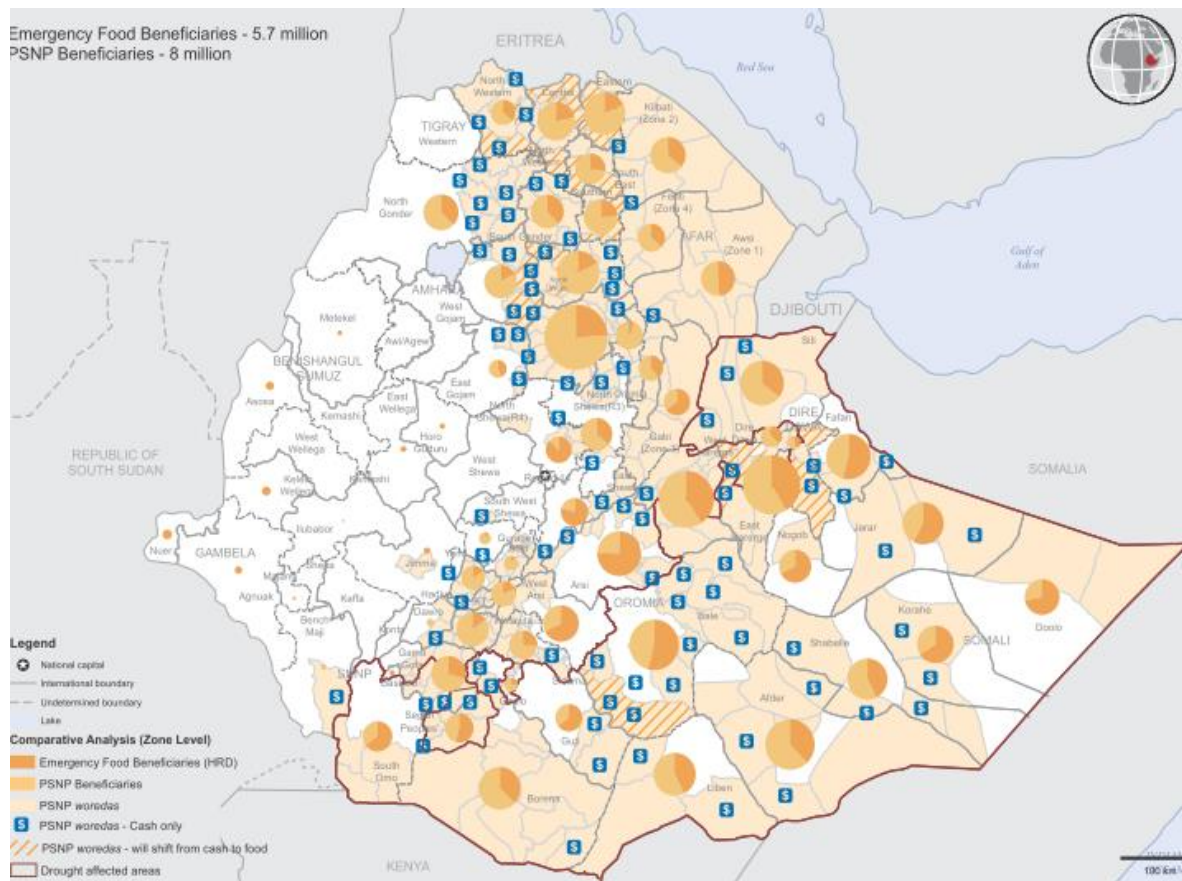


Figure 6. PSNP Outreach

Time Period		Total Households	Grid Conn. Added	Cumul. Grid Conn.	Grid Access Rate	Off-Grid Conn. Added	Cumul. Off-grid Conn.	Off-Grid Access Rate	Total Conn. Added	Total Cumul. Conn.	Total Access Rate
Program	Year	(millions)	(millions)	(millions)	(pct)	(millions)	(millions)	(pct)	(millions)	(millions)	(pct)
GTP II	2017	19.9	0.2	6.6	33%	0.0	2.2	11%	0.2	8.8	44%
	2018	20.4	0.3	6.9	34%	0.0	2.2	11%	0.3	9.1	45%
	2019	20.7	0.5	7.4	36%	0.1	2.3	11%	0.6	9.7	47%
	2020	21.1	0.7	8.1	38%	0.5	2.8	13%	1.2	10.9	52%
	2021	21.6	0.9	9.0	42%	0.7	3.5	16%	1.6	12.5	58%
GTP III	2022	22.0	1.3	10.3	47%	0.9	4.4	20%	2.2	14.7	67%
	2023	22.4	1.5	11.8	53%	1.0	5.4	24%	2.5	17.2	77%
	2024	22.8	1.6	13.4	59%	1.2	6.6	29%	2.8	20.0	88%
	2025	23.2	1.7	15.1	65%	1.5	8.1	35%	3.2	23.2	100%
GTP IV	2026	23.6	1.8	16.9	72%	-1.4	6.7	28%	0.4	23.6	100%
	2027	24.0	1.8	18.7	78%	-1.4	5.3	22%	0.4	24.0	100%
	2028	24.4	1.9	20.6	84%	-1.5	3.8	16%	0.4	24.4	100%
	2029	24.8	1.9	22.5	91%	-1.5	2.3	9%	0.4	24.8	100%
	2030	25.2	1.8	24.3	96%	-1.4	0.9	4%	0.4	25.2	100%

Figure 7. NEP 2.0 Electrification targets

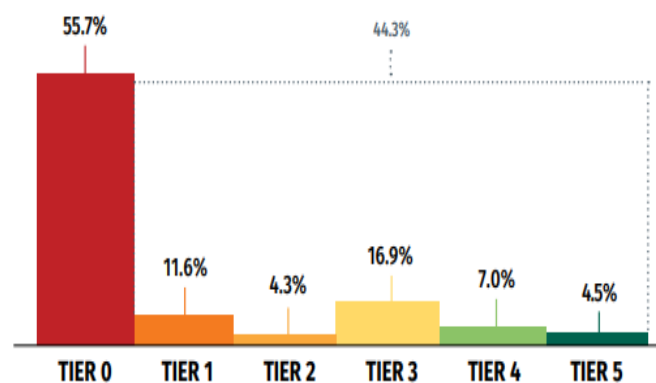


Figure 8. MTF 2018 Distribution of Tiers

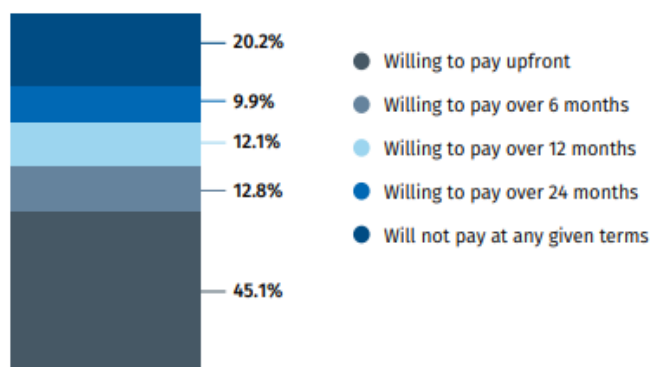


Figure 9. Willingness to Pay measurement

Table 13. PESTEL Ethiopia – Rwanda

The Table can be accessed and downloaded using this [link](#)

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