Federal Democratic Republic of Ethiopia

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Lighting to All

National Electrification Program 2.0

Integrated Planning for Universal Access

2019

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Contents

Boxes

Figures

Tables

Acronyms and Abbreviations

BPR	Business Process Reengineering
CBE	Commercial Bank of Ethiopia
CE	Citizen Engagement
CFL	Compact Fluorescent Lamp
CO2	Carbon Dioxide
CRGE	Climate Resilient Green Economy
DBE	Development Bank of Ethiopia
DoE	Directorate of Electrification
DP	Development Partner
EAPP	Eastern Africa Power Pool
EEA	Ethiopian Energy Authority
EEP	Ethiopian Electric Power
EEPCo	Ethiopia Electric Power Corporation
EEU	Ethiopian Electric Utility
ERP	Enterprise Resource Planning
ESDP	Education Sector Development Programme
FDI	Foreign direct investment
GDP	Gross Domestic Product
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
GW	Gigawatt
GWh	Gigawatt/hour
HDI	Human Development Index
HH	Household
HSPD	Health Sector Development Programme
IAIP	Integrated Agro-Industrial Parks
ICT	Information and Communication Technology
IDA	International Development Association
IDP	Internally Displaced Persons
IEC	International Electrotechnical Commission
IPP	Independent Power Producer
IRM	Implementation Roadmap
Km	Kilometers
KPI	Key Performance Indicator

Kw	Kilowatt
kWh	Kilowatt/hour
LED	Light-Emitting Diodes
LV	Low voltage
MDCL	Market Development Credit Line
M&E	Monitoring and Evaluation
MFI	Micro Financial Institution
MIS	Management Information System
MOFEC	Ministry of Finance and Economic Cooperation
MoWIE	Minister of Water, Irrigation, and Energy
MSME	Micro, Small and Medium Enterprises
MST	Minimum Subsidy Tender
Mt	Metric tons
MTF	Multi-Tier Framework
MV	Medium voltage
MW	Megawatt
NBPE	National Biogas Program of Ethiopia
NEP	National Electrification Program
NES	National Electrification Strategy
NGO	NonGovernmental Organization
NICSP	National Improved Cookstove Program
OPEC	Organization of the Petroleum Exporting Countries
PAYGo	Pay as You Go
PPA	Power Purchasing Agreement
PPP	Public Private Partnership; Power Purchasing Parity
PSE	Private Sector Enterprise
PSNP	Productive Safety Net Program
PVOC	Pre-verification of Conformity
REB	Regional Energy Bureau
REF	Rural Electrification Fund
SC	Steering Committee
SDG	Sustainable Development Goals
SE4All	Sustainable Energy for All
SHS	Solar Home System
SME	Small and Medium Enterprises
SSA	Sub-Saharan Africa
TVET	Technical Vocational Education and Training
UEAP	Universal Electricity Access Program
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Program
USAID	United States Agency for International Development
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
Wp	Watt Peak

Foreword

Following the successful launch and rolling implementation of Ethiopia's First National Electrification Program (NEP) in 2017, the Government of Ethiopia (GoE) has achieved significant milestones in connecting 33 percent of its population with on-grid electrification and 11 percent with off-grid pre-electrification, with the combined achievement of 44 percent of electricity access. Although substantial progress has been made in the sector, Ethiopia's electrification needs are still significant. More than half of Ethiopia's population (56 percent) still does not have access to electricity. By 2025, Ethiopia desires to attain middle-income country status, rural and urban electricity access is targeted to achieve 100 percent.

Achieving Ethiopia's development vision of transformative growth and widely shared prosperity requires timely provision of adequate, affordable, and reliable electricity access to all. Clean electricity access is an essential pillar of sustainable development, economic growth, and social and environmental development. Access to reliable and affordable energy is at the very core of the modernization of the national economy and well-being of our citizens and communities; enabling efficient, timely, and essential productive uses and service delivery of adequate quality in education and healthcare, as well as access to water, telecommunications and financial services.

With mega projects like the Grand Ethiopian Renaissance Dam and Koysha Hydro Power Plant, the installed power generation capacity of Ethiopia is expected to more than double from the current levels. These are visible indicators of rapid growth in electricity generation and overall development. In addition to significant upcoming increase in installed capacity, substantial progress has been made in terms of engagement of the private sector. The GoE has established Public-Private Partnerships (PPPs) for the transformation of energy project financing and implementation. Future geothermal, hydro, solar and wind power generation projects will be developed by private Independent Power Producers (IPPs) utilizing project finance modalities, where the public sector will focus on regulatory and off-taker roles. The major gaps in transmission and substation development to supply industrial parks, railway lines, agro-processing centers and rehabilitation of additional major towns are also being considered for Joint Venture development between the public and private sector. To further transform the power sector, enable PPP modalities, stakeholders are working on major initiatives to improve technical, operational and financial performance of EEU and EEP, and enhanced regulatory framework at EEA. The sector expects to reduce technical losses and improve power reliability with the recently completed 8-town rehabilitation and ongoing 6-town rehabilitation projects including in the capital city of Addis Ababa. With the introduction of Enterprise Resource Planning (ERP) system at both EEP and EEU, recent establishment of cost reflective tariffs, significant improvement in billing and collection rates and decentralization of the utility to regional constituencies, the sector is on the right track to become financially strong and operationally efficient.

The updated version of the National Electrification Program (NEP 2.0) focuses on integrated—grid and off-grid electricity access—and provides an implementation framework for the achievement of 35 percent of off-grid access by 2025. The NEP document has been updated to reflect the government's commitment to revise the electrification program based on implementation progress and improved analytics. To achieve GoE's universal electricity access goal by 2025, the NEP 2.0 takes stock of the progress achieved since the launch of the first NEP, updates grid electrification targets and costing, and provides a detailed off-grid implementation framework based on best practices and consultations with public and private sector implementing agents. The design of NEP 2.0 brings together all sector stakeholders and Development Partners, led by the GoE. In addition, NEP 2.0 presents a full-fledged integrated sector-wide approach to electrification, building on best practices: household connections are linked with generation and transmission plans, to ensure that clean and sufficient electrons reach all households across the country. Meeting the double electrification imperative—to increase both capacity and reach of electrification is a significant task. However, it's also an exceptional opportunity to develop Ethiopia in tandem with its aspiration of becoming a middle-income country and a leading player in the regional power trade.

By 2025, the NEP will implement: (i) 8.2 million new grid connections, and (ii) 6 million beneficiaries will have access to off-grid solutions through stand-alone solar solutions and mini-grids technologies, illuminating the country, irrespective of where someone happens to live.

The investment and directly related program implementation support requirements of the NEP 2.0 are substantial and require mobilizing significant amount of financing. The NEP 2.0 includes a Prospectus for syndicating nearly US$6 billion of financing in direct investments and Technical Assistance for on-grid and off-grid electrification. The GoE is confident that our stakeholders and Development Partners are as excited as we are towards achieving universal electricity access by 2025. With these strategic interventions of generation, access and improving efficiency; Ethiopia is well placed to achieve the 2030 agenda for Sustainable Development Goals (SDGs).

I wish to thank government agencies and our Development Partners for their contributions to date, toward preparation of this second NEP. Going forward, the NEP will keep being a living document, periodically updated, to respond to significantly changed circumstances or information about key technical, economic, or other variables underpinning its design.

Minister Dr. Seleshi Bekele
Ministry of Water, Irrigation, and Energy
Addis Ababa, Ethiopia

Executive Summary

National Electrification Program 2.0

In November 2017, the Government of Ethiopia launched the National Electrification Program (NEP), that represents the action plan for ***achieving universal electricity access nationwide by 2025,*** in a strategic and comprehensive as well as efficient and transparent manner, for the benefit of all its citizens. By 2025, 65 percent of access provision is targeted with grid solutions and 35 percent with off-grid technologies (solar off-grid and mini-grids). While the Ethiopian Electric Utility (EEU) will be the primary implementing agent for the grid program, off-grid scale-up will see the coordination and partnership of public and private efforts.

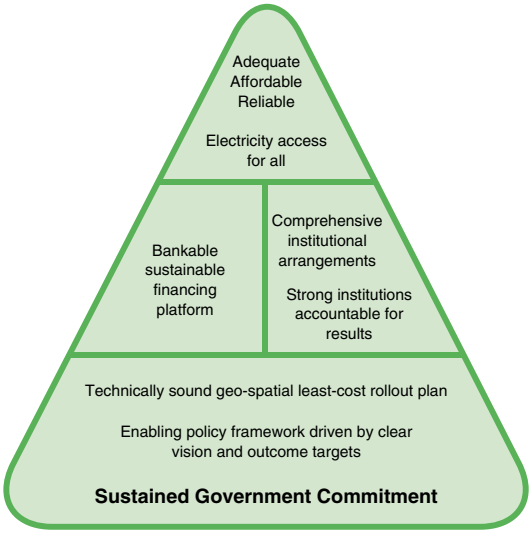
Tackling the access challenge with the coordinated deployment of all technology options allows the achievement of three important goals for the nation: (i) balancing efficiency and equity in access delivery, (ii) maximizing the reach of the electrification program while minimizing the time required for all Ethiopians to have access to electricity services, and (iii) supporting economic growth and human development.

The key operational action elements to reach the NEP target are:

- ***fast-paced ambitious grid connections rollout program implemented by the EEU,*** and designed for scaling up connectivity from 6.9 million households today to over 15 million households in customer count terms by 2025 (equivalent to about 65 percent of the population in 2025); and a
- ***complementary off-grid access rollout program alongside grid connections,*** targeted to provide access for the remaining 6 million rural and deep rural households without grid connectivity (equivalently to about 35 percent of the population in 2025) with a combination of public and private-led efforts;
- ***explicit cross-sectoral linkages with the productive and social services sectors and in support of vulnerable groups,*** for the achievement of 100 percent access at the latest by 2025 in the case of primary and secondary schools, hospitals, and primary health centers. In addition, the NEP provides for priority connection (grid or off-grid) to locations with high economic growth potential—particularly in the agriculture sector—and targeted assistance for safety net beneficiaries, while ensuring gender equality in access to electricity services.

The NEP is a homegrown design and emphasizes a practical and action-oriented focus on the near-term high priority actions. It is informed by international best practices from countries that have achieved near universal access or are well advanced in

Figure ES.1 Principles of NEP



implementation. While successful national electrification programs were undertaken in diverse country contexts and environments, they all share—in essence—a few core driving principles to effectively address and strike a workable balance between the key interrelated set of challenges centrally relevant to the provision of affordable electricity access for all.

The NEP directly addresses the crucial interplay of technical and planning, institutional and policy, and financing frameworks that all must come together, and in a sustained manner, to enable the efficient and timely achievement of the ambitious connection targets and outcomes sought.

The NEP was developed as a ***Consultative process*** orchestrated by GoE and sector-wide, bringing together key stakeholders under the organizing principles of ***"Many Partners, One Team, One Plan."***

Notably, the overarching core principles and policy considerations underlying the detailed design of the NEP building blocks are:

- ***Sustained Government commitment.*** The Government of Ethiopia has set up a high-level Steering Committee—with cross-sectoral members and other experts—supported by Ministry of Water, Irrigation, and Energy (MoWIE) to provide strategic oversight and monitor progress toward ensuring efficiency, effectiveness, and timeliness in program delivery and target outcomes consistent with available financing;
- ***Technically sound geo-spatial least cost rollout plan.*** Use of best practice and cutting-edge technologies for geo-spatial planning of service delivery and identification of targets and timetables for achieving universal access. Geo-spatial least-cost plans identify the optimal modality for access provision in time and space, coordinating grid and off-grid efforts and guiding the physical rollout of the NEP with local subprograms of social and economic priorities to ensure both efficiency and equity in service delivery;
- ***Comprehensive institutional arrangements.*** Clarity of roles and accountability for sector performance and results to ensure efficient and effective management and operation of the sector. While granting autonomy, the GoE will hold accountable the key energy-sector institutions and delivery agents—public or private—for implementation progress and results, measured against annual access targets. MoWIE and the Steering Committee will coordinate and oversee the NEP, both for the grid and the off-grid program;
- ***Bankable sustainable financing platform.*** A financing prospectus based on sound analytics for the mobilization (syndication) of financing on a programmatic basis, including technical assistance and capacity building requirements.

The update

This document, named NEP 2.0, is an updated version following the release of the NEP in 2017. The Government expressed its commitment to steadily update the electrification targets and timetables based on new analytics and progress on the ground. The following new analytics have become available as well as implementation progress and lessons learned over the first year of implementation:

- *Multi-Tier framework global energy access survey* provided a more accurate baseline assessment of the access outlook in the country.
- *Geo-spatial analysis and map* reflecting the digitized location of the existing MV network and the proximity to and density of the population, which allowed for the update of the costing of the grid program and informed the sizing, costing, and implementation mechanism for the off-grid program. The geo-spatial analysis also identified the location of roads, distribution channels and payment locations, which have informed the implementation framework for the off-grid program.
- *Implementation framework* for the off-grid program based on the strategic drivers identified in the first version of the document.

A High-Level Task Force was established at the MoWIE under the Directorate of Electrification in January 2018 and has since been shaping the design and implementation roadmap of the off-grid program. The off-grid program components—deploying individual solar systems and isolated mini/micro grids as feasible—include providing pre-electrification solutions for those beneficiaries not connected to the grid by 2025 and long-term solutions for those not expected to be connected at least-cost by the distribution network. In addition, the Government acknowledges the possible service delivery of off-grid solutions (market-based) to those communities that are expected to receive a grid connection in the latter years of the grid program by 2025, for a total expected sizing of the off-grid program of 9.2 million households.

Section 1: Defining the vision of NEP

The *Multi-Tier Framework (MTF)*[1] *Energy Access Household Survey* was conducted in 2017 across the country—in both rural and urban areas—for the development of a baseline to track progress toward the achievement of universal access,[2] and the results now constitute the baseline for access in the country. The survey was the first comprehensive data gathering conducted on access to electricity services. Through the tiers approach, the survey supplemented and complemented EEU customer accounts, gathered further and more granular information about the reliability and quality of grid services, and shed light on the current penetration—formal and informal—of off-grid technologies, as well as on the willingness and ability to pay by rural and urban households. A description of the MTF approach is described in Figure 2.

The MTF improves electrification targeting by:

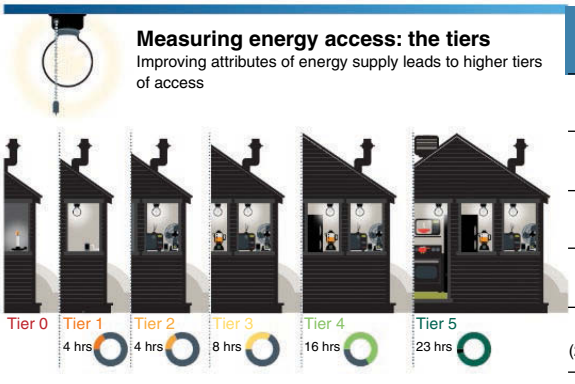
(i) Decomposing the access challenge in terms of quantity of services available and needed for the achievement of grid and off-grid targets—hence allowing for more granular targeting of beneficiaries, as well as monitoring of progress;
(ii) Allowing for policy decisions over the minimum tier of access for beneficiaries, particularly those benefiting from public financial support (e.g., not factoring lanterns distribution as access expansion);
(iii) Having another metric for tracking and monitoring adequacy, quality, and reliability of services, particularly for grid-based connections; and
(iv) Supporting a framework for targeting technologies by location of service need with the inclusion of demand estimates.

The MTF survey reported a 44 percent access rate in Ethiopia, where 33 percent of access is provided through grid connections and 11 percent through off-grid solutions. The survey revealed that the access rate for the country overall is 44 percent. About 56 percent of the population currently lacks access to adequate and reliable electricity services. While there are no changes in the baseline for off-grid access, the MTF indicates a higher percentage for 2017 for grid access than was initially estimated (33 percent versus the initially estimated 21 percent, based on customers registered accounts at EEU). The higher score of grid access is represented by the meter loading practice in the country, a phenomenon well known to sector stakeholders, which, however, had not been quantified until the MTF Survey. It is estimated that about 3.1 million consumers have formal connections (have registered accounts at EEU), whereas about 3.8 million consumers will need to be regularized.

About 96 percent of urban households are connected to the grid (including 99.9 percent in Addis Ababa), while only 27 percent of rural households have access to electricity services. Most rural customers gain access through off-grid solutions. The highest deficits are experienced in deep-rural areas, where 5 percent of people have access to electricity; followed by rural areas, where 5 to 10 percent of people access; and then peri-urban areas, where 20 percent of people have access.

The *geo-spatial map* allows the identification of the least-cost technology solution by location and over time, indicating the progressive extension of the grid footprint and simultaneously indicating the pockets for off-grid. By combining the geographic and time dimensions, the GIS analysis estimates the least-cost technology solution for the short- and the long-term,

Figure ES.2 The Multi-Tier Framework



Load level	Indicative electric appliances	Capacity tier typically needed to power the load
Very low load (3–49 W)	Task lighting, phone charging, radio	Tier 1
Low load (50–199 W)	Multipoint general lighting, television, computer printer fan	Tier 2
Medium load (200–799 W)	Air cooler, refrigerator, freezer, food processor, water pump, rice cooker	Tier 3
High load (800–1,999 W)	Washing machine, iron, hair dryer, toaster, microwave	Tier 4
Very high load (2,000 W or more)	Air conditioner, space heater, vacuum cleaner, water heater, electric cookstove	Tier 5

Figure ES.3 Access to electricity by tiers

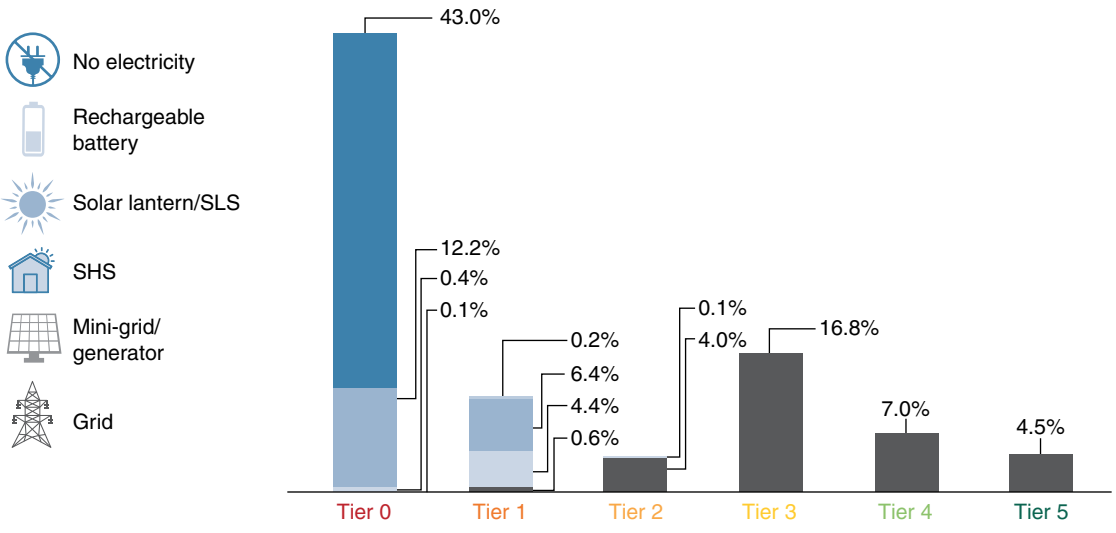
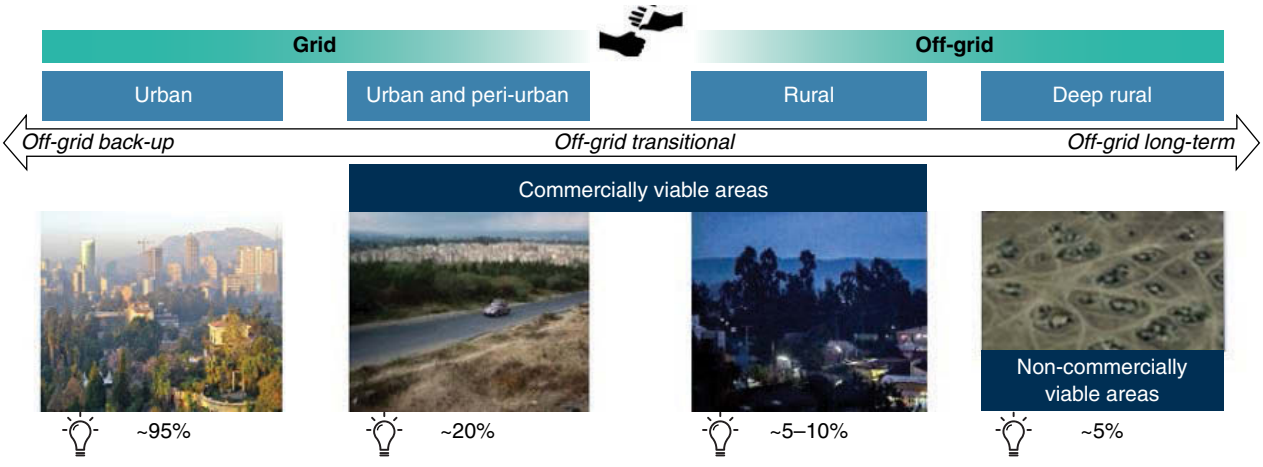


Figure ES.4 The access challenge by geography



ensuring the design of coordinated and complementary grid and off-grid programs.

A priority of the NEP launched in 2017 was the establishment of a geo-spatial planning framework for a data-driven approach to inform decision-making regarding grid and off-grid investments in electricity service delivery.

The Government has already established two ***geo-spatial platforms,*** one within MoWIE—to supervise and monitor NEP progress—and one within EEU—for network planning purposes. The development of the platforms started with data collection to create the geographic map for grid expansion planning and identification of off-grid pockets.

The analysis builds on two main parameters: geo-referenced population and digitization of existing network infrastructure (MV lines). Based on the current accessibility of the population to the grid —that is, the degree of proximity and density of the population with respect to the existing network—the geo-spatial analysis allows to further detail and size the components of the access program under the NEP by 2025 and beyond, and factor for population growth based on the information provided by the Central Statistical Agency.

The analysis used satellite imagery to identify and locate building structures throughout the country. This dataset was then "clustered" into approximately

455,000 settlement locations based on a geo-spatial algorithm. Allocation of population to these settlements was done on the basis of census, household size, and estimates for population growth rates. Those data were combined with geolocated information for existing medium voltage (MV) grid lines nationwide based on the recent on-site mapping.[3]

The results of the geo-spatial analysis indicated that the distance of the population from existing MV lines is as follows:

- 75–80 percent of the population resides within 5 km;
- 90 percent lives within 10 km;
- 95–96 percent of the current and future national population is estimated to reside within 25 km of existing lines.

The overwhelming majority of these communities are expected to be most cost-effectively served by grid expansion over the long term. Accounting for progress in grid connections in 2018 after the MTF survey was conducted, around 6.9 million households are estimated to already have a grid connection (accounting for 34 percent of access, a one percent increase from the baseline identified with the MTF). Fewer than half of these (3.1 million) are estimated to have formal connections, while the rest (3.8 million) have informal connections that will need to be "regularized."

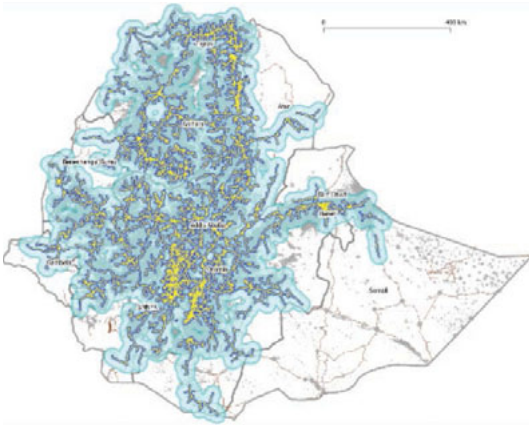
Combining MTF and GIS for a data-driven approach to grid and off-grid electrification

While these GIS tools can identify "where" and "what kind" of technologies (grid versus off-grid), and "when" they are least cost, the MTF approach supports the identification of "how much service" is needed to achieve the grid and off-grid targets. Combined, the GIS and MTF approaches enable the simultaneous targeting of beneficiaries by location and service, moving away from a binary approach to access of electricity service (haves versus have-nots) to a more service-centric approach, which sets at its center how much service need is to be provided for the achievement of universal access and where.

That is, a combination of the MTF and GIS creates the opportunity to identify:

- Beneficiaries, by location;
- Optimal technology solution in the short, medium, and long term, by location; and
- A framework for the provision of off-grid services based on local needs (demand).

Figure ES.5 The geo-spatial map of Ethiopia



Through the MTF, the targets for both grid and off-grid access identified by the geo-spatial analysis (65 on-grid/35 off-grid) can now be broken down through tracking of progress across service levels, where Tiers 1 and 2 approximately correspond to off-grid solar solutions, and Tiers 3-5 to mini-grids and grid connectivity. The combined adoption of GIS tools and the MTF approach breaks down the grid and off-grid targets in tiers, or hours of services, and therefore, into more detailed targets. This approach is particularly relevant for the off-grid program, as it drives the combination of local demand (kWh) with related technology costing (US$/ETB). Serving the population based on current and projected demand—including its activation and stimulation—is a key factor for the efficient and effective rollout of off-grid connectivity, and the technical assistance associated with the NEP provides for an earmarked study for demand estimation and affordability to be conducted in 2019.

The NEP 2.0 therefore presents the updated targets and timetable based on the MTF survey results and the geo-spatial analysis. The integrated approach, by location and technology, maximizes the deployment of access solutions: as the grid program expands from the center to the periphery, off-grid technologies are distributed in parallel from the periphery (beyond 25 km) inwards, in a continuum where off-grid solutions will also serve quality and reliability purposes by providing backup services after the arrival of the grid.

Figure ES.6 Combined MTF and GIS approach

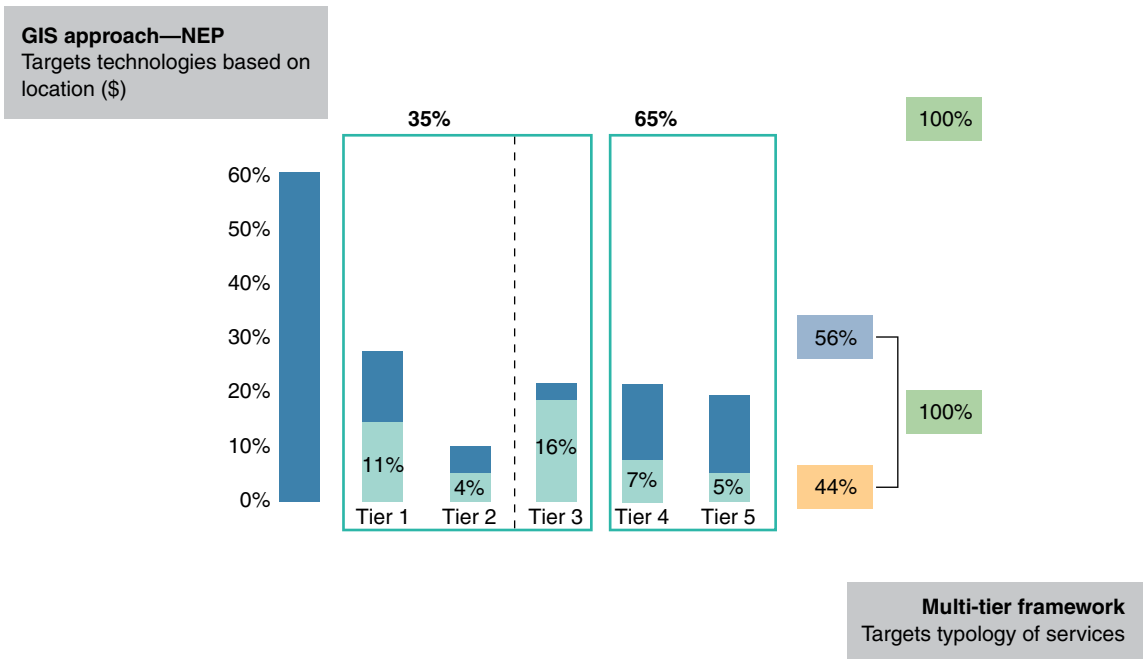


Figure ES.7 NEP targets and timetable

Time Period		Total House-holds	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%

Section 2: Setting the pathways to a comprehensive electrification approach

The main components of the NEP by 2025 are:

A. On-grid access—The target beneficiaries are households located within 2.5 km from the existing grid, corresponding to about 65 percent of the population, adding 8.2 million households for the cumulative achievement of about 15 million grid-connected households 2025 (including population growth).

B. Off-grid access—Long-term deep rural (0.9 million HHs)—About 1 million households (about 4 percent of the population) are target beneficiaries located beyond 25 km from the existing grid who are located in progressively remote and scattered settlements and villages that are less likely to be served in a cost- and time-effective way by grid connectivity. These households in deep-rural areas will be priority targets for electrification, as they not expected to be connected at least-cost by the grid by 2030 and will contribute to the achievement of 35 percent of off-grid access by 2025. *This component will be implemented with public funding support (Minimum Subsidy Tender described below) and combined public, cooperatives, and private implementation.*

C. Off-grid access—Mid-term pre-electrification (5 million HHs)—Beneficiaries residing between 2.5–25 km away from the existing grid, who are expected to be connected by the grid at least cost after 2025 (between 2025 and 2030) contributing to 31 percent of access in the country. The eventual delineation of the geo-spatial location, number, and nature of prospective beneficiaries will be determined in coordination with the scale and speed of grid developments. *These beneficiaries will be served by off-grid solar and mini-grids systems in support of productive uses and social services (health and education) with public, cooperative, and private sector implementation.*

D. Off-grid access—Short-term pre-electrification (3.3 million HHs)—While the grid is expected to be the least-cost solution by 2025, for 3.3 million households, the rollout will take up to seven years to materialize and several households will therefore need to wait for some time before getting access to electricity services. The NEP hence acknowledges this possible segment of beneficiaries of the off-grid program, for service delivery (market based) to those communities that are expected to receive a grid connection in the latter years of the grid program by 2025. *These beneficiaries will be served by the private sector complementing EEU's grid rollout.*

Figure ES.8 provides a visual summary of the grid and off-grid components of the NEP for the achievement of universal access and beyond with an integrated approach, leveraging in a coordination all technologies available.

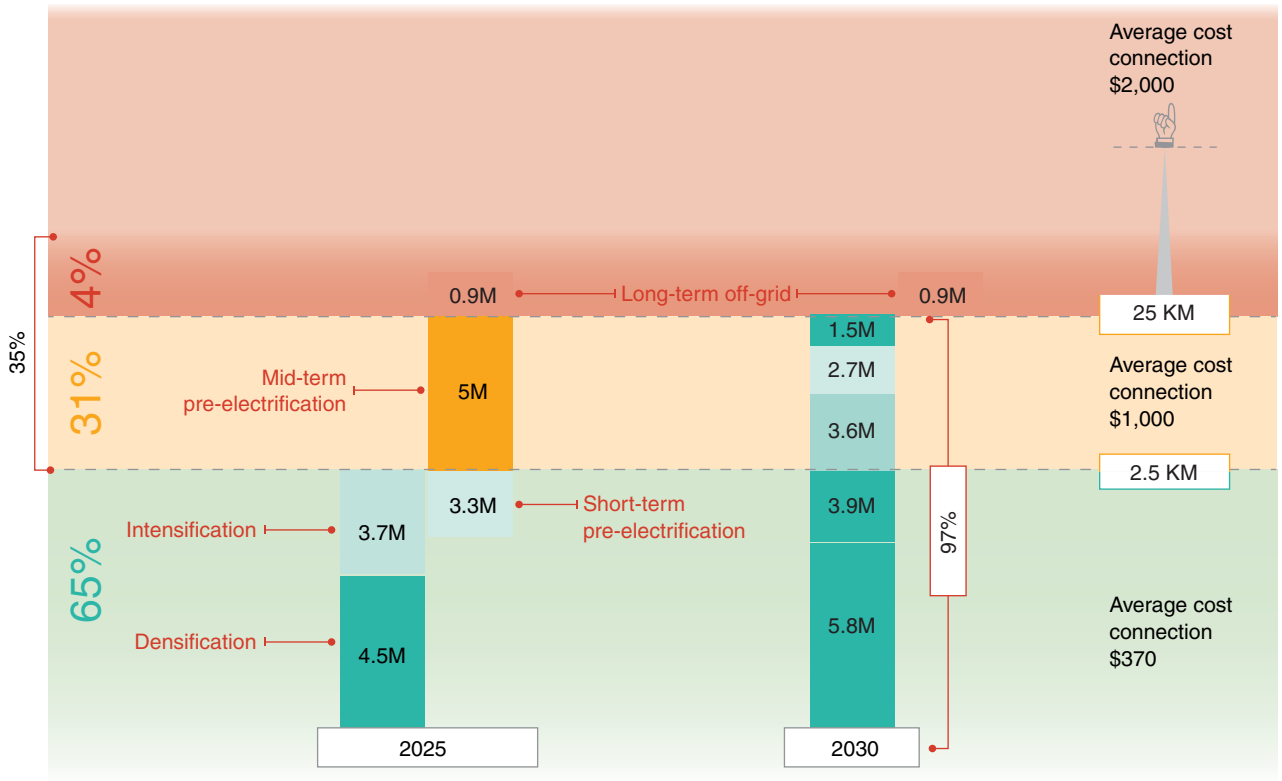
A. On-grid access

Based on the GIS mapping of existing grid infrastructure, geo-referencing of building and statistical growth projections provided by the Central Statistical Agency, the MTF new access baseline for 2017, and technical costing information provided by the EEU, four customer segments with corresponding costing are identified under the NEP, with related weight within the overall electrification program by 2025 and 2030. The different components and related costing reflect the location of currently unconnected households with respect to the existing grid infrastructure. These four customer segments are:

Connections in need of regularization—Meter loading is a well-known phenomenon in Ethiopia, which was quantified for the first time to amount to about 3.8 million households.[4] These HHs have been identified as the difference between the customer accounts reported by EEU in 2019 (3.1 million HHs), and the number of HHs with grid access identified by the 2017 MTF survey and new access baseline (6.6 million HHs) plus the 300,000 connections achieved in 2018 (for a total of 6.9 million HHs). These customers are currently paying for the electricity consumed, but they are unmetered and often connected through unsafe service drops. Based on EEU estimates, the individual cost of regularization amounts to US$100 and the overall cost of the regularization program is US$380 million. Regularization will be part of the 2025 on-grid targets.

Densification—Within 1 km from the existing grid,[5] where about 4.5 million HHs will reside by 2025 and about 6 million HHs will be located by 2030, cumulatively. These households will require mostly low voltage (LV) network-related capital expenditures—such as service drops, household metering, and possibly shared pole top transformers. The average cost per connection is of US$222, ranging from the cost of a connection drop only to a limited LV network. The overall cost of the densification program is about US$1 billion by 2025 and US$1.3 billion by 2030 with population growth.

Figure ES.8 The NEP integrated grid and off-grid components



Intensification between 1–2.5 km from the existing grid, where about 3.7 million HHs will reside by 2025 and almost 4 million households will be located by 2030. These households will also require some limited MV extension for an average cost per connection of US$600 and an overall cost of the "proximate" extension program at about US$ 2.2 billion by 2025 and US$2.3 billion by 2030.

Extension—Ranging from 2.5 and 25 km from the existing grid, serving almost 8 million HHs by 2030. These households are located farther away from the existing infrastructure and will therefore require incremental MV lines for an average cost of US$1,000 per connection, where connection costs range from US$900–1,300 depending on the location of households. The overall cost of the grid extension program is nearly US$8 billion and is expected to take place between 2025–2030.

B. Off-grid access

Alongside the grid densification and intensification program providing access to 8.2 million HHs by 2025 at least-cost, the NEP includes the launching of an off-grid program whose implementation framework and operational design is informed by best practices and established international experiences. The NEP off-grid program implementation framework focuses on two main technologies for service delivery to all the segments of beneficiaries: (i) Tier 1 and above solar off-grid solutions, and (ii) isolated mini-grids that are designed to handle grid-level loads, as well as a coordinated combination of these technology solutions. The off-grid program is technology neutral, reflecting the needs (demand) of the population, and economic and administrative centers, as well as social institutions on the ground.

The NEP off-grid program responds to the need for the following:

- **Speed:** Dramatic acceleration to an average of about 1 million off-grid connections per year;
- **Nationwide spatial outreach (scale):** Nationwide outreach of off-grid technologies, both in commercially attractive and less commercially attractive areas;
- **Improved services:** Transition from lanterns to higher systems complying to international quality standards. The Government intends to take

advantage of the latest technology advances and reduction in prices giving customers the opportunity to fully enjoy the benefits of electricity access. In addition, mini-grid solutions are to be targeted in areas with a current or potential load justifying the investment to ensure adequate service delivery for equitable opportunities to social and economic growth;

- **Commercial viability and affordability:** Adoption of business models adequate for the higher monetary value of solar home systems and mini-grids ensuring: (i) returns on investment for private-sector companies, including the availability of payment options, (ii) affordability of off-grid services, and (iii) steady quality of services after the sale; and
- **Enabling ecosystem:** Establishment of policies, regulations, and incentives supportive of the whole off-grid ecosystem across the value chain, from importers to customers. This includes adoption and enforcement of enabling regulations, as well as regulatory certainty, quality standards, and financial public support programs targeted to ensure equity, human capital development, and economic growth across the country.

To ensure equitable access, higher quality and affordability of services, and the necessary pace of the program, the GoE provides for public and private investments and intends to build on the decentralized nature of the public administration. To implement the transition to higher quality services (including after sale services) and affordability, the Government intends to harness the latest developments and best practices emerging in off-grid business models, particularly on PAYGo ones. Service delivery beyond "below the wire" will benefit from existing key infrastructure assets, such as roads, distribution channels, and payment points (such as bank branches, ATM point, post offices).

The size, scale, speed, and geographic coverage of the NEP off-grid program requires full leveraging of all available implementing agents and resources—public, private, as well as public-private partnerships and cooperatives. All efforts need to be scaled-up and stepped up to the challenge of adequate, affordable, and universal access provision. Development partner coordination to efficiently target the implementation needs of the off-grid program—from lending to access to finance, to capacity building and technical assistance—is also required.

The eventual degree of public and private participation will be determined based on implementation progress and quality of service provision. ***All activities will also be closely coordinated with the Safety Net and other Government programs and related Ministries*** (e.g., Ministry of Agriculture), enabling local processing of agricultural products and leading to increased local value generation and job creation.

To support both public and private efforts, the GoE has already put in place important measures to tackle both supply and demand challenges. On the **supply side:**

(i) the NEP provides for capacity building to the EEU for the deployment and operation of off-grid solutions, with a focus—but not limited to—mini-grids development to support productive uses and social services across the country, irrespective of where HHs happen to live;

(ii) efficient access to finance solutions will be scaled-up to serve the three main needs of private-sector companies, but with no government subsidies. These three main needs are:
   (a) forex for the importation of goods,
   (b) working capital for day-to-day trading operations, and
   (c) capital and operating expenditures for the establishment and expansion of the supply market infrastructure and funding of operations and logistics. In fact, while present in most of the country, existing infrastructure will not be sufficient for service delivery and further costs will be incurred by the private sector for the establishment and operation of distribution channels and adequate provision of after-sale services. Cost will also grow with distance from infrastructure points, which has been reflected in higher prices for end-users.

On the **demand side,** preliminary costing of public subsidies to ensure affordability of off-grid technologies has been identified and included in the investment prospectus. Further analysis will also be collected through the affordability study earmarked under technical assistance requirements, which will also inform the detailing of the implementation mechanisms for the demand-based subsidy, which will leverage the existing Safety Net program and its successes.

For the achievement of an enabling environment for the off-grid program, the Government is considering the following measures:

- Establishment of a uniform licensing scheme linked to grievance mechanisms and with customer

protection clauses to ensure quality at entry of off-grid companies;
- Establishment of a centralized monitoring platform to track pre-electrification achievements, conduct evaluation of program performance, help regulate off-grid product suppliers' operations, determine commissioning date and life cycle of products and determine actual off-grid energy usage to guide planning and future investments. This platform will also monitor grid progress, and is described in more detail in Section III;
- Streamlining of import procedures and expansion of mandatory standards for off-grid technologies and appliances;
- Engagement of international private sector companies beyond importation to support knowledge transfer to local companies;
- Removal of the costs associated with a fragmented supply chain to improve customer care and reduce price of service for end users;
- Support digital payment solutions in line with the Financial Inclusion strategy of the Government and commercial banks interests;
- Support synergies with other sectors that could help speed up the provision of off-grid services and their financial viability, such as the telecommunications sector;
- Establish incentives and skill development programs for private sector development at the scale required for the program.

Mini-grids development: Mini-grid technologies can provide a higher level of service and can support higher loads, including for social (e.g., health and schools facilities) and productive uses, from energy intensive businesses and even small industries.[6] While still in its nascent phases of market development, the performance of mini-grids around the world indicates the potential for communities electrified by mini-grids to become commercial centers for surrounding villages. The adoption of a mini-grid program is part of the Government approach towards integrated planning, as mini-grids and solar home systems, as well as grid connectivity, are technologies that complement each other, supporting different levels of current and future demand and reflecting different timeframes for access provision.

Two key technical assistance studies have been earmarked in the NEP to complement the findings of the geo-spatial analysis and identify priority sites through pre-feasibility studies. These studies include a rapid assessment of high-potential economic areas (see also the end of this section) and a parallel nationwide comprehensive study for the identification of productive use priority centers. These analyses will provide the eventual sizing and costing of the overall mini-grids program, which will also build on the lessons learned from the first pilot of 12 sites.

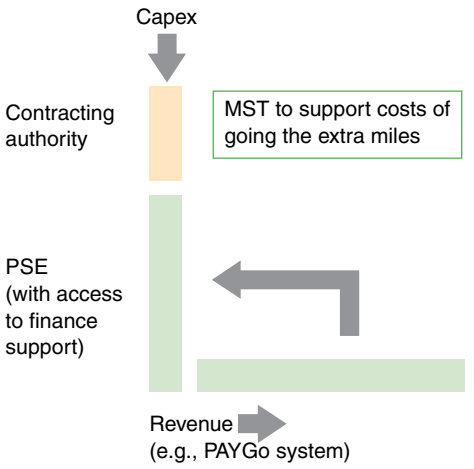
The mini-grids program will feature public and private actors, public-private partnerships (PPP) as well as cooperatives models, to be pursued through the establishment of an enabling environment. The Council of Ministers is currently reviewing the Energy Regulation that will provide the EEA with the authority to approve off-grid tariffs, safeguard private investments in case of grid arrival, and issue the directives required to detail the regulation of most of the aspects related to off-grid generation from mini-grids. The Energy Regulation currently foresees mini-grid tariff calculation under a Cost of Service approach. In addition, it contains an umbrella compensation clause for privately/cooperative owned mini-grids that will be detailed through directives.

The improvement of the regulatory environment for mini-grid developments will consider:

- Simplified licensing application processes for small mini-grids (up to 5 MW of distributed power) with an integrated generation, distribution and sales license;
- A clear and transparent tariff calculation methodology for mini-grid tariff setting, and potential fixed aspects to be contained in the licenses issued (i.e. a fixed payment and a kWh based);
- Compensation clauses, and related calculations, for grid arrival and integration of mini-grid into the main grid to ensure proper risk management of mini-grid investments (e.g., through net metering PPA agreements with EEU). Methodologies used in other countries will be taken into account, such as calculating the compensation using the equivalent of the current value of the assets according to depreciation tables plus the revenue of the last twelve months;
- Establishment of technical and service standards for grid integration, applicable to EEU as well;
- Safety, reliability and environmental protection.

The MST approach for long-term electrification in deep-rural areas: The challenges identified for the scale-up of off-grid technologies become more severe the further the distance to be covered by the supply chain for reaching out to customers. That is, long-term off-grid beneficiaries located beyond 25 km from the existing grid—who are not candidates for receiving a grid connection at least cost—constitute the most

Figure ES.9 The MST mechanism



challenging segment to be served under the off-grid program. According to the geo-spatial analysis, there are about 1 million of these beneficiaries. These areas are targeted by Government support to ensure that their less commercial attractiveness does not become the reason for lack of services or higher end-user prices.

In these areas, the Government will adopt a Minimum Subsidy Tender (MST) implementation mechanism combined with Results-Based Financing (RBF). The MST is a technology-neutral mechanism designed to provide incentives for private sector penetration in deep-rural areas at the scale and speed required for servicing about 1 million HHs (700,000 with off-grid solar and 300,000 through mini-grid connections) in synergy with public sector efforts, and with minimum interference in the market by ensuring the most efficient allocation of public resources through a competitive mechanism for the allocation of the subsidy. In some instances, the Government may consider full capex subsidization and/or service delivery through its agents, including in collaboration with other Government programs, such as the Safety Net program providing support to the bottom 10 percent of the population. The awarding of the MST recognizes the relatively higher working capital costs associated with distance for areas beyond 25 km from the grid, as well as the extra capex and operating costs.

The subsidy will be awarded through open-market bidding to ensure the least-cost allocation of the subsidy as well as transparency in the allocation and awarding of public financial support. Market competition will provide price discovery on the subsidy requirements for private sector penetration in deep rural areas. Tender documents have been drafted and will be finalized after a first phase of piloting. With a close collaboration between EEU and the REBs, the final tender documents will include information on the two key market dimensions: on the demand side, they will indicate the location and number of beneficiaries to be targeted (about 200,000–250,000 beneficiaries) and the indicative estimates of associated service needs; on the market supply side, the tender documents will provide available information on the multidimensional infrastructure present in the territory (e.g., shops, markets, roads). To ensure efficiency, effectiveness and accountability of service provision, the transfer of the MST to the awarded company or companies will be based on results (that is, after verification of installment of solar solutions or mini-grid connections). The allocation of the subsidy will be broken down in phases and based on connections achieved, as well as beneficiaries' consumption of the service, which will ensure control over service quality and after-sale activities, and avoid any distortions associated with an up-front and in-full subsidy allocation.

The high-level, geo-spatial analysis conducted for the update of the NEP identified areas 285 preliminary sites with the potential for mini-grid development in the country. These sites have communities of more than 250 HHs beyond 25 km from the existing MV lines. 151 of these sites are located beyond 100 km from existing MV lines. Private sector and cooperatives participation is intended to be incentivized through the MST mechanism, to be pursued together with EEU EPC tendering.

Connecting the social institutions: Under the NEP, the Government accords a targeted focus for achieving universal access for all social services delivery institutions as a top priority—especially in the education and health sector. In absolute terms, the biggest challenges in terms of lack of access to electricity services (whether grid or off-grid) are represented by primary schools with over 26,000 facilities and health posts with over 15,000 locations without light. In addition, about 90 hospitals, providing the most comprehensive services to the Ethiopian population, are still not powered and hence cannot perform their duties. All in all, there are more than 45,000 institutions in timely need of access to electricity services—grid or off-grid—which will be connected under the NEP.

By 2025, all primary and secondary schools and health facilities will be provided with access to adequate and reliable electricity services, whether on- or off-grid, and in compliance with the standards and guidelines set by the World Health Organization (WHO), United Nations International Children's

Figure ES.10 Connection targets for social institutions

	2018	2019	2021	2023	2025
Education facilities					
Secondary schools	70%		90%	100%	
Primary schools	24%		45%	70%	100%
Health facilities					
Hospitals	70%	80%	100%		
Health centers	28%		50%	80%	100%
Health posts	5%		30%	50%	75%

Emergency Fund (UNICEF), and other appropriate organizations. The connection of health posts, currently affected by a 95 percent deficit, is expected to achieve 75 percent of access by 2025 and will be updated over time on the basis of the strategic role assigned to posts by the Ministry of Health (currently under discussion) for the well-being of the population.

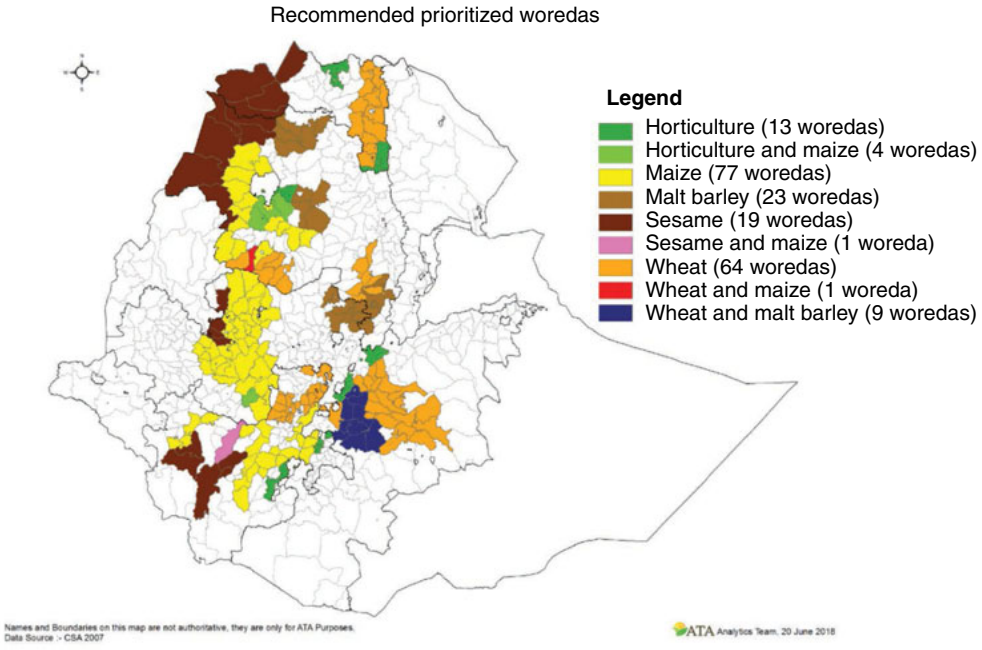
Based on available georeferencing of social institutions, the location of 95–100 percent of education and social institutions within 2.5 km from the existing grid infrastructure (MV lines) makes them candidates for grid connection at least cost. The connection of schools and clinics has already become part of the grid implementation program and will be pursued aggressively by the EEU in the next years to ensure the contribution of grid connections to access provision. The EEU has already integrated connection targets for education and health facilities within its yearly connection rollout in 2018. Following the overall connections rollout of the NEP, grid connections will mostly expand from the existing grid and are expected to provide access first to all social institutions within 2.5 km of the existing grid at least cost and in the shortest time and by 2025, and then move to the areas that are located 2.5 km away from the existing network infrastructure.[7] The provision of grid-based access to all institutions falling within 2.5 km from the existing grid will allow for achievement an access rate of 46 percent for primary schools, 76 percent for secondary schools, 67 percent of access for health centers, and 66 percent of access for health posts. Chapter 4 also provides the preliminary costing of the program detailed by type of facility.

The NEP provides for a Technical Assistance study to finalize the geo-referencing of education and health institutions, a nationwide assessment of the performance of electricity services provided, and a dimensioning of key end-uses requiring electricity for service delivery, particularly in the health sector (cold chain, simple vaccine and medicine refrigeration, lighting, and sterilization). The assessment and design will be conducted by working closely with the federal ministries of health and of education counterparts, as well as with the REBs. Based on the findings of the study, a detailed yearly connection rollout program will be finalized to combine and maximize access provision through grids and off-grids. The study and the implementation program will be designed in close collaboration with the EEU to integrate network capacity and with the REBs to integrate their knowledge of the territory, and in close collaboration with the ministries of education and health.

Connecting the agriculture load: The agricultural sector remains dominant in the Ethiopian economy and an important source of economic growth. Although there is an ongoing structural transformation in the Ethiopian economy—predominantly from agriculture to services and manufacturing—agriculture still comprises about 40 percent of total GDP and continues to dominate employment, with 78 percent of the population employed in agricultural activities. The sector is also a major contributor to export earnings, with over 80 percent of goods exported. Despite its declining share in the economy, the agriculture sector is growing rapidly. Over the past 15 years, the sector has grown at around 7 percent per year. To increase agricultural productivity of smallholders and their transformation to commercial farmers requires a strengthening and focusing of support services and infrastructure. To drive this transformation, the Government is moving toward focused support to specific commercialization clusters, targeting areas with the highest potential for the production of commodities for which Ethiopia has a comparative advantage and can stimulate agro-processing and value addition.

The NEP provides for a rapid assessment (3 months) and a parallel nationwide comprehensive study of productive uses locations across the country. The study will identify granular locations

FIgure ES.11 Recommended prioritized woredas



for productive uses, typology, and assess-related electricity needs. The study will inform the Government about the least-cost solution for electricity service provision in space and time and will provide field information about potential locations for mini-grids development informing the Government mini-grid program, from deep rural areas inwards. The analysis will also take into account electricity needs for larger and smaller scale irrigation, as well as dispersed water points for household use, to identify the optimal technology solution. The technical assistance study will also provide recommendations on the establishment of an enabling environment for productive uses, including availability of appliances—for which the Government is already considering the lifting of custom duties. In addition, the study will inform the detailing of an integrated (grid and off-grid) program implementation support activities for ensuring education and awareness of officers about the latest regulations, as well as end-user beneficiaries.

Section 3: Establishing the institutional mechanisms

Essential features of the NEP-IRM implementation framework are depicted schematically in Figure ES.12, broadly identifying key sector institutions and agents, and their designated functional roles and responsibilities along the following dimensions: Policy, Strategic Oversight, and Progress Monitoring; Financing; Regulation; and Implementation of approved targets on-grid and off-grid by designated sector agents. These are summarized in the following:

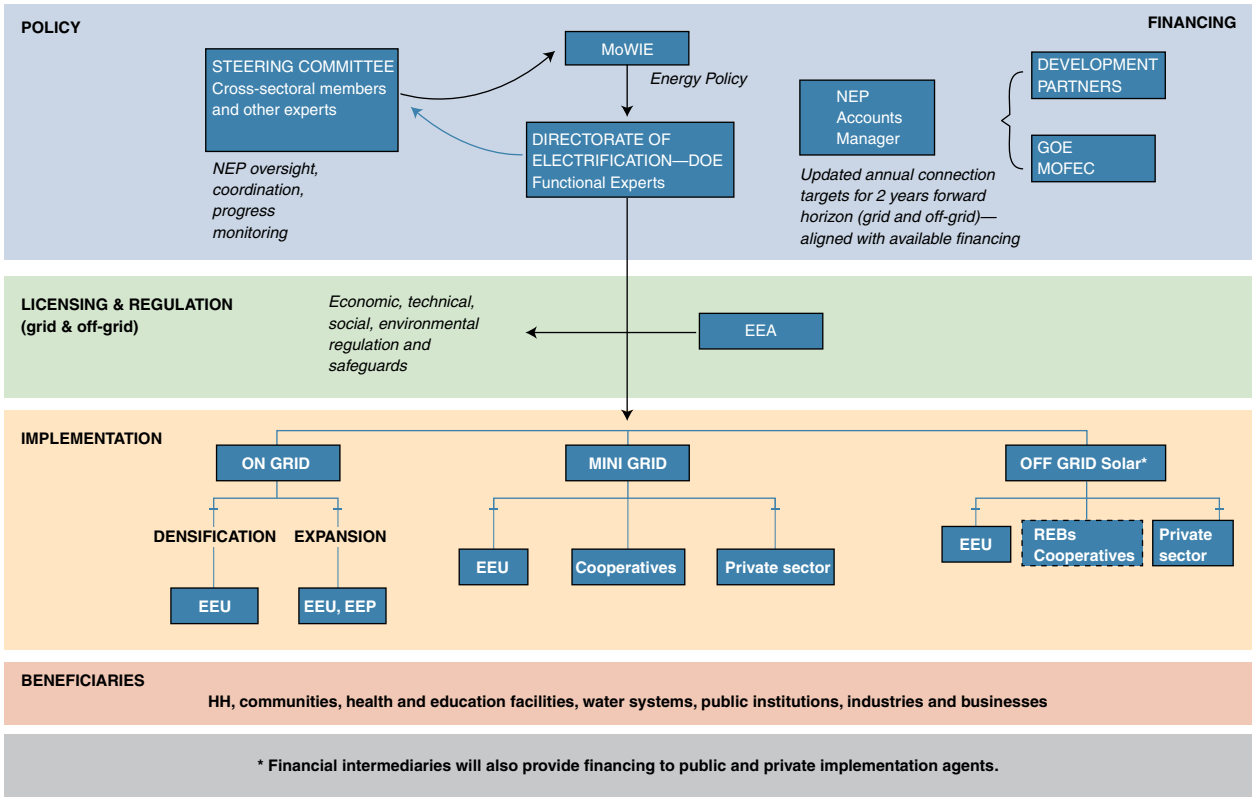
Policy guidance, overall program coordination and monitoring, strategic oversight

Responsibility for overall progress achieved by the implementation agents—on-grid and off-grid—rests with MoWIE. The Ministry, through its Directorate of Electrification, will coordinate and provide oversight for the effective and timely execution of all the NEP components via:

(i) ***The NEP Steering Committee*** convened and constituted by the Hon. Minister of MoWIE and comprised of cross-sectoral ministerial members and other experts, as needed.

The NEP Steering Committee provides high-level strategic direction and policy guidance, as well as facilitates effective coordination across Government Departments and Ministries, and monitors the sector level "dashboard" of key indicators of progress and performance, with a view toward accountability of results by institution, as well as ensuring the effectiveness and sustainability of the program implementation and results, and beneficiary experience

Figure ES.12 The NEP Implementation Framework



and concerns. The Steering Committee reviews and approves updated connection targets of a two-year forward implementation plan (grid and off-grid) submitted by the DoE (see below) and a corresponding authorization of funds to the respective implementing agents to undertake an efficient implementation of their approved plans.

(ii) ***The Directorate of Electrification (DoE)*** is the central institutional locus of the Government to provide day-to-day oversight and coordination of NEP implementation for the grid and off-grid programs. It serves as the coordinator of a sector-wide geo-spatial data, network, and connections planning platform, and facilitates a coordinated consultative process (coordinating the DoE, REBs representing regional and provincial priorities, EEP, EEU, and sector Ministry of Health, of Education, of Water) leading to the preparation of updated geo-spatial plans and a ground-level, detailed rollout construction program designed to achieve the targets—national and regional. The DoE designs and manages the sector-wide dashboard of key indicators of implementation progress, as well as other measures of program effectiveness and sustainability.

The DoE is also responsible for liaising regularly with the key sector implementing agents in the process of updating rollout plans, as well as sector-wide planning. To undertake this role effectively, the DoE has increased its staffing in 2018 with a portfolio of complementary functional experts, and grid and off-grid operational program specialists, covering the entire range of NEP's components and dimensions.

The DoE also supports the Steering Committee's functions. Is responsible for facilitating the day-to-day logistical support necessary for its effective functioning, including: organizing and facilitating quarterly meetings (more frequent as and when appropriate); preparing the relevant information, such as progress reports and other briefing inputs as appropriate; circulating in advance the relevant agenda and the supporting information package appropriate for the Steering Committee's deliberations; and drafting of minutes, and special occasional briefs for the Steering Committee when necessary.

Given the large-scale investments called for under the NEP, concessional financing from Development Partners (DPs) and grant financing are essential to complement in-country resources mobilized by the

Government/EEU, new customers, and the private sector, particularly in the off-grid space. In 2018, MoWIE and the DoE formally established a DPs coordination roundtable chaired by the H.E. Minister of MoWIE focused on the energy sector to engage DPs in the further design and implementation of the NEP and of the sector more broadly; and requested DPs coordination and support tailored to the targets and implementation mechanisms identified and designed by the NEP.

Licensing and regulation

The Ethiopian Energy Authority (EEA) was established as an independent sector regulator in 2013. Consistent with its mandate, the EEA will have licensing and regulatory oversight, including for private sector entry, across the functional value chain of generation, transmission, distribution, and sales functions within the power sector. The regulator will be responsible for establishing standards and regulations required for the implementation of the grid and off-grid programs, including social, safety, and environmental safeguards, as well as their compliance. More specifically, the EEA will define and enforce licensing requirements, rights and obligations of parties, amendments and certificates of competency. It will also advise the Government on tariff proposals submitted by a licensee (for grid and off-grid). It will also promote energy efficiency and conservation, and standards for electric equipment, appliances and labeling. Finally, it will be responsible for dispute settlements, mediation, and arbitration.

Implementation

The roles and mandates of public institutions and their implementation support reflect the intent to ensure speed, affordability and quality of services in the achievement of universal access. Public institutions will be key in supporting both the supply of and the demand for off-grid solutions and are adapted to serve both commercially attractive and deep-rural areas.

I. Grid access component—The EEU will be responsible and accountable for network planning, design and implementation of the grid component. The EEU has prepared an operations program manual as the umbrella framework to plan, procure, organize, construct and connect new customers to the distribution network, irrespective of the funding source, while proceeding with the extension of the grid. REBs are expected to continue providing bottom-up information for ensuring the harmonization of least-cost technical targets (for grid and off-grid rollouts) with the Government's regional socioeconomic priorities for a combined data-driven and equitable approach to electrification.

II. Off grid access component—Through public and private sector agents, encompassing:

Figure ES.13 Summary of main implementing agents in the off-grid space

	Implementing Agents and Intermediaries
Public sector	EEU, MoWIE, Regional Energy Bureaus, Cooperatives
Private sector	Private Sector Enterprises; Micro-Finance Institutions, other Financial Intermediaries

- *EEU service delivery in commercially attractive areas*, where and when appropriate and to be flexibly determined based on implementation progress and lessons learned, and with a focus on supporting productive uses and access to basic education and health services;
- *MST system with EEU as the Contracting Authority and* service provision in case of nonperformance of private sector enterprises within and/or after the MST time-frame;
- *Public sector support for the mini-grids program*—The EEU is already operating 31 diesel mini-grids and has established a mini-grids unit for the scale up of efforts starting from the most remote communities and in support of social and productive uses, including for pre-electrification. All new mini-grids will be at least hybrids and on par with the most up-to-date technologies and standards for long-term functioning as well as integration to the main grid;
- *Private sector market-based supply, delivery and, after-sales service chains in proximate/commercially attractive rural areas* for beneficiaries that are not located "under the wire," with focus on solar systems and in close collaboration with MFIs and REBs; and
- *Private sector and cooperatives mini/micro grids for deep rural and pre-electrification.* The Government intends to apply uniform network design and equipment standards, appropriate for rural mini/micro grids, to ensure their technical integration into the network when the grid arrives. The Government will also address explicitly in the regulatory framework the adequate provisions to address in a fair, equitable,

and transparent manner any "stranded assets" of private operators, should that circumstance occur.

Together with MFIs, the ***Regional Energy Bureaus (REBs)***—especially the strong and more dynamic among the ones with capacity—are expected to play an important role in the implementation of the NEP off-grid program, and implementation support funding is earmarked for both. REBs have already covered similar soles in the past and their experience is valuable for nationwide off-grid access scale-up. Public consultations with REBs are detailing their final roles and responsibilities for the implementation of the NEP, including for the establishment of a grievance redressing mechanism, demand estimation, demand activation and educational campaigns, and coordination of PSEs and MFIs activities.

Monitoring platform

The DoE established under MoWIE has adopted strict monitoring and reporting guidelines for the NEP. The DoE has already adopted monitoring and reporting guidelines and has established a GIS platform at MoWIE for the monitoring of the overall program. The platform will be expanded to track the progress of both grid and off-grid programs. The monitoring system will leverage the GIS infrastructure under development at EEU and other available off-grid tracking systems.

The monitoring system will be owned and managed by MoWIE's DoE and developed in collaboration with stakeholders in the public and private sector. The progressive transition to digital and innovative solutions will provide increased data collection that will better inform future development planning and better execution within and outside the sector. The monitoring system will also keep track of consumer complaints under the grievance redressing system and validate on-grid and off-grid implementation and the associated effectiveness and performance of both the public and private sectors. In addition, the system will be linked to the establishment of the customer database under the warranty scheme, monitoring of energy consumption and quality of services, needed and dispersed subsidies, and sector payment performances.

Section 4: Estimating the investment requirements

The NEP adopts a sector-wide approach for the design, implementation, and syndication of financing requirements. It intends to coordinate activities and investments leveraging on public, private and DPs support. The private sector will have a key role to play in the development of the off-grid program, and comprehensive consultations with local and international private sector enterprises also serve the purpose of ensuring their increased participation in the call for action embedded in the universal access efforts. The overall costing for the grid and off-grid programs for the achievement of universal access if of about US$6 billion. Figure ES.14 below provides a summary of the indicative scenario for resources mobilization (syndication).

For the grid access component, two main sources are envisaged, that is, within the sector—50 percent—and the balance—50 percent—syndicated from Development Partners under concessional terms and grants. Within the sector, the two main financing groups and revenue sources are identified with customer contributions, and the Government's equity contributions. The public share contribution reflects a syndication scenario for the grid of 35 percent customer contribution (about US$1.1 billion),[8] a 15 percent Government contribution of US$480 million out of the remaining US$2.1 billion, and 50 percent of the financing gap to be syndicated (for about US$1.6 billion).

For the off-grid access component, the Government contribution is estimated to be of about 40 percent—US$1 billion—and the remaining—US$1.5 billion—for syndication through Development Partners and private sector resources. The Government also intends to contribute about 40 percent to the program implementation support and technical assistance earmarked under the NEP for the successful implementation of the grid and off-grid programs and for the full implementation of integrated planning, as described below. These numbers reflect first estimates based on best practices and will be updated over time reflecting Government priorities and implementation progress.

Overall, the estimated financing requirement for the achievement of universal access by 2025—grid and off-grid together—is almost US$6 billion; of which about US$50 million are earmarked for program implementation support and Technical Assistance directly related to accomplish the target objectives and outcomes.

The main NEP 2.0 document is organized as follows:

Chapter 1 provides an overview of Ethiopia's power sector context and an updated of progress and developments in the sector over the last year

Figure ES.14 Breakdown of grid and off-grid investments and syndication scenarios for universal access, 2025

	Investment (US$ million)	GoE contribution (US$million)	Syndication (US$million)
A. Grid program			
Grid total investments*	3,200		
Customer contribution (—)	(1,100)		
Total	**2,100**	**480**	**1,620**
B. Off-grid program			
Access to finance (with a revolving fund)	1,760	530	1,240
End-user subsidy	72	72	-
Social institutions	230	70	160
MST off-grid solar	133	41	92
Mini-grids (MST and EPC)[a]	300	280	20
Off-grid total investment syndication	**~2,500**	**~1,000**	**~1,500**
C. Program implementation support (grid and off-grid)	**50**	20	30
Total Investment syndication (A + B + C)	**4,650**	**~1,500**	**~3,150**

*Excludes Ethiopian Electrification Program (ELEAP) and includes regularized connections. Based on the connection cost average for the program of US$370 and excludes connection fees coming from regularized connection and lifeline customers. Numbers do not reflect investments in transmission and distribution network upgrading and modernization nor expanded generation capacity These investment requirements will be provided by the updated of the Master Plan currently under procurement.
Note: Limited rounding applied.
[a]Overall financing requirements, public and private shares are an average of the different business models identified in Section 4.6 of the main document.

(since the launch of the first NEP) across the value chain.

Chapter 2 describes the integrated (grid and off-grid) planning approach adopted by the Government for the achievement of universal access and the combination of MTF and GIS tools.

Chapter 3 describes the on-grid program for the achievement of 65 percent connectivity by 2025, with the updated baseline provided by the MTF and the updated costing for connections rollout based on the GIS analysis.

Chapter 4 describes the off-grid program implementation framework for servicing all the segments of beneficiaries identified through off-grid solar and mini-grids solutions.

Chapter 5 describes the overarching sector-wide framework, and the implementation and monitoring of the program with the coordination of all sector stakeholders' participation, aligned to country priorities and harmonized with country systems.

Chapter 6 presents the prospectus for mobilizing financing (syndication) of investments and Technical Assistance needs for grid and off-grid access scale-up for the achievement of universal access by 2025.

Technical Assistance and Program Implementation support activities are also identified for the success implementation of integrated planning and for both the grid and off-grid programs. Finally, the list of Annexes contains supporting detailed background information, analyses, and best practices underpinning the NEP.

Notes

1. The MTF redefines energy access from the traditional binary count to a multidimensional and comprehensive definition of access and identifies the access rate based on the quantity of service available across six tiers (from 0 to 5), from a minimum of 4 hours per day to 23 hours per day, where Tiers 1–2 typically correspond to off-grid services, Tiers 3-5 to mini-grids and grid-based connectivity. The MTF comprehensive approach to service delivery defines access as "the ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy, and safe for all." The MTF looks at electricity access "beyond connections," locating at its center the end-user perspective on electricity services, that is, what is electricity going to be used for, depending on how much service is provided. In other words, the MTF looks at electricity as an intermediate factor, not an end goal in itself, thereby incorporating the human

and economic development dimensions to service delivery.

2. World Bank/ESMAP. 2018. Ethiopia. Beyond connections. Energy Access Diagnostic report based on the Multi-Year Framework, Washington D.C.
3. Conducted with the support of USAID.
4. The MTF survey was conducted for a random sample of households, irrespective of whether they had a customer account with the EEU or not. The difference between the total number of customers reported by EEU and the grid-connected households quantified in the MTF can be attributed to the meter loading phenomenon.
5. One kilometer is an estimate based on the possible extension in the country of LV lines to avoid faulting. In urban areas the value declines to about 500 meters, as indicated by EEU.
6. Example 1: OMC in India powers telecom towers (1.5 kW to 12 kW of power) and the surrounding villages with solar mini-grids. Example 2: Zengamina in Zambia runs a hydro mini-grid powering a fruit drying factory with >70 kW of power demand together with the surrounding communities.
7. The rollout of the connections will eventually depend on network capacity and on the inputs provided by the REBs on economic and social priorities. The sequencing of the connections along the cost curve represents a data-driven approach to electrification based on the location of the majority of the population with respect to the existing grid infrastructure.
8. Customer contributions are estimated based on new connections only, for an average of US$150/connection. They exclude payment of the connection fee for the poorest 20 percent (bottom quintile) and reflect progressive connection fees across the different consumption brackets (second bottom quintile was kept at US$50 as current practice for densification). The average fee per connection hence reflects a range of connection fee payments across the consumption brackets from US$0–370 (i.e., the average estimated connection cost for these beneficiaries). Customer contributions will be updated based on the ongoing cost of supply and connection cost study and will reflect the result of the affordability study earmarked for 2019.

CHAPTER 1

Power Sector Developments (2017–2018): A Sector-Wide Commitment to Universal Access

Over the past two decades, Ethiopia has achieved impressive results in the development of the power sector infrastructure, both upstream and downstream. In just over a decade, the national power generation capacity has quadrupled from about 850 MW available to 4,300 MW in 2017, the third highest power generation capacity in Africa. With the commissioning of the Gibe-III Hydropower Project (1,870 MW) and other well-advanced large-scale hydropower projects, most notably the 6,000 MW Grand Ethiopian Renaissance Dam, more than halfway through construction, the Government's investments have well positioned the country to become a power hub for East African neighbors, and in harmony with the nation's resilience to climate change and being a green economy front-runner.

In 2005, the Government of Ethiopia (GoE) launched the Universal Electricity Access Program (UEAP), which now ranks among the most successful grid electrification programs in Africa, with extension of the MV grid network to about 60 percent of towns and villages in the country (2005–2015), and 96 percent of the national population spatially located within 25 km of the existing MV infrastructure.

More recently, the GoE has embarked on implementing an aggressive set of initiatives to transform the structure and institutional framework of the power sector to better position it for the achievement of three strategic goals: expanding and diversifying power supply adequacy and energy exports, providing universal access to electricity services, and improving the operational and financial performance of the whole power sector to ensure its sustainability in the long run.

Massive and sustained public investments in the power infrastructure (together with roads, rail, and telecoms) have been at the center of Ethiopia's economic and social development strategy. The sole development plan under implementation is the Sustainable Development Goal (SDG)-integrated Growth and Transformation (GTP II, 2015–2020). Building on the first phase of the program (GTP I, 2010–2015), GTP II places a strong emphasis on structural transformation, industrialization, urbanization, and export promotion. The energy sector is a pivotal enabling driver of Ethiopia's GTP II targets and achieving universal electrification (connectivity) is at the core of its 2025 poverty reduction and development agenda, embedded in the ongoing GTP II.

Specifically, adequate, affordable, and reliable access (connectivity) to electricity is vital for enabling structural transformation of Ethiopia's economy and society, including further poverty reduction and a shift toward higher productivity rates and industrialization. Simply put, without electricity Ethiopia cannot develop a domestic manufacturing capacity adequate for local needs and exports, industrial parks, private sector entrepreneurship, the information and communication technology (ICT), and financial sectors—nor graduate to a middle-income country. Indeed, the highly correlated and mutually reinforcing relationship between electricity use, economic growth, and human development is widely accepted from irrefutable established worldwide experience

(Annex 1). Directly or indirectly, electricity is central to achieving progress on almost all dimensions of human welfare and development. Electricity access is crucial for achieving almost all of the Sustainable Development Goals (SDGs), from its role in the eradication of poverty through advancements in health, education, water supply, and industrialization, to mitigating climate change.

Over the past decade, real Gross Domestic Product (GDP) growth averaged over 10 percent annually. This has translated into a per capita real GDP growth rate of more than 7 percent. The incidence of extreme poverty fell from 55 percent in 2000 (one of the highest levels recorded internationally) to 26.7 percent in 2016, placing the country among the top most performers in poverty reduction results recorded internationally. Ethiopia also ranks among the high performing countries that have achieved improved well-being of its people. Specifically, over the past two decades, there has been significant progress in key human development indicators: primary school enrollments have quadrupled, child mortality has been cut in half, and the number of people with access to clean water has more than doubled. With only two exceptions, Ethiopia attained the Millennium Development Goals and a steady improvement in the United Nations Development Program (UNDP) Human Development Index.

Although Ethiopia has achieved impressive results in economic growth and social development indicators over the past two decades, further diversification of the economy is required to ensure sustained growth and end the fight against poverty. By 2025, the GoE intends to achieve universal access to electricity services to support the goal of graduating the country to middle-income status. By 2025, the GoE is also committed to positioning Ethiopia as the power hub for East Africa and beyond.

To transform this vision into action, the GoE launched in November 2017 the National Electrification Program (NEP)—Implementation Roadmap. The NEP is a homegrown implementation program for the achievement of universal access by 2025, based on the lessons learned from international best practices. In parallel, the GoE has embarked on an aggressive and transformative sector reform program to ensure its technical and financial sustainability as well as its expansion.

The sector reform program is driven by a sector-wide approach to electrification. At its core lies integrated planning among generation, transmission, and distribution investments, which will ensure an adequate and reliable supply of electricity services and increased sector revenues through energy exports to other countries. Opening the power sector to private sector participation and investments will ensure adequate infrastructure developments for the achievement of the GoE goals, expose the country to the best international know-how and technology advances, and redirect public funding from upstream developments to downstream investments. After years of successful capital-intensive project financing, the GoE is now fully realizing the transition from infrastructure development to service delivery. Through this approach, the Government is transforming into action the universal access by 2025 vision, freeing up and redirecting public resources directly toward its citizens, leaving no one behind.

The sector-wide approach also ensures the coordination of all sector stakeholders' activities, including Development Partners (DPs). Under the GoE umbrella, stakeholders are now organized under the "Many Partners, One Team, One Plan" principle, where a project-by-project approach is abandoned in favor of a programmatic one, directly supporting the financing and technical assistance needs of the NEP. The consultative approach ensures a more efficient allocation of resources, including from multilateral and bilateral donors, and more effective interventions and activities, all in all ensuring that the Government goals are successfully supported and achieved.

The NEP was launched by the GoE with the commitment of annual reviews to take stock of progress and implementation challenges and ensure timely improvements, should they be required, to keep the program on track for the end-goal of universal access by 2025. This document constitutes the first implementation update of the NEP.

1.1 A sector-wide approach to electrification

By 2025, Ethiopia aims at achieving universal access to electricity services and becoming a power hub in Eastern Africa. Toward this goal, in 2012 the Government embarked on implementing an aggressive set of initiatives to transform the structure and institutional framework of the power sector to better position it for the achievement of key strategic goals: expanding and diversifying the domestic power supply, initiating energy exports, providing universal network coverage to priority towns and villages, and achieving universal electricity access. Following the launch of the NEP in 2017, substantial progress has been achieved in support of these strategic goals.

Ensuring adequacy and diversity of supply

Ethiopia is blessed with an abundant clean and diversified energy resources base: large and small hydropower,

sunshine, geothermal, and wind energy, among others (Table 1.1) and has become an outlier in the East Africa region with almost 100 percent of its generation coming from clean energy sources, chiefly hydropower. Ethiopia is also leading the way at the global level and is one among the only 10 countries in the world that completely relies on renewable generation capacity. These achievements were possible through the GoE purposefully undertaking large-scale generation projects to substantially expand the national generation capacity and ensure supply adequacy for the cost-effective powering of Ethiopia's future economic growth and productivity (agriculture, industry, small business) and service delivery to all citizens.

In just over a decade, the national power generation capacity has quadrupled from about 850 MW to 4,300 MW, the third highest figure for Sub-Saharan Africa (SSA). On the current trajectory, the generation capacity is expected to exceed 9,000 MW of installed capacity by 2020 and exceed 14,000 MW by 2025.

The recently completed Gilgel-Gibe III dam has started feeding power into the grid, and ambitious large-scale hydropower generation projects are progressing at pace, chief among which are the Grand Ethiopian Renaissance Dam (GERD) and Koyisha projects. The GERD with its 6,000 MW of generating capacity will be the largest dam in Africa, and construction is already well advanced, with the first two units expected to come online in 2020. The Koyisha plant is also under construction but at an earlier stage of development and is expected to add about another 2,160 MW of generating capacity upon completion. Though still at an early stage of the pipeline, the Tams project should add about another 2,100 MW.

The GoE has also focused on aggressively diversifying its energy mix with wind, solar, and geothermal sources to complement the large base of hydro resources development vulnerable to short-term fluctuations in rainfall, both seasonal and annual. A diversified mix of supply resources not only ensures an adequacy of supply, but also contributes to mitigate climate change, in line with Pillar Three of Ethiopia's 2011 'Climate Resilient Green Economy (CRGE) Strategy', which requires 15–20 percent of the energy supply to come from non-hydropower based renewable resources by 2020. Several projects in solar, geothermal, and wind are under way with the support of several Development Partners, in order to meet this target. The Adama 1 and 2 and Ashegoda wind power projects, for a total capacity of 324 MW, have started generating electricity, with more wind projects to follow in their tracks.

Solar

Solar PV technology is also blazing the trail of independent power provision in Ethiopia. A first phase of the World Bank Group's Scaling Solar[9] initiative is currently being rolled out. This phase envisions the installation of a planned 250 MW of solar photovoltaic (PV) generation capacity with a phase 2 of Scaling Solar offering further generation expansion down the line, on the basis of the success of phase 1, for a total of 500 MW. A prequalification process has been completed, and the contractor selection process will be completed early this year. In parallel, about 100 MW of solar PV generation projects are planned in each of Metehara, Mekele, and Humera, where the GoE is availing itself of the technical assistance of Power Africa. The plant at Metehara is most advanced, with a bidder selected and the signing of a Power Purchasing Agreement (PPA) slated for early 2019.

Wind

Ethiopia has vast potential for wind power generation. A Danish Government and World Bank collaboration

Table 1.1 Ethiopia indigenous energy resources

Resource	Unit	Exploitable Reserve	Exploited Percent
Hydropower	MW	45,000	<10 percent
Solar/day	kWh/m^2	Avg. 5.5	<1 percent
Wind power	GW	1,350	<1 percent
Wind speed	m/s	> 6.5	
Geothermal	MW	7,000	<1 percent
Wood	Million tons	1,120	50 percent
Agricultural waste	Million tons	15–20	30 percent
Natural gas	Billion m^3	113	0 percent
Coal	Million tons	300	0 percent
Oil shale	Million tons	253	0 percent

Source: NES, 2016, updated.

is supporting high quality wind resource assessments for the preparation of bankable wind energy Independent Power Producer (IPP) auctions and wind IPP framework development. In addition, the World Bank through funding from the Global Infrastructure Facility is supporting with technical review and environmental and social risk review of all wind sites under consideration for potential wind IPP development. The objective is to support EEP in prioritizing the most suitable targets for an initial phase of competitive tendering. It is expected to enable the development of an estimated additional 500 MW of wind-powered generation capacity over the next five years, adding to about 324 MW of generation capacity already installed at the Ashegoda, Adama I, and Adama II wind farms. The Asella wind farm project, resulting from a Government-to-Government agreement between GoE and the Danish Government is already at the bidding stage, and will be the first wind IPP-auction in the country.

Geothermal

Geothermal generation has high potential for a reliable provision of baseload in the Ethiopian market. A number of sites appropriate for geothermal power generation are being explored with the expectation that supply to the grid will begin in the near future. Tendaho and Aluto Langano geothermal exploration projects for 12 MW and 70 MW, respectively, are being supported by AFD, Japan International Cooperation Agency (JICA) and the World Bank. Further generation capacity is expected to come from the (i) Corbetti geothermal project (up to 520 MW of generating capacity), across multiple phases of development, with the first-phase pilot plant of 10 MW slated to come online in 2021 and (ii) the Tulu Moye geothermal project, located in Oromia region (another 500 MW), with the first 50 MW expected to come online in 2023. Upon completion, these projects expect to increase geothermal generation capacity in the country from the current 7 MW to over 1,100 MW.

Other

In August 2018, the Reppie waste-to-energy plant came online, adding 50 MW to the country's generating potential. This is the first of its kind in the African continent, and besides diversifying the energy mix, it promises to help mitigate the growing problem of landfill overflow, which has plagued the city of Addis Ababa for years.

Demand-supply balance

Based on the most recent System Integration Study (January 2019), generation capacity is expected to adequately serve demand growth and electrification goals. This study is the first update of the 2014 Master Plan, to be followed with comprehensive update in the next months with a sector-wide integrated approach combining generation, transmission, and distribution investment needs (see also below). A comprehensive sector-wide planning will ensure positive feedback between electrification developments and upstream investment plans and integrate distribution investments into overall sector planning.

Total demand growth is forecasted at 14.3 percent, which includes exports as well as the projected improvements in transmission and distribution losses. Forecasts are in line with Ethiopia's goal of becoming a middle-income country and the power hub for East Africa. By 2025, total system demand is forecasted to be around 50,000 GWh, and by 2030 around 70,000 GWh. Demand growth forecasts include electrification goals.

Generation additions included in the base case included units already committed for development (comm.), as indicated in Figure 1.1. Committed projects are those that are already under development or with signed or currently negotiated PPA contracts. The installed capacity of all committed units is close to 10,500 MW and total installed capacity of all other units added during the planning horizon (2030) is 3,250 MW, so committed units already include significant capacity required to meet the demand growth until 2030. Forecasts take into account the projected improvements in transmission and distribution losses (13 percent).

Transfer capability of transmission system

The electric power grid of Ethiopia has experienced high load growth, particularly over the last five years. In many parts of the country, transmission lines and substations (140 in the country) are overloaded at peak times. Several upgrades to the transmission infrastructure in the country are already under way, and preliminary estimates provided by EEP for the upgrade and expansion of the transmission networks size investment requirements at US$6 billion by 2030, to be confirmed by the updated Master Plan under procurement (see also Chapter 2). To ensure that transmission keeps pace with generation and evacuation needs and the evolving geographic patterns of demand, a raft of new substations are being built country wide. Three such substations, one in Chilga in Amhara, one in Masha in the Southern Nations, Nationalities and Peoples Region, and one in Shambu in western Oromia have completed the procurement stage. Contracts have been awarded for the construction of these substations, as well as for the necessary bay extensions at upstream substations and the connecting transmission.

The electric network's stability and improved balance between power generation and consumption will

Figure 1.1 Generation additions

COD Year	Units Added/Location	Number of Units	Total Capacity (MW)
2020	Sugar (Beles, Welkayt, Tendah Kasem)	8	276 (comm.)
	Gerd 1	2	750 (comm.)
	Ayisha wind 1	1	120 (comm.)
	Metehara solar 1	1	100 (comm.)
	Dicheto solar	1	125 (comm.)
	GAD solar	1	125 (comm.)
	Corbetti geothermal 1	1	20 (comm.)
2021	Sugar (Omokuraz)	6	220 (comm.)
	Assela wind	1	100 (comm.)
	Tulu Moye geothermal 1	1	50 (comm.)
	Metehara solar 2	1	100
	Dire Dawa solar	2	200
	Juiga solar	2	200
2022	Corbetti geothermal 2	1	50 (comm.)
	Tulu Moye geothermal 2	1	100 (comm.)
	Koysha hydro	1	2,130 (comm.)
	Harar solar	2	200
	Weranfo solar	1	100
	Humera solar	2	200
	Metema solar	2	200
	Mekele solar	2	200
	Welenchiti solar	2	200
2023	Gerd 2	8	3,256 (comm.)
	Aluto Langano geothermal	1	70 (comm.)
	Yeda 1&2 hydro	1	280 (comm.)
	Tulu Moye geothermal 3	1	100 (comm.)
2024	Gerd 3	6	2,442 (comm.)
	Corbetti geothermal 3	1	200 (comm.)
2025	Tulu Moye geothermal 4	1	250 (comm.)
	Dabus hydro	1	798
	Geba hydro	1	385
2026	Corbetti geothermal 4	1	200 (comm.)
2028	Birbir hydro	1	467

Source: Power Africa (2019).

be strengthened by the establishment of the Load Dispatch Center (LDC) currently under development with the support of the Agence Francais de Developpement in collaboration with EEP. The main impacts of the LDC are expected to be: reduction in technical losses and improved control and management of power plants and substations, reduction of commercial losses, improved integration of intermittent renewable energy sources, improved asset management, efficient controlling of tie lines for interconnection with neighboring countries, and improvement do quality of electricity delivered.

Distribution network upgrade and reinforcement

Over the past years, the distribution network has been expanded in proximity of 80 percent of the population and covering 60 percent of the geographic coverage of the country. While some of this network has not been exploited yet, due to the slower pace of connections achieved (which led to the design of the NEP), some segments are overloaded and without the technical capacity to expand connectivity, particularly in first and second tier cities. EEU is already undertaking network rehabilitation and strengthening activities across the country, with several projects underway that are expected to highly improve network capacity and ensure the achievement of the targets of the NEP program, as well as ensure adequate and reliable service provision. EEU has conducted a preliminary assessment of investment requirements, indicating financing needs for about US$2.4 billion in the next years.[10] The investment sizing will also be updated by the Master Plan under procurement and the underpinning comprehensive technical assessment of the network based on the recently acquired information about the

location of the distribution infrastructure (through the digitization of MV lines), which will also support load flow analysis. The procurement of the Master Plan and the terms of reference are being developed through a close collaboration between EEP and EEU.

Integrated power sector planning

The update of the Master Plan is currently under procurement to systematically address the investments required for the sector infrastructure expansion and upgrade.[11] For its update, the Government decided to adopt an integrated vision of the power sector, to adequately address generation, transmission, and distribution investment needs in a harmonized way, ensuring a positive feedback loop across the different segments of the value chain and factoring in actual and projected connections rollout plans under the NEP. The Master Plan will therefore systematically take stock of the location and the sizing of investment requirements in line with electrification and exports plans. The plan will take into account: (i) supply demand balance in the country to identify generation investment requirements based on an assessment and estimation of demand across the country (see also Chapter 2); (ii) the evaluation of the transmission network ability to evacuate and transfer power between generators and the injection points for the medium voltage networks in anticipation of the projected demand growth from NEP connections, its required reconfiguration and upgrade; and (iii) technical design for the construction of distribution lines (33 kV and 0.4 kV), and installation of the distribution substation (33 kV) to support the rollout of connections under the program and the NEP up to 2025 and beyond. The design will include a comprehensive assessment of network capacity and related investment requirements.

1.2 A power hub for the region

A key strategic driver of the GoE strategy in the power generation sector is tapping into Ethiopia's comparative advantage as a cost-competitive generator of power. Revenues from exports can contribute to the financial sustainability of the sector and provide relief to the country's balance of payments. Neighboring power markets, on their part, experience much higher costs of generation and stand to benefit greatly from access to Ethiopia's low-cost clean power supply. The country's export revenue potential is estimated to be as high as an annual US$500 million by the end of the decade, with sales flowing mostly to Sudan, Djibouti, Kenya, and Tanzania (see Table 1.2), with export revenues currently priced at approximately US$0.07/kWh.

Given its massive clean energy reserves that can be developed cost competitively, the country aims at becoming a cornerstone of the regional power market of the Eastern Africa Power Pool (EAPP). The EAPP and its southern sister pool, the Southern African Power Pool (SAPP), bring together the members of the Common Market for Eastern and Southern Africa (COMESA) around the vision of optimizing the use of clean energy resources available in the region to

Table 1.2 Ethiopia export projections (MW), 2017–2030

Year	Djibouti	Sudan	Sudan or Egypt	Kenya	Kenya II	Tanzania	Total
2017	100	100					**200**
2018	100	100					**200**
2019	100	100					**200**
2020	100	100		400			**600**
2021	100	100		400		412	**1,012**
2022	100	100		400	200	412	**1,212**
2023	100	100	1,500	400	200	412	**2,712**
2024	100	100	1,500	400	400	412	**2,912**
2025	100	100	3,000	400	600	412	**4,612**
2026	100	100	3,000	400	600	412	**4,612**
2027	100	100	3,000	400	800	412	**4,812**
2028	100	100	3,000	400	1,000	412	**5,012**
2029	100	100	3,000	400	1,000	412	**5,012**
2030	100	100	3,000	400	1,000	412	**5,012**

Source: Power Africa, 2017; World Bank, 2016 and MoWIE.

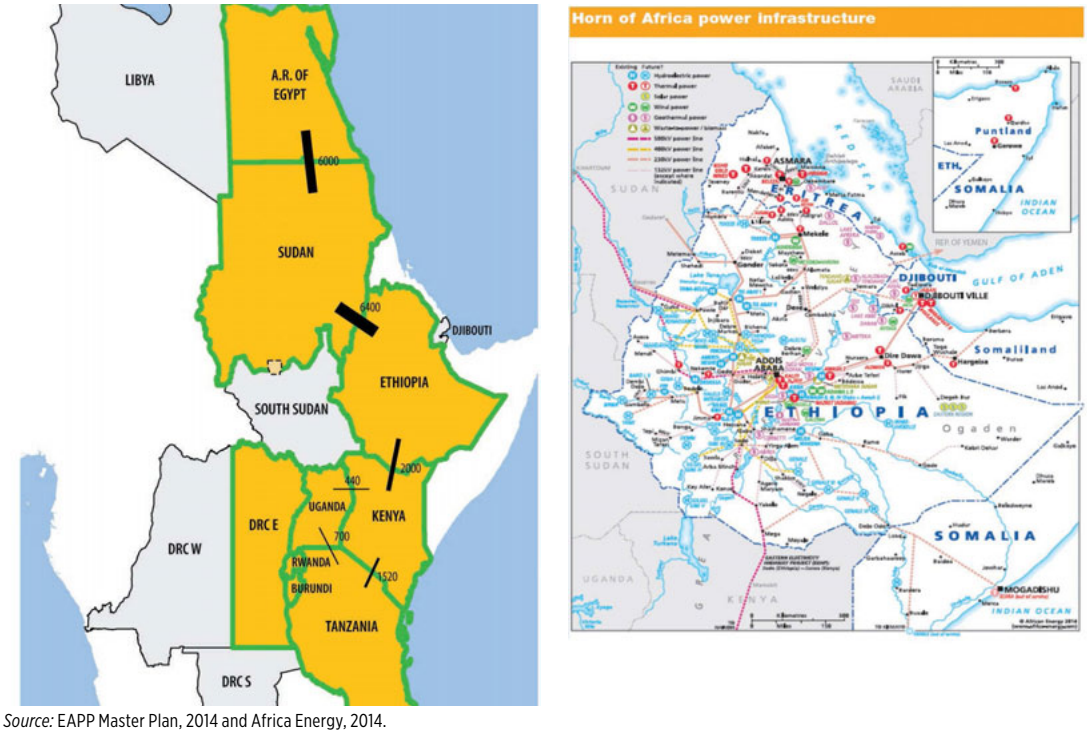
benefit the region's society with a reduced cost of electricity production and an increased rate of access.

Ethiopia is already exporting US$80 million worth of electrical energy on an annual basis through its high-voltage (HV) connections to Sudan and Djibouti. Ambitious infrastructure investments are laying the foundations of a truly regional, integrated electricity market in eastern Africa and beyond, under the auspices of a set of inter-Governmental Memorandums of Understanding (MoUs) coming under the Africa Clean Energy Corridor initiative.[12]

Construction of a high-voltage direct current (HVDC) transmission interconnection between Ethiopia and Kenya has already progressed. The project, costing almost US$1.2 billion and jointly financed by the World Bank, African Development Bank (AfDB), and AFD, will string bipolar transmission lines across about 430 km on the Ethiopian side, and about 610 km on the Kenyan side, capable of transmitting up to 1,000 MW. The line on the Ethiopian side of the border is already complete, and the necessary converter at Sodo/Welayta substation is under construction. EEP and its Kenyan counterpart, KETRACO, have committed to trade a minimum of 400 MW of firm power over the course of 25 years. With recent favorable political changes, there is also renewed interest in a 220 kV transmission interconnection between Ethiopia and Eritrea.

The link is expected to become online in 2019 and, once completed, it will be the first international interconnector in East Africa with a transfer capacity of more than 1,000 MW and will constitute a first inspirational step on the path to cementing a cooperative, trans-boundary approach to optimal power generation and supply. The Ethiopia-Kenya interconnection falls under a transformative, continent-wide initiative to connect EAPP and SAPP via Kenya, Tanzania, and Zambia. The second step will be the extension of the main regional transmission backbone, a high-voltage alternating current (HVAC) double circuit, by almost 508 km from Kenya to Tanzania. The project will require an investment of about US$140 million, financed by the AfDB and JICA and is expected to be completed by 2021. In the final leg, a Tanzania-Zambia high-voltage link will complete the interconnection of EAPP and SAPP, slated for 2024. The interconnection will mobilize a US$595 million investment in infrastructure, system readiness, resettlement compensation, and capacity building—co-funded by World Bank IDA, AfDB's AFD, and an EU grant—to bridge the approximately 1,500 km separating the Tanzanian grid and the Zambian grid and prepare the countries' systems and institutions to fully exploit the benefits of the link (Figure 1.2).

Figure 1.2 Committed links to 2020, with transfer limits and Horn of Africa infrastructure



Source: EAPP Master Plan, 2014 and Africa Energy, 2014.

Taken together, these investments will create an interregional electricity highway linking Addis Ababa to Cape Town. Further high-capacity links are planned onward to Sudan and Egypt, with feasibility studies for a 3,000 MW link between Ethiopia and Sudan already completed. The highway will eventually embrace the length of the African continent from the Cape to Cairo (Figure 1.2), and position Ethiopia at the center of the widest interconnected power market in the world.

EAPP is actively preparing for such a step-change in regional and continental integration. With support by the World Bank, AfDB, and the multi-donor trust fund (MDTF), EAPP will engage in a broad-ranging study and implementation program, that over the next three years, is centered around the following workstreams: operational and technical readiness, commercial readiness, regional infrastructure development, and capacity building. Key themes of activities under way in each of these workstreams are summarized and detailed in Table 1.3.

1.3 Sector reform

Over the past years, the GoE has initiated a reform program to enhance service delivery in the energy sector. Recent reform measures include:

- **Legal framework.** A new legal framework was approved in 2013, which included unbundling the vertically integrated Ethiopian Electric Power Corporation (EEPCo) into the Ethiopian Electric Power (EEP), responsible for the upstream functions of generation and transmission and the Ethiopian Electric Utility (EEU), responsible for power distribution, sales, and customer service.
- **Regulatory framework.** The new legal framework reestablished, with an adequate mandate, the Ethiopian Energy Authority (EEA) as the regulatory entity overseeing the sector and regulating service quality. The regulations to implement the law were approved in late 2018.
- **Private sector participation.** The Government has put in place a state-of-the-art legal and regulatory framework for PPPs in 2018, overseen by the Ministry of Finance and Economic Cooperation (MOFEC), to promote private sector investment, and has developed of a strong pipeline of PPP transactions in the power sector. The GoE is also preparing a transparent and competitive procurement framework (auction-based bidding procedures, for relevant technologies, as feasible) which is expected to become the default methodology for procuring PPPs. The GoE is working closely with key sector stakeholders to review existing commercial and banking regulations that may impact development of IPPs in the country. Finally, a dedicated IPP unit has been established at the Ethiopia Electric Utility (EEU) which would become the primary counterparty to the IPPs.
- **Institutional arrangements for electrification.** The integration of the Universal Electricity Access Program into the EEU as part of the unbundling to ensure simultaneous response to the mission of increasing grid connectivity, through MV network extensions and connection of final beneficiaries aligned NEP (2016) and measures to promote private sector participation in electrification.
- **Electricity tariffs.** The Government is also undertaking targeted measures to improve the financial health of the sector, without imposing on the poor segments of the population. In September 2018, the Council of Ministers approved a multiyear electricity tariff increase framework with a detailed implementation schedule to improve cost recovery while protecting the poor. Tariff increases will be scheduled progressively to achieve cost recovery and improve sector finances.
- **Capacity building:** With the technical assistance of several DPs, the Government has launched a comprehensive program for capacity building, encompassing legal and financial advisory services, and workshops and trainings for the staff as needed.

Key next steps in the reform program include:

- **Power sector reform.** The Government is currently preparing a comprehensive power sector reform roadmap charting out the objectives, reform measures, and reform milestones, including further unbundling and moves toward liberalization of wholesale and retail markets for power. The document would detail the possible interim and final market structure, the steps required in developing the proposed power market, as well as any implications to policy/law/regulation in Ethiopia. Implementation of the reform roadmap is expected over the next 5 to 10 years.
- **Quality of service improvements.** With system losses at 23 percent and the collection rate at 85–90 percent, there is room for improving the operational performance of the sector and enhancing revenues. To complement ongoing tariff and structural reforms, the Government is preparing a plan to improve the performance of the power

Table 1.3 EAPP short-term action plan

Workstream	Theme	Selected Planned Activities and Progress in 2018
Regional infrastructure development	**Regional planning and transmission infrastructure development**	**Plan:** Conducting regional load forecasts, load flow, steady state and dynamic studies, identify investments required, updating the Regional Master Plan, and conducting key feasibility and safeguard studies. **Progress:** Several studies under way, including the Ethiopia-Sudan-Egypt and Ethiopia-South Sudan-Uganda interconnection feasibility studies.
	Enabling studies for strategic renewable investment	**Plan:** Identifying sites for solar measurement, and conducting measurements, analyzing and reporting results. **Progress:** Site identification process under way.
Commercial readiness	**Establishing the commercial and legal foundations for bilateral trade**	**Plan:** Conclusion of ongoing trade negotiations; development of standardized documents (incl. PPAs) and charging methodologies to act as a basis for future bilateral agreements on energy trade and wheeling. **Progress:** Wheeling agreements between KETRACO and Tanesco ongoing. Generic PPAs, trans pricing, wheeling, loss and imbalance methodologies already prepared.
	Development of trading platforms	**Plan:** Development of central platforms to facilitate simple short-term bilateral trading; and begin experimenting with the development of a "pooled" market. **Progress:** All activities slated for 2019 and beyond.
	Energy exchange with SAPP	**Plan:** Ensuring technical and commercial readiness to interconnect and trade with the South Africa Power Pool through the Tanzania-Zambia interconnector. **Progress:** All activities slated for 2019 and beyond.
	Establish regulatory foundations to facilitate regional trade	**Plan:** Developing a strategy, identifying and implementing necessary legal changes for the pool's Independent Regulatory Board (IRB), the organ tasked with regulating the pool's functioning. **Progress:** IRB strategic plan preparation activities have begun; terms of references (TORs) have been drafted.
Operational and technical readiness	**Interconnection code compliance work**	**Plan:** Identification and mobilization of investment in equipment necessary for operational readiness and the integration of national power systems. **Progress:** A gap analysis has been completed for most member states, and some utilities are in the process of defining or even implementing national-level plans to mitigate the gaps. Regional load forecast in progress.
	Development of guidelines to support operational readiness	**Plan:** On the basis of rigorous analysis, the development of shared detailed guidelines and standards critical to ensuring the national utilities can operate in interconnected fashion; Establishment of control areas for regional connectivity and advanced systems operation training. **Progress:** EAPP has identified necessary technical assistance and is identifying necessary training in new concepts and processes.
Capacity building	**Develop the capacity of the EAPP and its organs**	**Plan:** Focused capacity building at the EAPP secretariat committees and the IRB, employing embedded expertise in various areas, knowledge transfer and exposure of EAPP staff to mature power pools and markets internationally, including the SAPP. **Progress:** Technical support to EAPP secretariat ongoing since early 2018.
	Delivery of new facilities and ICT systems	**Plan:** Developing the new EAPP headquarters, designing and procuring the requisite ICT systems. **Progress:** All activities slated for 2019.

Source: Adapted from EAPP Short-term Action Plan 2018–2021.

utilities, which is expected to be implemented over the coming 2–3 years.

- **Sustainable debt management.** Public borrowing by the utilities over the past decade (primarily, domestic bonds purchased by citizens) has created a growing debt service obligation. Overreliance on short-term loans, used to finance long-term assets (mostly hydropower), has created a cash flow problem, and there is no prospect of repayment from electricity tariffs. As a result, while any direct internationally held debt service obligations of the utilities are met on time, most of the domestically held debt is routinely rolled forward. The Government of Ethiopia is confronting the issue and has formed a task force to analyze the situation and develop actionable options for sustainable debt management in Ethiopia's state-owned electric utility companies EEP and EEU.
- **Brownfield IPPs.** The Government is also considering the option of selling EEP brownfield sites to domestic and international investors. The resulting inflow of capital would help consolidate the utility's finances, while the participation and know-how of experienced investors from the international energy sector would help build the managerial and program implementation capacity of the sector.

These initiatives position the sector for the achievement of three strategic goals: expanding and diversifying power supply adequacy and energy exports, providing universal access to electricity services, and improving the operational and financial performance of the whole power sector to ensure its sustainability in the long run.

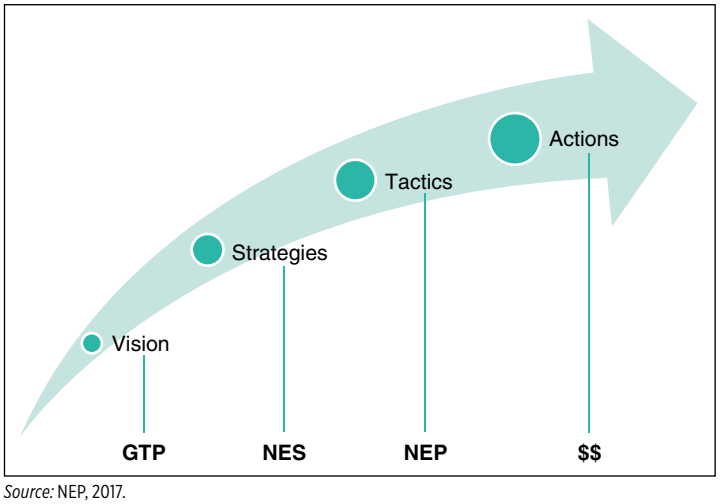
1.4 NEP building blocks and update: a customer centric approach

While the UEAP program achieved impressive results in grid access coverage in a relatively short amount of time with the expansion of the transmission infrastructure (MV lines) across the country, last-mile connections to households, businesses, schools, and clinics, and connections for service delivery to end beneficiaries have not kept pace with network expansion. Consequently, the corresponding targets set by GTP I for connectivity were not met as expected.[13]

Acknowledging the opportunity and the challenge posed by these infrastructure developments, the Government prepared and launched the National Electrification Program-Implementation Roadmap (NEP-IRM) in November 2017. The NEP provides a comprehensive, technically sound, and achievable physical implementation program to transform the Government's aspiration of achieving universal access by 2025 into yearly targets for a coordinated grid and off-grid rollout, and implementation support activities. The NEP is anchored in the specific recommendations provided by the National Electrification Strategy (NES), which was prepared in 2016.

Informed by relevant international best practice, the NEP is a homegrown design for reframing service delivery around the strategic urgency of putting people first. The operational design of the National Electrification Program adopts the key drivers of the success of electrification programs across the world, of countries that have achieved near universal access

Figure 1.3 Delivery of electricity services—from plans to implementation



Source: NEP, 2017.

or are well advanced in implementation and have done so in an effective and fast-paced manner.

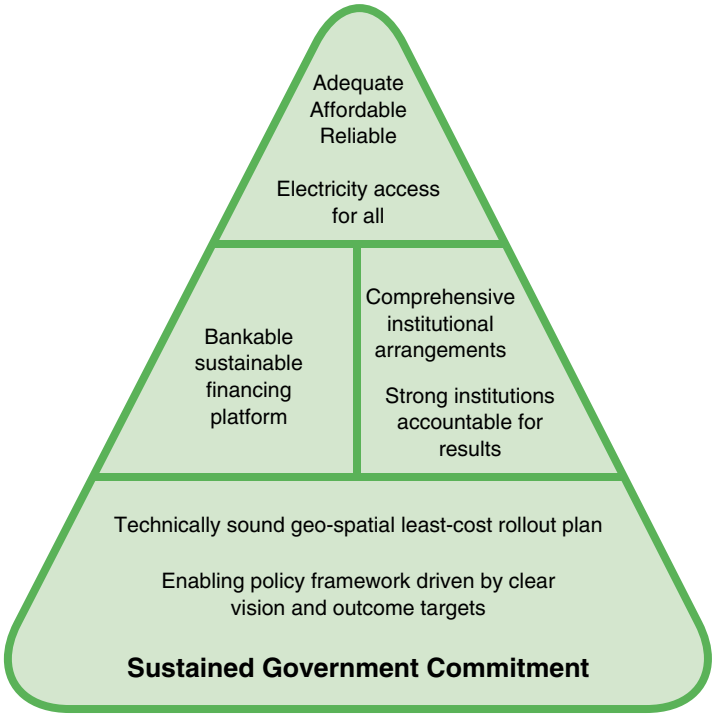
While successful national electrification programs have been undertaken in diverse country contexts and environments, they all share a few core driving principles that effectively address and strike a workable balance among the key interrelated set of challenges centrally relevant to the provision of affordable electricity access for all (Annex 2).

These are all integrated into the NEP, as well as in the broader sector-wide approach to electrification adopted by the Government, and reflect the crucial interplay of institutional, planning, technical, and financing frameworks that must all come together, and in a sustained manner, to enable the timely achievement of the connection targets established by the Government and the related development outcomes.

The driving principles are the pillars of the NEP and will be maintained throughout the years for the implementation of the program as well as across its updates:

- **Sustained Government leadership and commitment** for the duration of NEP-IRM and enabling policy frameworks. As shown in Figure 1.4, this constitutes the very foundation of the program. In GTPs I and II the Government set national electrification at the core of the development agenda of the country.
- **A comprehensive sector-wide least-cost geo-spatial connections rollout** strategy and implementation plan driven by a national development perspective, defined by grid and off-grid connection targets, and anchoring the NEP Financing Prospectus for mobilization (syndication) of financing on a programmatic basis.
- **Clarity of roles and accountability for sector performance and results** to ensure efficient and effective management and operation of the sector. While granting autonomy, the GoE will hold the key energy sector institutions and delivery agents accountable—be they public or private—for implementation progress and results, measured against annual access targets. The Minister of Water, Irrigation, and Electricity (MoWIE) and the Steering Committee will coordinate and oversee the NEP-IRM, both for the grid and the off-grid programs.
- **Ensuring financial viability** of the delivery agents on an ongoing basis over the program implementation period, while ensuring the medium-term financial health and sustainability of the sector itself.

Figure 1.4 Foundational building blocks of the NEP



Source: NEP, 2017.

- **Equity and inclusion** targeting disadvantaged groups and the poor nationwide; and due consideration to ensuring customer affordability, especially for the poor.
- **Environmental and social sustainability.**
- **Sector-wide framework and consultative processes** orchestrated by GoE, bringing together all key stakeholders under the organizing principles and architecture of "Many Partners, One Team, One Plan."

Figure 1.4 summarizes the foundational blocks of the National Electrification Program launched in November 2017. Building on these blocks, the NEP designed the physical implementation of the connections rollout—a comprehensive and coordinated program of grid and off-grid rollout—in an effective, efficient, and sustainable manner, under the organizing principles of a sector-wide approach to rally all stakeholders and development partners and syndicate financing through a bankable program.

The NEP provides a comprehensive and multidimensional implementation plan composed of four main elements that were established for the first time: (i) clear and credible targets and timetables for electricity access over the program life that are essential for realizing the broader modernization of the country, development of social services, and social

inclusion; (ii) an implementation framework with a clear definition of the roles, responsibilities, and accountabilities of sector stakeholders; (iii) a menu of technical assistance and implementation support activities immediately required for the successful kick-off of the program; and (iv) an Investment Financing Prospectus for the syndication of financing for the achievement of universal access by 2025.

The NEP-IRM also welcomes and acknowledges other sector policies adopted and efforts launched by the Government in recent years. The implementation of the program will ensure synergies whenever possible and adequately with:

Ethiopia's Climate-Resilient Green Economy Strategy (CRGE), 2011

The GoE intends to achieve the middle-income status by 2025 through the modernization and diversification of the economy, boosting agricultural productivity, and fostering exports while becoming a climate-resilient "green economy frontrunner."[14]

The expansion of electricity generation from renewable sources of energy for domestic and regional markets constitutes one of the four pillars of the green economy,[15] and the Government is committed to expanding electricity services through clean energy sources—whether grid or off-grid—to achieve the target set by 2030 of limiting the country's emissions to today's 150 Mt CO_2 (around 250 Mt CO_2 savings more than under a business-as-usual path)[16] and improve the resilience of generation capacity to weather conditions.[17]

The National Improved Cookstove Program (NICSP)

Traditional biomass currently accounts for more than 90 percent of total primary energy in Ethiopian households.[18] The NICSP constitutes a key component of the CRGE strategy to reduce the population's dependence on biomass-based fuel (firewood and charcoal) by promoting the use of cleaner cooking technologies. In 2010–2015, the NICSP distributed almost 9 million improved cookstoves in the country, and by 2020 the Government is targeting the distribution of almost 12 million extra cookstoves. Access to electricity services will lead to fuel substitution away from biomass sources, with attendant health benefits, reduced time spent on traditional fuels gathering, and mitigation of climate change and deforestation.[19]

The National Biogas Program (NBPE)

The NBPE Program was launched in 2009 and is now in its second phase of implementation with over 14,000 rural household beneficiaries of biogas digesters. Phase II targets 360,000 low-income households aimed at: (i) scaling up and expansion of the program to the whole country; (ii) consolidating public private partnership; (iii) improving access to credit; (iv) strengthening quality for improved functionality; (v) introducing new products; and (vi) supporting the pro-poor.

Notes

9. Scaling Solar is a World Bank Group holistic advisory, financial, and risk management support program for Sub-Saharan Africa, aimed at creating viable markets for grid-connected, privately owned solar PV power plants. A stringent set of technical and financial criteria is applied to bids, and a competitive bidding process is based on the offered tariff.
10. Estimates are based on consultations with EEU and investment requirements reflected into the recently approved tariff.
11. The most recent Master Plan available for the country was conducted in 2014.
12. The guiding principles of the initiative are contained in a January 2014 communiqué endorsed by ministers and heads of delegations from the EAPP and SAPP countries in Abu Dhabi.
13. Household connections have lagged behind for several reasons, including the absence of: (i) adequate coordination between UEAP and EEU and related planning, procurement, and construction works, and (ii) a programmatic approach to service delivery, as well as (iii) financial resources proportional to the new customers' targets sought and earmarked for social institutions such as schools and clinics.
14. Federal Democratic Republic of Ethiopia (2011). Ethiopia's Climate-Resilient Green Economy Strategy, Addis Ababa.
15. The remaining three pillars of the Strategy are: (1) Improving crop and livestock production practices for higher food security and farmer income while reducing emissions; (2) Protecting and reestablishing forests for their economic and ecosystem services, including as carbon stocks; and (3) Leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings.
16. Federal Democratic Republic of Ethiopia (2011). Ethiopia's Climate-Resilient Green Economy Strategy, Addis Ababa.
17. See also the Climate Resilient Strategy for Water and Electricity developed under the CRGE Strategy.
18. Johnson and Tadesse (2013). Alternative Future Pathways for Household Biomass Use in Ethiopia. Stockholm Environment Institute (SEI), Stockholm.
19. Traditional fuel consumption has been estimated to account for 46 percent of annual forest loss and, in turn, forest degradation for 37 percent of total CO_2 emissions. Federal Democratic Republic of Ethiopia (2011). Ethiopia's Climate-Resilient Green Economy Strategy, Addis Ababa.

CHAPTER 2

Integrating Grid and Off-Grid Solutions: The NEP Comprehensive Approach to Electrification

Ethiopia's National Electrification Program (NEP) builds on the latest developments and best practices emerging internationally for electrification programs. Since its first design, the NEP adopted an integrated approach to electrification, leveraging on the coordinated combination of grid and off-grid technologies for the achievement of universal access by 2025.

The baseline, targets, and timetables of the NEP, as well as the strategic vision underpinning the program, have been updated with new technical information that became available during the first year of implementation and with the acquired experience. The access baseline and targets have been updated by the Multi-Tier Framework (MTF) Energy Access Household Survey, conducted in 2017 and finalized at the beginning of 2018 with the support of the World Bank. In 2018, the digitization of the MV network and the geo-referencing of households were conducted and completed with the support of the United States Agency for International Development (USAID). Based on this key information, a high-level geospatial analysis was conducted for the whole country, detailing the location and clustering of households with respect to the existing network infrastructure, and providing an update of the electrification targets by 2025.

The MTF and Geographic Information System (GIS) tools have been combined to inform electrification targets and strategic approaches, setting Ethiopia at the vanguard in the journey for universal access. The MTF has been translated into operational uses for the first time, in support of the Government strategic shift from infrastructure development to service delivery.

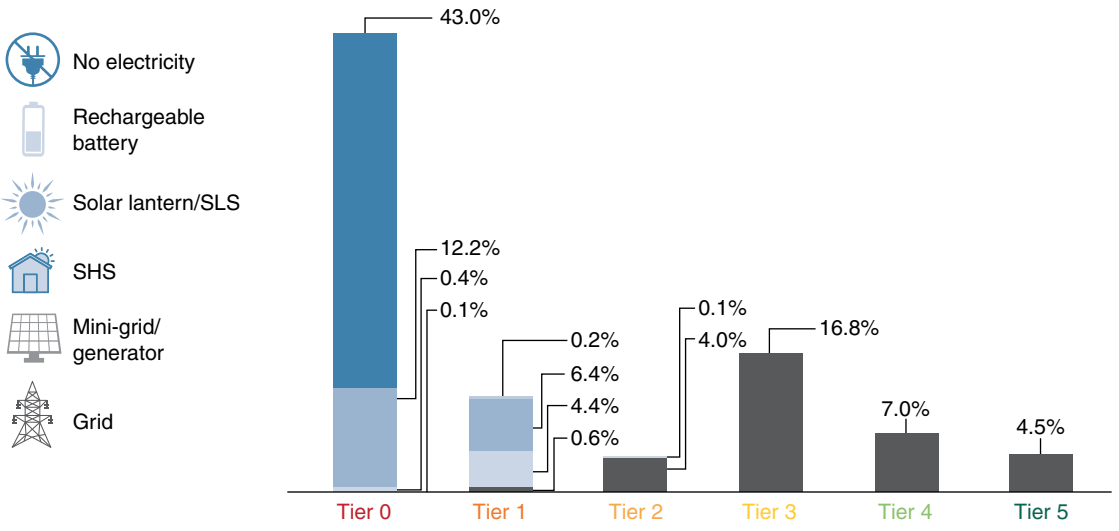
While the NEP is meant to be a living document, informed over time by implementation and technical assistance activities, the strategic vision adopted by the Government will underpin the multiyear electrification endeavors: a customer centric approach targeting beneficiaries' actual service needs, and balancing efficiency and equity in service delivery.

2.1 The access challenge

The Multi-Tier Framework (MTF) Energy Access Household Survey was conducted in 2017 across the country—in both rural and urban areas—for the development of a baseline to track progress toward the achievement of universal access,[20] and the results now constitute the baseline for access in the country. The MTF redefines energy access from the traditional binary count to a multidimensional and comprehensive definition of access and identifies the access rate based on the quantity of service available across six tiers, from a minimum of 4 hrs/day to 23 hrs/day, where Tiers 1–2 typically correspond to off-grid services, Tiers 3–5 to mini-grids, as well as to grid-based connectivity (see also Chapter 3).

The survey revealed that the access rate for the country overall is 44 percent, where 33 percent of access is provided through grid connections, and 11 percent through off-grid solutions. About 56 percent

Figure 2.1 The MTF baseline for access



Source: WB, 2018.

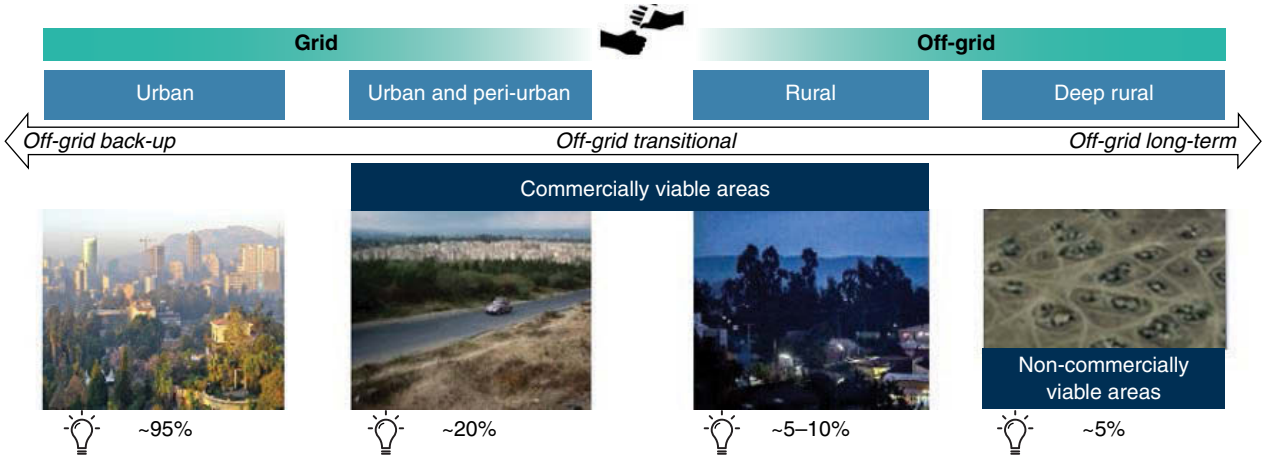
(Tier 0) of the population is currently without access to an adequate and reliable source of electricity service (including lanterns). The breakdown of these results is presented in Figure 2.1.

Whereas there are no changes in the baseline for off-grid access, for grid access the MTF indicates a higher percentage for 2017 than was initially estimated (33 percent versus the initially estimated 21 percent, based on customers registered accounts at EEU). The higher score of grid access is represented by the meter loading practice in the country, a phenomenon well known to sector stakeholders, which, however, had not been quantified until the MTF Survey. It is estimated that about 3.1 million[21] consumers have formal connections (have registered accounts at EEU), whereas about 3.7 million consumers will need to be regularized (see also Chapter 3).

Electricity access is primarily a rural challenge

As depicted in Figure 2.2, access to electricity services varies greatly across the country. At an aggregate level, about 96 percent of urban households are connected to the grid (Addis Ababa scores at 99.9 percent), whereas only 27 percent of rural households have access to electricity services, and mostly through off-grid solutions. The highest deficits are experienced in deep rural areas, with about 5 percent of access; followed by rural areas, with about 5–10 percent of access; and then peri-urban areas, with about 20 percent of access.

Figure 2.2 The access challenge, by geography



The access outlook of the country is the result of lower connectivity in rural areas. While impressive results have been achieved in a relatively short amount of time with the expansion of the transmission infrastructure (MV lines) across the country, last-mile connections have not kept pace with network expansion, which led to the Government's strategic shift from infrastructure development to service delivery under the NEP. Within a decade since its establishment (2005–2015), UEAP spread the electricity grid to about 6,000 towns and villages from the initial 667, and grid coverage reached 60 percent of towns and villages across the nation from the initial 15 percent. The number of EEU customers has also grown from 800,000 to about 2.8 million. By 2020, UEAP will provide network coverage to 90 percent of the country and to 10,000 towns and villages.

However, the geo-spatial work conducted in 2018 confirmed and further detailed the "low-hanging fruit" potential offered by the progress achieved in network extension in terms of densification connections in the short run, and grid connectivity over time. In addition, the geo-spatial analysis is informing the integrated approach to electrification adopted by the Government and further details the components of the access program. The GIS analysis builds on the support provided by USAID for the digitization of the existing MV infrastructure belonging to EEU and the geo-referencing of rooftops across the whole country.

As indicated in Table 2.1, the overwhelming majority of the country's population currently resides in areas within reach of grid expansion in the near term, and virtually all within the long term. The population within 1 km for the grid is almost 50 percent, both in 2017 and including population growth by 2025 and 2030. Similarly, the population within 5 km is estimated to be between 75–80 percent; if the radius is extended to 10 km the percentage rises to approximately 90 percent of the national population, and the percentage rises to about 95 percent within a radius of 25 km. EEU's coverage area extends up to 100 km from existing lines, and the population residing within this range is between 98 and 99 percent of the national total.[22]

Targeting beneficiaries with on- and off-grid solutions: a customer centric approach to electrification

While spatially the overwhelming majority of the population lives in proximity of existing network infrastructure, the time dimension for grid connectivity has to be factored in, as reaching out to the population residing further away from the grid, and in more scattered and dispersed areas will require longer time.

The NEP adopts an integrated approach to electrification with the simultaneous combination of grid and off-grid solutions, tailoring optimal (least-cost) technology choices by geographic location, while ensuring timely access provision and priority to disadvantaged groups and social institutions. Tackling the access challenge with the coordinated deployment of technology options allows the achievement of two important goals for the nation: (i) balancing efficiency and equity in access delivery, and (ii) maximizing the development impact of the electrification program and minimizing the time required for all Ethiopians to have access to electricity services.

Table 2.1 Population distances from existing MV lines—existing and projected, 2017–2030

Distance from Grid	2017 HH Est	2017 Pct of HH	2017 Cumul. HH	2017 Cumul. Pct	2025 HH Est	2025 Pct of HH	2025 Cumul. HH	2025 Cumul. Pct	2030 HH Est	2030 Pct of HH	2030 Cumul. HH	2030 Cumul. Pct
(km)	(thousands)		(thousands)		(thousands)		(thousands)		(thousands)		(thousands)	
< 1	8,700	44%	8,700	44%	10,500	45%	10,500	45%	11,700	46%	11,700	46%
1–2.5	3,300	17%	12,000	60%	3,700	16%	14,300	61%	4,000	16%	15,700	62%
2.5–5	3,500	18%	15,500	78%	4,000	17%	18,200	78%	4,200	17%	19,900	79%
5–10	2,400	12%	17,800	90%	2,600	11%	20,900	90%	2,800	11%	22,700	90%
10–25	1,300	6%	19,100	96%	1,400	6%	22,300	96%	1,500	6%	24,200	96%
25–50	290	1.4%	19,400	98%	330	1.4%	22,600	97%	350	1.4%	24,600	97%
50–100	160	0.8%	19,500	98%	190	0.8%	22,800	98%	210	0.8%	24,800	98%
100–200	140	0.7%	19,700	99%	170	0.7%	23,000	99%	180	0.7%	25,000	99%
> 200	190	1.0%	19,900	100%	230	1.0%	23,200	100%	250	1.0%	25,200	100%
	19,900	**100%**	**19,900**	**100%**	**23,220**	**100%**	**23,200**	**100%**	**25,200**	**100%**	**25,200**	**100%**

Source: Geo-spatial analysis of the digitized existing MV network, rooftop tagging, and woreda population estimates and projections.

Table 2.2 Grid and off-grid connection program for universal access (2019–2025)

Time Period		Total House-holds[a]	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[b]	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%

[a]Based on population assumptions derived from the geo-referencing of rooftops conducted by USAID, and CSA estimates and projections, 2017.

[b]Based on the MTF baseline.

Based on the MTF and the geo-spatial analysis, the NEP targets and timetables have been updated, as shown in Table 2.2. The integrated approach, by location and technology, maximizes the deployment of access solutions: as the grid program expands from the center to the periphery, off-grid technologies are distributed in parallel from the periphery (beyond 25 km). Off-grid access is most likely to be long term toward the grid, in a continuum where off-grid solutions will also serve quality and reliability purposes by providing backup services after the arrival of the grid.

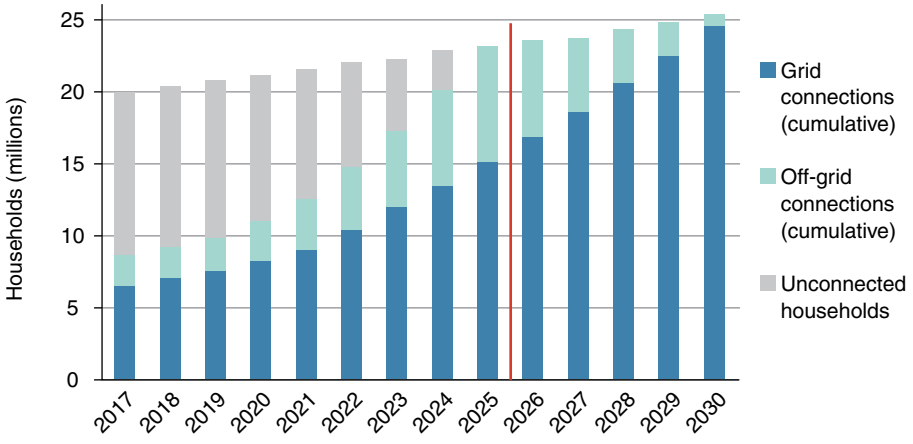
Consistent with the results of the geo-spatial analysis and the current access outlook of the country, the achievement of universal access by 2025 requires both grid and off-grid solutions. By 2025, both programs will experience a rapid acceleration to provide 8.2 million households with grid connections and benefit 5.9 million households with off-grid access. Leveraging on the spatial proximity of households to the grid (Table 2.1) and related lower cost per connection, grid connectivity will prioritize the area within 2.5 km from existing lines; whereas off-grid solutions will provide interim solutions—pre-electrification for areas between 2.5 km–25 km, and additional off-grid solutions to long-term off-grid ranges beyond 25 km.

Figure 2.3 presents the same information in graphic form. In both Table 2.2 and Figure 2.3, the red line highlights the period up to 2025 as the grid and off-grid programs rapidly ramp up to achieve 100 percent access by 2025. Between 2025–2030, the grid is expected to reach all households within a range of ~25 km from the current grid lines, progressively substituting off-grid solutions with grid connectivity. By 2030, 96 percent of access will be provided by the grid, with only a small fraction (~4 percent) remaining with off-grid service.

Components of the NEP access program

The geo-spatial analysis conducted for the country identifies the least-cost technology solution by location and over time, indicating the progressive extension of the grid footprint and simultaneously the pockets for off-grid. That is, geo-spatial tools provide a first answer in the optimal choice between location-based grid and off-grid technologies. By combining the geographic and time dimensions, the GIS analysis estimates the least-cost technology solution for the short and the long term, ensuring the design of coordinated and complementary grid and off-grid programs, where the latter also serves pre-electrification/transitional purposes.

Figure 2.3 NEP grid and off-grid connections rollout (2019–2030)



Source: Geo-spatial analysis, 2018.

The analysis builds on two main parameters: geo-referenced population and existing network infrastructure (MV lines). Based on the current accessibility of the population to the grid, that is, the degree of proximity and density of the population with respect to the existing network, the geo-spatial analysis allows to further detail and size the components of the access program under the NEP by 2025 and beyond:

A. **On grid access**—The target beneficiaries are households located within 25 km from the existing grid, corresponding to about 96 percent of the population by 2030, or about 18 million connections (including population growth). By 2025, the component of the grid program will entail the connection of about 8.2 million beneficiaries, corresponding to 65 percent of the population.
B. **Short-term pre-electrification**—While the grid is expected to be the least-cost solution by 2025, for 3.3 million households, the rollout will take up to seven years to materialize and several households (HHs) will therefore need to wait for some time before getting access to electricity services. The NEP hence acknowledges this possible segment of beneficiaries of the off-grid program, for service delivery (market based) to those communities that are expected to receive a grid connection in the latter years of the grid program by 2025.
C. **Mid-term pre-electrification**—About 5 million target beneficiaries residing between 2.5–25 km away from the existing grid, where grid connectivity is projected at least cost, may have to wait several years before they receive grid access. By 2025, the connection of the beneficiaries through off-grid technologies will contribute to 31 percent of access in the country. Given their proximity to the existing network, these beneficiaries are expected to be connected to the grid by 2030. The eventual delineation of the geo-spatial location, number, and nature of prospective beneficiaries will be determined in coordination with the scale and speed of grid developments.
D. **Long-term off-grid/deep rural**—About 1 million HHs (about 4 percent of the population by 2030) target beneficiaries located beyond 25 km from the existing grid and located in progressively remote and scattered settlements and villages that are less likely to be served in a cost- and time-effective way by grid connectivity. They may also include some homes that are not far from the existing grid, but their isolation from neighbors' settlements and transformers raises the cost of connectivity greatly. As their location is still within the mandate of EEU (100 km), some locations may eventually be connected to the main grid in the long run, beyond 2030.

Component A constitutes the grid access program for the achievement of 65 percent of on-grid connectivity at least-cost by 2025. Components C and D will be coordinated with grid developments for the achievement of the complementary off-grid access contribution of 35 percent by 2025. By 2030, it is expected that the majority of the population could be connected via the grid, with a remaining 4 percent of the population connected with off-grid solutions

(either solar off-grid or mini-grids) as a long-term access solution.

Figure 2.4 summarizes the different components of the NEP access program which are identified integrating the time and geographic dimension and inform the yearly grid and off-grid connection roll-outs by 2015.

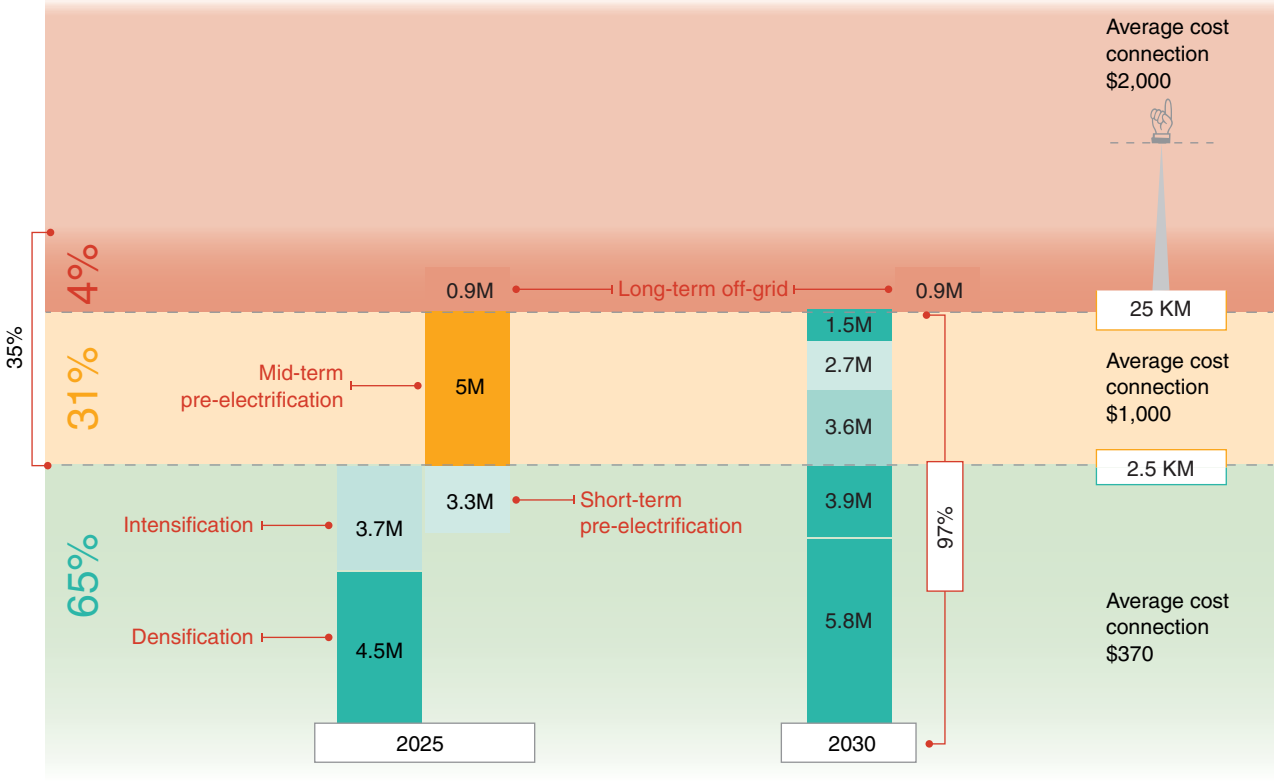
The figure indicates that by 2025:

(i) 65 percent of the population will be connected though a grid connection, and 35 percent will be candidates for off-grid solutions;
(ii) Within the grid, 4.5 million HHs are expected to be connected through low-cost grid intensification, whereas 3.7 million HHs though intensification of the existing network footprint;[23] and about 3.3 million HHs could benefit from short-term pre-electrification solutions while waiting for the grid to arrive in 2025;
(iii) Within the off-grid space, about 5 million HHs are candidates for mid-term pre-electrification while waiting for the grid to arrive after 2025 (constituting about 31 percent of the overall off-grid program for universal access); whereas the remaining less than 1 million HHs are located in areas that make them candidates for long-term off-grid solutions due to the increasing cost in grid connection and time required to reach out to those areas for the national network (about 4 percent of the NEP off-grid program).

In addition, Figure 2.4 depicts the change in the technology combination that is expected to characterize the Ethiopian landscape by 2030, which reflects the least-cost grid connectivity potential offered by the proximate location of about 96 percent of the population with respect to the existing grid:

(i) About 96 percent of the population is expected to be connected to the grid, 9.7 million through low-cost grid densification and intensification, and about 7.8 million through the grid extension required to reach out to customers residing beyond 2.5 km from the existing grid; and
(ii) The extension of the grid progressively substitutes off-grid technologies employed for pre-electrification (which can then become backup solutions in case of unreliable service and more broadly complement grid connectivity), leaving only less than a million HHs with

Figure 2.4 Integrated electrification for universal access: grid and off-grid connectivity



long-term off-grid solutions, or about 4 percent of the overall population by 2030.

The detailed technical parameters and implementation framework for the grid and off-grid programs under the NEP are presented in Chapters 3 and 4, respectively.

Social institutions and productive uses

Ethiopia's NEP goes beyond being a household connections program, be it on- or off-grid. To maximize the development impact of electrification, the implementation of the NEP takes into account building linkages with the Government's other development programs, and with key social services delivery sectors with a targeted focus on health, education, and income generating activities, in support of commercial agriculture development and overall nationwide economic growth.

Therefore, detailed planning and implementation of service delivery will be coordinated with relevant ministries and on the basis of further in-the-field assessments required to adequately estimate the demand associated with different education and health service providers and existing and potential economic centers (see the technical assistance and program implementation support activities detailed in Chapter 4). The more granular identification of related locations of these demand loads will also further inform and detail technology options, including over time.

Depending on their location, social facilities, both schools and clinics, may therefore receive grid connection by 2025, off-grid transitional solutions (through solar off-grid or mini-grids), or constitute a long-term off-grid beneficiary. Similarly, areas with high potential for economic growth may justify a priority grid connection or be adequately served by transitional or long-term off-grid solutions, such as with mini-grids. Both programs and their potential are presented in Chapter 4.

2.2 Targeting electricity services by demand location

The integrated approach to electrification planning and service delivery adopted by the Government is also reflected in the combination of GIS and MTF tools, which reflects the customer centric vision at the core of the NEP. Indeed, both the GIS tools and MTF survey respond to a bottom-up approach to access. GIS allows for identifying where people are located and how to most efficiently and effectively serve them over time. The MTF also reflects the strategic driver of "putting people first" by moving away from a binary count to access (have and have nots) to a multidimensional one focused on the amount of services received, and what could be powered with it in terms of human and economic activities.

The MTF comprehensive approach to service delivery defines access as "the ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy, and safe for all." The MTF looks at electricity access "beyond connections," locating at its center the end-user perspective on electricity services, that is, what is electricity going to be used for, depending on how much service is provided (Figure 2.5). In other words, the MTF looks at electricity as an intermediate factor, not an end goal in itself, thereby incorporating the human and economic development dimensions to service delivery.

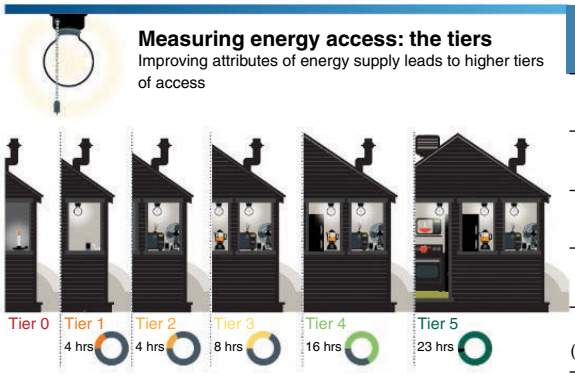
The MTF survey identifies the access rate based on the quantity of service available across six tiers (0–5), from a minimum of 4 hrs/day to 23 hrs/day, where Tiers 1–2 can be associated with off-grid services, Tiers 3–5 to mini-grids, as well as grid-based connectivity,[24] although fast-paced technology advances are making the boundaries between tiers more and more blurry (Figure 2.5).

The MTF presents several advantages for electrification targeting by:

(i) Decomposing the access challenge in terms of quantity of services available and needed for the achievement of grid and off-grid targets—hence allowing for more granular targeting of beneficiaries, as well as monitoring of progress;
(ii) Allowing for policy decisions over the minimum tier of access for beneficiaries, particularly those benefiting from public financial support (e.g., not factoring lanterns distribution as access expansion);
(iii) Having another metric for tracking and monitoring adequacy, quality, and reliability of services, particularly for grid-based connections; and
(iv) Supporting a framework for targeting of technologies by location of service need with the inclusion of demand estimates.

The MTF survey was the first comprehensive data gathering on access to electricity services conducted in the country with a multidimensional nature. Through the tiers approach, it allowed to supplement

Figure 2.5 The MTF tiers for access to electricity with load levels, indicative electric appliances, and associated capacity tiers



Load level	Indicative electric appliances	Capacity tier typically needed to power the load
Very low load (3–49 W)	Task lighting, phone charging, radio	Tier 1
Low load (50–199 W)	Multipoint general lighting, television, computer printer fan	Tier 2
Medium load (200–799 W)	Air cooler, refrigerator, freezer, food processor, water pump, rice cooker	Tier 3
High load (800–1,999 W)	Washing machine, iron, hair dryer, toaster, microwave	Tier 4
Very high load (2,000 W or more)	Air conditioner, space heater, vacuum cleaner, water heater, electric cookstove	Tier 5

Source: ESMAP/WB, 2018.

and complement EEU customer accounts, gather further and more granular information about the reliability and quality of grid services, and shed light on the current penetration—formal and informal—of off-grid technologies, as well as on the willingness and ability to pay by rural and urban households with respect to different tiers of off-grid service (discussed more in detail in Chapter 4).

The results of the MTF survey are presented in more detail in Annex 3. The findings for each of the attributes of access, that is capacity, availability, reliability, quality, affordability, formality, health, and safety, as well as the gender analysis, have all further informed the sector-wide approach of the Government and specific interventions, and technical assistance and implementation support activities, as well as investment requirements for the successful implementation of the electrification program over the years. More specifically, the information on willingness and ability to pay have been factored into the implementation framework of the off-grid program—and a related focus on PAYGo payment models—and the sizing of the public subsidy program in support of the poorest of the poor to ensure equal access to electricity services.

Combining GIS and MTF for electrification targeting

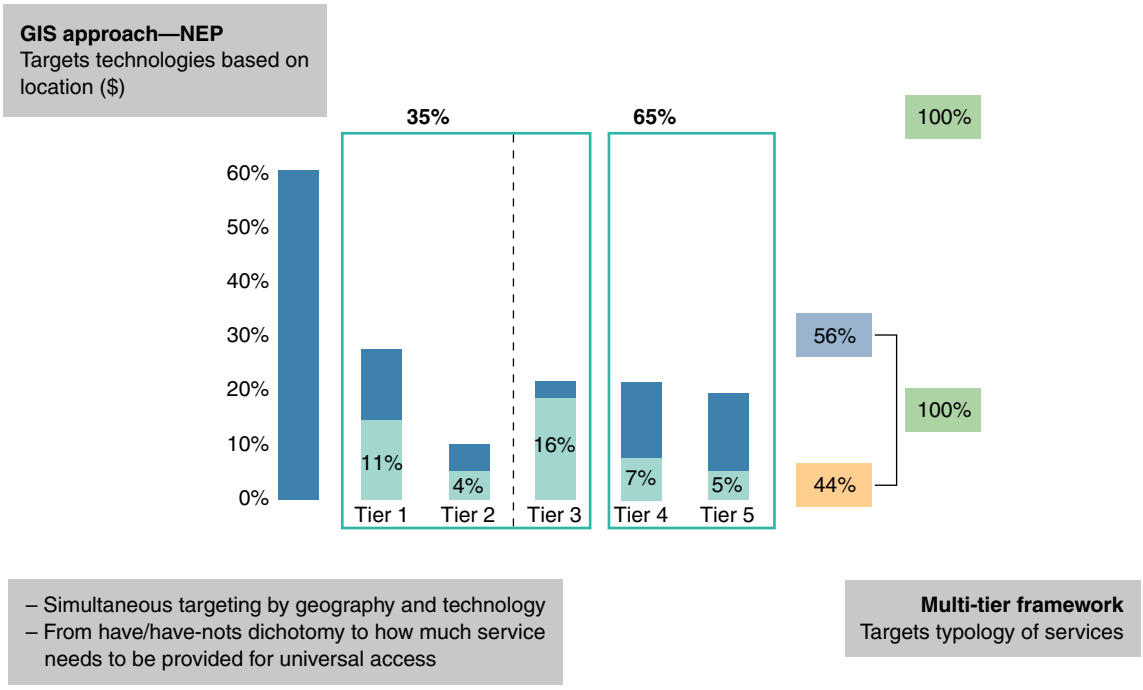
Whereas GIS tools allow to identify "where," "what kind" of technologies (grid versus off-grid), and "when" they are least cost, the MTF approach supports the identification of "how much service" is needed to achieve the grid and off-grid targets. Combined, they allow for simultaneously targeting beneficiaries by location and service, moving away from a dichotomic approach to access of electricity service (haves versus have-nots) to a more service centric approach, which sets at its center how much service need is to be provided and where, in order to achieve universal access. In addition, the combination of these two instruments supports a data driven approach to electrification, balancing efficiency in the use of resources, with equity.

More specifically, GIS tools support the identification of the least-cost technology solution—in space and time—for meeting the service needs of the population; while the MTF simultaneously breaks down the targets for grid and off-grid target beneficiaries by tiers of service needs. That is, their combination identifies:

- Beneficiaries, by location;
- The optimal technology solution in the short, medium, and long term, by location; and
- A framework for provision of off-grid services based on local needs (demand) guiding the implementation of the NEP, by location.

Figure 2.6 depicts the universal electrification goals of the Government in a different fashion. The 65 percent of on-grid and 35 percent of off-grid access have been validated with more detailed information coming from the GIS analysis[25] and have been integrated with the MTF approach. Through the MTF, the targets for both grid and off-grid access can now be broken down through tracking of progress across service levels, where Tiers 1 and 2 approximately correspond to off-grid solar solutions, and Tiers 3–5 to mini-grid or grid connectivity.

Figure 2.6 MTF-based policy framework for access to improved services



The combined adoption of GIS tools and the MTF approach breaks down the grid and off-grid targets in tiers, or hours of services, and therefore, into more detailed targets. This has added value, particularly for the off-grid program, as it drives the combination of local demand (kWh) with related technology costing (US$/ETB), for Tiers 1–3.

The implementation framework for demand estimates

The MTF survey has disclosed that the majority of off-grid access currently consumed by the Ethiopian population is through off-grid solar lanterns that are typically used for one lightbulb and mobile charging. For the time being, the implementation of the NEP and the achievement of the targets will, however, adopt the definition of access provided by the MTF, which only recognizes lanterns as a fraction of minimum tier of service. At the same time, the implementation of the electrification program will reflect rapid technology changes that are characterizing the off-grid market and adapt to them with flexibility, as the focus of servicing beneficiaries is not determined by the technology, but by the level of service that can be provided.

Serving the population based on current and projected demand—including its activation and stimulation—is a key factor for the efficient and effective rollout of off-grid connectivity. As detailed in Annex 3, demand estimates have more and more become the focus of electrification planning across SSA, particularly as they serve the following purposes:

(i) Ensuring the integration of top-down electrification planning with bottom-up information, that is, actual service needs of the population, by geographic location;
(ii) Efficient targeting of technologies, avoiding either over- or under-planning for electricity access; and
(iii) Translate into implementation mechanisms the integration of service needs and their tier related correspondence.

The estimation of demand needs has been integrated into the implementation of the off-grid program, and information gathering will leverage on the mandate of Regional Energy Bureaus (REBs) and on the interest of private sector companies in collecting and monitoring information about perspective and actual customers (detailed in Chapter 5).

Moving forward, the Government recognizes the key role that the Central Statistical Agency (CSA) could play for the further detailing of demand assessments and their sustainability over time. In fact, CSA is currently conducting the census[26] and for this purpose, it has geo-referenced the whole population across the

country. Combined census and location information will allow for further detailing and increasing sophistication of the NEP program.

Monitoring and evaluation of the NEP program

Both GIS and MTF state-of-the-art tools are also being integrated into the NEP monitoring and evaluation system, allowing for progress tracking across the country and map visualization, which is further described in the section below as well as in Chapter 5.

2.3 Implementation support for integrated planning

Table 2.3 summarizes the list of priority interventions for 2019 for the establishment of adequate integrated planning and implementation capacity. These activities will support of the identification of the least-cost technology solution for different segments of priority beneficiaries in the country (e.g., safety net recipients, social institutions, productive uses for economic growth) and the coordination, monitoring, and quality supervision of grid and off-grid activities.

Combined, these interventions will comprehensively address integrated planning and implementation capacity and provide the immediate and key policy, operational, regulatory, and monitoring tools for the efficient and effective performance in grid and off-grid connection scale-up.

All of the activities are targeted for completion by 2019, and will inform implementation from 2020 onward (with the exception of sector-wide capacity building, which will be undertaken throughout the years of implementation), and build on the progress achieved in terms of implementation and completion of technical assistance and program implementation support, either completed in 2018 (activities that were prioritized under the first version of the NEP), or ongoing.

1. Nationwide geo-spatial least-cost rollout plan. The geo-spatial least-cost plan will identify the optimal modality (grid and off-grid) for access provision, taking into account technical and economic viability, geo-referenced demand centers, and load forecasts. The GIS least-cost plan will update the NEP yearly rollout plans and targets and related financing requirements and gaps for both the grid and the off-grid program. The development of a least-cost rollout plan for the country, further detailing the sequenced cost segmentation of connections rollout, will also inform the update of the Master Plan for the power sector (see Chapter 3) and the tracking and monitoring of NEP implementation. In addition, it will provide more granular information about the location of off-grid pockets of beneficiaries and mini-grids potential sites, increasing the detail of the geo-spatial analysis already conducted for the country.

2. Nationwide demand estimates and modeling and expenditure assessment. Demand estimates (residential and commercial/industrial) are the most critical modeling parameter affecting modeling and electrification planning, from geo-spatial least-cost plans, to overall power sector planning. This is because demand (load) fundamentally impacts investment requirements across the power sector value chain. Upstream, demand influences investments for adequate available generation capacity, transmission wheeling, voltage fluctuations, and reliability of supply. Downstream, demand affects the relative cost-effectiveness of various technologies with very different balances of initial and recurring costs and informs system absorption and expansion capacity and related investment needs. To improve demand estimates across the country and update/inform the power sector Master Plan, least-cost plans, and further detail public support for affordability of grid and off-grid services, the MTF survey will be expanded to increase the sample size and in synergy with the ongoing census conducted under the leadership of CSA. The consultant(s) will also, in collaboration with EEU, analyze the customer consumption time series and develop a demand estimate model for grid connected users across the consumption brackets, to inform demand projections for nonconnected ones. The time series from EEU customers will also be analyzed for demand modeling, particularly for low-income HHs, to understand grid consumption patterns. The analysis will be conducted on an ongoing basis to ensure sufficient and progressive data gathering, including its geo-referencing, and in synergy with the targeted analytics to be conducted for specific segments of the population (as described below).

3. Generation, transmission, distribution master plan—GIS informed. Carrying out a detailed survey and technical design for the construction of distribution lines (33 kV and 0.4 kV), and installation of the distribution substation (33 kV) is necessary to support the rollout of connections under the program and the NEP up to 2025 and beyond. The assignment includes a detailed measurement survey for the purposes of land acquisition, compensation, and the land use along the Right of Way (RoW). Based on the above, a detailed investment prospectus for adequate network capacity will be developed, in synergy and integration with related

studies planned in the same time frame, for upstream investment requirements in collaboration with EEP. In close collaboration with EEP, the study will lead to the adoption of an integrated least-cost plan for the sector encompassing generation, transmission, and distribution investment requirements, as well as will support other power sector goals (e.g., exports). The investment assessment and sector-wide planning will also integrate the network GIS information collected in 2018 and expand asset geo-referencing to the extent required for adequate asset management and dynamic integrated planning. The updated Master Plan will also be informed by the demand estimates and affordability study to be conducted for the whole country for the geo-referencing of loads and understanding of customers' consumption behavior.

4. Social institutions priority connection implementation design. A detailed design and operational implementation strategy for the achievement of the NEP grid and off-grid targets for the universal social facilities connection program is planned by 2025. The consultant will complete the geo-referencing of social facilities (schools and clinics) in collaboration with the Ministry of Health and Education to ensure the integration of geo-referenced information into their management information system (MIS). In addition, the consultant will undertake a detailed dimensioning of key end-uses that require electricity for service delivery (cold chain, simple vaccine and medicine refrigeration, lighting, and sterilization), and an assessment of the current performance of electricity services provided, whether grid or off-grid, and the upgrading required at existing facilities classified as having some access. For off-grid solar powered facilities, the assessment will include power equipment and maintenance standards and provide options for standardized solar packages appropriate for supporting service delivery and informed by the United Nations International Children's Emergency Fund (UNICEF), the World Health Organization (WHO), and other appropriate guidelines. The consultant will also assess the 10,000 water supply points identified for the development of, e.g., water pumps. Finally, the consultant will work with counterparts in the Federal Ministry of Education or Ministry of Health, as well as with MoWIE and EEU. The study is planned to be completed by the end of 2018, in time to inform the detailed ground level design and rollout plans for implementation post mid-2019 onward. It will build upon available geo-spatial data, including the geo-spatial mapping of social institutions and any geo-referenced assessments already conducted by REF, Ministry of Health or Ministry of Education, and MoWIE. In particular, one output of the study will inform recommendations for the adoption of uniform service standards for social institutions and improved coordination among ministerial and Development Partners programs.

5. Safety net beneficiaries priority connection implementation design. Within the context of consultations and data gathering for the NEP, the Ministry of Agriculture has launched an effort to collect information about access to electricity services as well as electricity needs. The consultant will support MoWIE and the Ministry of Agriculture in finalizing the data gathering required for the sizing and design of an implementation program for priority access provision for safety net beneficiaries. The consultant will support in the identification of the least-cost technology solution based on geography, while balancing priority targeting. In addition, the consultant will support in the detailed design of an implementation program for safety net beneficiaries, taking into account the opportunities offered by the existing safety net-cash transfer-public infrastructure in place. The safety net program has also been successfully launched and intends to expand a mobile payment mechanism for the transferring of the subsidy. Anecdotal evidence indicates that safety net beneficiaries are currently using part of the cash received to purchase kerosene as the main copying mechanism for lack of grid or off-grid connectivity, which could be redirected toward payments for clean, reliable, and increased quality technology solutions. The consultant will size the potential additional subsidies required in these areas for affordable access provision, factoring the current practice of community work as an eligibility criterion for receiving public financial support.

6/7. Productive uses rapid assessment and detailed implementation design. In collaboration with the Ministry of Agriculture and EEU, a rapid assessment of productive uses demand centers for identification of the fastest while least-cost technology solution to support productive uses—starting from, but not limited to, agriculture—and economic growth will be undertaken. The assessment will be conducted to also identify priority sites for mini-grid developments. The rapid assessment will be followed by a nation-wide study to identify entrepreneurial sites across the country to be supported in their development by a priority targeted electricity access program. The assessment and the study will identify the demand associated with economic activities (existing or to be supported) and the ecosystem interventions required (see also Section 4.9), including

affordable access to appliances. The collaboration with the Ministry of Agriculture will also include the identification of possible synergies to be built on for leveraging farmers' distribution channels of goods (e.g., fertilizers).

8. Communication and educational campaign. The consultant will support the Government in the design of a multimedia (radio, newspapers, text, pamphlets) campaign to raise awareness about the universal electrification goals. The campaign will include adequate communication of off-grid technologies, including rights and duties of end-users and available grievance mechanisms, use of technologies after the grid arrival, uses of electricity and available appliances; and support expectation management on the grid or mini-grid arrival.

9. Comprehensive performance tracking and monitoring system. Monitoring of key performance indicators for efficiency, effectiveness, and progress against the NEP grid and off-grid targets and for course adjustments as and when appropriate by relevant actors (e.g., EEU, DoE, other ministries is planned). The system will include regular reporting (e.g., quarterly and annually) of program progress, analysis of impacts, and the creation of a performance-based dashboard with inputs from relevant ministries (e.g., Health and Education), and appropriately interface with GIS information and the MIS. The consultant will provide the software needed and work in close collaboration with the DoE and EEU for the design of the monitoring and tracking system. The monitoring system will integrate a tracking system for off-grid technologies and, combined with the GIS infrastructure to be established under EEU, will allow for an integrated visual progress monitoring of the NEP program. The GIS-based M&E tracking platform will not only support tracking the location of off-grid technologies, but will include information provided by PSEs on customer management, to also inform the grievance redressing and licensing mechanisms and overall quality of off-grid services. The establishment of the platform will be conducted in partnership with PSEs, and host cross-sectoral information (e.g., social facilities, water points, and productive uses centers) for the establishment of a Spatial Development Infrastructure (SDI), (see also Section 5.5).

10. Sector-wide capacity building. Training and capacity building across sector institutions, including MoWIE (DoE and REF), REBs, woreda administrations, EEU, and EEA for the successful implementation of the NEP and establishment of an enabling environment for grid and off-grid connections rollout will be instigated. Capacity building activities for DoE will include program and financial management, procurement, and M&E, as well as verification, and will strengthen the capacity of the new staff in DoE to effectively administer the NEP on a day-to-day basis and support the work of the Steering Committee. With the shift in focus toward electricity service delivery, capacity building may be required for EEU to support its ongoing efforts tailor aimed at optimizing its commercial processes and reengineering of policies and business process with a focus on service quality.

Capacity building will be launched in 2019 on the basis of the immediate and key needs identified for the prompt achievement of universal access by 2025. Capacity may be required to improve coordination across ministries and improve the detailing of the implementation mechanisms under the NEP to ensure priority access to vulnerable groups and in support of productive uses. Further, capacity building will support the strengthening of the DoE day-to-day monitoring and oversight of the electrification program in synergy with power sector developments.

Table 2.3 Summary of immediate priority technical assistance and capacity building support activities for the implementation of the NEP integrated approach to service delivery, 2019

	Activity	Scope	US$Million	Leading Agency
Integrated planning	1. Nationwide geo-spatial least-cost rollout plan	Optimal modality (grid and off-grid) for access provision, taking into account technical and economic viability, geo-referenced demand centers, and load forecast. The plan will update the NEP connections rollout and investment prospectus.	Ongoing	DoE, EEU
Demand estimates and affordability	2. Nationwide demand estimates and modeling and expenditure assessment	Data gathering on nationwide demand and expenditure for electricity and coping mechanisms through expansion of the MTF survey and EEU customer data. Data gathering will inform demand modeling as an input for the Master Plan and the implementation of the grid and off-grid programs under the NEP. The study will also further inform the design of the connection policy and provide input parameters for the Master Plan.	3	DOE, EEU
Integrated planning	3. Generation, Transmission, Distribution Master Plan	Integrate sector-wide Master Plan, GIS informed. The updated Master Plan will also be informed by the demand estimates and affordability study to be conducted for the whole country for the geo-referencing of loads and understanding of customers' consumption behavior.	Ongoing	DoE, EEU
Human capital development	4. Social institutions priority connection implementation design	Finalization of geo-referencing of education and health institutions and assessment of electricity needs for service delivery (cold chain, simple vaccine and medicine refrigeration, lighting, sterilization), and of quality and reliability of current services. Design of least-cost access program for timely and equitable provision pf adequate access to electricity services to the social infrastructure in the country.	1	DoE
Human capital development	5. Safety net beneficiaries priority connection implementation design	Assessment of access needs among beneficiaries of the PSNP program and design of a tailored least-cost access plan, including technology options and implementation mechanisms.	2	DoE, EEU, in collaboration with the Ministry of Agriculture
Human capital development	6. Productive uses rapid assessment	Rapid assessment of productive uses location and electricity needs to inform the design of mini-grid sites for piloting of the mini-grid program.	0.5	DoE, EEU, in collaboration with the Ministry of Agriculture
Human capital development	7. Productive uses detailed priority implementation program design	Nationwide assessment of productive uses locations and electricity service needs. Identification of least-cost technology solutions in space and time for the adequate support to economic growth. The study will include a focus on barriers faced by female entrepreneurs.	1	DoE, EEU, in collaboration with the Ministry of Agriculture
Citizen engagement and awareness raising	8. Communication and educational campaign	Design and launching of a consumer awareness and education campaign on grid and off-grid technologies, expected timing for grid connection, rights and duties of end-users, and available grievance redressing mechanisms.	1	DOE, EEU, in collaboration with REBs
M&E	9. Comprehensive performance tracking and monitoring system	Establishment of a GIS informed platform for monitoring of key performance indicators for the grid and off-grid electrification programs. KPIs include tracking of efficiency, effectiveness, and equity of the NEP.	2	DoE, in collaboration with EEU and PSEs
Capacity building	10. Sector-wide capacity building	Training, capacity building, and financial support to sector stakeholders for the implementation of the NEP grid and off-grid programs and establishment of an enabling policy, regulatory, institutional enabling ecosystem. Includes day-to day administration of the NEP, EEU grid and off-grid implementation capacity, EEA regulatory support.	15	
	Total		**25.5**	

Notes

20. World Bank/ESMAP. 2018. Ethiopia. Beyond connections. Energy Access Diagnostic report based on the Multi-Year Framework, Washington D.C.
21. Based on EEU officially reported information.
22. Population numbers were calculated based on the nationwide rooftop tagging conducted by USAID and population estimates and growth projections provided by the Central Statistical Agency (CSA).
23. Based on network capacity, taken into account by the integrated master plan under development to ensure adequate power supply across the country.
24. To some extent this is a simplified framework for looking at access delivery through the tiers' lengths as, for instance, grid services could belong to Tier *q* if less than four hours of service are provided per day. However, the framework identifies the different technology associated on average with the hours of services provided and identified by the tiers. Similarly to the grid, depending on the quantity of service provided a day, mini-grids can fall into different access tiers, which for simplicity are considered here as mostly belonging to Tier 3 and part of the off-grid program.
25. The geo-spatial analysis conducted for the design of the implementation framework for the NEP is being further detailed with least-cost algorithmic modeling to further inform the cost associated with grid rollout sequencing, which will in turn inform network design.
26. Expected to be finalized by the end of 2019.

CHAPTER 3

The Grid Program

Ethiopia's National Electrification Program (NEP) constitutes the Government's action plan for *achieving universal electricity access nationwide by 2025 (with a focus on the first stages of implementation, 2019–2023)*[27] through combined grid and off-grid connections. It also includes a targeted program component for social institutions such as schools, clinics, and productive uses, including the industrial parks' Government program and support of the development of micro, small, and medium enterprises (MSME) and agri-processing.

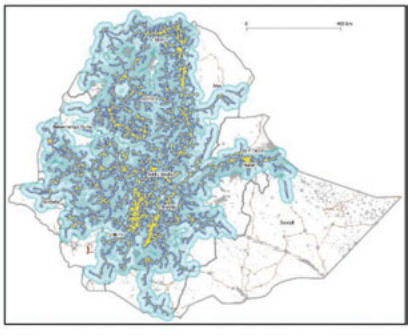
By 2025, grid access will provide electricity services to 65 percent of the population. To further inform and support the achievement of the target, the NEP has been updated by the geo-spatial analysis conducted in 2018, and the results of technical assistance activities, as well as the experience acquired during the first year of implementation of the NEP. In 2019, a nationwide GIS least-cost connections rollout plan will be finalized and provide a more detailed optimal sequencing of connections with associated costing.

The NEP grid program also accounts for the activities conducted over the year and the progress achieved. It also identifies the immediate program implementation support and technical assistance activities required for the second year of implementation of the NEP program.

The NEP least-cost rollout strategic plan (Tables 3.1 and 3.2) is underpinned and informed across Ethiopia by two defining metrics of the spatial distribution of population clusters:

- Currently, EEU provides connections to customers within 100 km from a substation ("grid radius"). Around 95–96 percent of the current and future national population (by 2030) is estimated to reside within 25 km of existing grid lines and so will be most cost effectively served by grid expansion over the medium to long term.
- More importantly, as shown in Figure 3.1, the population within 5 km from existing lines is estimated to be between 75–80 percent, and 90 percent of the population resides within 10 km from existing lines. Electrification programs and utilities in most communities within 5 km of existing grid lines would be considered as targets for grid expansion within the short term, and a 10 km distance from the existing grid is considered in close range to the grid.

Figure 3.1 Population within 2.5 km (dark blue, 65 percent) and 25 km (light blue, 96 percent) from existing grid



Distance from Grid	2017 HH Est	2017 Pct of HH	2017 Cumul. HH	2020 HH Est	2020 Pct of HH	2025 HH Est	2025 Pct of HH	2030 HH Est	2030 Pct of HH
< 1 km	8,677,338	44%	44%	9,350,481	44%	10,516,316	45%	11,724,019	45%
1–2.5 km	3,284,656	17%	60%	3,459,962	16%	3,735,663	16%	3,986,267	16%
2.5–5 km	3,507,734	18%	78%	3,691,820	17%	3,977,267	17%	4,229,794	17%
5–10 km	2,357,113	12%	90%	2,472,932	12%	2,648,552	11%	2,797,772	11%
10–25 km	1,272,349	6.4%	96%	1,335,698	6.3%	1,431,270	6.2%	1,511,760	6.0%
25–50 km	286,203	1.4%	98%	301,735	1.4%	325,557	1.4%	346,376	1.4%
50–100 km	163,022	0.8%	98%	174,538	0.8%	193,080	0.8%	210,775	0.8%
100–200 km	141,217	0.7%	99%	151,416	0.7%	167,714	0.7%	183,155	0.7%
> 200 km	190,449	1.0%	100%	204,928	1.0%	228,510	1.0%	251,382	1.0%
	19,880,083	**100%**	**100%**	**21,143,509**	**100%**	**23,223,929**	**100%**	**25,241,301**	**100%**

The NEP grid program is designed to leverage the substantive extension of the grid infrastructure achieved by the UEAP program over the past decade, the plans for further extension, and the advantage offered by the proximity of the overwhelming majority of the population to the existing network infrastructure. The positive correlation between existing grid and population location offers a unique opportunity to provide grid connections at least cost over the next years, for the achievement of 65 percent of grid access by 2025 but also beyond.

3.1 Least-cost staged program of grid capital expenditure (2019–2030)

Based on the GIS mapping of existing grid infrastructure, geo-referencing of building and statistical growth projections provided by CSA, the MTF new access baseline for 2017, and technical costing information provided by EEU, Table 3.1 provides the buildup differentiated by the spatial distribution of household segments.

The overall capital expenditure (capex) for the grid rollout (medium and low voltage lines and final connections, excluding upstream costs of generating and transmission) program—providing universal on-grid access through densification and expansion by 2030—is estimated at about US$11.5 billion, at an average capex cost of US$650 per household for a total number of 17.5 million household connections.

Based on the available technical reports, four customer segments with corresponding costing are identified under the NEP, with related weight within the overall electrification program by 2030. The different component and related costing reflect the location of currently unconnected HHs with respect to the existing grid infrastructure:

Connections in need of regularization—meter loading is a well-known phenomenon in Ethiopia, which was quantified for the first time to amount to about 3.8 million HHs.[28] These HHs have been identified as the difference between the customer accounts reported by EEU in 2019 (3.1 million HHs), and the number of HHs with grid access identified by the 2017 MTF survey and new access baseline (6.6 million HHs) plus the 300,000 connections achieved in 2018 (for a total of 6.9 million HHs). These customers are currently paying for the electricity consumed but are unmetered and often connected through unsafe service drops. Based on EEU estimates, the individual cost of regularization amounts to US$100. The overall cost of the regularization program is US$3.8 million. Regularization will be part of the on-grid targets by 2025 (Table 3.2).

Densification—within 1 km from the existing grid,[29] where about 6 million HHs will be located by 2030. These households will only require mostly low voltage (LV) network-related capital expenditures—such as service drops, household metering, and possibly shared pole top transformers. About 6 million HHs are or will be located within 1 km from the existing grid and the average connection cost is US$222, ranging from the cost of a connection drop only to a limited LV network. The overall cost of the densification program is about US$1.3 billion.

Intensification between 1–2.5 km from the existing grid, where about 4 million households will be located by 2030. These households will also require some limited MV extension for an average cost per connection of US$600 and an overall cost of the "proximate" extension program at about US$2.3 billion.

Extension—ranging from 2.5 and 25 km from the existing grid serving almost 8 million HHs by 2030. These households are located farther away from the existing infrastructure and will therefore require incremental MV lines for an average cost of US$1,000 per connection, where connection costs range from US$900–1,300 depending on the location of households. The overall cost of the grid extension program is less than US$8 billion dollars.

The update of the technical analysis for the NEP based on improved data on customer connection and location confirms and further informs the electrification access program in the country. While connections in need of regularization are quantified for the first time, the practice of "meter loading" has been well recognized by the Government and the utility and incorporated into the shift to a programmatic approach to electrification, embedded in the first NEP, as these are households that could not in the past afford to pay in advance for the cost of connection. By itself, the regularization of these connections constitutes about 23 percent of the electrification program. Through the NEP programmatic approach to electrification and improved coordination between UEAP and EEU (now the same institution), large efficiency gains have already been experienced in the provision of connections. This has been accomplished by moving away from the provision of a single connection at a time to a systematic approach benefiting from economies of scale and higher cash inflows.

Components A and B of the access program, densification and intensification requiring mostly LV and limited MV, constitute half of the overall grid electrification program by 2030—or 56 percent—where

Table 3.1 Grid capital expenditure (capex)—least-cost staged program, by 2025 and 2030

HH Segments	Spatial Proximity to the Grid	US$/Connection	2025		2030	
			Number of HHs (million)—Cumulative[a]	Estimated Capex (US$billion)	Number of HHs (million)—Cumulative[a]	Estimated Capex (US$billion)
A. Densification (mostly LV)	≤1km	US$222	4.5	US$1	5.8	US$1.3
B. Intensification (mostly LV + some MV)	1–2.5 km	US$600	3.7	US$2.2	3.9	US$2.3
Subtotal A + B	Average cost/ connection	US$370	8.2	US$3.2	9.7	US$3.6
C. Grid extension (MV)	2.5–5 km	US$900	3.2	US$2.8	3.6	US$3.1
	5–10 km	US$1,000	2.5	US$2.5	2.7	US$2.7
	10–25 km	US$1,300	1.4	US$1.8	1.5	~US$2
Subtotal C	Average cost/ connection	US$1,000	7.1	US$7.2	7.8	~US$7.9
Total A + B + C	Average cost/ connection	US$650	15.3	US$10.4	17.5	~US$11.5

Note: Order of magnitude estimate, not including: (i) capex for MV network strengthening and reinforcements in all 15 regions necessary to enable densification of customer connections (i.e., network capacity); (ii) transmission investments for adequate and reliable transfer capability; (iii) capex required/payment obligations for increased generation capacity; (iv) for the off-grid program rollout; and (v) the cost of Technical Assistance necessary for strengthening institutional capacity directly linked to facilitate and support the achievement NEP implementation targets (DoE, EEU, as well as off-grid program implementing agents and key intermediaries).

[a]Includes population growth through 2030. Central Statistical Agency census data (2017) and location of households based on rooftop tagging (USAID, 2018) and the Center for International Hearth Science Information Network—CIESIN (2018). Assumes HH sizes ranging between 3.3 and 6 people per household. 2017 population: Numbers are rounded.

grid extension amounts to the remaining 44 percent. Component A is also the single biggest element of the access program with 34 percent of contribution at the lowest unit cost of US$222 (component C—extension is subdivided in several connection costs, as shown in Table 3.1). Together, component A and B represent the most "proximate" connection potential, serving about 10 million HHs by 2030, at the average cost of US$370, where the remaining 8 million HHs, including population growth, will be served by grid extension at an average cost of US$1,000 for a total of about 18 million HH connections by 2030.

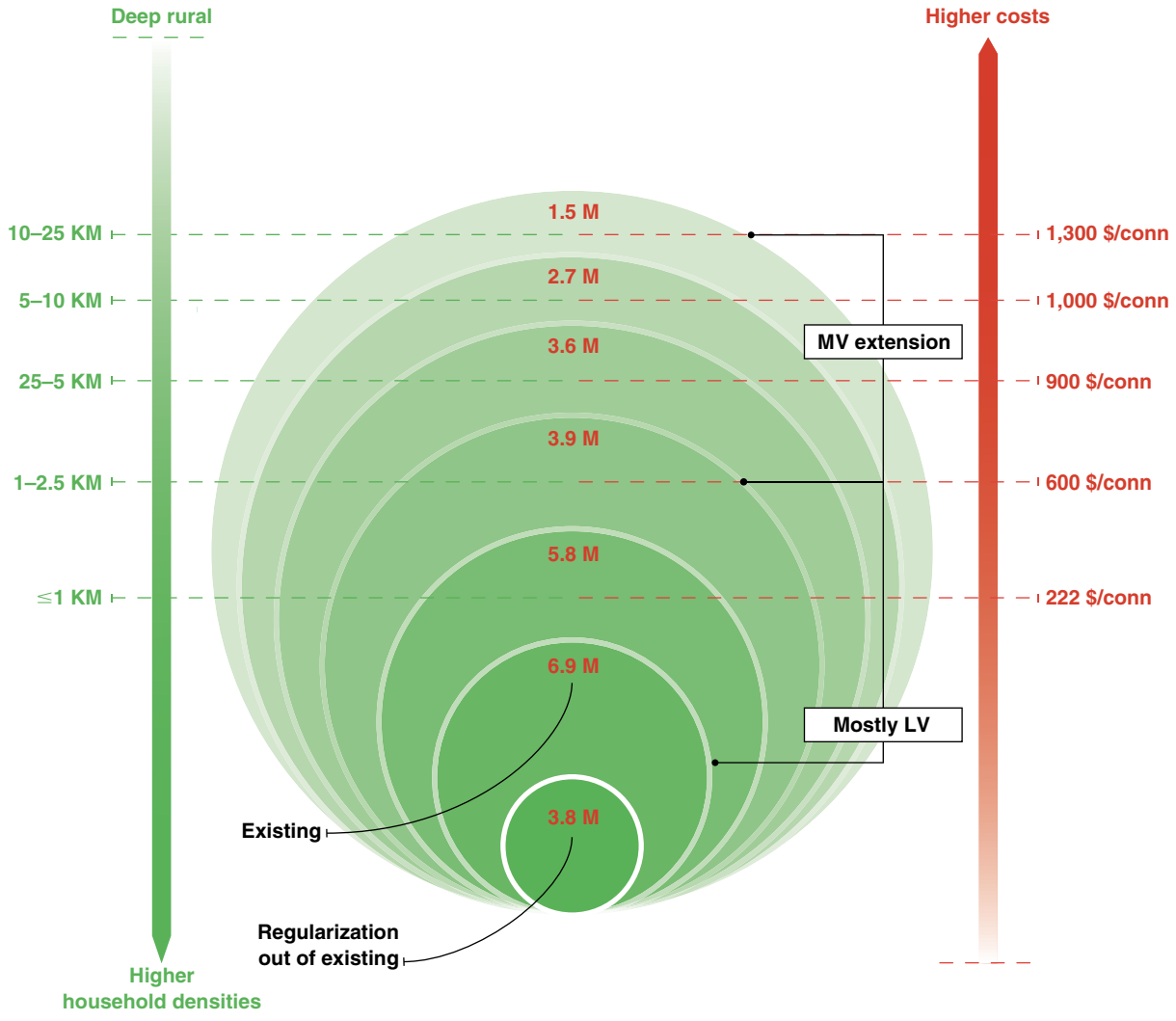
From an investment costing perspective, the connection of 56 percent of the population by 2030 through grid densification and intensification—within 2.5 km for the existing grid—will require US$3.6 billion, while the remaining 44 percent of the population will be connected between 2.5 and 25 km through grid extension for about US$8 billion or requiring doubling the investments.

Table 3.1 and Figure 3.1 indicate that for each year of implementation of the grid program by 2030, there is a descending contribution offered in terms of connectivity by the different components of the access program, from the highest, densification of HHs within 1 km of the existing grid, to the lowest, grid extension to HHs located up to 25 km from the existing MV lines. Based on CSA census data population growth projections, the table also reflects a proportionally higher population growth in clusters closer to the grid, which are in most cases represented by peri-urban centers of different tier levels.

Figure 3.2 depicts the segmentation of the potential customer segments A, B, and C identified above and the relationship between geographic location and investment requirements, from the most proximate HHs within 1 km from the existing grid infrastructure, to those located 25 km away from existing MV lines and beyond.

The widening cycles symbolize, *within each circle,* increasing spatial spread, and lower spatial density will be encountered as grid rollout implementation advances over time in its reach geo-spatially. The newer grid connections on the margin will be increasingly situated further away from the existing EEU network infrastructure footprint—urban, peri-urban, and rural toward the furthest deep rural area households and communities—where there will be on average fewer connections per unit of network line and investment required to connect them to the grid, as

Figure 3.2 Schematic least-cost access delivery to household segments spatially differentiated



— Grid connections circle will be complemented by off-grid pre-electrification solutions

identified by the geo-spatial analysis and the population growth projections developed at the woreda level by CSA.

Further, Figure 3.2 visualizes the single biggest contribution offered to the grid access program by component A: densification of HHs within 1 km from the existing MV infrastructure. The figure provides an overview of the access challenge today—with the inclusion of regularized connection—while taking a long-term view up to 2030 with the inclusion of projected population growth by location 9distance from existing MV network).

The combination of the geo-spatial analysis, identifying the location of HHs with respect to the existing grid combined with population growth projections provided by CSA (aggregated here at the national level), also identifies the connection *potential* (i.e., HHs without a connection) and related investment requirements at different stages of the electrification program for the different access components of the NEP. In other words, it identifies the location of HHs without a connection by geographic location and for different years.

3.2 NEP grid densification program implementation (2019–2025)

The implementation of the grid program under the NEP responds to the following priorities of the Government:

- Providing electricity access at least cost based on the footprint of the existing grid infrastructure and location of HHs, current and projected to grow;
- Providing electricity access at an annual pace based on the above and informed by international best practices, which translates into 65 percent of grid access by 2025 and 96 percent by 2030, as grid connection represents the least-cost solution for the majority of the population;
- Giving priority to social institutions, such as schools and clinics to ensure the well-being of the population;
- Giving priority to centers with high economic growth potential, such as industrial parks, MSMEs, and agri-processing, and supporting the diversification of the economy; and
- Giving priority to the remaining paid and unpaid waiting list, including HHs that have already paid for the connection and those that have submitted a formal application to EEU offices.

Given the advantage offered by the proximity of the majority of the population to the existing MV network, the Government intends to leverage grid connectivity as the least-cost solution for prompt access provision. At the same time, the grid program will be coupled by an off-grid one for the timely provision of access to electricity services in those locations where the grid may take time to arrive (for transitional/pre-electrification purposes), and in those instances where off-grid solutions constitute the least-cost technology option (long-term off-grid solutions). Off-grid solutions will complement and coordinate grid developments to ensure the timely achievement of universal access by 2025. Chapter 4 provides a description of the implementation details of the NEP off-grid program. Table 3.2 presents the least-cost staged program for 2025.

Table 3.2 Indicative grid connections rollout—least-cost staged program, 2025

HH Segments	Spatial Proximity to the Grid	Number of HHs (million)[a]	US$/Connection	Estimated Capex (US$billion)[b]
Regularized connections (service drop)	Grid connected	3.8	US$100	0.38
A. Densification (mostly LV)	≤1 km	4.5	US$222	US$1
B. Intensification (mostly LV + some MV)	1–2.5 km	3.7	US$600	US$2.2
	Average cost/ connection		US$390	
Subtotal A + B		8.2		US$3.2
Subtotal A + B + regularization				~US$3.6
C. Extension (MV)	2.5–5 km	3.2	US$900	US$2.8
	5–10 km	2.5	US$1,000	US$2.5
	10–25 km	1.4	US$1,300	US$1.8
	Average cost/ connection		**US$1,000**	
Subtotal		7.1		US$7.1
Total access program: A + B + C		15.3		US$10.3
Total with regularization				~US$10.7

Note: Order of magnitude estimate, not including: (i) capex for MV network strengthening and reinforcements in all 15 regions necessary to enable densification of customer connections (i.e., network capacity); (ii) transmission investments for adequate and reliable transfer capability; (iii) capex required/payment obligations for increased generation capacity; (iv) for the off-grid program rollout; and (v) the cost of Technical Assistance necessary for strengthening institutional capacity directly linked to facilitate and support the achievement NEP implementation targets (DoE, EEU, as well as off-grid program implementing agents and key intermediaries).

[a]Includes population growth through 2030. Central Statistical Agency census data (2017) and location of households based on rooftop tagging (USAID, 2018) and the Center for International Hearth Science Information Network—CIESIN (2018). Assumes HH sizes ranging between 3.3 and 6 people per household. 2017 population: Numbers are rounded.

[b]Numbers are rounded.

Physical program for scaled up grid customer connections

The NEP targets and timetables for the grid connectivity contribution to the achievement of universal access by 2025 and beyond are presented in Table 3.3. The grid connections yearly rollout has been updated[30] based on:

- The MTF new access baseline (33 percent of grid access in 2017), corresponding to about 6.6 million grid connections;
- Progress achieved by EEU in providing connectivity in 2018 (about 300,000 HHs);
- Geo-referencing of rooftops across the whole nation (population data) and triangulation with CSA population estimates and growth projections by woredas and the Center for International Earth Science Information Network (CIESIN) information on urban and rural population location. All in all, the population analysis revealed higher population number estimates.[31]

Consistent with the least-cost rollout spatial costing estimates provided by the high level geo-spatial analysis conducted in 2018 and the goals of the Government, the focus of this immediate phase of NEP implementation is systematically connecting the approximately 4.5 million new customers (Table 3.2), situated very close to the existing network infrastructure of EEU. More specifically, the NEP will keep taking advantage of the spatial density of the population, starting from the closest connections to the grid and progressively moving outward (Figure 3.2).

By 2025, 8.2 million connections will be provided for a total investment cost of US$3.2 billion in newly provided access, plus US$380 million will be required to regularize 3.8 million connections, for a total investment cost of about US$3.6 billion.

By 2025, the grid connections program will have reached all HHs residing within 25 km from the existing grid and provide access through densification and intensification of the existing grid, taking advantage of population proximity to the existing network. Universal access can be achieved in Ethiopia by leveraging the success in network extension achieved under the UEAP program, at the least-cost average per connection of US$390 and potentially no further grid extension.

By the time the grid rollout advances to its identified economic limits (circa 2030), based on the existing network and the location (including population growth) and density of the population, grid access is projected to be the least-cost solution for about 96 percent of the population, with the remaining 4 percent provided with long-term off-grid access. The grid connections rollout takes advantage of the location of 96 percent of the population within 25 km from the exiting MV infrastructure.

Table 3.3 Grid connections program and universal electricity access (2019–2025)

Time Period		Total Households[a]	Grid Connection Added	Cumulative Grid Connection	Grid Access Rate
Program	Year	(millions)	(millions)	(millions)	(percent)
GTP II	2017	19.9	0.2	6.6[b]	33%
	2018	20.4	0.3	6.9	34%
	2019	20.7	0.5	7.4	36%
	2020	21.1	0.7	8.1	38%
	2021	21.6	0.9	9.0	42%
GTP III	2022	22.0	1.3	10.3	47%
	2023	22.4	1.5	11.8	53%
	2024	22.8	1.6	13.4	59%
	2025	23.2	1.7	15.1	65%
GTP IV	2026	23.6	1.8	16.9	72%
	2027	24.0	1.8	18.7	78%
	2028	24.4	1.9	20.6	84%
	2029	24.8	1.9	22.5	91%
	2030	25.2	1.8	24.3	96%

[a]Based on population assumptions derived from the geo-referencing of rooftops conducted by USAID, and CSA estimates and projections, 2017.

[b]Based on the MTF baseline.

3.3 On-grid program implementation progress and readiness for the achievement of universal access

The Government is mindful that the year-on-year connection targets driving the Implementation Roadmap (Table 3.3) are ambitious and seemingly daunting, but only if viewed retrospectively in comparison to the annual on-grid connection rates achieved historically. They call for a quantum shift and fast-paced acceleration in the scale of new connections each year, by several orders of magnitude (over ten-fold plus) by 2023.

These challenges are surmountable, and the Government and sector institutions have started working on strengthening implementation capacity since the launching of the NEP in 2017. Several important initiatives and activities have been launched for the positive impact on connections, customer services, and sector financial health that will impact the NEP grid program over the whole course of its implementation. Taken together, these activities are transformative in respect to EEU's readiness for the NEP grid program. Immediate implementation support activities have also been identified for 2019 and are presented in Section 3.4.

Grid program implementation progress, 2018

Based on the implementation priority identified in the NEP, EEU adopted and launched a comprehensive institutional strengthening program for the timely and successful achievement of the connectivity targets. The activities are comprehensive as they encompass all aspects related to well-functioning of the utility and are meant to leverage the success achieved under the UEAP program over the course of two decades, which led to having 96 percent of the population living within 25 km from the existing infrastructure.

Activities encompass planning and engineering; operational efficiency; improved financial, procurement, and commercial management; strengthened environmental and social safeguards, and the Occupational Health and Safety (OHS) system within the utility. Further, several actions were undertaken to ensure the provision of equitable services to men and women, as well as improve gender quality within EEU. Important steps were also undertaken to ensure the engagement of citizens in the electrification program, as the grid is meant to reach out to most of the population across the country over a time span of 11 years.

With the Government, EEU is professionally committed to the provision of adequate and reliable electricity services on a timely basis to the Ethiopian population. In the process, EEU also aims at becoming the example of a leapfrogging approach to planning and implementing electrification programs while ensuring utility and sector viability. All the initiatives undertaken in 2018 were developed in close dialogue and collaboration with MoWIE.

A key statement to EEU's commitment has been the **provision of about 280,000 connections since the launching of the first NEP in November 2017,** increasing the number of registered accounts from 2.4 to 3.1 million (as also reflected in the yearly connections rollout plan). EEU performance showcases that, while challenging, the targets set by the NEP are achievable, and indeed based on the best international practices in rapid scale-up of access provision. In addition, the rapid progress achieved last year indicated that the **rollout of connections is accorded top priority** as mandated by the NEP.

The **integration of the UEAP program under EEU** (see also paragraph below) has allowed to take full advantage of the reciprocal strengths, and leverage the experience-based institutional and professional capacity to effectively undertake the entire chain of technical, engineering, and managerial functions and processes that need to be brought to bear by a professional utility to achieve the results at the scale delivered so far. These results include: (i) at the upstream stage, a systematic techno-economic screening framework for selection and sequencing of the list of towns and communities nominated as priorities by regional authorities; (ii) informed by the outputs, undertaking detailed MV network technical design and costing; (iii) managing procurement, logistics of material handling, warehousing, and inventory management of a diverse catalogue of poles, conductors, insulators, transformers, switches, and a myriad of other component parts; and (iv) downstream program management associated with orchestrating construction crews for work.

EEU governance, business reengineering, and NEP program management

In 2018, EEU completed the process of integration with UEAP starting with the unbundling phase, and then launched and completed the ***institutional restructuring of the utility (business reengineering).***

With the approval of the Government, EEU is now organized in 11 offices (nine regional plus two in federal cities) overlapping with both the UEAP offices and the administration ones, the Regional Energy Bureaus. This restructuring ensures full coordination among the implementing actors at the local level, leveraging on their respective mandates. Additionally, it will improve the prompt identification of implementation bottlenecks on the ground, to either be tackled locally or raised at the Steering Committee/DoE level.

In addition, the restructuring will further facilitate the planned extension of the MV network infrastructure, which has been under the mandate of UEAP, and ensure the parallel provision of actual connections to the villages and communities as the grid reaches further out across the country.

A ***NEP Program Management Unit*** was established to ensure adequate planning and implementation of the NEP program and ensure oversight over all the aspects related to the program, from planning to construction works to procurement of financial management and customer care. The unit is also in charge of coordination and implementation of donor funding.

EEU has also adopted and installed an ***Enterprise Resource Planning (ERP)*** system to improve its business and commercial functions. EEU has embarked on a multiyear, multifaceted process of comprehensively modernizing its back-office information technology (IT) systems, tools, and resources, to allow it to become a service delivery–oriented and efficient corporation. This includes the installation of a state-of-the-art ERP system and a comprehensive GIS system for asset management, planning, and monitoring. The ERP will not only revolutionize EEU's technical planning capabilities but will also improve the reliability of information on customers and the infrastructure used to serve them, and collectively, also contribute to improved complaint handling.

Further capacity needs for the implementation of the program were also identified and launched for 2019 and 2020 (see below).

Planning

EEU prepared the ***first connection rollout plan*** for the fiscal year July 8th, 2018–July 7th, 2019. For the first time, and based on the targets, (i) the assessment of connection potential was identified at the feeder level; (ii) network capacity and the related number of pursuable connections were estimated; (iii) works and goods were technically and financially detailed, as well as staff requirements, and procurement launched; (iv) priority social facilities for 15 percent of the overall number of connections, by region, were identified; and (v) a process was set in place for keeping track of female-headed households and establishing a baseline for pursuing equal access to electricity services. The connections rollout plan identifies the technically viable connections by region and is ***equitably spread out across the country.***

The ***GIS platform at EEU was expanded*** to support the processing of network information gathered through the ***digitization of MV lines.***[32] Together with the GIS platform at MoWIE (established for program monitoring purposes) the one at EEU constitutes the first pillar in the establishment of a ***GIS sector-wide infrastructure capacity,*** to be further expanded with EEP in 2019 (see below), where ***bottom-up information will feed into and be integrated into generation and transmission plans and dynamically updated, resulting in a positive feedback loop across the different segments of the power sector value chain.***

The geo-location of buildings and geo-spatial analyses[33] are conducted in partnership with MoWIE. The geo-tagging of rooftops was conducted for the first time and, triangulated with CSA and other available information, has provided the best basis to identify the location of the population across the country. In the future, the Government will pursue further collaboration with CSA to establish synergies for data collection in the country. The geo-spatial analysis further details the capital investment requirements and physical rollout plan for the targeted connections under the NEP and is informing program implementation, while a full-fledged GIS least-cost rollout plan is being modeled and will be ready by the end of the fiscal year.[34] The full-fledged least-cost plan will further break down the costing of the sequenced rollout of customer acquisition and support the identification of technically viable connections.

Procurement

The rapid ramp-up of connections required on an annual basis to achieve universal access is associated with a rapid increase in procurement of goods and services, ensuring the quality and reliability of electricity services. To improve, streamline, and scale up the procurement processes and procedures, EEU took a series of initiatives. More specifically:

(a) ***The Procurement procedures and manuals of both EEU and UEAP have been revised and consolidated*** for the preparation of a procurement manual for the implementation of the NEP program, under the leadership of the NEP Program

Implementation Unit. This process includes the revision of the Works and Procurement Policies and Procedures (WPPP) issued in August 2014 and the Ethiopian Electric Power Procurement Manual issued June 8, 2012;

(b) Procurement procedures include ***contract management, resolution of complaints, and dispute resolutions, as well as record keeping;***

(c) All ***procurements are to be made through a competitive process,*** in line with the applicable available guidelines[35] and newly established procurement procedures aimed at strengthening quality control over the goods and services procured; and

(d) ***Internal and external audits*** have been established to ensure that all procurements and contract managements are done in accordance with the procurement policies and procedures established.

Financial management

Several actions were also undertaken to improve the financial management of the utility, to be further supported by the full running of the ERP system, which will allow for further automation of activities. In 2018, the EEU focused on:

(a) Strengthening reporting mechanisms, procedures, and timelines for the ***Quarterly Interim Financial Report (IFR) and Annual Financial Reports;***

(b) Strengthening ***internal auditing procedures and establishment of external audits*** toward the adoption of International Financial Reporting Standards (IFRS), including in-time collection of all financial reports from regions under the leadership of the NEP program coordination unit;

(c) Internal procedures have been strengthened for ***control over cash, stock and inventories, and budget design*** and management, including improved coordination between headquarters and the regional offices; and

(d) A ***Chart of Accounts*** that was improved for strengthened financial accountability and coordination between EEU's headquarters and the regional offices (cost centers).

Environmental and social safeguards

While the provision of last mile connections to the Ethiopian population is not expected to cause harm to the environment and to people, EEU has strengthened its environmental and social practices to ensure that all risks were tackled and mitigated. For this reason, the EEU has adopted:

(a) ***Environmental and Social Management System Guidelines;***

(b) ***Resettlement System Guidelines;***

(c) Hiring of skilled staff for the implementation of the guidelines, their monitoring and evaluation, and the ***establishment of an environmental and social system at EEU;***

(d) Establishment of ***Annual Environmental and Social Audit and Performance Review*** guidelines and procedures.

Occupational Health and Safety (OHS)

To improve OHS, EEU has adopted an action plan focusing on: (i) priorities to ensure safety of workers, (ii) live line maintenance, and (iii) strengthening of EEU procedures. Several trainings were organized in the past year, as well as a launched audit of safety systems on worksites to improve EEU organized training sessions and audits of safety systems. EEU has already integrated their recommendations.[36] The OHS training courses were delivered as Training of Trainers (TOTs), not lastly to improve awareness, safety, and community engagement. EEU is also in the process of reviewing its procedures manual, which will also be informed by the results of the study commissioned to improve civil works efficiency.

Customer care, grievance mechanisms, and citizen engagement

The design and adoption of the NEP had at its core the shift to a customer-centric approach for provision of electricity services. In light of this, EEU has undertaken several steps to ensure adequate customer care and grievance mechanisms for the implementation of the electrification program. Customer care will also be supported by the full functioning of the ERP system. In 2018, EEU drafted and launched an updated ***annual customer satisfaction survey*** (nationally representative) targeting households, businesses, industries, and social institutions (all information collected is kept confidential and aggregated to ensure privacy).

The survey has been updated to include the following service dimensions more comprehensively: grievance, transparency and dialogue, customer expectations, customer perceptions about the value and quality of their actual experiences, customer complaints, and customer retention. The surveys focused on getting customer feedback on the following key EEU service areas: new connections, sustained and

quality power supply, billing, complaint handling, maintenance, efficiency/courtesy of call centers, and accessibility of service centers. Moving forward, in-house customer satisfaction surveys are planned to be carried out in all EEU regions on a biannual basis, with a view to reach out to its customers and mobilize their support and participation in meeting its goals and objectives. This will be complemented by building in-house staff capacity at EEU central offices and regions to guide and manage external customer satisfaction surveys and using the results for improving EEU services and enhancing its transparency and accountability to customers.

EEU's citizen engagement-related activities have focused mainly on the following activities, where specific attention was devoted to grievance and complaint handling mechanisms. More specifically, EEU has started facilitating ***public fora*** with related operational guideline platforms (also prepared by EEU[37]) for sharing EEU's activities with customers and providing them a channel to share their requests and complaints on EEU service delivery gaps. The forums are also used to share valuable information on efficient energy use, safety, and protection. Over the course of 2018, 177 such public forums were held across the country with 12,216 participants. In addition, EEU drafted and adopted ***guidelines with the procedures for complaint handling and grievance redressing.*** This guideline will help make complaint filing and handling procedures at EEU transparent, accountable, and consistent across regions and work units.

Finally, a ***Customers' Charter*** was approved and implemented. The charter outlines the service standards to which customers are entitled, as well as the requirements they need to meet to get access to the services. The customer charter was made public on large and visible banners and posted in each of the EEU service centers and was disseminated through discussions with EEU customers.

Gender

EEU already established the Women, Children and Youth Affairs Directorate (WCYAD) in 2014 to promote gender equality, institutionalize gender mainstreaming, and advocate for the rights of women employees. In 2018, important actions were undertaken to advance the gender equality agenda of the utility. More specifically:

(a) A ***five-year strategy of Gender and Citizen Engagement*** was adopted in July 2018, chartering the path from ad-hoc actions on to a programmatic yearly plan to close key gaps in areas such as women's employment and child care provision. The work program lays out the key priorities and actions to be taken on progress toward gender equality and citizen engagement as part of overall energy sector engagements, including annual targets and the required budgets;
(b) A ***Technical and Steering Committee on Gender Equality*** was established to track the delivery of gender priorities by senior management;
(c) A ***leadership gap assessment*** was carried out with 76 senior and middle-level women managers with WCYAD;
(d) Sensitization of contractors, beneficiaries, and communities, and institutional response strengthening were conducted to ***prevent gender-based violence;***
(e) ***Child care services*** are being established at EEU headquarters and in the regional offices, also In line with the Federal Civil Servant Proclamation No. 1064/2017 for the establishment of child care service provision in all Government institutions;
(f) An ***Energy Sector Gender Stakeholder Forum*** was launched in October 2018 at the Addis Ababa University to comprehensively engage energy stakeholders on gender equality across EEU, EEP, EEA, and the Ethiopian Women Lawyers Association (EWLA).

A further detailed list of activities undertaken in 2018 to strengthen gender equality and citizen engagement is presented in Annex 5.

South-South knowledge exchange with international best practices countries

In their efforts to provide universal access provision to their citizens, the NEP builds on the lessons learned from other countries and on the best practices that emerged for equitable, reliable, and affordable electricity services. While the NEP has been built on these fundaments, activities were undertaken to further inform the implementation of the electrification program and its update. Two knowledge exchange programs were undertaken in 2018, one in Indonesia and one in Vietnam. Both were tailored to gather operational understanding of fast paced universal access programs from the two countries that led the way in the achievement of nationwide universal access, starting at low-income levels. Both countries centered the electrification program at the core of their development agenda and were able to achieve their targets within two decades.

The knowledge exchange with Vietnam has further led to the provision of technical assistance for the implementation of the NEP connections rollout from officials that were in the front line of electrification efforts, and to EEU staff that was embedded in ENV (Electricity of Vietnam) to gather first-hand experience of utility management and day to-day operations. The technical assistance provided by the Vietnamese counterpart has been embedded in the NEP and is currently supporting EEU in the first stages of implementation of the program to ensure the: (i) adequate and timely provision of priority technical studies and management support, (ii) sustained improvement of procurement management, (iii) operational efficiency gains across the value chain, including warehouse management for construction works, and (iv) development of local manufacturing capacity over time for the production of on-grid electrification materials. The key areas for implementation support have been reflected in the activities launched for 2019 (described below) as well as in the immediate program Implementation support activities detailed in Chapter 5.

3.4 Program implementation readiness and technical assistance, 2019

Building on the program implementation activities and technical assistance support requirements identified in the NEP for the first year of implementation of the electrification program, EEU has also launched key activities to be fully undertaken in 2019.

They include:

1. Establishment of a GIS-based planning infrastructure integrated with the ERP and SCADA systems. Establishment of a EEU decentralized GIS infrastructure for the planning, updating, and monitoring of NEP connections rollout. The bottom-up information on connections rollout will also inform the new Master Plan for the sector (see below). The integration of GIS based information into the ERP system will also improve asset and customer management, and the integration into the SCADA system will provide real-time data on a geographic view of the electrical network.

2. EEU strengthening of operational and commercial efficiency. Capacity building for management of increased procurement, financial, customer acquisition, and M&E requirements is currently under procurement to establish the adequate capacity for NEP implementation and rapid scale-up of connections and customer acquisition and management. The ERP system will ensure automation of customer registration and management, and the integration with GIS-based asset information will allow the prompt identification and problem solving for customers possibly affected by network disruptions. Commercial efficiency will also be strengthened through the introduction of mobile payment solutions (see below) starting from big customers and progressively expanding to smaller ones.

3. Cost of connection study. Technical assessment of connection costs for the adoption of an affordable connection fee policy and structure to lower a key first cost barrier to becoming a EEU customer. The assessment will be conducted across the country on a regional basis. The study will focus on front-end affordability measures (e.g., connection payment through installments) and demand-side management mechanisms, and will be informed by the MTF analysis, the geo-spatial analysis, and the least-cost rollout plan, and other best information available (leveraging on triangulation of sources) to provide recommendations to the GoE for the design of a connection cost policy. Consistent with good practice experience and based on the findings and recommendations of a high priority special study provisioned for under the Technical Assistance component of the NEP Densification Phase, the existing customer connection fee policy will be appropriately revised, including introducing the facility for qualifying customers to pay the fee in easy installments collected by their EEU bill.

4. Low-cost technical standards (includes for construction works). Technical assessment of past experiences and recommendations for the adoption of low-cost network design and material, adequate to the Ethiopian context. The technical study will also assess and provide recommendations for the development of local manufacturing capacity to support an adequate supply of quality materials (Box 3.1). The study will also identify a pilot for SWER implementation. In addition, the assessment includes the identification of efficiency gains in construction work, to identify efficiency gains and ensure the adoption of civil works construction standards. The impact of the adoption of low-cost standards on cost reduction is presented in Annex 9.

Table 3.4 provides a summary of the ongoing and immediate priority technical assistance and capacity building activities for the implementation of the grid electrification program in synergy with sector developments across the value chain. Further capacity building funding requirements are earmarked under the implementation capacity support

Box 3.1 Lowering cost in electricity network distribution

Providing electricity services to the Ethiopian population is a capital intensive effort. To ensure the rapid spread of the grid's reach and connections, the wide range of existing low-cost methods, technologies, and equipment for service provision and electricity consumption will be taken into account. EEA will be accountable for promptly approving required technical standards and regulations.

International experience shows that cost reductions in the order of 20–30 percent are realizable through improved engineering and material selection and by simplifying the design of low voltage networks, without compromising safety and security (see Annex 9). The implementation of the NEP-IRM will aggressively pursue cost reduction methods, both on the supply and on the demand side, ensuring that, overall, a holistic cost reduction culture permeates the design and construction of the distribution network and electricity consumption.

EEU has already launched initiatives and pilots to reduce infrastructure costs in network design and construction:

- Deployed Single Wire Earth Return (SWER) for over 10,000 households and 100 towns;
- Reduced number of poles and accessories required per km (UEAP);
- Developed a network optimization scheme (UEAP);
- Investigated best poles mix (poles constitute up to 25 percent of network investment costs);
- Launched an initiative to harmonize and customize International Electrotechnical Commission (IEC) standards for network materials;
- Developed concrete poles production and related training (UEAP);
- Conducted network analysis to map network capacity with existing and potential new costumers (including those on the paid and unpaid waiting list); and
- Installed 879 power factor correctors (particularly for large customers) and made them mandatory.

The implementation of the NEP will require a programmatic expansion of these undertakings as well as the identification of a portfolio of cost reduction methods. To support the identification of the best mix of cost reduction methods, a specific implementation support study is provided for under the NEP, which has been launched in 2019. Informed by the best practice experience of other countries, while focusing on the specific Ethiopian geographic and climate context, the analysis will provide specific inputs to lower the cost of network design and construction and electricity consumption to inform implementation from 2020 onward. The program implementation support study will also comply with the 2017 EEA Draft Distribution Code Regulation (currently under review by MoWIE), legally establishing technical grid requirements for the connection to and use of an electrical distribution system and ensuring a safe, secure, reliable, and efficient operation.

In particular, the implementation support study—to be developed closely with EEU—will take into account the cost reduction methods emerged worldwide as the most effective, such as (a comprehensive list and cost comparison is provided in Annex 9):

- Network design and equipment based on local load forecast, with flexibility to upgrade (up to 50 percent savings);
- Large-scale SWER development (up to 40 percent savings) and Shield Wire Systems (30–50 percent savings);
- Standardization of technical features and all equipment and components used for construction of distribution systems;
- Reliance on local manufacturing and strategic location of facilities (30–50 percent savings);
- Centralization of procurement process and bulk purchases and incorporation of incentives for cost reduction in open and transparent bidding;
- Warehouse management and quality control; and
- Deployment of ready boards, particularly for poorest consumers and premises currently not eligible for connections as per EEU regulation (50–75 percent savings).

activities for integrated electrification planning and implementation.

In addition to the activities listed above in either course of finalization or under procurement, the NEP identifies key immediate technical assistance and program implementation support activities for the successful implementation of the grid program.

5. EEU-wide capacity strengthening. EEU has launched several activities of significative importance for the success of the NEP program and for the establishment of a well-functioning institution managing millions of customers. The utility is and is intending to take advantage of leapfrogging opportunities in utility management (from planning to customer care) which may require further financial support for capacity building and technical assistance to ensure that it achieves its ambitions. Further support may be required as some of the approaches adopted by the

Table 3.4 Summary of ongoing and immediate priority implementation support and technical assistance activities, 2019

	Activity	Scope	US$Million	Leading Agency
Implementation support				
Planning and resource management	1. Establishment of a GIS-based planning infrastructure integrated with the ERP and SCADA systems	Establishment of a decentralized GIS infrastructure for the updating and monitoring of the NEP connections rollout and sector asset management. Improved financial and customer management.	Under procurement	EEU, EEP
Operational efficiency and customer care	2. EEU strengthening of operational and commercial efficiency	Capacity building for management of increased procurement, financial, customer acquisition, and M&E requirements	Under procurement	EEU
Utility performance	3. EEU-wide capacity strengthening	Support to the overall strengthening of EEU capacity for the successful achievement of the NEP on-grid targets. This provides for possible further support to the ongoing and under procurement activities.	3	EEU
Technical assistance				
Affordability and connection cost reduction	4. Cost of connection study	Design of an affordable connection policy for achieving universal access	Under procurement	
Operational efficiency and connection cost reduction	5. Low-cost technical standards	Lowering of network design, construction works efficiency gains, and adoption of high quality low-cost material in network rollout. Includes design of standards for construction works.	Under procurement	EEU
Connection cost and Forex requirements reduction	6. Development of local manufacturing capacity	Assessment, based on international best practices, of options for development of local manufacturing capacity and import substitution	1	EEU
Commercial viability	7. Mobile payment solutions for EEU customers	Design and operational implementation of an interoperable payment acceptance platform for the Ethiopian Electric Utility to kick off a mobile payment solution for big customers, and progressive expansion to registered customers	1	EEU, in collaboration with CBE
Total			**5**	

sector and the utility, such as sector-wide integrated planning, and GIS-informed and integration of geo-referenced assets into the ERP system, are innovative and cutting edge. In addition, further support may be required to support EEU in the successful implementation of its business restructuring, launched and completed in 2018. The restructuring aims at leveraging on the coordination of EEU's activities with REBs and within the regional development policies and will lead to the establishment of new processes and practices, including between the headquarters in Addis and the regional decentralized offices. In addition, EEU has already identified some areas where further capacity building is required for improved planning sophistication with the inclusion of LV lines mapping.

6. Development of local manufacturing capacity. Assessment, based on international best practices, of options for development of local manufacturing capacity and import substitution. With limited available Forex and sizable import requirements of material for the establishment of safe, quality connections, and for distribution network reinforcement and upgrade the development of an import substitution mechanism is key. The development of a local manufacturing capacity, informed by best practices experiences, will ensure adequate availability of quality materials, contribute to job creation and diversification of the economy, and set the stage for potential regional trading of materials. This work will be also informed by the experience of Vietnam through the

South-South knowledge exchange program already in place.

7. Mobile payment solutions for EEU customers for bill payment collection, to be identified through a technical study of current options for mobile payment, including those adopted for the bill collection of other utilities. The assessment will identify a roadmap for the establishment of a payment platform for an EEU progressive expansion of mobile payment solutions, starting from big customers and progressively expanding to the rest of the population. In 2019, the Directorate of Electrification (DoE) intends to support the establishment of an interoperable payment acceptance platform for the Ethiopian Electric Utility. This payment platform will accept inbound payments from different payment networks and will be designed to increase the efficiency of electrification throughout the country. The Government will benefit from improved accounting, increased transparency, and improved tariff collection.

3.5 Local entrepreneurship and industrial parks

Under the NEP, the Government will provide universal access to electricity services (grid and off-grid) to about 17 million beneficiaries by 2025 (including short-term pre-electrification). Even in small quantities, electricity can catalyze economic activities and improve incomes. A cross-cutting firm analysis indicates that achieving universal access would lead to an increase of 4.1 percent in labor productivity.[38]

The NEP acknowledges the importance of access to reliable and affordable electricity services to support current economic activities and boost potential new ones, from micro, small, and medium enterprises (MSMEs) development to agro-processing and industrial activities. While progress has been achieved in the identification of areas for development of productive uses, and related ecosystem enabling measures, the NEP provides for comprehensive appraisal of entrepreneurship in Ethiopia, including electricity needs associated with different economic activities, and current reactions and challenges encountered with the arrival of the grid for the efficient and reliable undertaking of commercial activities. The study will inform the scope and design of a specific productive use program. The appraisal will be conducted in 2019, and the program is expected to be launched in 2020.

The Government is committed to ensuring access to adequate and reliable electricity services for the modernization and industrialization of the economy. Within the 8.2 million grid connections to be rolled out by 2025, priority will be given to MSMEs, as key engines for economic growth and transformation, connection of industrial parks, and densification of areas surrounding them, as well as to areas with high potential for agriculture development. Further, off-grid solutions will be considered whenever adequate to support economic and commercial activities of different size and nature, from isolated mini-grids to solar off-grid solutions.

Micro, small, and medium enterprises

The development of MSMEs is a core aspect of the development agenda of the Government: micro (0–9 employees) and small (10–20 employees) enterprises are expected to contribute with more than 3 million jobs over the GTP II reference period.

The driving objective of GTP II[39] states: "*Ensuring rapid economic growth, creating job opportunities in urban and rural areas and ensuring equitable growth helps to improve the income of the people and thereby reduce poverty. To enable micro and small enterprises to register rapid and sustainable growth and sustain rural development and lay the foundation for industry development, focus will be on the expansion of enterprises by creating substantial developmental investors. (. . .) massive efforts will be made to promote small and micro enterprises to the level of developing medium enterprises or company levels.*"[40]

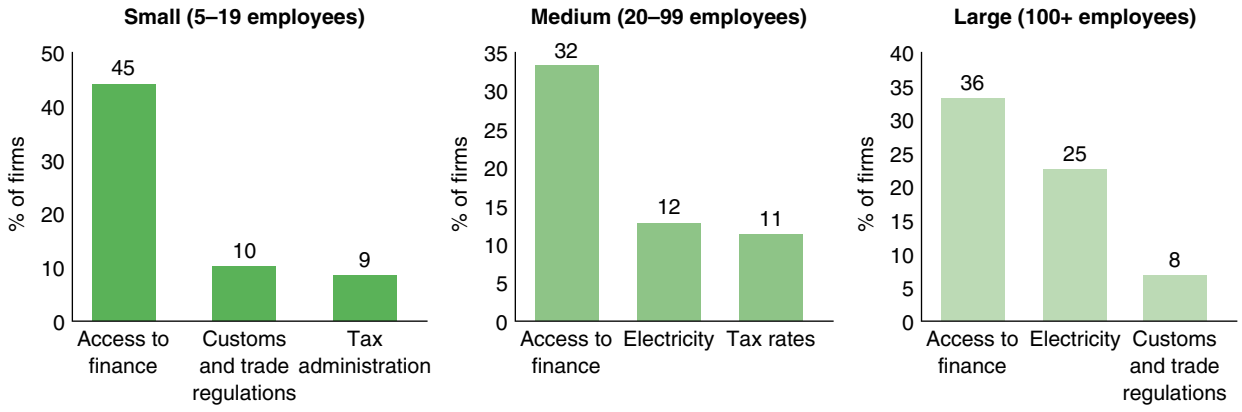
In 2014–2015 the industrial sector, which is mainly comprised of small and medium (20–99 employees) enterprises, accounted for about 15.2 percent of the GDP.[41] In 2008, the aggregate figure of 43,338 MSMEs contributed to 50 percent of total employment,[42] and 2.2 million women benefited from MSMEs.[43]

After finance, access to electricity services currently represents the main constraint for medium and large enterprises (Figure 3.3). Currently, it takes up to 195 days to get an electricity connection in the country.[44]

Efficiency in the operation of the private sector also requires a reliable supply of electricity. Figure 3.4 shows the extent to which firms face failures in the provision of electricity and the effect on sales as measured by the losses they generate. An inadequate electricity provision supply can increase costs, disrupt production, and reduce profitability.

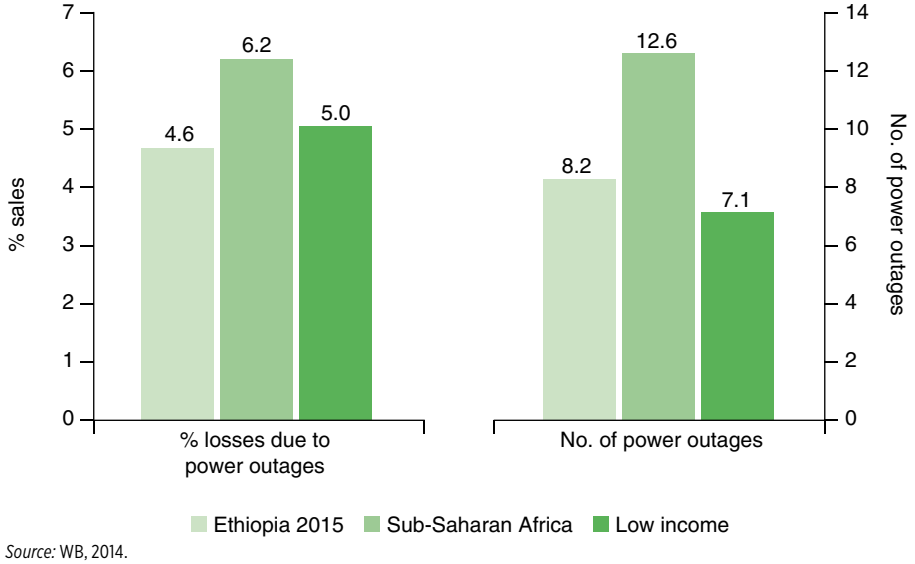
The ongoing initiatives launched for EEU's performance improvement are combined with loss reductions for improved reliability of services and network capacity to avoid business losses for MSMEs. Grid connected ones are therefore expected to receive better services, and off-grid existing and potential

Figure 3.3 Top three business environment constraints by size (percent of firms)



Source: Ethiopia Central Statistical Agency and WB, 2014.

Figure 3.4 Reliability of electricity supply and related losses



Source: WB, 2014.

economic and entrepreneurial activities will be supported by access to quality and affordable services with the option of installment sales. The study commissioned under the NEP on productive uses aims at better understanding service level needs (demand) to support market development.

Industrial parks

To realize the ambitious development plan of the country aiming for rapid industrialization, and nurturing manufacturing and agro-processing industries, and to accelerate economic transformation and attract domestic and foreign direct investment, the GoE launched the development of industrial parks to provide the necessary services and facilities for industries. The focus of the Government on industrial park development and expansion reflects the vision to make Ethiopia a leading manufacturing hub in Africa by 2025, using the textile and garment sector as a key component. Industrial parks are part of the overall goal of achieving a 24 percent growth in the manufacturing sector and increasing contribution export revenues from the current 10 percent to 25 percent (Figure 3.5).[45]

Industrial parks are located along key economic corridors, connected to ports by road and electric powered railway lines in proximity to high labor force pools, and open to both domestic and foreign direct investments (FDI). A wide-ranging comprehensive package of fiscal and non-fiscal incentives is offered

Figure 3.5 Existing and planned industrial parks, 2017

Source: EIC (2017).

to developers and enterprises.[46] All industrial parks are anchored to the following principles:

- Specialized parks: enhancing economy of scale and efficiency through the development of specialized/clustered industrial parks;
- Export promotion: Government provision of industrial park incentives targeted at increased export performance and competitiveness;
- Sustainability: maintaining high environmental standards through the use of renewable energy and zero liquid discharge (ZLD) technology; and
- Vertical integration: enhancing forward and backward linkages in the economy; and skills development and competitiveness: developing workers' skills for enterprise competitiveness.

Two kinds of industrial parks are being developed: (i) large, medium, or light scale, and (ii) integrated agro-industrial parks. In 2014, the Government established the Industrial Parks Development Corporation (IPDC)[47] with a mandate to develop, operate, and administer the industrial parks in the country through lease, transfer, and sale of land and construction for large, medium, and light industrial parks. Five industrial parks are already commissioned in Hawassa, Addis Ababa (Bole Lemi phase I), Adama, Kombolcha and Mekelle. (Figure 3.6).

The ministries of industry and of agriculture are responsible for the development of the Integrated Agro-Industrial Parks (IAIP), aimed at transforming the agriculture sector by enhancing domestic value addition. So far, 17 areas with agro-industrial potential (Agro-Industrial Growth Corridors—AIGCs) have been identified across the country,[48] and feasibility studies for four pilots have been completed. Overall, the agro-industrial parks represent over US$1.5 billion in investments and will create over 400 business opportunities and over 400,000 direct employments.

Powering industrial parks with adequate and reliable electricity services is an essential dimension of industrial park development. The Ethiopian Electric Power (EEP) has assessed the least-cost solution for service provision to the not yet operational sites (Hawassa Industrial Park is already operational) and identified the detailed scope of investment requirements for the connection to the grid of each site.[49] The assessment is based on the estimated electricity requirements for each site and provides detailed related transmission and distribution line expansion to be planned and constructed for adequate service delivery.

The implementation of the NEP will build synergies and optimize the infrastructure network being developed to serve industrial parks. Consultations among MoWIE, EEP, EEU, and IPDC will be

Figure 3.6 Industrial parks development

Source: EIC (2017). Photo credits (bottom left): The Reporter.

strengthened to ensure adequate budget allocation. In addition, cooperation among sector institutions will ensure that network design and connection of industrial parks is conducted in sync with densification efforts (industrial parks are currently served by 33 kV). Cooperation among sector institutions leverage on the establishment, in 2017, of the Energy Supply Directorate within IPDC to improve cooperation with EEP for substation and HV lines construction, and EEU for MV distribution and billing. The implementation of the NEP-IRM will also ensure coordination and synergies between the EEU, responsible for customer connections, and the IPDC, responsible for connecting industrial parks with transmission lines.

The efficient connection of industrial parks will take into consideration possible changes in the regulatory environment, and hence consider possible private sector participation in investments in transmission, in line with the energy regulations currently under discussion at the Council of Ministries. In the future, private sector participation could be envisioned across the power sector value chain, and be considered for serving industrial parks as well, through public private partnerships (PPP), concessions, independent power transmission (IPT), and fully private investments (merchant). All in all, a multitude of business models could be adopted to ensure the adequate syndication of financing requirements for power infrastructure investments, ranging from fully public to fully privately financed and owned projects.

Notes

27. The first NEP, launched in November 2017, was focused on 2018–2022.
28. The MTF survey was conducted for a random sample of households, irrespective of whether they had a customer account with EEU or not. The difference between the total number of customers reported by EEU and the grid connected households quantified in the MTF can be attributed to the meter loading phenomenon.
29. One kilometer is an estimate based on the possible extension in the country of LV lines to avoid faulting. In urban areas the value declines to about 500 meters, as indicated by EEU.
30. From the first version that appeared in the National Electrification Program launched in 2017.
31. The CIESIN datasets were used to triangulate the identification of rural and urban households, based on the information provided by CSA and contained in *Population Projections for Ethiopia and Population Projections for Ethiopia, 2007–2037,* July 2013.
32. Supported by the World Bank and USAID.
33. Ibid.
34. With the support of USAID.

35. Including: Procurement Compliant Handling Mechanism—Federal Public Procurement Proclamation and Directive No. 649/2009 issued in September, 2009; Debarment/Blacklisting Procedure—Federal Public Procurement Proclamation and Directive Proclamation No. 649/2009 issued in September, 2009; Establishment of Procurement Endorsing Committee—Federal Public Procurement Proclamation and Directive Proclamation No. 649/2009 issued in September, 2009; Responsibilities of the Procurement Endorsing Committee—Federal Public Procurement Proclamation and Directive Proclamation No. 649/2009 issued in September, 2009.
36. Under the World Bank ENREP project.
37. The EEU's communications department led preparation of the guidelines and refined them through stakeholders' consultations.
38. World Bank. 2016. Ethiopia. Priorities for Ending Extreme Poverty and Promoting Shared Prosperity. Systematic Country Diagnostic, Washington, D.C.
39. GPT II.
40. GPT II.
41. Industrial Parks Development in Ethiopia, Embassy of Ethiopia BXL, May 2016.
42. Central Statistical Agency of Ethiopia and IFC, 2015.
43. World Bank (2016). Ethiopia. Priorities for Ending Extreme Poverty and Promoting Shared Prosperity. Systematic Country Diagnostic, Washington, D.C.
44. WB (2014). Enterprise Survey. Ethiopia 2015. Country Profile.
45. Industrial Parks Development in Ethiopia, Embassy of Ethiopia BXL, May 2016.
46. For more information visit the Ethiopia Investment Commission (EIC) website at: http://www.investethiopia.gov.et/investment-opportunities/strategic-sectors/industry-zone-development
47. The Industrial Parks Development Corporation was established in 2014 by the Council of Ministers (Regulation 326/2014). The IPDC is designated to prepare a detailed national industrial parks masterplan based on the ones of the Regional States or the two city administrations (Addis Ababa and Dire Dawa).
48. AIGCs' sites selected for the pilot development are located in the regions of Oromia, Gende Arba (Bulbula), Southwest Amhara, Bure, Eastern SNNP (Southern Nations, Nationalities and Peoples), Weynenata, and Western Tigray.
49. Grid connection has resulted as the least-cost option against the establishment of captive power for the powering of industrial parks.

CHAPTER 4

The Off-Grid Program

The NEP-IRM responds purposefully to the Government of Ethiopia's priority for advancing equity and inclusion and shared prosperity, irrespective of where one happens to live. This also means not leaving behind traditionally underserved rural populations and rural institutions such as schools, health centers, and administrative buildings.

In the pursuit of universal access, there is no dichotomy or trade-off simply based on a narrow least-cost calculus between grid-based access provision and off-grid solutions. Rather, off-grid access provision plays a complementary and coordinated role alongside grid rollout. The manner in which the off-grid and grid combination plays out during implementation varies by country and is dynamic in space and over time.

Alongside the grid densification and intensification program providing access to 8.2 million HHs by 2025 at least cost, the NEP includes the launching of a revamped off-grid program whose implementation framework and operational design is informed by best practice and established international experience, especially in the solar products and systems market segments.

For the achievement of universal access by 2025, off-grid solutions are preliminarily expected to provide services to 35 percent of the population (Table 4.1), while acknowledging possible short-term electrification solutions for those households and communities waiting to get a grid connection by 2025, for a total of 9 million beneficiaries.

Table 4.1 Grid connections program and universal electricity access (2019–2025)

Time Period		Total Households	Off-Grid Connections Added	Cumulative Off-Grid Connections	Off-Grid Access Rate
Program	Year	(millions)	(millions)	(millions)	(percent)
GTP II	2017	19.9	0.0	2.2	11%
	2018	20.4	0.0	2.2	11%
	2019	20.7	0.1	2.3	11%
	2020	21.1	0.5	2.8	13%
	2021	21.6	0.7	3.5	16%
GTP III	2022	22.0	0.9	4.4	20%
	2023	22.4	1.0	5.4	24%
	2024	22.8	1.2	6.6	29%
	2025	23.2	1.5	8.1	35%
GTP IV	2026	23.6	–1.4	6.7	28%
	2027	24.0	–1.4	5.3	22%
	2028	24.4	–1.5	3.8	16%
	2029	24.8	–1.5	2.3	9%
	2030	25.2	–1.4	0.9	4%

More specifically, for the prompt and adequate service delivery of electricity services to the Ethiopian population, the components of the off-grid program are identified as follows:

Short-term pre-electrification—While the grid is expected to be the least-cost solution by 2025, for 8.2 million households, the rollout will take seven years to materialize, and several HHs will therefore need to wait for some time before getting access to electricity services. The NEP hence acknowledges for the possible rollout of a short-term pre-electrification program, private-sector led, and targeting those communities that are expected to receive a grid connection in the latter years of the grid program by 2025, for about 3.3 million households.

Mid-term pre-electrification—For the target beneficiaries residing between 2.5–25 km away from the existing grid, grid connectivity is projected at least cost, but they may have to wait several years before they receive grid access. By 2025, the number of beneficiaries of off-grid technologies (off-grid solar or mini-grids) is expected to be at 5 million, corresponding to 31 percent of access in the country. Given their proximity to the existing network, these beneficiaries are expected to be connected to the grid by 2030. The eventual delineation of the geo-spatial location, number, and nature of prospective beneficiaries will be determined in coordination with the scale and speed of grid developments.

Long-term off-grid/deep rural—The target beneficiaries are located beyond 25 km from the existing grid and are progressively remote and scattered household settlements and villages that are less likely to be served in a cost- and time-effective way by grid connectivity. They may also include some homes that are not far from the existing grid but whose isolation from neighbors' settlements and transformers raises the cost of connectivity greatly. The size of this component is estimated at about 1 million households, or about 4 percent of the population by 2030. As their location is still within the mandate of EEU (100 km), some locations may eventually be connected to the main grid in the long run, beyond 2030.

The NEP off-grid program implementation framework focuses on two main technologies for service delivery to all the segments of beneficiaries: (i) Tier 1 and above solar off-grid solutions and (ii) isolated mini-grids, as well as a coordinated combination of these technology solutions. The off-grid program is technology neutral, reflecting the needs of the population, and economic and administrative centers, as well as social institutions on the ground. However, the Government also recognizes the opportunities offered for speed, scale, and efficient improved quality of services offered by solar systems. To date the off-grid program has provided access to over 2 million beneficiaries, broadly differentiated by the delivery modality deployed (public versus private sector-led), and spatially (rural and deep rural versus proximate urban locations).

4.1 Achievements to date

Ethiopia has already achieved significant results in the availability and distribution of off-grid solutions, and shows potential for market scale-up, being the largest unserved market yet in East Africa. Over the past years, the Government has set the stage to increase the penetration of off-grid technologies, taking a series of important measures to deregulate the market and establish an enabling environment, in line with best practices. Recent years witnessed an acceleration of regulatory initiatives aimed at supporting the establishment of an enabling ecosystem for the scale-up of off-grid solutions.

1. **Quality standards:** Lighting Global (LG) standards are now mandatory for products up to 15 Wp. This is combined with the IEC standards that have been adopted for systems up to 350 Wp by the Ethiopian Standards Agency.[50] For pico-PV products, the Ethiopian Government has harmonized its national standards with the Lighting Global Quality Standards, as well as the test methods specified in IEC TS 62257-9-5. For larger systems, it accepts a variety of verification certificates from third parties.

2. **Custom duties:** The Ethiopian Revenues and Customs Authority (ERCA) usually charges up to 35 percent duty and an excise tax of up to 100 percent 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 solar home systems with quality certificates are also benefiting from this exemption. Larger solar home systems are exempted from custom duties (but 15 percent VAT and 3 percent withholding tax are applicable).

3. **Lifting of testing:** 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 taking of samples from every shipment, related testing fees, and a previous 0.5 percent deposit based on shipment value.

Table 4.2 Social facilities provided with off-grid stand-alone systems, 2018

Electrified by	Health Post	Primary Schools	Health Centers	Subtotal
Rural Electrification Fund (REF)	613	436		1,049
Federal Ministry of Health	1,109		467	1,576
Total				**2,491**

Source: MoWIE and Ministry of Health, 2018.

Solar lighting and stand-alone systems: achievements to date

By the end of 2018, through Government supported initiatives and private sector involvement, about 2.2 million off-grid connections—corresponding to 11 percent of access in the country—have been made.[51] Through the public sector program under the Rural Electrification Fund—established in 2003 with the mandate of overseeing off-grid electrification—these important efforts have been undertaken:

- More than 45,000 Solar Home Systems (SHS) have been provided to unelectrified communities through almost
- 696 Rural Electric Service Cooperatives (RESC);
- 1,049 schools have been served;
- 1,576 health posts gained access to off-grid solutions, in collaboration with the Ministry of Health (Table 4.2);
- Over 200 micro-technicians were trained in operation and maintenance of SHS;[52] and
- A solar PV testing facility was acquired and handed over to the Ethiopian Conformity Assessment Enterprise for quality control of products.

The program has seen improved service standards over the years on the basis of the facilities' needs. Schools were initially provided with solar lamps but are now served with 300 Wp solar systems for the lighting of 2–3 classrooms.[53] Health posts and clinics are currently provided with 600 Wp systems (at the launch of the program only 200 Wp were distributed), which allow for six light bulbs, refrigeration, radio, and TV for five to six hours a day.

In addition, the REF is chairman of the technical evaluation team for the Private Sector Enterprises (PSEs) applications to the credit line at the Development Bank of Ethiopia (DBE), under the Directorate of Alternative Energy Technology Promotion and Dissemination. Under MoWIE, the evaluation team is composed of five members.

In 2018, the activities of the REF focused on: (i) providing technical assistance to Rural Electric Service Cooperatives (696 cooperatives throughout the country), (ii) reviewing and approving application of PSEs, and (iii) following up on institutional solar systems installed at health posts and rural schools.

Private sector developments supported by the Development Bank of Ethiopia

Micro financial institutions (MFIs) and private sector enterprises (PSEs) have been key players in the provision of solar lighting and charging products and solar home systems. Through a credit line at the Development Bank of Ethiopia (serving as a financial intermediary for funding provided by the World Bank), over 70,000 solar home systems and 1.1 million Lighting Global certified solar lanterns have been distributed to the Ethiopian population.

The Market Development Credit Line (MDCL) is a component of the Electricity Network Reinforcement and Expansion Project (ENREP) under the June 2012 financing agreement between the Federal Democratic Republic of Ethiopia (FDRE) and the International Development Association (IDA). It was created in response to growing demand for renewable energy technologies and products among customers not connected to the electricity grid. With no local manufacturing, virtually 100 percent of the market currently requires imports of off-grid technologies. Ethiopian importers needed liquidity and access to forex at affordable rates to bring market leading international technologies to Ethiopia. MFIs needed affordable local currency (Birr) capital to enable their clients to purchase these products through installment payments. In order to (i) provide access to affordable finance for off-grid renewable energy products to complement the electricity grid connection program and (ii) promote private sector investments in renewable energy technologies and energy efficient products in Ethiopia as well as develop a private sector market, especially in rural areas, the credit line was designed with two windows:

A. Retail loans to Ethiopian private sector enterprises (PSEs) and small and medium sized enterprises (SMEs), with guaranteed access to forex, for up to two years, (including a grace period of 6 months), at 12 percent interest; and

B. Wholesale loans to Ethiopian MFIs in local currency, for up to six years (including a grace period of 12 months) at 6 percent interest.

Under the credit line, training is also provided to ensure proper appraisal of technologies, products, and services, as well as to set and adhere to quality standards of the sector. Supplemental capacity building activities to strengthen the capacity of MFIs in administering their credit lines, as well as coordination with other stakeholders (e.g., Regional Energy Bureaus), business development, and community engagement are ongoing. As part of IFC Lighting Global's education and training program, about 100 technicians have been trained to provide after-sale services to support PSEs.

Approved MFIs provide affordable financing to rural communities entering into tripartite agreements with Regional Energy Bureaus (REBs) and selected PSEs to procure and install off-grid products for the customer. DBE has mostly worked with fourteen MFIs, and an inclusion Committee was established to expand the network of participating ones to thirty. The PSEs can access credit and foreign exchange to import and commercialize products.

The credit line at the DBE has already underwent two phases of implementation, for an overall funding of US$40 million. Phase I was for 2012–2016 (US$20 million), whereas Phase II started in 2017 with the same amount of funding. The rate of nonperforming loans (NPLs) has been kept at 0 percent since the opening of the windows.

Latest developments under the credit line at the DBE

In response to market demand and ongoing supply shortages, an additional US$20 million was made available under the MDCL beginning in 2017, with two key changes:

- A US$4.5 million collateral support facility guaranteed up to 75 percent of the loan amount; and
- A MoWIE policy to allocate 75 percent of MDCL funding for solar home systems, and 20 percent for lanterns (5 percent is allocated to clean cooking technologies).

This phase of the credit facility has shown impressive results in just over a year, reflecting the market needs for both access to foreign currency and working capital. In addition, the number of off-grid PSEs applying to the credit line has tripled to 30, and MFIs participation officially grew from five to 14 (with the full 30 MFIs recently approved for participation). The summary comparison between the two phases is presented in Table 4.3, and specifically, the following results were achieved in one year:

- The US$20 million allocation has been oversubscribed (compared to four years for the initial US$20 million);

Figure 4.1 Eligible products under the credit line at the DBE

Source: DBE, 2018.

Table 4.3 DBE Credit line: off-grid connections by technology

Technologies	1st Phase (2012–2016)	2nd Phase (2017–August 2018)	Total
Solar lanterns	828, 805	296,033	1,124,838
Solar home systems	10,499	61,876	72,370
Total	**839,304**	**357,909**	**1,197,208**

Source: DBE, 2018.

Note: For the second phase, the number of lanterns and solar home systems refers to the number of loan applications approved by DBE and signed by PSEs.

- The US$4.5 million collateral guarantee has been used in full;
- Nonperforming loans (NPLs) continue to be 0 percent;[54] and
- Solar home systems under approved applications have grown from 10,000 to 70,000 in line with MoWIE's 75 percent allocation target;
- Applications to finance an additional 120,000 solar home system connections are technically approved applications and in review by DBE

Significantly, the performance of the credit line shows the growing interest of the market in distributing off-grid solar solutions for higher quality of services, in line with the Government's commitment to transition from lantern-based off-grid access. Table 4.3 summarizes DBE lending by technology up to December 2018.

Gender and off-grid

Gender gaps in access to finance and entrepreneurship are being tackled in the DBE Market Development for Renewable Energy and Energy Efficient Product Credit Line (US$45 million). Large gender gap identified in female applicants and beneficiaries of credit line, led to a focus on the women's segment. Thus far, a workshop was hosted in February 2017 with all MFIs engaged under credit line to map out barriers and opportunities to tackle gender gap. In 2018, important actions were undertaken to advance the gender equality agenda in off-grid with highlights outlined below:

- Women's business associations and female entrepreneurs engaged in a half-day information session co-hosted by DBE on the opportunities available in the off-grid sector together with the WB, IFC, and the Ethiopia Climate Innovation Center (ECIC). In the months after the session, four female entrepreneurs have come forward to apply for a total of US$1.5 million of funding to import off-grid technologies, from a baseline of only nine male-headed entrepreneurs accessing finance.
- As part of the technical assistance for MFIs under the DBE credit line, a specific module focused on reaching more women with financing solutions has been delivered in January 2019 to all MFIs actively engaged in consumer finance aspects in off-grid. The training focused on the business case for reaching women, case studies globally on what works, and designing new approaches that focus on women as target market segment.

Isolated mini-grids: achievements to date

EEU operates a number of isolated diesel generation distribution systems where grid power is not yet available. Out of 36 mini-grids constructed, five have been successfully connected to the grid, and the remaining ones are mostly located in the Somali region (see Table 4.4). About 35 percent of the mini-grids have an

Table 4.4 Installed capacity and number of connections provided by EEU diesel mini-grids

Installed kW	No. Sites	%		Connections	No. Sites	%
100 & 150 kW	14	39%		No data	17	47%
200 & 250 kW	8	22%		1–250	11	31%
320 & 360 kW	8	22%		251–500	4	11%
520 kW	1	3%		501–750	2	6%
Grid connected	5	14%		1,001–1,250	1	3%
				1,251–1,500	1	3%

Source: NRECA, EEU (2016).

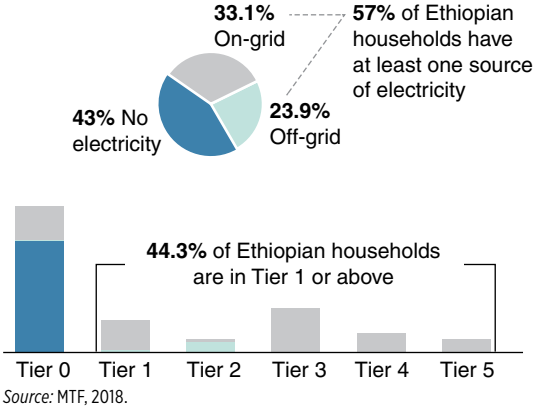
installed capacity of 100 kW, with one site at 520 kW and the remainder between 150 kW and 360 kw. About 8,000 connections are estimated to be currently provided through these existing installations.

The Government is also collaborating with development partners for the piloting of mini-grids powered by renewable energy sources. USAID is conducting feasibility analyses for the conversion of EEU's diesel mini-grids to renewable energy power, five hydroelectric sites identified by Water Works Enterprise,[55] and several clusters of unelectrified villages to evaluate mini-grid solutions for access provision. The European Union is financing five hydro mini-grids implemented by GIZ, testing a model for renewable energy–distributed generation that is currently based on cooperatives, but is aimed at scaling up the market for private or public agencies, as well as a combination of both. In collaboration with the Korean International Agency Cooperation, UEAP also launched in 2017, two hydro mini-grids. In addition, solar, wind, and other renewable mini-grids activities are being piloted. A summary of ongoing and planned mini-grid activities in the country is provided in Table 4.5.

4.2 NEP off-grid program: challenges and opportunities

The MTF survey results confirmed the baseline for off-grid access at 11 percent and the market assessment presented in the NEP on technology penetration and provided further analytical support to the Government's commitment to ensure the successful transition from lanterns to a higher quality of service. As shown in Figure 4.2, about 13 percent of the Ethiopian population is currently served by lanterns, and is not reflected in the overall off-grid access rate for the country (11 percent) which takes into account the minimum definition of access (Tier 1) and above. Access to lanterns is therefore reflected in the no access bar and statistics. The minimum definition of access requires at least a service of four hrs/day.

Figure 4.2 Grid and off-grid access, MTF results



Source: MTF, 2018.

The development of a bankable and sustainable off-grid implementation program responds purposefully to the interlinked challenges currently affecting the achievement of 35 percent of off-grid access by 2025 (which translates into about 6 million HHs) over a time frame of seven years (2019–2025) to cover for mid-term, pre-electrification, and long-term needs, as well as for the additional 3.3 million HHs interested in short-term pre-electrification services. That brings the overall number of expected beneficiaries at about 9 million HHs. Through the combined deployment of solar off-grid and mini-grid solutions, the NEP off-grid program responds to the need for the following:

Speed: Dramatic acceleration to an average of over 1.2 million off-grid connections per year;

Nationwide spatial outreach (scale): Nationwide outreach of off-grid technologies, both in commercially attractive and less commercially attractive areas to ensure adequate service delivery irrespective of where someone happens to live and to promptly serve the long-term off-grid beneficiaries residing in deep rural areas;

Improved services: Transition from lanterns to higher systems complying to international quality standards. The Government intends to take advantage of the latest technology advances and reduction in prices (mostly due to reduction in the cost of batteries and efficient appliances), particularly for solar home systems, which can now be bundled with efficient appliances (such as fans, radio, TVs), giving customers the opportunity to fully enjoy the benefits of electricity access. This transition implies a fundamental change in the Ethiopian retail market, which is still affected by the penetration of counterfeit and low-quality products. The findings from the International Finance Corporation (IFC) Lighting Ethiopia program market survey the estimate that quality-verified products make up only 20 percent of the market. In addition, mini-grid solutions are to be targeted in areas with a current or potential load justifying the investment;

Commercial viability and affordability: Adoption of business models adequate for the higher monetary value of solar home systems (and mini-grids) ensuring (i) returns on investment for implementing agencies, including availability of payment options,

Table 4.5 Summary of ongoing mini-grid initiatives in the country

Development Partner	Organization	Name of the Project/ Initiative	Stage of Development and Time Frame	Size (Kw installed capacity)	Source of Fuel	Business and Institutional Model	Connections (actual projected)	Location	Cost (US$)	Capacity Building Description (TA)	Costing TA ($US)	Further Information
Power Africa	Ethio-Resource Group PLC	Six Wind power micro-grids	Installed and operational: Awaiting distribution and sales license	6 kW (1 kW each)	Wind	Private model	300 households, 20 enterprises, and 1 health clinic	Menz district, Amhara region	$100,000 grant support through U.S. African Development Foundation, Energy Challenge Award	USAID/ Power Africa assisting them in getting distribution and sales license	—	Six 1-kilowatt wind turbine systems powering six micro-grids
Power Africa	Rensys Engineering and Trading PLC	Solar mini-grid system	Installed and operational: Awaiting distribution and sales license	12 kW	Solar	Private model	198 households, small businesses, and institutions	Deke (Lake Tana), Amhara region	$100,000 grant support through U.S. African Development Foundation Energy Challenge Award	USAID/ Power Africa assisting them in getting distribution and sales license	—	—
DFID		Green Minigrid Regional Facility	Funding allocated to WB and AfDB	N/A (TA)	Renewables	TA for developing mini-grids	N/A	N/A	c. 1.3 m	Work with GoE and EEU/EEP	c. 1.3 m	
EUD		SE4ALL TAF assignment	Pre-feasibility studies of 3 sites, Q1 2019			TA for developing mini-grids tender documents	Q1 2019	Q1 2019	Q1 2019	MoWIE/EEU		
GIZ/EnDev		Engrin	Tendered. Finalization late 2019	30	Hydro	Cooperative	252 households projected	Amhara 10.883342° 37.166393°	124,169	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government
GIZ/EnDev		Abaye	Tendered. Finalization late 2019	50	Hydro	Cooperative	420 households projected	Amhara 11.230909° 36.987210°	206,948	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government

(continues)

Table 4.5 Continued

Development Partner	Organization	Name of the Project/ Initiative	Stage of Development and Time Frame	Size (Kw installed capacity)	Source of Fuel	Business and Institutional Model	Connections (actual projected)	Location	Cost (US$)	Capacity Building Description (TA)	Costing TA ($US)	Further Information
GIZ/EnDev		Timbil	Tendered. Finalization late 2019	30	Hydro	Cooperative	327 households projected	Amhara 11.028972° 36.532505°	124,169	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government
GIZ/EnDev		Idris	Tendered. Finalization late 2019	30	Hydro	Cooperative	170 households projected	Oromia 9.073567° 36.851200°	124,169	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government
GIZ/EnDev		Waro	Tendered. Finalization late 2019	25	Hydro	Cooperative	220 households projected	Oromia 7.529914° 36.807061°	103,474	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government
GIZ/EnDev		Naso	Tendered. Finalization late 2019	35	Hydro	Cooperative	320 households projected	Oromia 7.739350° 36.488167°	144,863	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government
GIZ/EnDev		Gibe	Tendered. Finalization late 2019	30	Hydro	Cooperative	256 households projected	Oromia 7.620150° 36.618383°	124,169	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government
GIZ/EnDev		Ameka	Tendered. Finalization late 2019	50	Hydro	Cooperative	435 households projected	SNNPR 7.817313° 37.759877°	206,948	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government
GIZ/EnDev		Fuamo	Tendered. Finalization late 2019	52	Hydro	Cooperative	575 households projected	SNNPR 7.764899° 37.744989°	215,226	Knowledge transfer + on-the-job training	Tender procedure ongoing. TBD	Cost includes 33% grid cost to be paid by the Reg. Government

Source: Development Partners Roundtable and EEU.

(ii) affordability of off-grid services, and (iii) steady quality of services after the sale; and

Enabling ecosystem: Establishment of a set of policies, regulations, and incentives supportive of the whole off-grid ecosystem across the value chain, from importers to customers, to mini-grid developers. This includes adoption and enforcement of enabling regulations, as well as regulatory certainty, quality standards, and financial public support programs targeted to ensure equity, human capital development, and economic growth across the country.

A joint effort by public and private actors

The size, scale, speed, and geographic coverage of the NEP off-grid program requires full leveraging of all available implementing agents and resources—public, private, as well as public private partnerships and cooperatives. All efforts need to be scaled-up and stepped up to the challenge of adequate, affordable, and universal access provision. Development partner coordination to efficiently target the implementation needs of the off-grid program, from lending to access to finance, to capacity building and technical assistance is also required. The eventual degree of public and private participation will be determined based on implementation progress and quality of service provision. All activities will also be closely coordinated with the Safety Net and other Government programs and related Ministries (e.g., Ministry of Agriculture), enabling local processing of agricultural products and leading to increased local value generation and job creation.

The implementation of the NEP seeks to build on the comparative advantage of public and private actors, and their potential for scale-up in the Ethiopian context under the overall planning, monitoring, and sector enabling role of the Government. The NEP also identifies a comprehensive menu of implementation support and technical assistance activities deemed key for the success of the program and its sustainability over the years, detailed at the end of this chapter.

The comprehensive approach of the off-grid program, the role and responsibilities of sector institutions, the implementation framework, and the enabling ecosystem requirements for its success have been informed by the latest developments in the off-grid market and lessons learned from international best practices, such as in Kenya, Rwanda, Nigeria, Myanmar, Bangladesh, Peru, and Argentina. Institutional arrangements are detailed in Chapter 5, and an overview of the latest developments in the off-grid space is presented in Annex 6.

Table 4.6 Sector stakeholders in the off-grid space

	Implementing Agents and Intermediaries
Public sector	EEU, MoWIE, Regional Energy Bureaus, cooperatives
Private sector	Private sector enterprises, micro-finance institutions, other financial intermediaries

Opportunities offered by off-grid technologies—latest international developments

The implementation of the NEP off-grid program intends to take full advantage of the latest developments in the off-grid market, both in terms of technology advancements and business models. In fact, the sector grew at rates of over 100 percent over 2011–2013 (where half of the sales were in Africa),[56] proving its capacity to achieve scale reaching more remote households earlier than grid extension and thus accelerating economic development. Growth has been driven by advances in technology and pay as you go (PAYGo) business models, which have led to improvements in service and commercial performance and reduction in price. Particularly, the market has been benefiting by the following main developments:

- Steep price reduction and improvement in technologies (higher level of service available for a lower price);
- Improvements in appliances, particularly with the DC super efficient ones;
- Improvements in business models and affordability (mostly PAYGo) and spread of mobile phone solutions;
- Expanded geographic reach of off-grid technologies within countries (off-grid technologies started being sold beyond the wire/urban/highly commercially attractive areas;
- Markets have expanded to backup solutions as well, in case of unreliable grid services.

Continued rapid technology advancement has enabled higher service levels at lower costs than ever before. Powerful lanterns can also charge mobile phones and other small devices, and small rooftop solar home systems can now provide Tiers 1, 2, and even Tier 3 service levels.

Pay as you go systems

Recent years have shown the emergence of PAYGo systems, whether combined with mobile payment

systems or not, as the most promising—in terms of both efficiency and effectiveness—technology driven business models for the rapid scale-up of improved services and more expensive technologies (i.e., solar home systems), thus ensuring both commercial viability for the private sector and affordability for costumers. PAYGo models have been introduced for mini-grid payments as well.

PAYGo allows consumers to pay the lease amount for a given energy system or pay a fee for consumption. It includes a range of business models, which differ as to how payments are accepted and to whom the ownership of the system ultimately devolves. The PAYGo model offers a one-stop shop, where the product and the financing are available from the same source. The willingness of companies to finance products gives customers confidence in the new technology, and operational efficiency is improved as there is no need for coordination between financial providers and technology providers. When associated with mobile communication technologies, the model also reduces the costs associated with collecting repayments, although other solutions are available in the absence of these technologies and/or network coverage.

In countries with the most developed private sector off-grid solar markets, private companies and MFIs are the main providers of such installment payment plans. With PAYGo, the companies are able to provide longer term loans than those usually offered by MFIs, allowing the provision of relatively large credit amounts (to cover the cost of the renewable energy system) to consumers whose creditworthiness may be unknown. The credit risk is partially mitigated by the incentive system that links payments to service provision. Furthermore, companies have an incentive to ensure quality of service and provide adequate after-sale services (including maintenance), as their revenue stream depends on consumption.

Not lastly, PAYGo can become an important source of financial inclusion and financial sector development more broadly, as detailed in Section 4.4.

Increased interest in the Ethiopian market

Throughout 2018, an increased interest in the Ethiopian off-grid market was manifested in two main dimensions. The first showed an increase in the number of private sector enterprises, an exponential increase in the number of applications to the credit line, and an increase in solar home systems. The second included a multitude of workshops on off-grids that were organized over the year, showcasing also an increased interest from Development Partners. This interest was also supported by the Government, which had several rounds of consultations on both off grid solar and mini-grids developments.

Preparatory work for the design of the NEP off-grid program

Acknowledging the depth and breadth characterizing the achievement of the off-grid target, the Government undertook a series of analyses and assessments to ensure that all aspects impacting the successful design and implementation of the off-grid program were adequately taken into account. These studies also reflect the implementation support activities and technical assistance identified in the first version of the NEP. More specifically, the following work was conducted to inform the off-grid program of the NEP:

(i) GIS analysis
(ii) Access to finance assessment
(iii) Business model assessment
(iv) Preliminary supply chain analysis assessments and barriers to private sector scale-up
(v) Payment options
(vi) Mini-grid business model options
(vii) Review of best practices
(viii) Affordability
(ix) Enabling environment assessment

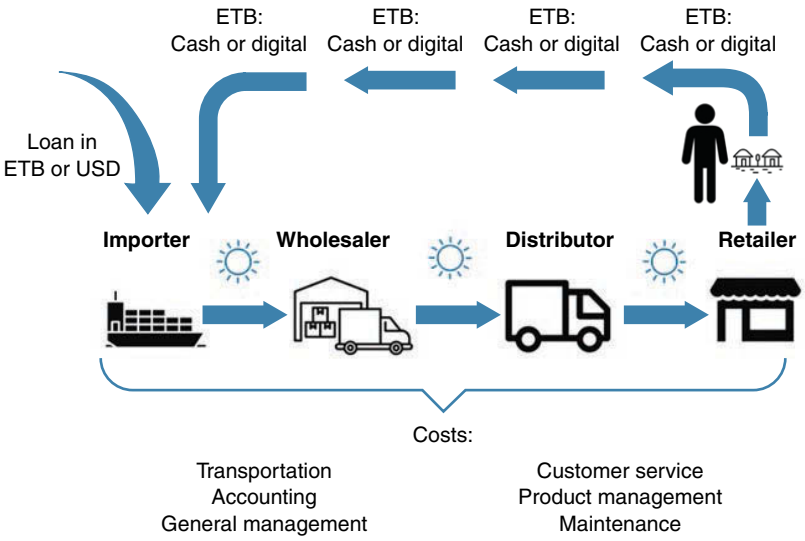
The results of these studies also informed the identification of immediate implementation support and technical support activities to be undertaken during the first year of implementation (2019) of the off-grid program, as detailed at the end of this chapter.

4.3 Trading of solar off-grid technologies

The establishment of a well-functioning market for off-grid solutions is key to reach the off-grid targets for the sustainability of the program, irrespective of the implementing agent (whether public or private, or a combination of both). The NEP identifies the main barriers for scale-up of off-grid technologies both on the supply and demand sides. More specifically, it addresses challenges and tackling measures with these six key dimensions (steps) characterizing trading of off-grid solar solutions and their sustainability:

1. Access to finance
2. Streamlined imports and quality assurance of products
3. Supply chain
4. Ensuring affordability

Figure 4.3 Financial and goods flow (trading) within the off-grid market



5. Paying for solar products
6. Supporting access to finance through an improved financial system

The identification of tackling measures to overcome the main barriers across the six trading steps is also reflected in the priority technical assistance and program implementation support activities identified at the end of the chapter, to ensure the adequate establishment of: (i) an enabling environment for off-grid technologies, including coordination between public and private activities in both commercially attractive and deep rural areas; (ii) adequate capacity of implementing agents; and (iii) further analytical work needed to inform implementation.

The six steps in trading off-grid technologies

The functioning of the off-grid market is characterized by six main steps, summarized in Figure 4.3. Undercapitalized companies need access to finance to import off-grid technologies and to finance the logistics associated with transferring the technologies to the customers. Every step is characterized by a monetary transaction: importers purchase the system, then sell it to wholesalers, who in turn sell it to distributors and then retailers, to eventually supply the customers. Every step of the supply chain is associated with specific transaction costs, as the supply network needs to be established, expanded, and sustained over time. The costs associated with the supply of goods are then either recovered as a cash sale or over time through installment payments, which could happen in cash or in a digital format. The backward fund flow is eventually needed to repay the loans that were needed to start the business in the first place, and over time ensure a profitable activity (where revenues are higher than costs).

The financial needs are associated mostly with importing the solar off-grid systems from abroad—requiring access to forex—and to finance management and logistics, which encompasses inventory and warehouse management, product management (quality) and maintenance, and financial management and accounting, as well as transportation (e.g., fuel and vehicles), employees, security, and more. Once the product reaches the customer, after-sale service and customer care need to be financed as well. All local transactions to finance the distribution of off-grid solar systems and the payment associated with the purchase of the goods are performed in local currency, Ethiopian birr (ETB).

A well-functioning and profitable market is characterized by limiting the time lag between accessing finance and paying the loans back, with a profit margin between the cost of the investment and the revenue stream associated by the supply of goods (return on investment). The stickier each step of this process is and the higher the cost associated with each, the longer it takes entrepreneurs to return the loan, and the lower the profit margin. As the interest rate paid to financially support the establishment and running of the business is determined by the pricing risk over time (all things being equal), the higher the time lag, the higher the interest rate associated with access to finance. This creates three main negative

consequences for the market, impeding its functioning well: (i) overall lower amount of capital available and at a higher price (interest rate), (ii) lower number of entrepreneurs that can participate in the market, and (iii) higher price of the goods for end-user customers needed to repay all the transactions that led to the supply of the goods themselves.

Based on comprehensive consultations with private sector enterprises, both local and leading international ones, the end-user cost of solar off-grid technologies (e.g., Tier 1), is currently estimated to result in a higher price for customers, depending on their location, the number of steps in the supply chain used to reach them, and the mark-up at each step. The greater the number of steps in the supply chain and the higher the costs associated with reaching out to the customer, the higher the end-user price. These costs are estimated to result in a market cost of off-grid technologies at a price ranging from a 50 to almost 200 percent markup from the cost of the systems at importation—establishing an enormous barrier to affordability of off-grid technologies, as well as for the expansion of off-grid technology delivery. That is, a system imported for US$150 could end up being sold in remote areas for about US$400.

This is a well-known consequence of thin (or illiquid) markets, where individuals and firms cannot purchase or sell an asset quickly without causing a drastic change in the asset price, and where the latter is also associated with high volatility. By contrast, a liquid market allows to realize two major benefits, that is surpluses for both the consumer and producer. If goods can be provided fast and cheaply, the end-user would have access to affordable off-grid technologies, paying less than what they initially were willing (surplus) to and/or expanding the number of customers participating in the market and providing revenue streams back to the entrepreneurs. In turn, if the revenue stream is higher than the costs associated to establishing the stream itself, producers also benefit from a surplus. That is, the surplus comes from how much of a good the producer is willing to supply versus how much is received in the trade. Specifically, in the off-grid solar market, suppliers are interested in providing mid- to long-term services for systems of higher quality of services (Tier 1 and above), as the estimated payments over time (as an alternative to an on-time cash-based transaction, which would less likely be affordable to the population—as described in Annex 10).

If trading barriers are removed, more products can be imported and supplied, and more beneficiaries can be served.

4.4 Establishing a well-functioning (liquid) off-grid market

Table 4.7 summarizes the components of the off-grid program for the achievement of universal access by 2025 based on the geo-spatial analysis of location of beneficiaries, distance from the existing grid, and expected timing for receiving a grid connection. While mini-grid sites have been preliminarily identified with priority services in deep rural areas (Section 4.7), the mini-grid program will also support pre-electrification needs, particularly for productive uses and access to adequate basic services (health and education), as described in Section 4.5.

Serving over 9 million HHs by 2025 is a daunting challenge, but not an insurmountable one. Ethiopia constitutes the biggest unserved market of East Africa, as is clearly indicated by the market size of potential beneficiaries. The achievement of the universal access targets only requires the establishment of a well-functioning market infrastructure and trading platform, which would have positive externalities and synergies with other important development mandates, from financial inclusion and development to agri-processing. This would support overall service delivery (beyond electricity) to the Ethiopian population, access to goods and services, and a diversified and growing economy, in line with what is required for the successful achievement of middle-income status by 2025.

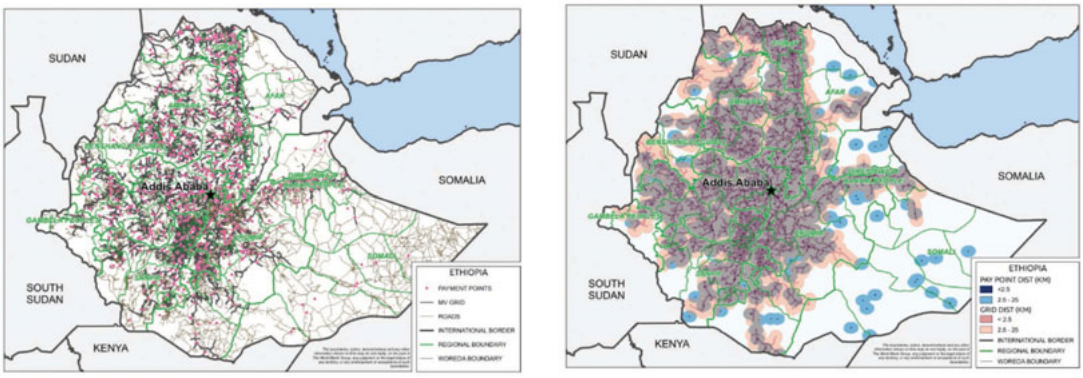
Commercial attractiveness and deep rural areas

As depicted in Figure 4.4, there is an overlap among MV lines, roads, and payment points (such as bank branches and ATMs), which are the key dimensions relevant for serving the market. Their existence, as well as lack thereof, constitutes an indication of the commercial attractiveness of the different areas of the country for the delivery of off-grid solutions, and hence of the commercial attractiveness in serving the different segments of beneficiaries. As the geo-spatial overlay of available information showcases, most of the existing infrastructure is located within 25 km of the existing grid. Hence, beneficiaries residing within this space—that is, those targeted for short-term and mid-term pre-electrification—are relatively more attractive for service delivery than those beyond the 25 km buffer, as less infrastructure is available to distribute and retail off-grid products, and increased costs are associated with logistics overall, from transportation to staffing.

Table 4.7 Components of the off-grid program, 2019–2025

Components of the Off-Grid Program	Distance from Existing Grid	Total HHs (2019–2025), Million
Short-term pre-electrification (grid reaches by 2025)	<2.5 km	3,300,000
Mid-term pre-electrification (grid reaches after 2025)	2.5 km–25 km	5,000,000
Long-term off-grid/deep rural (grid does not reach by 2030)/solar off-grid	>25 km	700,000
Long-term off-grid/deep rural (grid does not reach by 2030)/mini grids		210,000
Total		**9,210,000**

Figure 4.4 Combined overview of MV, roads, and payment points



Source: Geo-spatial analysis, 2018.

In addition, the assessment of commercial attractiveness does not exclude the relevance and importance of other parameters, but integrates key dimensions for service delivery and relies on the best available information and reasonable proxies. For instance, based on private sector consultations, the areas considered as commercially attractive are those within a 150 km diameter from the main urban centers, which is correlated with existence of roads and payment points.

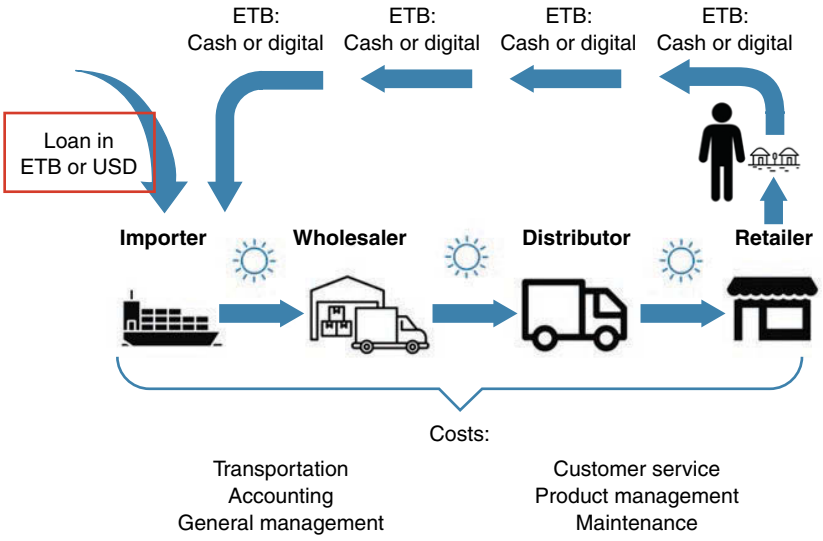
Long-term off-grid areas—for about 1 million beneficiaries—are hence characterized by lower commercial attractiveness (deep rural areas) and increased costs associated with service delivery. To ensure adequate access to lighting products, the Government has set in place a supply-side financial support mechanism, which is described later in this chapter. In addition, the more granular overlap of priority beneficiaries, such as those belonging to the Productive Safety Net Program (PSNP) of the Government, as well as those deemed to have the highest growth potential under the agriculture policies of the Government, would be required to further detail the challenges related to their servicing. Preliminary targeted solutions, based on information available, are presented in at the end of this chapter. The collection of this information is prioritized under the technical assistance earmarked for 2019, as described at the end of this chapter.

The implementation framework for the NEP off-grid program looks at six main steps characterizing trading of off-grid solar technologies and identifies options for improved time and cost efficiency gains, all in all to establish a well-functioning market. More specifically, the following key dimensions of the trading flow have been comprehensively analyzed: (i) access to finance, (ii) streamlined imports and quality assurance, (iii) supply chain, (iv) affordability, (v) payment system, and (vi) decrease in overall financial needs for business development (that is, the need for access to financing, where the trading flow begins).

All of these are key for service delivery regardless of the location of beneficiaries, where the costs associated with inefficiencies of each step increase with distance.

Step 1. Access to finance

Enterprises operating in the off-grid market will require access to three main functional sources of funding, (i) forex—for the importation of goods, (ii) working capital for day-to-day trading operations,



and (iii) capital and operating expenditures for the establishment and expansion of the supply market infrastructure and funding of operations and logistics.

Table 4.8 indicates the cost breakdown by distance. Forex estimates are based on a weighted combination of Tier 1 and Tier 2 systems,[57] for an average cost per system of US$150. Working capital estimates are based on the markup associated with the fragmented supply chain currently characterizing the Ethiopian off-grid market, where on average importers and distributors would require an additional 30 percent (based on the information provided by the private sector), and MFIs 16 percent (based on the current interest rate). Table 4.8 also shows the increased working capital and capex and operating expenses associated with service delivery to the different segments of beneficiaries, by distance.

Working capital requirements decrease for short-term pre-electrification beneficiaries residing within 2.5 km of the existing infrastructure (urban and peri-urban areas) as a result of higher turnover of assets and increases for long-term off-grid beneficiaries (up to 150 percent) from the average working capital needs of US$200 in mid-term pre-electrification areas.

Capex and operating expenses are the most elastic to distance as the costs of logistics (e.g.,

Table 4.8 Capital requirement breakdowns by distance

	Short-Term Pre-Electrification <2.5 km	Mid-Term Pre-Electrification 2.5–25 km	Long-Term/Deep Rural 25–100 km	Total
Connections	**3,300,000**	**5,000,000**	**700,000**	**9,000,000**
Forex	$475,000,000	$750,000,000	$105,000,000	**$1,330,000,000**
	$150/unit	$150/unit	$150/unit	**$150/unit**
Working capital	$540,000,000	$1,000,000,000	$210,000,000	**$1,750,000,000**
	$160/unit	$200/unit	$300/unit	**$200/unit**
Capex and operating costs	$200,000,000	$375,000,000	n/a—MST Fund	**$575,000,000**
	$60/unit	$75/unit	$90/unit	**$70/unit**
Total	**$1,215,000,000**	**$2,125,000,000**	**$315,000,000**	**$3,655,000,000**
	$370/unit	**$425/unit**	**$540/unit**	**Average $406/unit**

Note: Estimates based on a 30 percent markup for importers, wholesalers, and distributors, and a 16 percent interest rate of MFIs. The increase in working capital by distance is assumed to be 150 percent higher than the average working capital of US$200 for 2.5–25 km. The increase in capex and operating costs is estimated based on information provided by private sector companies during consultations. They reflect an average 20 percent of revenue/system for cost recovery (US$60) based on the average end-user price of US$300 for the closes communities, an increase of capital and operating expense of 125 percent for HHs residing within 2.5–25 km and of 150 percent for those beyond 25 km.

staffing, transportation) increases with a progressive decrease in the supply and payment infrastructure in the country, including, for example, roads. Estimates are based on consultations with private sector enterprises, which reflect, as of now, an increase in financial needs of US$60/unit in areas very proximate to the grid and supply infrastructure, US$75/unit within 2.5 to 25 km from the existing grid and supply infrastructure, and US$90/unit in areas beyond the existing grid as well as supply infrastructure. As indicated by the geo-spatial analysis, there is in fact an overlap between the location and footprint of the grid infrastructure and the current supply infrastructure.

Table 4.9 summarizes the overall forex and working capital requirements to achieve, on a yearly basis, the NEP off-grid targets (which are mostly fixed regardless of the location of the end customer, with limited increases for the working capital needs) and the additional capital and operating expenditures associated with servicing the different segments of beneficiaries belonging to the off-grid market. The estimates also take into account loan repayments expected from the previous phases of implementation of access to finance solutions.[58]

With business as usual, the access to finance requirements are significant, adding overall to US$3.7 billion, where about US$1.3 billion are in forex requirements, US$1.8 billion in working capital, and about US$600 million for capex and operating expenditures. Together with ensuring the availability of adequate financing needs for the proliferation of local entrepreneurship (including jointly with international private sector enterprises), these access to finance requirements have the ultimate effect of increasing the end-customer price of off-grid solar technologies, posing a risk for system affordability and access even with the adoption of monthly installment sales (PAYGo system) to reduce the up-front investments from the customer perspective.

Efficient use of access to finance

Several instruments and activities have been identified to improve the efficiency of access to finance instruments, encompassing all three kinds of capital needs, forex, working capital, and additional capex and opex needs, which are also sometimes intertwined.

A. Continuous availability of financial resources through a revolving fund. The first revolving credit line was established in Ethiopia to provide access to forex and working capital to private sector enterprises, to ensure adequate support to the off-grid technology supply, and to MFIs to ensure affordability, that is, support to market demand. A first of its kind, the credit facility is now being replicated in over 19 countries as a key instrument to fill the gap in private sector financial needs to engage and operate in the off-grid market. In turn, private sector participation in the off-grid sphere is being increasingly pursued internationally as a means to complement and increase limited public funding available and overall increase operational efficiency and effectiveness, and in turn scale and speed outreach of off-grid solutions.

Table 4.10 indicates the potential savings for almost a half of the access to finance needs: from US$3.7 billion (Table 4.9) to about US$1.8 billion and avoid the continuous injection of additional funding.

B. Decrease in collateral requirements. Current collateral requirements constitute a barrier to overall lending, as also showcased by overapplication (within one year) of the collateral support facility under the DBE during its second Phase of

Table 4.9 Projected forex, working capital, and capex and operating expenditure requirements for service delivery to 9 million HHs by 2025

	2019	2020	2021	2022	2023	2024	2025	Total
Annual NEP connections	310,000	1,000,000	1,400,000	1,800,000	2,000,000	1,200,000		9,000,000
Annual forex needs	US$45M	US$150M	US$210M	US$270M	US$300M	US$180M	US$195M	
Carryover funding[a]	US$15M							
Net forex needs	US$30M	US$150M	US$210M	US$270M	US$300M	US$180M	US$195M	US$1,330M
Annual working capital	US$110M	US$350M	US$375M	US$310M	US$275M	US$165M	US$165M	US$1,750M
Annual capex and operating capital	US$25M	US$75M	US$100M	US$125M	US$150M	US$85M	US$15M	US$575M
Total	**US$165M**	**US$575M**	**US$685M**	**US$705M**	**US$725M**	**US$430M**	**US$375M**	**US$3.7B**

Note: Based on the assumption described for Table 4.7 above.

[a]DBE loan applications received in 2018, which due to lead times, fund 2019 connections.

Table 4.10 Estimated benefits of a revolving fund mechanism—lowered capital requirements

	2019	2020	2021	2022	2023	2024	2025	Total
Net annual forex needs	US$30M	US$150M	US$210M	US$270M	US$300M	US$180M	US$195M	**US$1.330B**
Cumulative working capital needs	US$110M	US$460M	US$835M	US$1.1B	US$1.4B	US$1.6B	US$1.8B	**US$1.8B**
Reduction through revolving forex facility structure	(US$25M)	(US$160M)	(US$505M)	(US$970M)	(US$1.36B)	(US$1.36B)	(US$1.36B)	**(US$1.36B)**
Net additional working capital funding needs	US$85M	US$215M	US$30M	—	—	—	—	**US$330M**
Annual operating capital	US$25M	US$75M	US$100M	US$125M	US$145M	US$85M	US$15M	**US$575M**
Reduction through revolving facility structure	—	—	(US$25M)	(US$75M)	(US$75M)	(US$75M)	(US$75M)	
Net additional capex and operating capital funding needs	US$25M	US$50M	—	—	—	—	—	**US$75M**
Total investment funding	**US$140M**	**US$415M**	**US$240M**	**US$270M**	**US$300M**	**US$180M**	**US$210M**	**US$1.76B**

implementation. Reduced collateral requirements would allow for increased lending volume, also increasing the turnaround under a revolving fund. Options for asset-based/inventory lending (similarly to what is already applied by commercial banks) are currently being taken under consideration, to be developed in collaboration with commercial banks (based on their experience and performance) and considering the potential use of receivables as collateral assets as well.[59]

C. Overcoming lack of forex availability. The main measures that support the increased access to forex in the market as well as a decrease in the need to access it altogether are identified as follows, where benefits are also interlinked with the possible adoption of an integrated supply chain, as described in Step 3:

- Foreign private sector participation in the Ethiopian supply chain (companies currently sell to importers or import components to be assembled locally, or locally manufactured and do not participate in distribution, wholesaling, and retailing): to reduce the markup applied to the products exported to a closer cost to the production one. Foreign participation is also expected to bring investments to the country in FDIs.
- Remittances: support from the Ethiopian diaspora grew substantially in 2018, and remittances have become a meaningful contributor of foreign exchange. A Diaspora Trust Fund has been established to manage their channeling.
- Development of local manufacturing capacity: to overall reduce the need for imports and to support foreign investments under the current regulatory framework. This could offer interesting business potential on a regional basis as well.

NEP off-grid priority technical assistance

Under the immediate technical assistance needs for 2019, NEP provides an assessment of the challenges, opportunities, impacts on forex, and recommendations for an implementation roadmap for the development of local manufacturing capacity.

In addition, a study is also commissioned for the impact on the use of remittances

D. Decreasing working capital. The biggest potential for reduction in working capital would be increasing the turnover of assets in the market, which would be supported by the adoption of an integrated supply chain, as described in more detail under Step 3.

E. Streamlining of loan provisions. For the scale-up of access to finance solutions in the country in support of the scale-up of off-grid solutions, several measures are currently under consideration. More specifically:

- To reduce loan application processing to 15 working days,

- Access to finance solutions could establish an Energy Directorate to manage the expected increase in lending,
- Removal of the requirement that any open loans must be fully repaid before new or additional loan applications can even be considered,
- Borrowers could be required to draw funds within six months of signing, where the grace period will commence on the disbursement date, rather than on the current signing date. Repayment will also be based on actual funds disbursed rather than the contract amount.

NEP off-grid priority program implementation support

Collaboration with commercial banks will be pursued to de-risk the off-grid market and increase overall lending volumes.

Step 2. Streamlined imports and quality assurance of products

Import streamlining, duty removal, and quality assurance are all keys for the adequate supply and affordability of products. Avoiding counterfeit or low-quality product entrance in the market is key for sustainability, as it ensures no exit from the market due to faulting goods and loss of credibility in the value of the transaction, particularly at the nascent stages of development. On all matters, several important measures have already been undertaken with the adoption of Lighting Global certified products and lifting of custom duties.

Moving forward, the following measures will also be considered:

(i) Extend streamlined importation procedures to products with solar panels larger than 15 Wp by making the current voluntary quality standards applying to products up to 350 Wp mandatory. Fully streamline importation procedures by implementing PVOC; eliminating sampling, fees, and deposits, and 'green lane' expediting of arrival clearance for all products up to 350 Wp;

(ii) Import duties and value added tax (VAT)/sales taxes removal for spare parts;

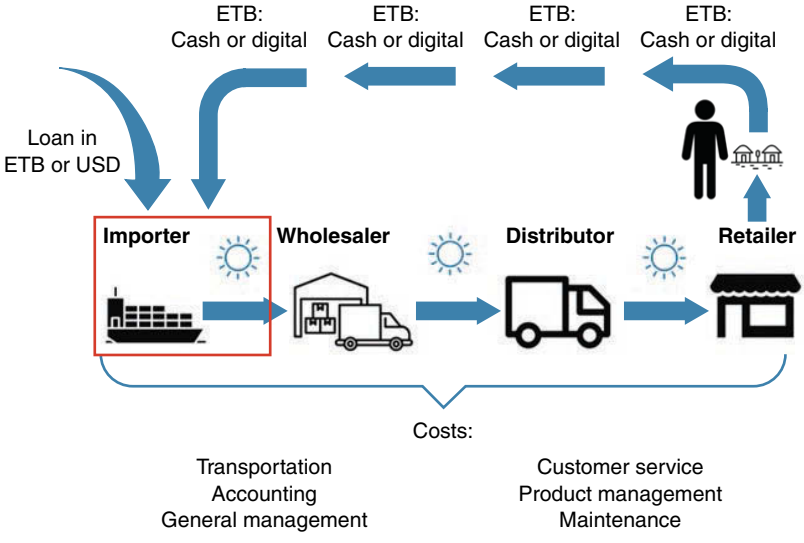
(iii) Import duties and value added tax (VAT)/sales taxes removal could be extended to AC compatible appliances to ensure their affordable availability in the market, as well as DC ones. Recent research highlights a positive correlation between access to appliances and an increase in productive uses.

NEP off-grid program public implementation support

The NEP provides for an educational campaign across sector institutions and public implementing agents for access to the most up-to-date regulations on quality standards. A capacity building training is also included, in collaboration and partnership with relevant ministries, for the enforcement of the regulations adopted.

NEP off-grid program priority technical assistance

In addition, "quality assurance" needs to be ensured, not only for off-grid technologies, but also for off-grid market operators. MoWIE will pursue an improved and more streamlined system of licensing



for off-grid companies—in partnership with other relevant ministries—with the inclusion of a customer protection code (similar to the one recently designed by GOGLA) and the introduction of a system of penalties in case of inadequate customer care. (See also below under grievance mechanisms.)

Step 3. Supply chain

Consultations with private sector companies, combined with best analytics avaiable, allowed an initial estimate of the costs associated with service delivery in the different segments of the country. As shown by Table 4.11, while forex requirements do not change with the location of service delivery, working capital, capex, and operating expenditure associated with expanding and operating the supply chain vary. This results in an increased price of the product for the end-user.

The change in end-user price reflects the faster stock turnover in more commercially attractive areas—where the goods are exchanged faster—and the progressively higher time lag for service delivery associated to outreach with areas that are less endowed with the supply infrastructure, as well as related capital and operating expenses associated with establishing the service supply infrastructure and running it. The lower capex and operating costs associated with serving short-term pre-electrification beneficiaries is due to the higher turnover characterizing urban and peri-urban areas (which is part of their commercial attractiveness), and in fact where off-grid service delivery has currently been focusing.

As indicated in Table 4.11, working capital is the biggest source of financial need. In fact, with business as usual, the access to finance requirements are about US$1.3 billion in forex requirements, almost US$1.8 billion in working capital, and almost US$600 million for capex and operating expenditures. This is due to the lower turnover of assets pending the current fragmentation of the supply chain, with the result of increasing, by each step, transaction costs and markups of involved agents. Based on consultations with the private sector the markups applied at each step of the supply chain, particularly importers, wholesalers, and distributors, are equal to about 30 percent of the cost of the system. If MFIs are involved, they currently charge a 16 percent interest rate.

Indeed, an integrated supply chain has also emerged from other countries' experiences as a key determinant for customer care and for oversight of the customer experience, particularly with PAYGo systems. In fact, customer care is required to ensure continued consumption of streams of revenue.

The adequate provision of off-grid solar technologies will also require an expansion of the physical supply infrastructure, from the number of operating private sector companies, to their size (and number of employees, including agents), to the number of distribution and retail locations. This is recognized as another key determinant for the scale-up of off-grid technologies, for which public support will be provided. In addition, the expansion of the market constitutes a big opportunity for job creation in the country, particularly—but not limited to—the younger generation, from low- to high-skilled functions (see

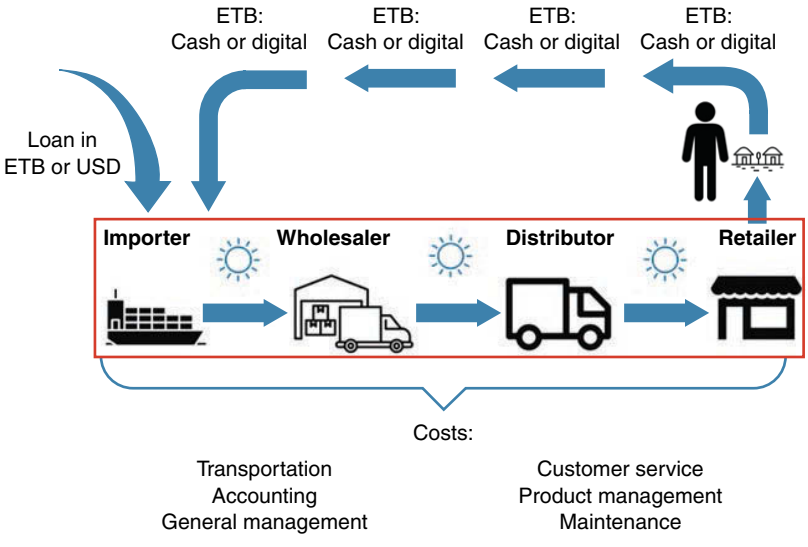


Table 4.11 Estimates of end-user cost by location

	Short-Term Pre-Electrification <2.5 km	Mid-Term Pre-Electrification 2.5–25 km	Long-Term/Deep Rural 25–100 km
Connections	**3,300,000**	**5,000,000**	**700,000***
Forex	$150/unit	$150/unit	$150/unit
Working capital	$160/unit	$200/unit	$300/unit
Capex and operating costs	$60/unit	$75/unit	$90/unit
Total	**$370/unit**	**$425/unit**	**$540/unit**
End customer price range	**$225–275/unit**	**$275–325/unit**	**$350–400/unit**
Average price		**~$300/unit**	

Note: Estimates based on a 30 percent markup for importers, wholesalers, and distributors, and a 16 percent interest rate for MFIs. The increase in capex and operating costs is estimated based on information provided by private sector companies during consultations. They reflect an average 20 percent of revenue/system for cost recovery (US$60) based on the average end-user price of US$300 for the closer communities, an increase of capital and operating expenses of 125 percent for HHs residing within 2.5–25 km, and of 150 percent for those beyond 25 km.

*About 300,000 connections will be provided in deep rural areas through mini-grids solutions and have therefore been deducted from the off-grid solar program.

also Section 4.5 on job creation). The implementation of the NEP off-grid program regulations currently affecting the establishment of an integrated supply chain will be reviewed, in partnership with other relevant sector stakeholders.

NEP off-grid program public implementation support

(i) **Workforce expansion** of technicians, market campaigns, and agents who support market activities through: communication and education campaigns, and after-sale and maintenance services. Training activities will be organized leveraging on the existing Technical Vocational Education and Training (TVET) programs and in synergy with ongoing Government programs, the PSNP and the AGP, offering new income generating opportunities and/or community work opportunities (required to receive cash transfers under the PSNP program). This workforce will support private sector delivery by offering skilled workers and reducing the burden for them in establishing their business. Training activities and related workforce creation will be conducted in collaboration with the REBs, when applicable and adequate.

(ii) **Expansion of existing distribution channels** both in their scope and number. The Government will support the expanded scope of the public distribution channels currently employed by off-grid distributers and retailers, such as post offices, which could provide, for instance, warehouse services. In addition, the Government will pursue agreements with the major distribution channels in the country. Collaboration between local entrepreneurs and these major distribution channels will not only provide logistical support and reduce operational costs, but provide knowledge sharing for the increased efficiency of the value chain. The leveraging of these distribution channels will also increase the number of potential payment points in the country, therefore contributing to the supply infrastructure.

(iii) **Increased PSE, REB, and MFI coordination.**

Step 4. Ensuring affordability

The MTF survey indicates that pent-up demand for adequate access to electricity services is high for a Tier 2 system (~US$500), as indicated in Figure 4.5.

In addition to the results of the MTF, the analysis of the Household Consumption and Expenditure Survey (HCES) provides a more detailed picture of affordability of off-grid services in the country. Table 4.12 shows the monthly expenditure by quintile under different monthly expenditure shares for energy consumption.

Data on willingness to pay for a grid connection and a Tier 2 off-grid solar device indicates that female-headed households are less willing to pay for both energy solutions, in comparison to male-headed households. 15.5 percent of female-headed households said that they would never accept the offer of being connected to a grid and 30.5 percent were against purchasing a Tier 2 off-grid solar product at any given term. 2.6 percent and 18.6 percent of male-headed households, in comparison, said that they would

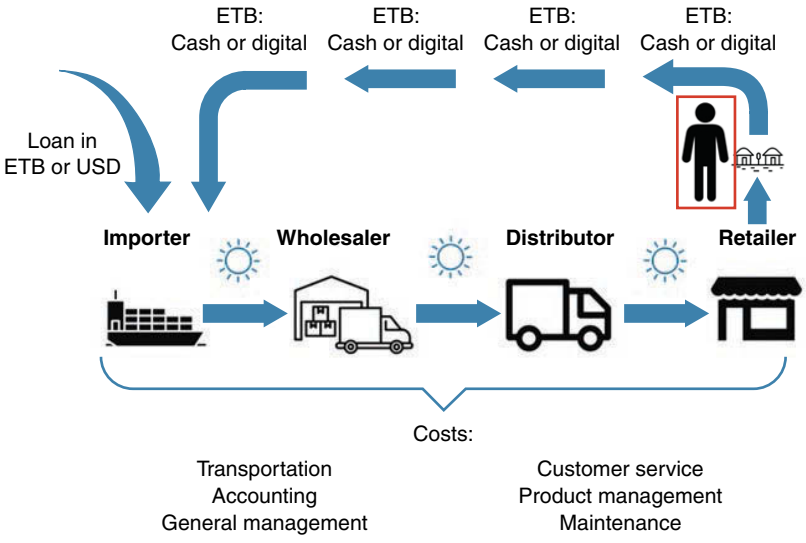
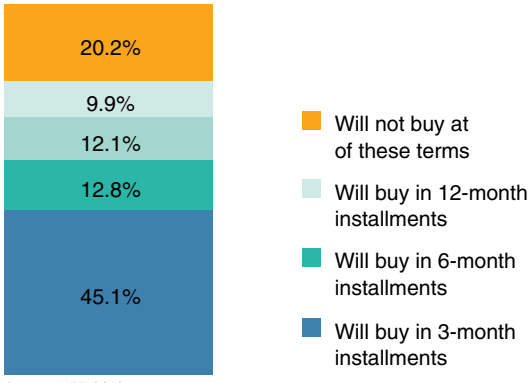


Figure 4.5 Willingness to pay for a Tier 2 solar product



Source: MTF, 2018.

never accept the above offers, respectively (further details Annex 3).

Based on consultations with private sector companies, the monthly payment for a Tier 1 system in Ethiopia could range from US$4.5–US$10 with the adoption of a PAYGo system, which will allow end-users to pay by installments and eventually own the system, without having to pay up front in cash for the whole cost of the system itself, which could become daunting on monthly expenditures particularly for mid-term pre-electrification candidates and long-term ones (Table 4.11).

The end-user financial support is targeted to support access to off-grid services for the poorest of the poor based on a 5 percent monthly expenditure for energy services, reflecting current estimates for energy consumption for the bottom of the pyramid, while other scenarios are also being showcased to allow for flexibility. Based on the expected monthly expenditure (at least US$4.5/5 per month),[60] the bottom 20 percent of the population is expected to be in need of some financial support to afford off-grid services.

The success of the NEP off-grid program rests on the adequate supply of quality products affordable to the whole population. Along with the lifeline tariff adopted as part of the tariff brackets, off-grid services—even if prevalently served by PSEs—will have to ensure the affordability of reliable and quality systems.

Building on the success of the Safety Net program (launched in 2005 as part of the strategy to address

Table 4.12 Monthly expenditure scenarios for electricity expenditure by quintile (Q) and bottom deciles (D)

		D1	D2	Q2	Q3	Q4	Q5
Monthly expenditure		US$59	US$84	US$105	US$136	US$139	US$199
Expenditure for electricity	**5%**	US$3	US$4	US$5	US$7	US$7	US$10
	8%	US$5	US$7	US$8	US$11	US$11	US$16
	10%	US$6	US$8	US$11	US$14	US$14	US$20

Source: Calculation based on the HCES survey, 2018.

Note: Based on a USD/ETB exchange rate of 28.2 (as per January 2019).

chronic, and then temporary, food insecurity) currently supporting about 1.6 million HHs—13 percent of the population (i.e., D1 and more), the NEP will also ensure that the poorest of the poor have access to adequate, reliable, and affordable electricity systems. For this purpose: (i) synergies will be built from an operational perspective to ensure that the implementation of the NEP builds on effective distribution channels and quality control mechanisms under the public program, and (ii) end-user financial support is provided for the bottom decile, for whom PAYGo monthly payments for a Tier 1 system would not be affordable. Based on synergies with the Safety Net program, information to be collected harnessing local administration knowledge of the population, particularly REBs, and further information becoming available with the nationwide affordability study earmarked under the NEP, implementation mechanism in support of market demand will be further detailed.

Table 4.13 shows the current estimates of end-user support required for the affordable rollout of off-grid solutions—for about US$63 million—to be updated over the course of implementation. Estimates are calculated to ensure affordability for a Tier 1 system through installment sales of about US$4.5/5 per month and compounded over the years up to 2025.

End-user subsidies are estimated to financially support the population belonging to the bottom decile of expenditure. The estimates are based on the achievement of 96 percent of the population through a connection to the grid by 2030, with only about 4 percent of the population in need of an off-grid solution in the long term (at least until 2030 and likely beyond). By 2025, the Ethiopian population will be universally connected, 65 percent through grid access, and 35 percent through off-grid solutions. After 2025, the grid is expected to start substituting off-grid solutions with a connection and longer service hours. Off-grid technologies will still provide a useful backup solution in case of inadequate 24/7 supply but would be not be a key economic and social development means anymore. The time frame is also set to allow for implementation flexibility, upon which estimates for long-term off-grid beneficiaries will be updated, reflecting realities on the ground of access consumption and willingness to pay. In parallel, long-term off-grid access is included to reflect the priority need to provide access to the most remote areas of the country.

Geographically, the geo-location of PNSP beneficiaries—currently under way under the leadership of the Ministry of Agriculture—will also support the effective implementation of the NEP, coupled with the nationwide affordability study listed under the priority Technical Assistance studies. Combined, if needed, they will have a further detailed and geographically tailored implementation of the NEP in support of the poorest.

Microfinance institutions have been playing a critical role in ensuring affordability of off-grid solutions, and indeed are the main institution currently providing the equivalent of PAYGo, that is, installment sales, to end-users. They currently serve 47 percent of the rural population, although lending for off-grid technologies represents only about 1 percent of their portfolio. MFIs can also play a key role in ensuring adequate information provision to end-users and are expected to become a key ally in off-grid service provision, with positive effects on financial inclusion as well.

NEP off-grid program public implementation support

From an implementation standpoint, the NEP identifies increased MFI capacity as a key driver for expanding affordability and access to off-grid solutions to the Ethiopian population. Building on an assessment of past performance, a program for their increased capacity will be supported to address the main barriers to their scale-up of lending capacity, as

Table 4.13 End-user subsidy for PAYGo Tier 1 affordability by quintile (Q) and bottom decile (D)

	2019	2020	2021	2022	2023	2024	2025
Off-grid connections added	310,000	1,000,000	1,400,000	1,800,000	2,000,000	1,200,000	1,500,000
Total new D1 connections	31,000	131,000	271,000	451,000	651,000	771,000	921,000
Total new D2 connections	31,000	131,000	271,000	451,000	651,000	771,000	921,000
Total D1 subsidy	576,600	2,436,600	5,040,600	8,388,600	12,108,600	14,340,600	17,130,600
Total D2 subsidy	111,600	471,600	975,600	1,623,600	2,343,600	2,775,600	3,315,600
Total subsidy yearly	688,200	2,908,200	6,016,200	10,012,200	14,452,200	17,116,200	20,446,200
						Total Subsidy	**71,639,400**

Note: Estimates are compounded by 2025, and they exclude short-term pre-electrification beneficiaries.

well as presence on the territory, as they constitute a key component of the off-grid market infrastructure. This is also highlighted to support a supply of off-grid solutions and for access to payment. The MFIs role in the off-grid space is intended to grow, both in terms of on-lending volume and in scope, to include improved collaboration with PSEs and REBs. The Government intends to put in place capacity building initiatives in synergy with the financial inclusion strategy to strengthen their understanding of the market, PAYGo models, and repayment schedules, and maximize financial intermediation services.

NEP off-grid program priority technical assistance

The NEP requires undertaking a comprehensive assessment of affordability of HHs across the country to further import the public support needed to ensure the benefits of off-grid solutions. The assessment will be conducted in partnership with the REBs and will be coupled with capacity building for REBs for data gathering and updating.

Step 5. Paying for solar products

Payments happen at every step of the off-grid solar supply chain, including from retailers to distributors to wholesalers to importers. Without payments, the supply chain cannot be financed, hence the service provided. Payments are at the core of the existence and sustainability of the off-grid market and access provision as they constitute the means for settling trading transactions. All 23.2 million off-grid solar users will make payments to retailers in exchange for solar power, too. Many of these transactions will occur entirely in cash. Today, 99 percent of all payments for electricity take place in cash.[61]

Cash is, however, an expensive means for settling transactions, as it needs to be transported and stored securely. Solar users travel with cash, sometimes for long distances, to make payments. Private sector companies are forced to secure, transport, and account for cash, making operations more expensive. And cash transactions are more opaque for the Government, making proper taxation more difficult.

The establishment of a well-functioning off-grid market aims at minimizing transaction costs through payment system improvements, payment infrastructure expansion, and digital payments. These will lower the cost of service delivery, translating into more working capital for private sector enterprises and a lower total cost of electrification for users and providers. All in all, this will lead to more and faster transactions.

As mentioned in Section 4.4, there is an overlap among MV lines, roads, and payment points. About 85 percent of bank and MFI branches are currently located within 2.5 km from the grid (increasing their commercial attractiveness). A breakdown of bank and MFI branches can be seen in Table 4.14.

Currently, there are 3.47 branches per 100,000 people within 2.5 km of the grid. While this is not as high as many other countries,[62] it is higher than the country average. Between 2.5 and 25 km from the grid, there are 2.09 branches per 100,000 people, and more than 25 km from the grid, there are just 0.65 bank branches per 100,000 people.

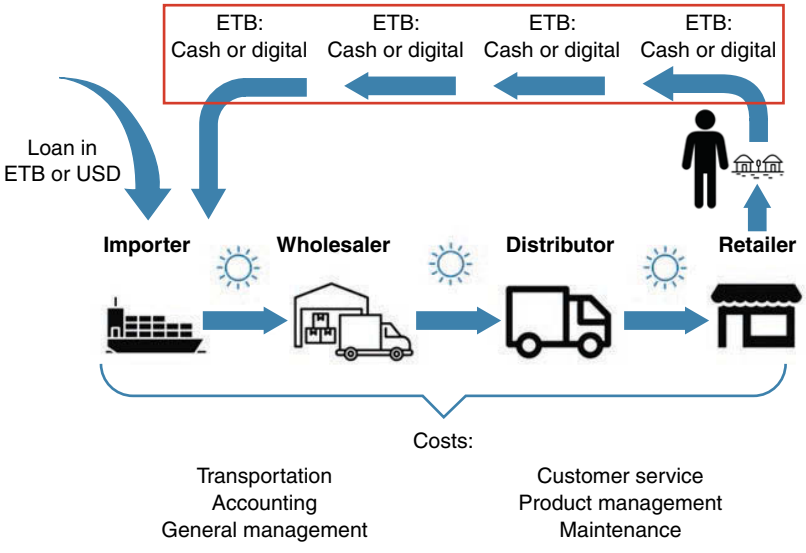
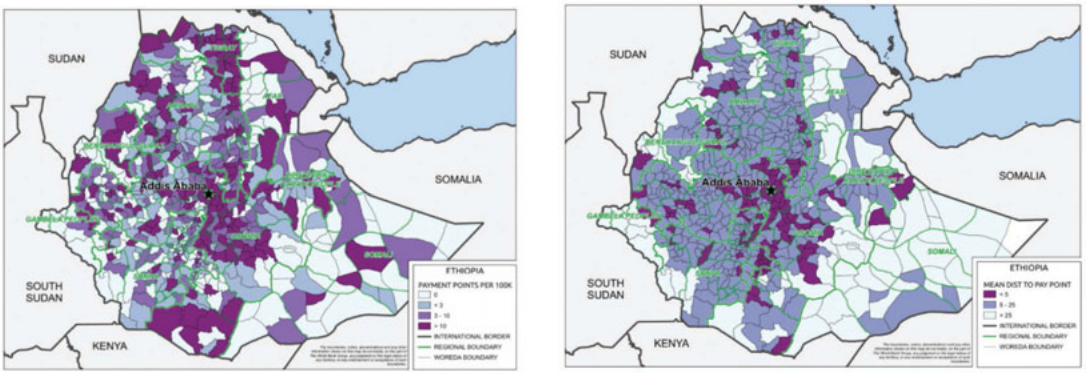


Table 4.14 Number of branches by distance from the grid

Grid Distance (km)	Branches per 100k People	Branches, ATMs, Agents per 100k People	Grid Arrival Year	Beneficiary Population (million HH)	% of Total Population
Ethiopia average	2.90	16.89			
<2.5	3.47	21.31	2025	3.3	12%
2.5–25	2.09	8.76	2030	5	31%
>25	0.65	3.55	Long-term off-grid	0.9	3–4%

Figure 4.6 Payment points per person by woreda (left) and mean distance to payment point by woreda (right)



Source: Geo-spatial analysis, 2018.

If bank and MFI agents and ATMs (together called "payment service points") are taken into consideration, the financial infrastructure in Ethiopia is more extensive. In that case, there are 16.89 financial service access points per 100,000 people.[63] These financial service access points, however, are still correlated with access to the grid. In fact, 90 percent of financial service access points are within 2.5 km, where there are 21.31 points per 100,000 people. Short-term pre-electrification beneficiaries are hence confirmed to be the most commercially attractive ones.

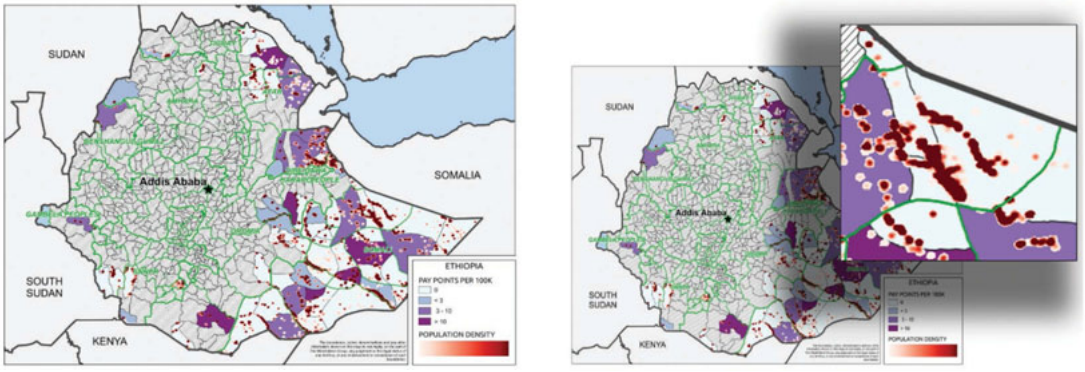
The off-grid service challenge hence again applies to beneficiaries residing between 2.5–25 km from the existing grid and increases in space to those beyond 25 km, where there are only 3.55 financial service access points per 100,000 people. Only 1 percent of financial service access points are located more than 25 km from the grid. The financial service access points per person are mapped in Figure 4.6.

Payment infrastructure is currently insufficient for universal electrification. Many off-grid solar providers need formal financial institutions to help with cash management and customer due diligence. Therefore, synergies will be established to ensure the prompt development of the payment infrastructure across the country, giving everyone the opportunity to pay for the services received.[64]

A robust physical infrastructure is necessary to facilitate payments for electrification, whether through cash or digital, through banks, MFIs, or non-bank actors. For digital payments, this physical footprint can serve as the points where people and companies can enter cash into a digital payment system or take cash out. Opportunities for payment system development are also offered by the density of the population in areas beyond 25 km, as shown in Figure 4.7. Population density will be leveraged for the efficient expansion of payment solutions and the decrease in expenses for agents.

Bringing together the analysis surrounding financial service access points, population, and distance from the grid leads to the insight that there are large population clusters located a large distance from both the grid and financial service access points. This indicates that there are areas of Ethiopia with large population density, but very few payment points.

Figure 4.7 Population kernel density estimation with payment points per 100,000 (left) and expanded area (right)



Source: Geo-spatial analysis, 2018.

In the expanded area, there are a number of population clusters located in woredas with few if any payment points. Areas like these, with significant populations but no financial infrastructure, represent an indication of commercial attractiveness for the development of agents' network and overall expansion of the payment and off-grid supply infrastructure.

Digital payment solutions

Distance affects the cost of payments as well, in the absence of an existing infrastructure. It increases transaction costs (including the time required to perform the transaction), and the efficient outreach of the whole population across the country requires a massive investments endeavor. In line with the financial inclusion strategy, the NEP off-grid intends to leverage on digital payment modalities. Digital payments offer the opportunity to cover a larger distance in the presence of proportionally fewer physical payment points, hence offering important efficiency gains across the value chain of off-grid technologies trading. The adoption of digital payment solutions offers several benefits, among them are (i) decreasing working capital needs as payments can increase asset turnover, (ii) decreasing operating costs associated with customer outreach and service delivery (less e.g., staffing and transportation required) increasingly with distance, and (iii) decreasing loans maturity (as payment settlement is what allow to pay back for loans) and interest rates, favoring increased lending volume overall (with de-risking of trading transactions), while at the same time decreasing the need for borrowing (due to increased profits).

Digital payments are also a key enabler of PAYGo technology. Off-grid solar companies have used digital payments for electrification, enabling the collection of smaller, more frequent payments from a larger number of customers than would have been possible with cash. Digital technology has allowed companies to "turn off" and "turn on" off-grid solar units remotely, based on digital payments. This obviates the need of solar companies to send employees in person if users do not pay for their electricity. The combination of digital payments and remote-control technology allows companies to sell solar units into more remote areas than otherwise possible.

There is currently very little usage of digital payments in the country. All digital payment accounts are linked to possession of a financial (bank or MFI) account, which are also currently low.[65] The ability to pay for electricity through formal transaction channels will increase account ownership. Demand for these payments will help banks and MFIs move into new areas not currently served by the Ethiopian financial sector. These banks and MFIs will then move more value into the formal financial system, rather than allowing it to languish in more informal channels like cash.

Electrification will also add to the goal of creating a more digitally connected Ethiopia. Mobile network coverage is a key enabler of digital payments, and Ethio Telecom has stated that with ongoing updates, total mobile network coverage will be achieved. The telecommunication network's Unstructured Supplementary Service Data (USSD) channel also needs to be maintained and updated, and the company has committed to USSD channel maintenance and investment. Synergies will be pursued between banks, Ethio Telecom, and NEP stakeholders.

The Government has established a goal of 5 percent adoption of mobile money by 2021.[66] At the same time, the Government recognizes that this will not be enough to enable the 9 million off-grid beneficiary

Table 4.15 Current and potential mobile money usage

	2019	2020	2021	2022	2023	2024	2025
Current targets							
% Households using mobile money	2%	3%	5%	7%	8%	10%	11%
Number of rural households using mobile money	309k	579k	863k	1.2M	1.5M	1.8M	2.1M
Potential NEP support							
NEP off-grid connections	703k	1.1M	1.3M	1.5M	1.6M	1.5M	1.5M
Cumulative potential new mobile money users	703k	1.8M	3.1M	4.6M	6.2M	7.7M	9.2M
Potential total mobile money users—rural areas	1.0M	2.4M	4.0M	5.8M	7.7M	9.5M	11.3M
Potential % mobile money usage with NEP 'bundling'	6%	13%	21%	30%	39%	47%	55%

households to pay for solar with mobile money. The NEP is considering the adoption of a "bundled sale," where rural residents who purchase solar power systems are automatically enrolled for a bank account. A program designed to 'bundle' solar connections with digital payment solutions will help the country achieve financial inclusion targets faster. If every mid-term pre-electrification and long-term off-grid service provision were to be bundled with accounts for mobile money, the Government of Ethiopia would be able to reach its mobile money goals faster. As shown in Table 4.15, the 5 percent goal could be achieved within a year, and the country could achieve 55 percent mobile money usage by 2025.

The added NEP off-grid connections would also reach into pre-electrification, peri-commercially viable, and deep rural areas. Bundling basic financial service accounts with NEP off-grid electrification could also increase financial-sector investment into these areas, increasing the commercial viability throughout the country. At the same time, these accounts could decrease transaction costs for private sector entities, enabling lower cost electrification in difficult-to-reach places.

To increase payment access in the country (cash or digital), the Government is taking into consideration the following activities:

- Allowing mobile payment providers to set up bank accounts;
- Increase the efficiency of bank account applications;
- Expansion of payment points to retail ones, and leveraging on the opportunities offered by leveraging on all major distribution channels in the country (as described under Step 3);
- Support training of off-grid workforce, including agents to expand customer outreach in the absence of a physical infrastructure (closing the gap between the existing one and customers);
- Leveraging population density while ensuring that remote communities also benefit from access to off-grid technologies and payment systems, through a focus on multi-payment service provision (i.e., for multiple services) ensuring the sustainability of the business for agents as well; and
- Establishment of synergies with commercial banks and mobile payment providers to include off-grid solar payments with commercial bank plans for expansion for digital solutions.

In addition, there is a recognition that the current regulatory environment poses barriers to scale-up. These will be tackled in collaboration and partnership with relevant ministries and the National Bank of Ethiopia. In fact, these key cross-sectoral barriers constitute a key impediment not only for off-grid access expansion, but in line with the overall process of liberalization of the economy. Relevant stakeholders could become key allies, if approved, for the economic development of the country as a whole. More specifically, the implementation of the NEP will take into account the following regulatory dimensions to increase the scale and speed of payment solutions in the country and off-grid access provision:

Inclusion of non-bank financial actors in the payment system

The Government supports the efforts of banks and MFIs to expand the payment infrastructure inside of Ethiopia. At the same time, other countries[67] have increased access to financial services by including non-bank actors, especially mobile network operators, in the payment system. These mobile networks have the scale necessary to create a vibrant cash-in and cash-out system. This would enable controlled, small-size payments for solar to flow through and strengthen the digital payments system. The Government understands the risks to the financial system

inherent in including other actors, including a competitive and monopolistic risk, a financial system stability risk, and the risk of fraud. The Government will weigh all relevant risks and potential benefits to create a safe, bankable, and inclusive path to universal electrification.

Customer due diligence laws

Ethiopian rules around agent banking and payment service providers prevent money laundering and terrorism financing, and protect the stability of the banking sector. These laws may also have the unintended consequence of making it harder for beneficiaries to pay for off-grid solar electricity. The Government will consider new recommendations surrounding these customer due diligence laws, consistent with the risk-based approach that the Financial Action Task Force (FATF) recommends. Topics for reconsideration could include the opening of transaction accounts and regulations surrounding agent banking.

Mandated interoperability

The ability to send payments from one payment system to a different one, known as payment-system interoperability, could make it easier for beneficiaries to pay for solar electricity. It could also increase the overall utility of digital payment systems by allowing people around the country to send money to each other, irrespective of where those people bank. The Government will consider making recommendations surrounding mandated interoperability of agent networks or payment systems, consistent with recommendations created by the International Telecommunications Union.

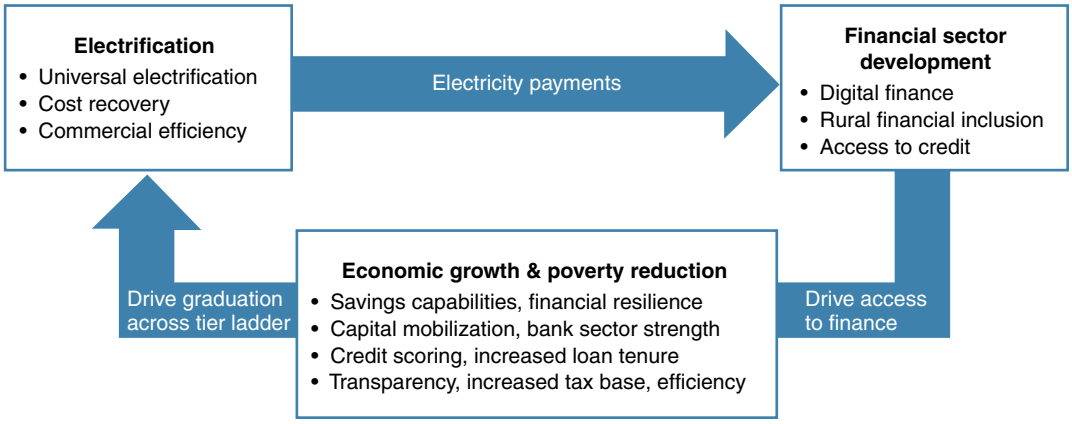
Allowing airtime payments for solar

While there are fewer than 15,000 financial service access points currently in Ethiopia, there are more than 100,000 airtime resellers in the country. The logistics network set up by Ethio Telecom to sell airtime stretches throughout the country currently serves more than 60 million subscriptions.[68] Other industries in Ethiopia, including nonprofits, have been able to accept airtime as a form of payment. Other countries, including Nigeria, have begun allowing off-grid solar providers to accept payments for solar electricity using airtime. This has enabled the sale of some 11,000 solar home systems, as of March 2016.[69] The Government of Ethiopia will coordinate with the relevant stakeholders to consider the use of airtime as a valid form of payment for solar power.

Increasing access to formal identification

There is currently no national identification card in Ethiopia. This lack of a reliable, digital identification system makes it more difficult for all digital systems to identify customers and users. In terms of payments for electrification, the lack of a national ID makes it more difficult to identify customers on digital payment systems, and to keep track of customers for private sector enterprises. With this in mind, the Government will consider encouraging the creation of a national ID system. This could enable more efficient disbursement of all social services, including finance, health care, education, and subsidy targeting and monitoring. In terms of access to payments for electrification, a national ID system could enable more efficient customer due diligence, and better enforcement of anti-money laundering and counter-terrorism financing laws.

Figure 4.8 Virtuous cycle of electrification and financial sector development



Economy-wide benefits for Ethiopia of payments for off-grid services

Financial sector development for electricity creates positive externalities for the Ethiopian economy as a whole. Expanding access to payment mechanisms for electricity drives access to finance and financial sector development. Greater access to finance can then support poverty reduction, as shown by the experience accumulated over the past years. For instance, research shows that 194,000 households in Kenya, or 2 percent of the population, were able to lift themselves out of poverty (US$1.25 per day) due to access to the digital payment service provided by M-Pesa.[70]

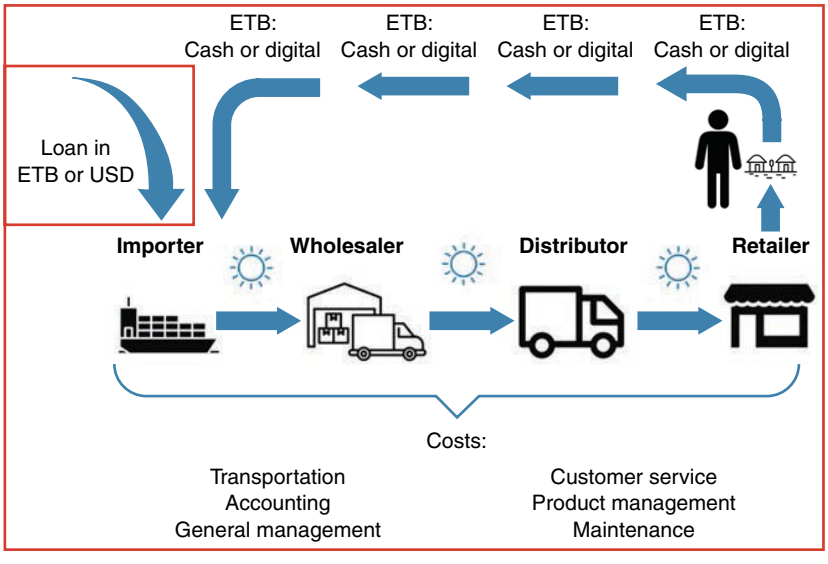
Overall, payments for electricity will create a virtuous cycle of efficiency gains from the implementation of the NEP to financial sector development to positive externalities for the whole economy (Figure 4.8). Benefits include poverty reduction and increased demand for electricity, while ensuring financial sustainability for its steady outreach across the country.

Step 6 Goes Back to Step 1. Supporting Private Sector Development through an Improved Financial System

Two main factors affect the overall need for borrowing: (i) fragmentation of the supply chain, and (ii) cash payments. They both negatively affect the efficiency of the trading chain, decreasing the turnover of assets and associated payments—resulting in longer loan maturity at higher interest rates. This high cost of capital is then proportionally correlated with higher operating expenditures, not lastly reducing the margin for profit for private sector companies. These inefficiencies negatively impact the amount of working capital needed to operate in the off-grid market, as well as the capex and operating expenditure associated with serving the Ethiopian population, and do not allow for an overall de-risking of the market, as indicated by current interest rates applied to borrowing and by the low participation (and higher interest rates) of commercial banks to the market. The performance of the DBE since 2012—with nonperforming loans—showcases the opportunities offered by off-grid market expansion and profitability.

By contrast, an integrated supply chain and a progressive migration toward digital payments both offer the biggest opportunity to increase the liquidity of the off-grid market. An integrated supply chain would support higher turnover of assets (for reduced loan maturity, i.e., reduced costs associated with doing business) and greater customer care (for increased revenues). Digital payments reduce the costs of collecting payments (reducing investments in physical infrastructure) while expanding the reach to customers for their inclusion in the market.

Both the supply chain and the payment system are key for bridging the gap between supply and demand of off-grid services. By reducing the costs for operating in the off-grid market, these interventions would positively impact its de-risking, offering a higher volume of loans—with the progressive participation of commercial banks (foreseen as the exit strategy for a credit line) at a lower cost (interest rate). In turn, this would allow increased access for private sector enterprises to participate in the



market and reach the scale required to serve about 9 million HHs by 2025. Further, it would progressively reduce the need for borrowing, because of reduced costs and increased adequate customer revenues.

This combination of adequate and inexpensive access to finance and profitability of the market would then result not only in a higher participation of PSEs to the market, but an overall decrease in borrowing needs and higher diversification of their portfolio, which would in turn lead to local entrepreneurship development and diversification of the economy.

NEP off-grid program implementation support: grievance mechanisms

A well-functioning off-grid market rests on the opportunity to voice grievances as an alternative to exiting the market. To ensure the credibility of the off-grid market at its nascent stage, public support will be provided to ensure adequate monitoring of private sector performance with customer care. The mechanisms will be developed in partnership with local REBs, which are the closest public administrative arm in the territory and would be part of the overall capacity building envisioned for the involvement of REBs in improved coordination with PSEs and MFIs. A public education campaign will also be launched. The Government is currently considering linking off-grid licenses to a system of penalties that could ultimately result in the debarring of PSEs from operating in the market, in case of non-adequate service provision.

4.5 Mini-grids development

Mini-grid technologies can provide a higher level of service and can support higher loads, including for social (e.g., health and school facilities) and productive uses, from energy intensive businesses and even small industries.[71] While still in its nascent phases of market development, the performance of mini-grids around the world indicates the potential for communities electrified by mini-grids to become commercial centers for surrounding villages. Electric milling for soft flour, electric welding, modern wood processing, electric cooking, and battery charging can be offered by mini-grids and will benefit citizens in a radius of 10 km and beyond the mini-grid network coverage. In rural areas with mini-grids, not only are jobs created, but often banks settle in these communities and are able to provide access to finance, and telecom companies improve data connectivity as a reaction to the availability of reliable electricity and the rising buying power of local customers.[72] If built to standards, most of the mini-grid infrastructure is fully compatible with the main grid.

The adoption of a mini-grid program is part of the Government approach toward integrated planning, as mini-grids and solar home systems, as well as grid connectivity, are technologies that complement each other, supporting different levels of current and potential demand and reflecting a different time frame for access provision. Consistently with the green growth objectives of the Government, only hybrid or renewable mini-grids will be developed.

Ensuring adequate targeting of mini-grid solutions

The mini-grids program will be launched under the NEP with a phased approach, to be also informed by the implementation experience of the recently launched EPC tendering under EEU for 12 pilots. Development Partners are also already providing technical assistance for the full design of the mini-grids program and tender documents. More specifically, the Government intends to focus first on the most remote communities to ensure timely access provision and equitable powering of social institutions for basic needs (schools and clinics) as well as for income generating activities, as described in Section 4.6.

In parallel, the program implementation support and technical assistance activities earmarked under the NEP off-grid program (see Section 4.12) will provide key information necessary for the final identification of candidate sites in remote areas as well as for the rest of the country. All mini-grid implementation will be closely coordinated with the Safety Net and other Government programs, enabling local processing of agricultural products and leading to increased local value generation and job creation.

While the geo-spatial analysis has preliminarily indicated the location of potential sites for mini-grids development, experience worldwide highlights the importance of field data gathering to measure and project demand loads. The key studies to be conducted will launch or finalize (as in the case of social institutions) the geo-referencing of demand loads and the identification of possible anchor customer for mini-grids.

As described in Section 4.12, two studies will be key for the development of the mini-grid program:

(i) A rapid assessment and a nationwide comprehensive study for productive uses, including the areas already identified (at the woreda level) for

agricultural development (described in Section 4.10) by the Ministry of Agriculture. The rapid assessment is expected to be conducted in collaboration with EEU within a three-month timeframe to promptly kick off the mini-grids program, while the more comprehensive study will proceed in parallel for further identification of possible candidate sites; and

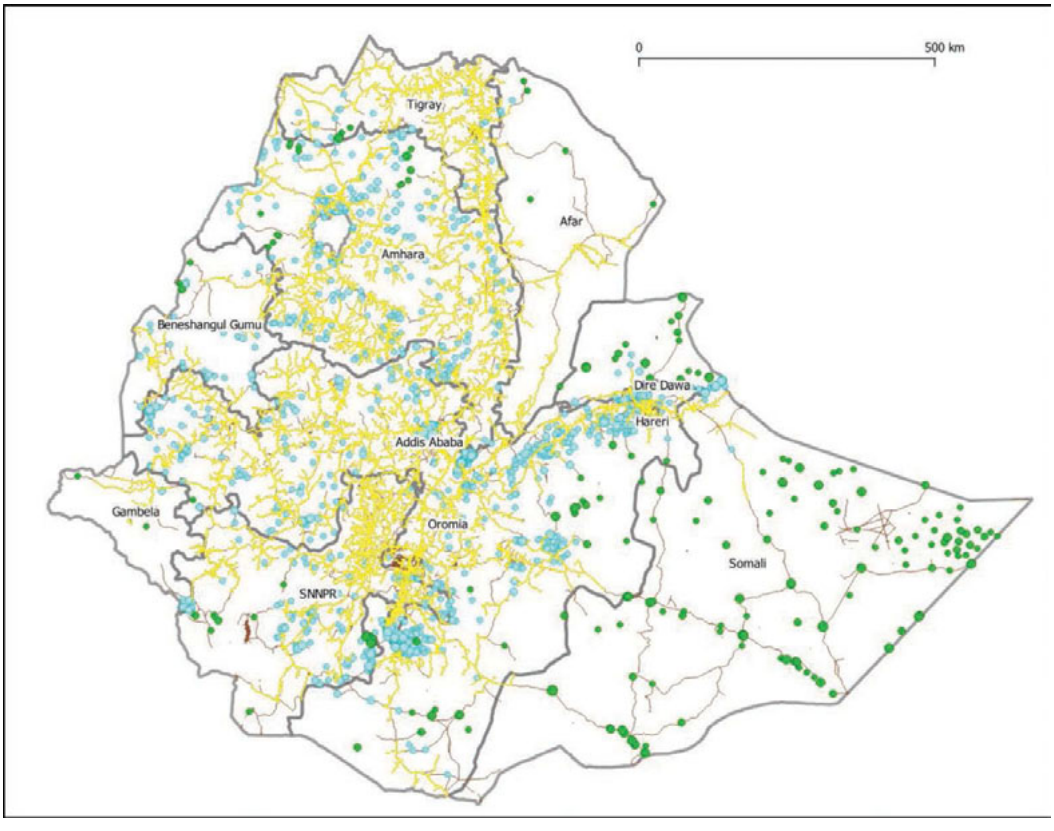
(ii) The comprehensive assessment and validation of estimates of electricity needs for schools and clinics. While a preliminary investment prospectus and implementation program are identified under the NEP, more information will be gathered to further detail the adequate provision of electricity services.

The Government will take action to establish mini-grids where they have the strongest economic impact, and particularly where there is electricity demand for processing of goods or even small industries that cannot be supplied sufficiently by solar home systems anymore. Thanks to local generation of electricity especially renewable mini-grids can supply more reliable electricity than the main grid in that same area, providing opportunities for businesses which are particularly sensitive to the reliability of electricity, like banks, Internet-based businesses, or businesses processing and cooling perishable goods.

As indicated by Figure 4.9, the geo-spatial analysis indicates potential sites across the country which will be investigated for potential mini-grid developments to timely serve the population while waiting for a grid connection. Due to lack of reliable information on population within 2.5 km from the existing grid (due to undetectability of the number of stories per building), only the number of clusters between 2.5–25 km were identified, for a total of about 1,160 sites (in light blue).

While the NEP grid program currently envisaged the achievement of 65 percent of on-grid connectivity at least cost by 2025, and of 96 percent by 2030, the mini-grid program may support the timely provision of adequate tiers of service in support to the social and economic development of the population, and responding to the double mandate of the Government to ensure efficiency and equity in the deployment of public resources. For this purpose, technical standards for grid compatibility will be adopted, starting from the twelve pilots. In addition, the Government is cognizant of the

Figure 4.9 Nationwide preliminary potential for pre-electrification mini-grid developments (light blue)



need to establish an enabling environment to attract private sector developers to join efforts with EEU and to provide for ownership options when the grid arrives.

Implementation options for mini-grid development

For the development of mini-grids in areas within 25 km from the existing network, the Government intends to harness EEU expertise and capacity, as well as cooperatives and private sector developers. The extent to which each will play a role will be determined based on further sizing of the mini-grid sites potential, implementation progress and lessons learned (e.g., from the first EEU-EPC pilot of 12 mini-grids). For these areas, the Government is considering the scale-up of two main business model options: (i) EEU-led with EPC; (ii) private sector or cooperatives to install generation assets and operate and maintain the system, where EEU would retain ownership of the distribution assets, as most of the sites are expected to be connected to the grid.

The Energy Regulation currently under review would allow for cost-reflective tariffs and attract private sector participation while decreasing the need for public support for mini-grids scale-up. Cost-reflective tariffs are currently expected to be in the range of 0.30 US$/kWh to 1.20 US$/kWh, according to other countries' experiences, but to be validated over implementation. If public subsidies become required in the pre-electrification areas, they will likely be provided to the operator per kWh sold to third party household and public customers. Fully automatic monitoring of electricity sold through information technology is also a key requirement for the smooth implementation of the cross-subsidy.

The selection of the sites by private companies/cooperatives is expected to be based on the availability of natural resources and local skilled labor. Mini-grid electricity would be used to process the natural resources into tradeable goods and this decentralized process would decrease transportation costs and increase quality.

Any generation assets paid for by the private operator could either be transported to a new site or be sold to the EEU which may use these assets for decentralized main-grid stabilization. Alternatively, a feed-in tariff scheme could be established.

To establish the generation assets, private sector/cooperatives would need access to low interest rate loans. Mini-grids usually require capital with 10 years or more of tenure in local currency with reasonable interest rate in a project finance-like structure (low or no collateral beyond the mini-grid assets) to be financially viable. At the same time, developers would also need access to foreign exchange, especially to hard currency to procure and import system components. Consultations on efficient access to finance solutions for mini-grid developers have already been launched.

An enabling environment for mini-grids nationwide development

Ethiopia's Energy Policy, published in 2012, sets out the core policy objective of increasing access to modern, affordable energy through on- and off-grid solutions, and encouraging energy cooperatives and societies as well as the private sector to participate in energy service delivery. Proclamation No. 810-2013 (the Energy Proclamation) and Regulation No. 308-2014 establish the Ethiopian Energy Authority (EEA) and outline its role in determining guidelines for off-grid tariffs and licensing off-grid energy generation, distribution, and sale.

The Council of Ministers is currently reviewing the Energy Regulation that will provide EEA with the authority to approve off-grid tariffs, provide protection from main-grid connection to private investments in mini-grids, and issue the directives required to detail the regulation of most of the aspects related to off-grid generation from mini-grids. The Energy Regulation under consideration currently foresees mini-grid tariff calculation under a Cost of Service approach. In addition, it contains an umbrella compensation clause for privately/cooperative owned mini-grids that will be detailed through directives.

After the approval of the Energy Regulation, the improvement of the regulatory environment for mini-grid developments will consider:

- Simplified licensing application processes for small mini-grids (up to 5 MW of distributed power) with an integrated generation, distribution, and sales license;
- A clear and transparent tariff calculation methodology for mini-grid tariff setting, and potential fixed aspects to be contained in the licenses issued (i.e., a fixed payment and a kWh based payment);
- Compensation clauses, and related calculations, for grid arrival and integration of mini-grid into the main grid to ensure proper risk management of mini-grid investments. Methodologies used in other countries' experiences will be taken into account, such as calculating the compensation using the equivalent of the current value of the assets according to depreciation tables plus the revenue of the last twelve months;

- Establishment of technical standards for grid integration, applicable to EEU as well; and
- Safety, reliability, and environmental protection.

The data driven geo-spatial least-cost connections rollout program adopted by the Government will also provide clarity and certainty about the grid arrival to potential private sector investors, and information would be publicly shared with mini-grid developers, based on the latest connections, achievements, and future rollout plans identified by EEU. Moving forward, the further design and detailing of the mini-grid program will be conducted in close consultation with local and international private sector companies.

4.6 Ensuring nationwide reach: deep rural areas

The challenges identified for the scale-out of off-grid solar technologies become more severe the further the distance to be covered by the supply chain for reaching out to customers. That is, long-term off-grid beneficiaries, located beyond 25 km from the existing grid and who are not candidates for receiving a grid connection at least-cost constitute the most challenging segment to be served under the NEP off-grid program. According to the geo-spatial analysis, the number of these beneficiaries is about 1 million.

They are the farthest away from both the off-grid supply chain and payment points. They are also the farthest away from any kind of infrastructure access (including e.g., multipurpose point shops and markets), where the liquidity of the off-grid market reaches its lowest—corresponding to the highest price for end-users of off-grid technologies, as indicated in Table 4.11.

These areas are targeted by Government supply-side support to ensure that their less commercial attractiveness does not become the reason for lack of services or higher end-user prices. In fact, as reflected in Table 4.16, in deep rural areas end-user prices are expected to be in the range of US$350–400/unit, reflecting consultations with private sector enterprises and their estimated costs of delivery and service provision. These costs reflect a combination of 75 percent Tier 1 and 25 percent Tier 2 systems, imported at an average price of US$150.[73]

In these areas, the Government is adopting a Minimum Subsidy Tender (MST) implementation mechanism combined with Results Based Financing (RBF), based on the latest developments in the off-grid market space, such as in Kenya and Nigeria (see also Annex 6). Further, the adoption of the MST was also informed by consultations with domestic and international private sector companies; and the implementation mechanism for off-grid areas was designed based on what PSEs require to distribute and operate in deep rural areas versus commercially attractive ones. That is, the incremental working capital and capex and operating costs associated with reaching out to these areas were factored into the identification of the need for such a public support instrument, as well as its design.

The MST is a technology neutral mechanism—as the identification of Tiers will be informed by local demand estimates, to be collected in collaboration with the REBs—designed to provide incentives for private sector penetration in deep rural areas at the scale and speed required for servicing about 1 million HHs, and with minimum interference in the market by ensuring the most efficient allocation of public resources through a competitive mechanism for the allocation of the subsidy. The MST focuses on providing supply-side support recognizing the higher working capital costs associated with distance at about US$100/unit for areas beyond 25 km from the grid,[74] as well as the extra capex and operating costs at about US$90/unit. Preliminary estimates of the overall MTS financing requirements are provided in Table 4.16, for a total support of about US$133 million. While the MST reflects a form of market supply support, market demand support for affordability was discussed under Step 4 in Section 4.4 and will coordinate, when applicable, with the MST. The affordability study

Table 4.16 Preliminary estimate of MST requirements for deep rural areas, 2025

	Long-Term/Deep Rural 25–100 km	MST USD Million
Connections	**700,000**	
End-user price range/unit	**$350–400/unit**	**~US$300**
Working capital/unit	$100	US$70
Capex and operating costs/unit	$90	US$63
Total		**US$133**

provided for under the NEP will also increase the sophistication of targeting, in collaboration with the REBs. Implementation experience will also inform the Tiers of technologies needed in these areas. In addition, a PAYGo payment model is expected to be applied to ensure the affordability of the system, for about US$5/month.[75]

The MST estimate aims to cover for the "commercial viability gap" related to the extra "cost of doing business" associated with going the extra mile and to avoid the end-customer having to bear the price for the commercial viability of business, either in terms of the increased price of the system or absence of service all together. It also acknowledges, as indicated during private sector consultations, the extra cost associated with market assessment, which is also decreased through the implementation mechanism identified by the MST and the design of the tender documents, more specifically.

Estimates are based on the best available information, and piloting is expected to be launched by the end of 2019. The first rounds of implementation will allow for price discovery, as there is currently close to no presence of private sector companies in these areas. In addition, pilots will be a precious source for trial and error to improve the MST design and the related tender documents.

Estimates also include for provision of off-grid solar technologies to all beneficiaries residing beyond 25 km for the existing grid and considered long-term off-grid beneficiaries. However, the geo-spatial analysis also revealed the existence and location of potential mini-grids sites, as described in the following section. The in-the-field assessment of these sites will identify the timing and the adequacy of mini-grid versus off-grid solar solutions and coordinate the two technologies for adequate service delivery.

MST implementation framework: tender documents

The subsidy will be awarded through open market bidding to ensure the least-cost allocation of the subsidy as well as transparency in the allocation and awarding of public financial support. Market competition will provide price discovery on the subsidy requirements for private sector penetration in deep rural areas, and over time, the minimum subsidy tender can reasonably be expected to apply downward pressure on the subsidy requirement, as information about the market and its infrastructure develops as a result of increased presence of market operators (including agents).

With a close collaboration between EEU and the REBs, the tender documents will include information on the two key market dimensions: on the demand side, they will indicate the number of beneficiaries to be targeted and the indicative estimates of associated service needs (Tiers); on the market supply side, the tender documents will provide available information on the multi-dimensional infrastructure present on the territory (e.g., shops, markets, roads).

Being the "eyes on the ground," the REBs and woreda offices are expected to play key roles in data gathering in support of MST implementation and its efficiency. It is in fact recognized that the more information provided in the tender documents, the lower the costs associated with market assessment for PSEs.

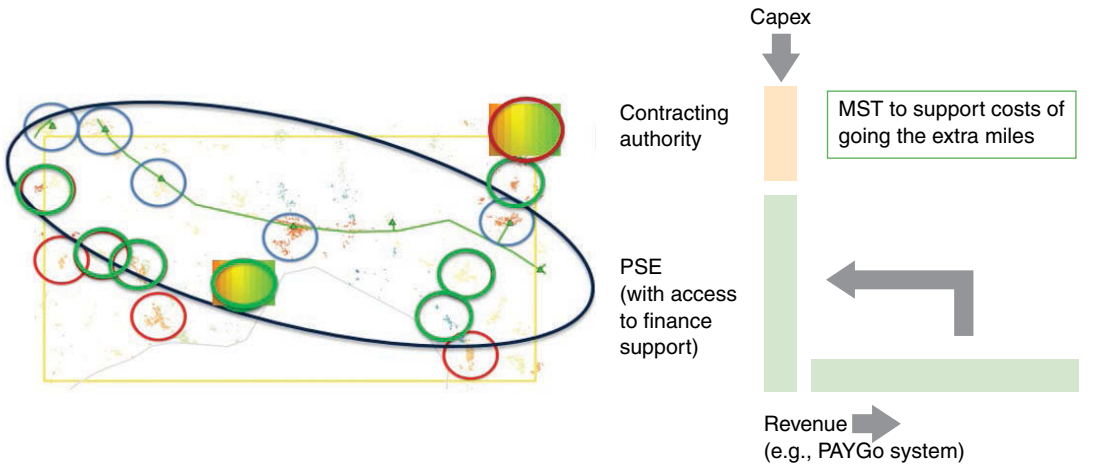
The information on the multidimensional market infrastructure will preliminarily include, to the extent possible, information about the closest (if any):

(i) Off-grid distribution point,
(ii) Markets, shops, and any other potential social gathering and new distribution points for off-grid solutions,
(iii) CBE branches, MFIs, or any other possible payment location,
(iv) Telecom coverage and estimated mobile phone penetration, and
(v) Unemployed population (that could be leveraged to become part of the workforce benefiting from his/her knowledge of the territory and local communities).

Further, the tender documents will provide information about the number and indicative location of beneficiaries and related estimated demand/service needs and willingness to pay. Customer aggregation will be based on proximate small administrative units *(kebeles)* for about 200,000–250,000 beneficiaries. However, the piloting phase of the MST will allow for further understanding of the best aggregation, based on the specific territory realities and challenges.

The EEU, given the multi-decade experience with procurement and its latest improvements, has for the time been assigned with the role of Contracting Authority for the management of the auctioning process for the MST. Technical assistance will be required in the first stages of implementation of the MST to ensure the prompt modification and improvement of the tender documents and processes, as well as flexibility in the evaluation of the bidding documents submitted by the private sector, where the key factor will be quality and affordability of off-grid technologies

Figure 4.10 The MST mechanism



Note: Green circles indicate areas within 2.5–25 km from the existing grid, whereas the red circles indicate the areas beyond 25 km identified as deep rural and candidates of the MST mechanism. The different colors are associated with the different demand levels to be served and information expected to be collected with the support of the REBs.

and service delivery. Development partners have already signaled their interest in supporting the finalization for the tender documents, as well as assisting in the first phases of implementation, including with the provision of embedded technical advisors.

The Government acknowledges that the cost of supply and hence the subsidy requirements could vary in deep rural areas after the market clearance point. Further, private companies' bids could offer higher services for a slightly higher subsidy, and the technical criteria and weights employed for the evaluation of the proposals will be developed to ensure the flexibility required to achieve the highest equity, particularly in PSNP areas and areas that show the highest economic growth potential, to support and ensure productive uses of electricity services as well.

Preliminary evaluation criteria will include: price, implementation methodology, management strategy, PAYGo and collection payment mechanisms, code of conduct, work program, risk assessment, and job creation strategies. Tender documents will also include minimum warranty requirements for different technology sizes, and only Lighting Global products will be allowed to be retailed. Private companies would also be required to sign a consumer protection code, being drafted on the basis of the one currently developed by GOGLA. Only certified (licensed) companies would be allowed to participate.

Private sector companies will be required to submit their business plans within their technical and financial proposals. More specifically, PSEs will be required to provide detailed information related to: (i) technology specifications and warranty, (ii) payment plans and methods, both for cash-based and mobile-based payments, (iii) after-sale and customer care provision, (iv) verification of results strategy, (v) marketing strategy, and (vi) local job creation associated with service delivery.

Results-Based Financing and verification of results

To ensure efficiency, effectiveness, and accountability of service provision, the transfer of the MST to the awarded company(ies) will be based on results (that is, after verification of installment of solar solutions or mini-grid connections). Results-Based Financing (RBF) is being increasingly used in the off-grid market to link financing to the quantity and quality of service, improving delivery performance.

Tender documents will include disbursement instructions based on technology sizes, as higher quality services will be associated with longer warranty and repayment schedules. The allocation of the subsidy will be broken down in phases and based on connections achieved, as well as beneficiaries' consumption of the service, which will ensure control over service quality and after-sale activities, and avoid any distortions associated with an up-front, and in full, subsidy allocation. More specifically, the first payment of the subsidy will likely be provided upon proof of connection of customers (either in the form of a down payment and/or first installment, or in the form of payment for one month of consumption). Subsequently, subsidy payments will be based on proof of consumption, on a biannual or trimester basis.

PSEs will be required to collect information about the location of their acquired customers, as they would be incentivized to do to ensure payment collection and after-sale services. These "questionnaires" will be part of the documentation required for the disbursal of the subsidy. The location of the customer will be used to ensure that only long-term off-grid communities are benefiting from the MST.

The PSEs will be required to serve consumers for at least three years, based on an average warranty duration of two years, to ensure adequate and quality after-sale services, and the RBF will be tailored to this schedule. The last subsidy payment will require proof from the PSE of compliance with the exit clause described in the tender document. The scheduling for the payment and for the timing of the exit clause also reflects the maturity of the loans provided under the DBE for working capital purposes, tailored to the different repayment schedules associated with different technology sizes.

The exit clauses will give two options: (i) either entering into a contract directly with the consumer with no Government support, or (ii) if the PSE cannot sustain the operational cost for service delivery, EEU will enter into a contract with the consumer directly. Technical assistance for EEU to ensure readiness for this option has been earmarked in the NEP, as indicated in Table 4.27.

PSE activities will be monitored through the RBF scheme, which will also function as a tracking and "early warning" for implementation challenges, should they arise. Further, PSEs will be required to share with the DoE Key Performance Indicators (KPIs) for the adequate monitoring of service delivery, to be agreed through public private consultations. This information will become part of the DoE dashboard and GIS-based monitoring system for grid and off-grid developments.

To ensure the sustainability of the off-grid program and its increased sophistication over time, the Government is considering empowering the REBs to progressively digitize the information collected on customer location and service delivery, together with the existing market infrastructure of reference. This wealth of information would be further expanded by the information collected by the PSEs during market assessment, service delivery, and verification of results. The Government is already working with the utility on the expansion of the GIS platforms for planning and monitoring established at EEU and MoWIE, respectively, on the design of a GIS nationwide system to ensure least-cost vertically integrated planning. This expanded GIS capacity would be cross-sectoral in nature, supporting development programs under the ministries of health, education, financial inclusion and more, and respond to the Government's intention of establishing an integrated and cross-sectoral GIS-based planning platform.

Servicing deep rural areas with mini-grids

The high level geo-spatial analysis conducted for the update of the NEP preliminarily identified the potential for mini-grid development in the country for communities of more than 250 HHs beyond 100 km and between 25–100 km from the existing MV lines for a total of 285 preliminary sites, where 151 were located beyond 100 km. These locations were identified as hosting about 1,000 beneficiaries each, which corresponds to a high likelihood of having enough potential for a mini-grid to drive significant economic development. As shown in Figure 4.11, several regions would be initial candidates for mini-grid development, such as Afar, Amhara, Somali, Oromia and SNNP, Gambela, and Benishangul-Gumuz.

Under the NEP, priority focus is given for potential mini-grid development to those most remote areas followed by a focus further inward into the country.

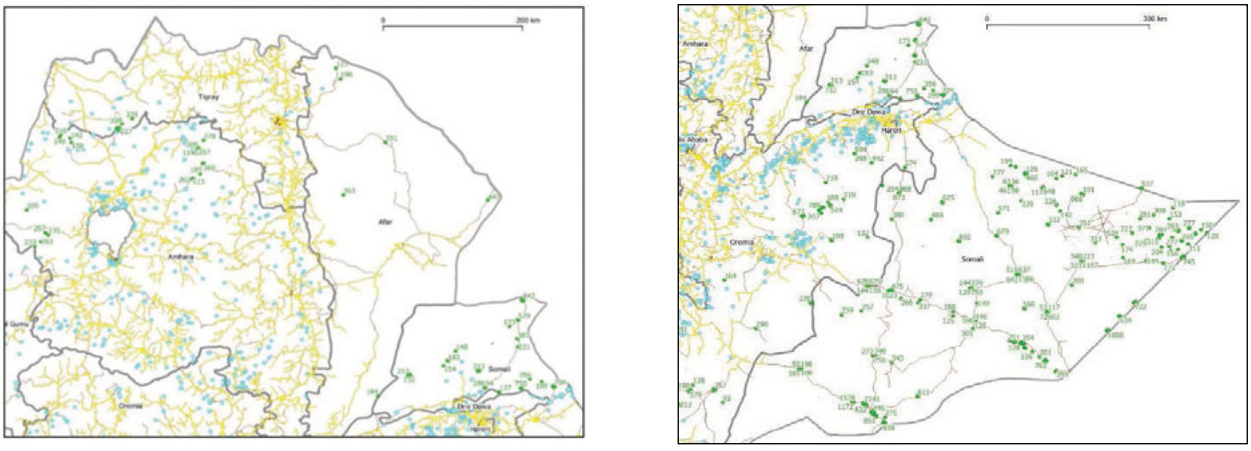
While long-term off-grid areas shall be covered primarily by Government financed initiatives, the Government leaves room for private sector and cooperative financed initiatives in areas designated for mini-grid pre-electrification. Industry, including cooperatives and private companies, are interested in a reliable electricity supply for those communities with access to natural resources. Harvesting these resources, processing them locally using the mini-grid electricity supply, and trading the resources will be the main motivations for private sector and cooperative lead mini-grid rollouts. In addition, private companies and cooperatives can pre-electrify their employees' and members' homes this way. The Government intends to establish the framework required to implement these privately lead mini-grids as outlined below. This framework will comprise access to debt finance and tariff setting regulations, as well as a compensation mechanism in case of main-grid connection.

The future development of the mini-grid implementation framework will continue benefiting from consultations with private sector companies and EEU and will take into account the latest technological advances and business models in the field.

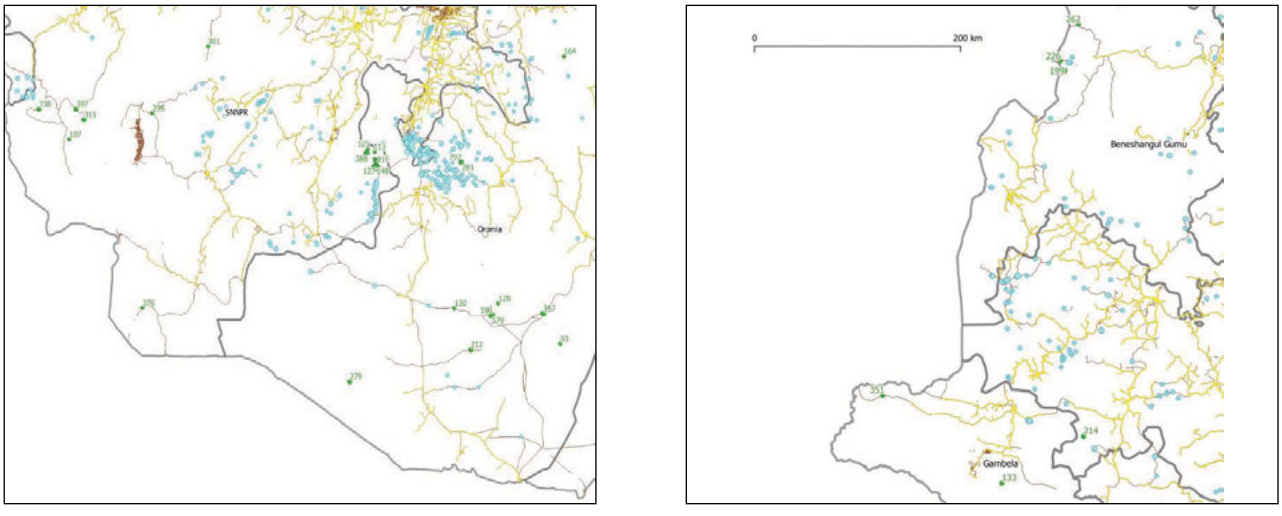
Servicing areas beyond 25 km

While the establishment of an enabling environment for mini-grids and private sector participation is and will be pursued, the 285 sites beyond 25 km from the existing distribution infrastructure have been

Figure 4.11 Potential for mini-grid developments in remote areas across the country



Afar and Amhara (left), Somali region (right)



Oromia and SNNP (left), Gambela and Benishangul-Gumuz (right)

2025			
Sites identified for mini grid development	Distance from existing grid	HHs connections (2019–2025)	Number of mini-grids
Long-term off-grid/deep rural (not reached by the grid by 2030)	> 25 km	100,000	134
Long-term off-grid	> 100 km	110,000	151
Total		**210,000**	285

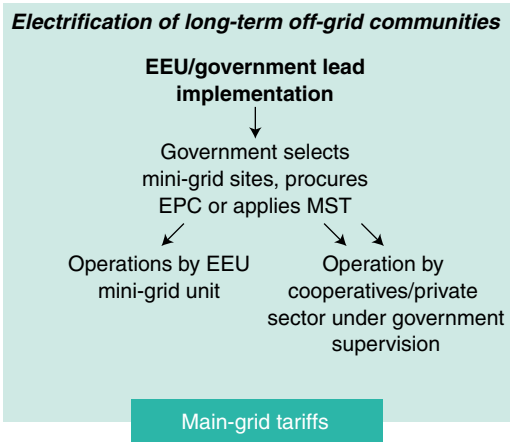
Source: Geo-spatial analysis, 2018.

Note: Mid-term pre-electrification villages (blue) between 2.5–25 km from the grid and long-term off-grid villages (green) beyond 25 km with more than 250 households per cluster.

preliminarily identified as potential sites for public funding support, to be confirmed by more local comprehensive assessments and pre-feasibility studies. These areas have a sizable estimated density but are far away from any infrastructure and may have unserved growth potential.

For these areas (and potentially for the overall development of a mini-grid nationwide program), two business models have been identified, which are summarized in Figure 4.12 with preliminary identification of investment requirements based on implementation models. While currently the uniform

Figure 4.12 Business model options for servicing remote communities and preliminary financing requirements scenarios



Mini-Grid Electrification of 285 Systems; 210,000 HH by 2025				
		Option 1: EPC with National Uniform Tariff	**Option 2a: MST with 7.5% Private Investment and National Uniform Tariff**	**Option 2b: MST with 7.5% Private Investment and Cost + Tariff**
	Assumptions	*Consumption as in main grid, all customers fall under lifeline tariff*	*Consumption as in main grid, all customers fall under lifeline tariff; 20% equity IRR expectation of private investor*	*Tariff: 0.43 USD/kWh; reduction of consumption by 70% due to price elasticity; 20% increase in service cost due to energy efficiency requirements*
CAPEX	**Govt. contribution/CAPEX subsidy**	$ 345,000,000	$ 319,000,000	$ 143,000,000
CAPEX	**Private investment**	$ —	$ 26,000,000	$ 15,500,000
OPEX	**Annual revenue from electricity sales**	$ 995,000	$ 995,000	$ 9,444,000
OPEX	**Annual OPEX subsidy from EEU**	$ 4,400,000	$ 11,000,000	$ —
	Main-grid tariff increase [USD/kWh]	0.084	0.124	0.00

Note: Overview of CAPEX and OPEX distribution between the Government and the private sector for the three mini-grid implementation options in communities >25 km beyond the national grid. The numbers presented are based on assumptions like CAPEX per connection, price elasticity and others that have not been proven in the field. Therefore, these numbers should be understood as indications only.

tariff would be applied, regulatory review is expected to also allow for cost-reflective ones. Both business model options and the preliminary financing requirements will be tested through the recently launched twelve pilots as well as the formal launching of the mini-grid program in the forthcoming months, based on the data gathered in the field.

Service provision to all the 285 sites, for about 210,000 HHs (including population growth projections by 2025) or about 1 million people, is estimated at US$1,500/connection, based on best available information.[76] Sites will be clustered to increase efficiency and minimize implementation costs, based on the latest international experience, such as in Kenya. As described in more detail below, private sector and cooperatives participation is intended to be incentivized through the MST mechanism, as well as EEU EPC tendering.

Under these assumptions, a budget of US$345 million may be required to cover the capex of these mini-grids. If the tariff is calculated using a Cost of Service approach, the capex may go down to US$143 million due to price elasticity out of which US$15.5 million could be provided by the private sector.

In the national uniform tariff scenario, cross-subsidies from urban tariffs to mini-grid tariffs will have to be provided to cover the operational cost. It is expected that the systems will be designed with a high renewable fraction based on solar energy while using load and demand management in times of a lack of energy, and therefore ongoing diesel fuel costs

will be rather low. The main cost item will therefore be the maintenance, operational services, and management, as well as the cost of replacement of assets after the end of their lifetime.

Consumption is currently expected to be close to grid-connectivity levels (and higher than East African solar mini-grids with cost covering tariffs by a factor of eight to ten) and to lead to reduced fixed overhead costs (usually a significant part of mini-grid tariffs), to supported through the establishment of an enabling environment for productive uses as well (see also below). These assumptions will be confirmed by field data gathering and pre-feasibility studies.

If almost all customers in mini-grids fall under the lifeline tariff, the required cross-subsidy would be of about US$4.4 million per year, reflecting a main-grid tariff increase of approximately 0.084 USDcents/kWh.[77]

Regarding total capex, a well-designed EPC tender for a large-scale rollout prepared by the Government is expected to lead to costs that are equally efficient as several small-scale private sector implementations on their own accounts. Thus, the capex to be covered by the Government, as well as the cross-subsidy, are considered to be independent from the operational model.

An alternative option to the EPC tendering approach is the implementation of systems using a Minimum Subsidy Tender (MST) for pre-selected sites. The winning bidders would not just deliver and install systems but would also operate the mini-grids. Under a Minimum Subsidy Tender, the private sector may shift costs covered by the Government from capex subsidy to opex subsidy slightly, depending on the conditions of the tender; and a 5–10 percent private sector contribution is currently assumed based on private sector consultations, to be confirmed through implementation experience.

The assets financed with public funding could be either owned by EEU or the private sector. In the first case, the Government would provide a usage right over the publicly financed mini-grid assets to the private or cooperative operator, as was recently done in Sierra Leone. In the second instance, the Government would provide grant funding to the private sector operator as was recently designed in Nigeria for the domestic MST program.

As the Ethiopian Government works toward providing electricity tariffs on the main-grid level on long-term off-grid communities electrified by mini-grids, the MST could be run on the opex subsidies required, while the equity/debt contribution to the capex from the private sector would be fixed. The bidder with the lowest opex would be awarded the subsidy. The latter may have a fixed payment component and a per kWh related payment one to be balanced to avoid bankruptcy for the operator in case of low demand, while providing some reasonable profit to the operator in case of success. The opex subsidy would be reviewed by the EEA and adjusted to changing conditions considering the initial bid of the operator.

Overall, preliminary estimates for the financial requirements associated with the development of 285 sites serving over 210,000 connections in deep rural areas indicate an average of about US$300 million between the three business models, at an average cost of US$1,500 per connection. A combination of grants (90–95 percent) is assumed under the MST model plus opex support. The EPC model assumes 100 percent grant support.

Operations models in long-term off-grid communities with national uniform tariffs

Several models are currently under consideration for the operation of mini-grids under the national uniform tariff, to be revised based on (a) implementation and (b) regulatory interventions currently under consideration (see also below).

1. **EEU as operator:** EEU has recently established a mini-grid unit within its organization in preparation for the rollout of the mini-grid program under the NEP. This unit has a lean management and operational structure and is expected to employ the latest software and monitoring tools, as well as a mini-grid specific call center for customer questions and complaints. EEU is currently operating 31 diesel mini-grids already and will soon add 12 pilot solar mini-grids under this unit.

As mentioned above, the EEU mini-grid unit is expected to play a central role for the rollout of mini-grids in long-term off-grid areas. This unit is advised to closely monitor and manage its own operational cost and report to MoWIE. Within the unit, technical maintenance of mini-grids needs will be organized to ensure minimum downtime in case of technical failures.

2. **Private sector company or cooperatives as operator:** Private companies can be either professional mini-grid operators (currently not active in the country), or existing Ethiopian industrial companies that are interested in natural resources in rural areas. Cooperatives may have the sole purpose of operating mini-grids or agricultural or pastoral ones that would like to run the mini-grid as a side business to electrify their members and/or see some advantage in processing agricultural goods. A cross-subsidy scheme may have to be designed to incentivize rural development and demand growth and support the

operator in becoming the driving force behind local development and livelihood creation. The inclusion of tracking and monitoring tools and procedures would be linked to the disbursement of the cross-subsidy through a partially fixed payment and a per kWh one. For the implementation of this model, private sector/cooperatives would be required to partly invest in the mini-grid assets, conveying some risk to the operator and therefore aligning interests and actions.

Monitoring

Monitoring of EEU/private/cooperative mini-grid operation will require the adoption by the operators of a software compatible with the monitoring tool used by the Government (see also Chapter 5) and hosted at the DoE for the oversight of the whole NEP electrification program, whether grid or off-grid. The monitoring of technical performance will be based on best practices and take into account latest developments in the field, such as the NREL's Quality Assurance Framework.[78] While monitoring and oversight of mini-grid performance would be mostly undertaken by the DoE, EEA will also play a key role.

4.7 Job creation opportunities offered by the off-grid market

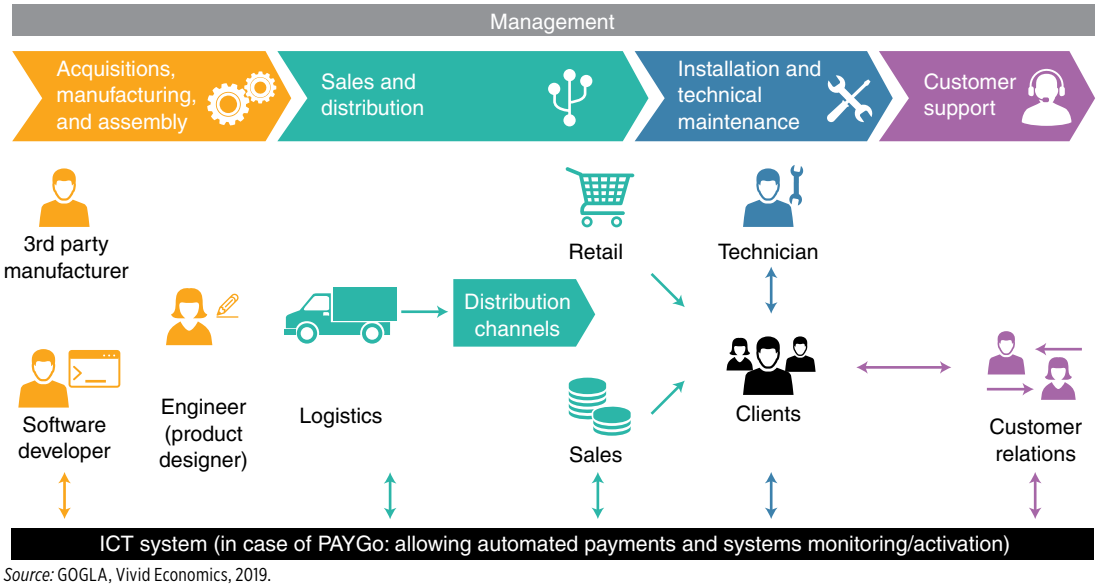
To reach and serve an additional 9 million households by 2025, more products and solutions will need to be produced, imported, distributed, sold, maintained, serviced, and financed. Thousands of Ethiopians will be trained and employed to participate in these activities, with the greatest potential of job creation with in-country distribution, sales, and after-sales servicing segments of the value chain. Figure 4.13 provides an overview of the main areas for increased participation to the off-grid market.

As shown in Figure 4.14, the off-grid solar sector provides different types of employment opportunities along the value chain, from technology acquisition and manufacturing, to sales and customer relations.

The sector creates employment widely across the different activities in the value chain and the different job functions involved, with concentration on functions changing depending on the technology provided and the sales model (over-the-counter cash sales versus PAYGo). Cash sales employ a larger proportion of employees under the sales and retail portion of the supply chain, while the PAYGo model has relatively more people employed to provide technical assistance and installation, manufacturing and acquisition, customer outreach and after-sale services. Sales through PAYGo employ a higher concentration of skilled workers given the higher proportion of jobs in after-sales services. Regardless of the sales model, management and finance roles are also created in similar proportion.

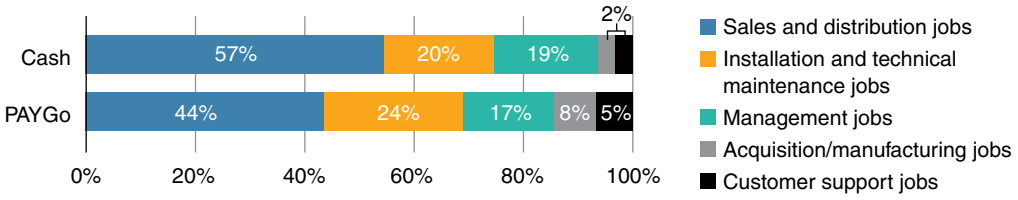
Table 4.17 shows different estimated scenarios of potential employment generation, based on global jobs estimated ratios and other countries' experience

Figure 4.13 Types of employment opportunities across the off-grid solar value chain



Source: GOGLA, Vivid Economics, 2019.

Figure 4.14 Distribution of types of jobs according to the sales model (cash vs. PAYGo)



Source: GOGLA, Vivid Economics, 2019.

Table 4.17 Job creation potential for servicing 9 million HHs with Tier 1 solutions

Scenario 1: Conservative (around 18 jobs per 1,000 HHs)	160,715
Scenario 2: Moderate (around 25 jobs per 1,000 HHs)	227,700
Scenario 3: Ambitious (40 jobs per every 1,000 HHs)	360,000

including Kenya, India, and Bangladesh. In Ethiopia, the sector could generate between 80,000 and 200,000 direct jobs (part-time and full-time).[79] An additional 50 to 100 percent more jobs are estimated to be created indirectly for each direct job in the industry, for an additional 50,000 to 200,000 jobs.[80] This represents total Ethiopian employment in the range of 130,000 to 400,000, mainly to support management and staff functions in importation, production, warehousing, distribution, logistics, installation, maintenance, sales, customer service, technical support, and finance. Depending on the proportion of products sold through cash-based and PAYGo models, around half of the employment generated in the off-grid solar sector would potentially go to sales and distribution functions, a fourth to installation and technical maintenance jobs, and a fifth to management and finance jobs. A smaller proportion (less than 10 percent), would be related to technology acquisition and manufacturing. This employment split is expected to evolve over time, together with the business models and technologies employed to grow the market.

Local geographies, infrastructure conditions, and demographic density can all impact the job creation potential. Reaching an additional 9 million households with off-grid connections could potentially create between 150,000–360,000 jobs in the following years in Ethiopia to produce, import, distribute, sell, install, maintain, and finance off-grid electrification products and services. Several additional jobs will be indirectly created in related industries and sectors because of the new opportunities to engage in income-generating activities that electrification brings.

4.8 Gender and citizen engagement

Access to reliable off-grid household energy and public lighting can reduce energy poverty and give women and men additional income-earning opportunities. Women can earn income and gain employment from production, distribution, retail, and maintenance of solar appliances and clean cookstoves, and provision of after-sales services. Off-grid technologies can also support income earning activities by extending the working day or setting up small businesses that depend on energy provision. Labor-saving mechanized community services such as electric water pumping and grain grinding yield time savings that can also allow women to set up their own small enterprises.

Specifically, some key considerations include:

- **Product preferences:** Women and men may have different preferences when it comes to off-grid technologies and services. In the small business sector, there are indications that women who use off-grid lighting have slightly different preferences than men; the types of businesses women tend to operate drive these preferences.
- **Key buyers:** Women hold significant sway in household decisions related to the purchase of lighting technology (20–50 percent depending on the country), which underscores the importance of reaching women with marketing and educational messages.
- **Financing gap:** Access to finance—with a focus on women's' finance—is a key to the development of

the off-grid market. Financing opportunities and frameworks are often different for women than for men with opportunities for women often relying more on informal networks and lending groups.

In line with the commitment of the Government to ensure gender equality under the NEP, several initiatives have been identified for fostering women's enhanced participation as entrepreneurs in the market and support female-headed HH access to off-grid technologies. The following areas of intervention have been identified with priority:

Promoting women entrepreneurship and employment in the off-grid energy value chain

The Government intends to promote gender quality in the off-grid sector as well. Recognizing the main challenges affecting women's participation in the sector (either as service providers or beneficiaries), the following dimensions have been identified and integrated into the program implementation support and technical assistance requirements for the successful implementation of the NEP off-grid program:

Women in service delivery

Access to finance and development of women entrepreneurship: based on local consultations, women entrepreneurs often lack information about access to finance options in the country. In addition, development of enterprises requires technical assistance support tailored to women's needs. Partnering with networks such as the Ethiopian Chamber of Commerce, Alliance of Women Enterprise Program (AWEP) and Association of Women in Business (AWiB) is key to creating awareness about the credit line among women entrepreneurs. At the institutional level, as part of the implementation capacity for access to finance solutions envisioned under the NEP, focus will be given to assessing credit worthiness of women entrepreneurs within the overall scale-up of access to finance procedures and requirements. Potential solutions could include creating a "priority window" for women entrepreneurs to reduce loan processing times and requirements.

Local solar jobs for women: In addition to supporting women entrepreneurs at the wholesaler and distributor level, all manufacturers and distributors will be encouraged to employ women in the last-mile delivery of the products in rural areas as part of public support to local job creation and skills development. For instance, having women sales agents and local suppliers will create opportunities for women buyers to feel more comfortable interacting with them. Specifically, as part of the focus on jobs under the NEP opportunities for women's employment will be sought through exploring:

- Closing skills gaps for women by working with local vocational training (TVET) to train solar technicians and electrical engineers. This also helps fill a talent gap at the national level in the sector;
- Raising basic skill levels to enable women in rural and lower-income areas to access/qualify for entry-level positions and additional vocational training; and
- Local capacity building for female entrepreneurs and SMEs to participate in the value chain as, e.g., last-mile retailers.

Women as beneficiaries of off-grid solutions

Demand creation, marketing and affordability: Current financial products and business models have had a limited reach in promoting the uptake of off-grid energy products by women. Gender targeting will be taken into account by REBs when identifying potential new customers and supporting PSE penetration. Targeted support for women affordability and access to micro-credit will also be part of the MFIs program implementation support. The communication and education campaign envisioned under the NEP will take into account women as specific targets and seek the collaboration with saving groups that are committed to improve financial inclusion, particularly in rural areas. Behavior change communication tools, especially radio, can be useful in creating mass awareness and demand.

Paying for solar: Financial services—not only accounts, but payments, savings, and credit—give women some basic tools they need to enhance their livelihoods and economic status. Based on the 2017 Global Findex data, 41 percent of men have an account, compared to 29 percent of women. Under the current ecosystem, bank accounts are key to ensure payments for off-grid solar, and targeted interventions will be envisaged to ensure women's participation to the financial sector and solar market. The use of digital payments can also further reduce access barriers for women. In the key activities related to digital payments under the NEP, attention will be paid to ensuring that the women's segment is not left behind.

Monitoring and evaluation: Complementary to EEU's efforts on the grid side (currently establishing a baseline for grid connected female households to inform gender specific connection targets), access to off-grid solutions will be monitored to ensure adequate access

by women to technologies and be part of the overall NEP M&E system, to be developed in partnership with PSEs (see also Chapter 5). Sex-disaggregated data will further inform the implementation of the off-grid program.

Citizen engagement

Citizen engagement activities will be key for the implementation of the NEP off-grid program to manage expectations about grid arrival and for the adequate understanding of the rights and duties associated with off-grid technology payment and ownership. Particularly at the nascent stages of the off-grid market development, education and communication campaigns will be fundamental, not lastly for beneficiaries to be aware of customer care and grievance redressing mechanisms. For these purposes, a close collaboration among REBs, MFIs, and PSEs is envisaged and provided for under the capacity building activities identified under the priority program implementation support activities earmarked for 2019. Along these lines, the following activities have been identified:

1. **Strengthening citizen engagement mechanisms at the community level:** As part of the work on the NEP, linkages between on-grid and off-grid citizen engagement actions will be explored, including engagement with REBs, customer grievance mechanisms, and energy education and communication around products, customer rights, and after sale services.

2. **Targeted energy education:** To drive demand and ensure consumer energy education, marketing material will be designed to message about the health benefits of off-grid technologies, such as reduced smoke inhalation and eye irritation, an issue for women, men, and children alike, or other useful benefits such as time savings or drudgery reduction. Key is engagement with respective household heads and couples about the household decision on the adoption of certain technologies. Other key topics will include information on consumer rights, maintenance, and grievance readdress processes.

4.9 Targeted program for connecting public institutions

Under the NEP Implementation Roadmap, the GoE accords a targeted focus for achieving universal access for all social services delivery institutions as a top priority—especially in the education and health sector. While electricity access rates achieved to date in schools and health facilities are relatively higher than for households, they still remain short for providing universal access, and they will hence be given priority.

Table 4.18 highlights the baseline access statistics. As a result of heavy investment of the Government in the education and health sectors, there are over 58,000 facilities across the country, that is, more than

Table 4.18 Nationwide access to reliable electricity services of education and health facilities

Institution Type	Number of Existing Institutions	Electricity Access (%)[a]	Number of Institutions with No Access
Education facilities (2016)			
Primary schools	34,867	24	26,499
Secondary schools	3,156	70	947
Subtotal	38,023		27,446
Health facilities[b]			
Hospitals[c]	303	70	90
Health centers	3,544	28	2,552
Health posts	16,251	5	15,438
Subtotal	20,078		
Total	**58,121**		**45,526**

Source: Federal Ministry of Education (2016); Education Statistics Annual Abstract 2008 E.C. (2015/16); Federal Ministry of Health and ICF International (2015); Federal Ministry of Health (2018).

a. Includes connection to a central power grid, solar power, or both, or has a functioning generator with fuel. b. Numbers of facilities for all facility types except hospitals are based on the findings of the Ethiopia Service Provision Assessment Plus Survey 2014 and total sample size of 1,327 health facilities. Access rates are based on the 2018 Service Availability and Readiness assessment. c. Includes referral, general, and primary hospitals. The access rate is a weighted average. Data on facility numbers is from 2017.

38,000 schools and 19,000 health facilities.[81] The number reported refers to formal institutions only.

In absolute terms, the biggest challenges in terms of lack of access to electricity services (whether grid or off-grid) are represented by primary schools with over 26,000 facilities and health posts with over 15,000 locations without light. Health posts are particularly important as they provide health services across the country, even in isolated and remote areas and where more service-comprehensive health services are lacking, ensuring that the basic needs of the population are covered. In addition, about 90 hospitals, providing the most comprehensive services to the Ethiopian population, are still not powered and hence cannot perform their duties. All in all, there are more than 45,000 institutions in timely need of access to electricity services—grid or off-grid—which will be connected under the NEP.

Further, the implementation of the NEP will be done in close collaboration with the Ministry of Education and Ministry of Health to ensure that the construction and operation of new facilities are also taken into account, to ensure that electricity services are adequately provided, and that the number of institutions without light does not increase. In line with the overall implementation approach of the electrification program, the collaboration will ensure an integrated and multidimensional approach to service delivery and the establishment of synergies among different development mandates of the Government.

International experience indicates that the presence of electricity services not only supports education and health services (that is, access to education and health), but improves their quality as electricity creates an incentive to, for instance, teachers to move and perform their duties in more remote locations. In the hottest areas of the country, a simple fan can improve teacher attendance and effectiveness, and student performance. Coupled with the right educational materials and appliances, solar systems can power modern, multimedia teaching methods, and so drive an improvement in pass rates.

Grid and off-grid service delivery to social institutions

As indicated in Table 4.19 and Figure 4.15, the overwhelming majority of social institutions follow the paths of the grid infrastructure and are mostly located within 25 km of existing MV lines (between 95 and 100 percent of social institutions). In Figure 4.15, the map shows education and health facility locations along with the existing grid (in yellow) and a 25 km blue "buffer zone" surrounding the grid. Only a small minority of facilities are located beyond the 25 km range (about 1,200 institutions), and even fewer are beyond 100 km from the existing grid (about 500 institutions).

The geo-spatial analysis[82] also highlights the main challenges in geographic terms. Again, a correspondence exists between the location of the main infrastructure and deep rural areas. The areas with the lowest amount of social facilities are in fact Somali Region, the most remote parts of Oromia, Afar, State of Southern Nations, Nationalities and People (SNNP), and other small areas.

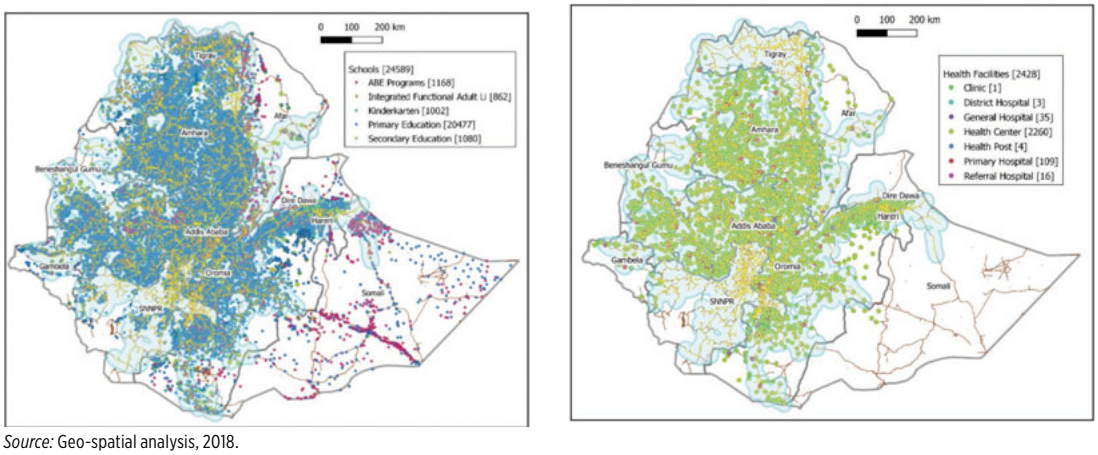
Further, the access outlook could significantly change from one region to the other. As indicated in Table 4.20, Harari, Tigray, Addis Ababa, and Dire Dawa have already achieved near to universal access to secondary schools, which constitutes the regions with

Table 4.19 Geographic distribution of education and health facilities

	Distance of Institutions from Existing Grid Infrastructure (MV lines) and Cumulative Distribution											
Institution Type	**Facilities (#)**	**<2.5 km (#)**	**<2.5 km (%)**	**<2.5 km**	**2.5–25 km (#)**	**2.5–25 km (%)**	**Cumulative Coverage (%)**	**25–100 km (#)**	**25–100 km (#)**	**Cumulative Coverage (%)**	**>100 km (#)**	**>100 km (%)**
Primary schools	34,867	7,808	22	**46**	17,126	49	**96**	1053	3	**99**	512	1
Secondary schools	3,156	196	6	**76**	661	21	**97**	64	2	**99**	26	1
Hospitals	303	50	17	**87**	40	13	**100**	0	0	**—**	0	0
Health centers	3,544	1,380	39	**67**	1,074	30	**97**	94	3	**100**	3	0
Health posts	16,251	9,913	61	**66**	—	—	**—**	—	—		—	—
Total	**58,121**	**19,347**			**18,901**		**390**	**1,211**		**541**		

Source: Calculation based on the available geo-referencing of social institutions.

Figure 4.15 School (left) and health facilities (right) within 25 km of existing grid lines (MV)



Source: Geo-spatial analysis, 2018.

Note: Geo-referencing of social institutions does not cover the entirety of existing infrastructure.

Table 4.20 Access to electricity of secondary schools by region, 2016

	Population[a]	Secondary Schools (#)	Secondary Schools with Electricity (#)	Secondary Schools without Access (#)	Rate of Access (%)
Tigray	5,056,000	189	187	2	99
Afar	1,723,000	34	11	23	33
Amhara	20,401,000	433	312	121	72
Oromiya	33,692,000	1,297	960	337	74
SNNP	18,276,000	124	45	79	36
Somali	5,453,000	68	36	32	53
Benishangul	1,005,000	705	409	296	58
Gambella	409,000	53	12	41	23
Harari	232,000	15	15	0	100
Addis Ababa	3,373,000	217	206	11	95
Dire Dawa	440,000	21	19	2	90
Total	**90,060,000**	**3,156**	**2,212**	**944**	**70**

Source: Calculation based on Federal Ministry of Education (2016); Education Statistics Annual Abstract 2008 E.C. (2015/16).

[a]Central Statistical Agency, projections for 2015.

the highest populations. Electricity access is the lowest, in terms of number of secondary schools lacking service provision, for Oromiya, Benishangul, followed by Amhara. The implementation of the Government will target with priority the areas with the highest access deficit for both schools and health institutions, in collaboration with the relevant ministries.

In addition, the reported access to reliable electricity services declines with the size of the health facility.[83] All hospitals, regardless of the type (referral hospitals have 87 percent of access, general 80 percent, whereas primary ones have 60 percent) and health clinics are in fact more likely than health centers (57 percent)[84] to have regular, uninterrupted electricity. Fewer than three in ten health posts have regular, uninterrupted electricity.[85] Table 4.21 summarizes the distribution of health facilities by type across regions. Based on the reported correlation between service reliability and institution size, most of the regions suffer from unreliable services, as the overwhelming majority of the health institutions are constituted by health posts, followed by health clinics.

Hospitals have the most reliable supply of electricity but are also a very limited percentage of the overall number of institutions, again across all regions in the country. With the exception of Addis Ababa,

Table 4.21 Distribution of GoE owned health institutions by region, 2016

Regions	Distribution of Health Facilities by Regions				
	Population[a]	Hospitals (%)[b]	Health Centers (%)	Health Posts (%)	Total (#)
Tigray	5,056,000	4	23	73	918
Afar	1,723,000	1	17	82	462
Amhara	20,401,000	2	20	78	4,239
Oromia	33,692,000	1	17	82	7,847
SNNPR	18,276,000	1	16	83	4,597
Somali	5,453,000	1	13	86	1,237
Benishangul	1,005,000	1	10	89	431
Gambella	409,000	2	22	76	146
Harari	232,000	5	19	77	43
Addis Ababa	3,373,000	13	87	—	111
Dire Dawa	440,000	6	28	66	47
Total	**90,060,000**				**20,078**

Source: Federal Ministry of Health Infrastructure Directorate, July 2016.

[a]Central Statistical Agency, projections for 2015.

[b]Includes referral, general, and primary hospitals.

Dire Dawa, and Harari, all regions across the country have about 1 percent of hospitals within the portfolio of health institutions. Under the NEP electricity access will be reliable across the different typologies of health institutions to ensure, in turn, the adequate provision of electricity services.

Targets for universal access provision to social institutions

The summary of the priority connection program under the NEP for social institutions is depicted in Table 4.22. By 2025, all primary and secondary schools and health facilities will be provided with access to adequate and reliable electricity services, whether on- or off-grid, and in compliance with the standards and guidelines set by the World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF), and other appropriate organizations. The connection of health posts, currently affected by a 95 percent deficit, is expected to achieve 75 percent of access by 2025 and will be updated over time on the basis of the strategic role assigned to posts by the Ministry of Health (currently under discussion) for the well-being of the population.

The targets presented in Table 4.22 reflect three main dimensions: (i) the successful experiences achieved by other countries with fast-paced connection programs for social institutions, (ii) the policy urgency of adequate access to electricity services in support to education and health, and (iii) the opportunity offered by grid proximity of social institutions.

The implementation of the NEP and the timely achievement of the targets will take into account the priority assigned to the regions with the highest number of facilities lacking access to electricity

Table 4.22 Connection targets for social institutions, 2019–2025

	2018	2019	2021	2023	2025
Education facilities					
Secondary schools	70%		90%	100%	
Primary schools	24%		45%	70%	100%
Health facilities					
Hospitals	70%	80%	100%		
Health centers	28%		50%	80%	100%
Health posts	5%		30%	50%	75%

services, in close collaboration with the Ministry of Education and Ministry of Health for the adequate supply of newly constructed facilities.

The focus will be not only on access, but also on the crucial upgrading required to ensure service reliability, maintainability, and sustainability over time, particularly in the case of service delivery facilities that are off-grid who rely on solar-powered access provision. The NEP provides for a Technical Assistance study to finalize the geo-referencing of education and health institutions, a nationwide assessment of the performance of electricity services provided, and a dimensioning of key end-uses requiring electricity for service delivery, particularly in the health sector (cold chain, simple vaccine and medicine refrigeration, lighting, and sterilization). The assessment and design will be conducted working closely with the federal ministries of health and of education counterparts, as well as with the REBs.

Based on the findings of the study, a detailed yearly connection rollout program will be finalized to combine and maximize access provision through grids and off-grids. The study and the implementation program will be designed in close collaboration with the EEU to integrate network capacity and with the REBs to integrate their knowledge of the territory, and in close collaboration with the ministries of education and health.

Investment financing requirements for off-grid service provision to social institutions

Based on the best available information, the majority of the institutions currently benefiting from access to electricity services are connected through the grid, with a few benefiting from off-grid solutions thanks to the efforts of the Ministry of Health, the REF, and Development Partners support (see also Section 4.1). In addition, most of the facilities with access are also estimated to be in close proximity to the grid (within 2.5 km from the existing grid infrastructure). The Technical Assistance study commissioned under the NEP will allow for completing the geo-referencing of the social infrastructure, updating the access rates, and identifying the access needs by institution type and location.

The location of 95–100 percent of education and social institutions within 2.5 km from the existing grid infrastructure (MV lines) makes them candidates for grid connection at least cost. The connection of schools and clinics has already become part of the grid implementation program and will be pursued aggressively by EEU in the next years to ensure the contribution of grid connections to access provision, taking advantage of the proximity of the facilities to the existing grid. Indeed, EEU already integrated connection targets for education and health facilities within its yearly connections rollout in 2018.

While grid connection may represent the least-cost solution, network capacity and the efforts directed to the overall programmatic implementation of the NEP may not be able to support the timely provision of grid connection. The implementation of the NEP social institutions program hence provides for an off-grid social institution program which will be implemented in coordination with grid developments, and be further detailed on the basis of the Technical Assistance study commissioned by the NEP.

The implementation of the NEP social institution program will leverage the close proximity to the existing grid to maximize the number of connections to be provided in the shortest time frame. Following the overall connections rollout of the NEP, grid connections will mostly expand from the existing grid and are expected to provide access first to all social institutions within 2.5 km of the existing grid at least cost and in the shortest time and by 2025, and then move to the areas that are located 2.5 km away from the existing network infrastructure.[86] The provision of grid-based access to all institutions falling within 2.5 km from the existing grid will allow for achieving an access rate of 46 percent for primary schools, 76 percent for secondary schools, 67 percent of access for health centers, and 66 percent of access for health posts.

EEU already has in its grid connection rollout plans targeted for social institutions, which started in 2018. While the investment prospectus focuses and gives priority to those areas located beyond the short-term reach of the grid (i.e., beyond 2.5 km), implementation progress and the results of the technical assessment will further inform the grid and off-grid targets over time.

Table 4.23 illustrates the estimated investment requirements for the provision of pre-electrification off-grid services complementing grid expansion for the timely achievement of the targets, which will allow all institutions to be powered through grid or off-grid solutions by 2025. The off-grid targets and related investment requirements do not include hospitals, as the 50 facilities currently lacking power will be connected to the grid to ensure adequate provision of health services. All facilities are located beyond 25 km and service level needs were preliminary estimated based on information provided by the ministries of education and health and informed by

Table 4.23 Preliminary investment prospectus for pre-electrification and long-term access provision for social institutions

Institution Type	Facilities in Scope for Pre-Electrification (<25 km from grid)	Facilities in Scope for Long-Term Off-Grid Solutions (>25 km from grid)	Total Facilities to Connect (#)	Service Level*	Average Cost (US$)	Total Capital Cost (US$ millions)
Education facilities						
Primary schools	17,126	1,565	18,691	1.5 kW solar PV system, 12 hours/day, 7 days per week, providing all classrooms with light, and public areas and staff offices with printers and computers	6,600	123
Secondary schools	661	90	751	2.5 kW solar PV system, 12 hours/day, 7 days per week, providing same plus science lab with science kit (multimeters, ammeters); computer lab (computers, printers)	16,500	12
Subtotal			**19,442**			**136**
Health facilities*						
Health centers	1,074	97	1,171	5 kW solar PV system, 24 hours/day, 7 days per week, providing light, phone charging, refrigeration, diagnostic and monitoring equipment, other basic medical equipment	33,000	39
Health posts	Not available	Not available	6,338	1.5 kW solar PV system, 24 hours/day, 7 days per week, providing light, phone charging, refrigerator	9,900	63
Subtotal	**17,787**	**1,655**	**7,509**			**101**
Total, all facilities			**26,951**			**~230**

Note: Excludes hospitals. The role of posts in provision of health services is currently under discussion. Investment estimates provide for a solar system adequate to power at least a refrigerator.

*Conservative industry standard five hours per day of full sun is assumed; systems generate full day power needs in five hours. Battery storage is therefore seven hours for schools (12 hours/day in use) and 19 hours for health facilities (24 hours/day in use). Estimates are based on information provided by the ministry of education and health.

matching best-practice guidance by the WB, USAID[87] and the International Energy Agency.[88]

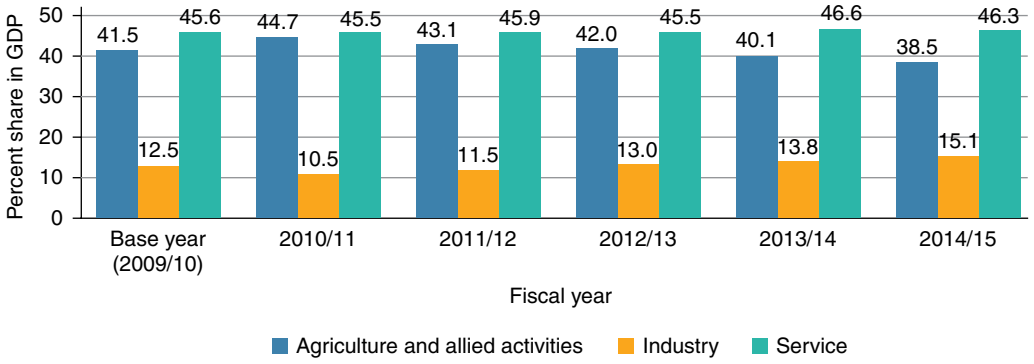
Based on the information provided by the Ministry of Education and Ministry of Health, as well as other cross-sector experts, all institutions are planned for three-phase 240 volt AC power, seven days per week, recognizing that health care is a continuous operation, and school facilities often serve dual purposes as community centers or are used after hours for other purposes. Technical assistance studies will provide field verification for all demand and cost estimates.

The financing investment requirements are based on the preliminary social institutions demand assessment. The figures will be updated on the basis of the nationwide demand assessment provided for under the NEP (see also Section 4.11), including potential for PAYGo systems and possible funding implications for the ongoing public grant funding mechanism for operational expenses for social institutions.

4.10 The agriculture-energy nexus

The agricultural sector remains dominant in the Ethiopian economy and an important source of economic growth. Although there is an ongoing structural transformation in the Ethiopian economy—predominantly from agriculture to services and manufacturing—agriculture still comprises about 40 percent of total GDP (Figure 4.16) and continues to dominate

Figure 4.16 Percentage share of GDP by major economic sector



Source: GTP II (2016).

employment, with 78 percent of the population employed in agricultural activities. The sector is also a major contributor to export earnings, with over 80 percent of goods exported. Despite its declining share in the economy, the agriculture sector is growing rapidly. Over the past 15 years, the sector has grown at around 7 percent per year.

Much of the growth has stemmed from an increased area under cultivation and from increased productivity, the latter driven by large public investment in the sector, including agricultural extension, rural roads, and advances in public policy, such as improvements in land tenure security. In addition to contributing to economic output and exports, agricultural growth is correlated with poverty reduction for smallholder farmers and with positive impacts on non-farm rural economies. The National Nutrition Program (NNP) was revised in 2013 to strategically address the nutrition problem in the country to include initiatives that have emerged since the 2008 NNP, including initiatives that take into account the multi-sectoral and multidimensional nature of nutrition and the linkages among key implementing sectors, one being agriculture.

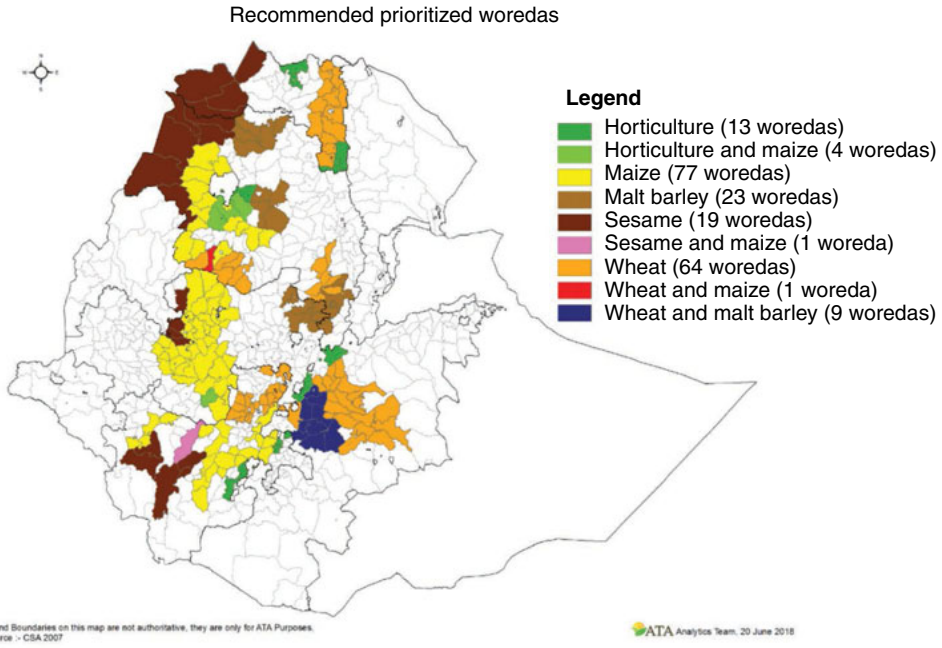
Ensuring sustainable agriculture through the development of natural resources and aligning the agriculture development plan with the green economy development strategy, coupled with expansion of irrigation developments, are the strategic directions to be pursued with regard to natural resource conservation and management. Enhancing the income of farming households through progressive transition from producing subsistence crops into high value crops, putting in place an efficient agricultural marketing system, and enabling the youth and women in rural areas to benefit from agricultural development are the other strategic directions to be pursued during the GTP II period.

The following major targets are set with respect to irrigation development during GTP II: (i) increase the area of land covered by irrigation from 2.34 million hectare in 2014/15 to 4,143,000 hectares by the end of 2019/20, (ii) develop 1,743,000 hectares of additional irrigated land during the plan period and provide access to at least one alternative water point for 80 percent of smallholder farmers (semi-pastoralists), of which 50 percent are users of the full irrigation farming package. Achieving these targets will help the country harness its irrigation potential.

To increase agricultural productivity of smallholders and their transformation to commercial farmers requires a strengthening and focusing of support services and infrastructure. To drive this transformation, the Government is moving toward focused support to specific commercialization clusters, targeting areas with the highest potential for the production of commodities for which Ethiopia has a comparative advantage and can stimulate agro-processing and value addition (Figure 4.17).

The World Bank is supporting this approach under the AGP II project, which supported the identification of high potential cluster areas based on the following criteria: (i) access to markets (access to cities of 50,000 population or over in less than five hours); (ii) natural resource endowment (factors to consider are good rainfall distribution with annual average of 700 mm or over); (iii) suitable rainfall and soil for crop and fodder production; (iv) potential for development of small-scale irrigation facilities; (v) institutional plurality of service providers, including good basis and growth of viable cooperatives and farmer groups, and existing partnership engagements with the private sector; (vi) willingness and commitment to participate (supportive environment; performance of programs/programs supported by other donors); and

Figure 4.17 Map of areas with high growth agricultural potential, by field



Source: ATA (2018) and WB AGPII Project.

(vii) woreda clustering as a criterion for selection to develop synergies for growth.

Access to adequate and reliable electricity is a key component of services and infrastructure support. As part of the study on productive uses to be conducted in 2019, a focus will be granted to agriculture processing and automation (e.g., post harvesting and threshing), particularly for the areas with the highest potential. The study will inform the Government about the least-cost solution for electricity service provision in space and time. Given the proximity of existing populations to the existing grid and the proximity of the areas of high potential to main roads, as well as the electricity demand associated with these areas, it is foreseen that the grid could constitute the least-cost technology solution in a number of locations, which should be prioritized.

Based on the results of the analysis, the Government, in dialogue with the Ministry of Agriculture and EEU, will consider providing priority grid access to those areas, to boost economic productivity and support agricultural activities. The analysis will also take into account electricity needs for larger and smaller scale irrigation, as well as dispersed water points for household use, to identify the optimal technology solution.

Agriculture activities currently rely heavily on diesel-based solutions (particularly for irrigation purposes). Access to grid-based services would offer several advantages, including energy and costs savings, reliable services (not affecting productivity negatively), milling, automation, and mechanization of activities. Currently, supply chains for dairy, vegetables, and fruits are negatively affected by interruptions in the power supply across the value (cold) chain, with significant losses in sales. In addition, an inadequate and unreliable power supply is often associated with the informal sector and constitutes one of the major barriers for the transition to formal operations, distribution, and delivery.

However, in some instances off-grid solar systems could offer a mid- to long-term technology solution, when adequate, to promptly support activities. In addition, mini-grid solutions may constitute the least-cost option to adequately serve loads that are located in remote and dispersed areas, and/or in those areas that may need a network upgrade first. Off-grid options will also be investigated in the least-cost analysis in the Technical Assistance study earmarked for 2019.

Potential for diesel substitution

Agricultural water development is crucial to improve smallholders' livelihoods, since irrigation can help farmers diversify their production with high-value crops such as fruits and vegetables and enable multiple cropping seasons. In Ethiopia, the current land

under irrigation is around 2 million hectares (ha), which is 16 percent of total cultivated land. Over the next five years, GoE plans to reach the full irrigable potential of the country of over 5 million ha. Household Irrigation (HHI) as well as small-, medium-, and large-scale schemes will be important strategies to achieve this goal, in combination with exploring and developing groundwater potential.

Ethiopia's agriculture is dominated by smallholder farming. In this context, the most transformative and cost-effective technology for groundwater irrigation is small household irrigation pumps. Smallholder farmers stand to reap many economic gains from household irrigation technologies in terms of the variety and value of crops they can grow, as well as for the same crop, resulting in heightened yields that are more resilient to periods of drought. This consequently results in increased farm income, improved food and nutrition security, and an improved quality of life for the farming household. Income gains can be very large, with estimates of revenues per hectare doubling as a result of irrigation.[89]

A thriving HII market will also host small- and micro-level enterprises, including those providing well drilling services, after-market sales of replacement parts and fuel, maintenance and advisory, and finance opportunities for entrepreneurs—including irrigation service providers (ISPs) that might supply a combination of services.

Recent research has confirmed the suitability for irrigation of significant swathes of agricultural land, particularly in proximity of surface water and river basins. The first spatially explicit groundwater irrigation area suitability map of Ethiopia[90] indicates that 6 million ha of land are suitable for irrigation in Ethiopia. Much of the irrigable land is located in the Abbay, Rift Valley, Omo Ghibe, and Awash river basins, where significant shallow groundwater resources are also present. These would supplement the plentiful surface water resources in these areas in servicing the small-, medium-, and large-scale irrigation schemes already planned in these areas.

Household irrigation pumps can be motorized or nonmotorized. Nonmotorized pumps come in a range of forms, with two being most widely used in Ethiopia:

- Rope-and-washer pumps are hand operated and are characterized by the lowest installation costs. Operation and maintenance costs are minimal and measured in hours of labor rather than monetary terms, as they don't require specialist knowledge. However they can only irrigate minimal plots (0.1 ha or less)
- Treadle pumps (among which are pressure treadle pumps, suction-only treadle pumps, and overflow treadle pumps) are operated by foot. They also boast low installation, operation, and maintenance costs but are more efficient than rope-and-washer pumps in terms of the hours of labor required and irrigation outcomes, and can irrigate larger plots (0.25 ha or less).

Motorized pumps remove the need for manual labor and can use one or more different energy sources to power the pumping. Diesel, petrol, grid-electricity, wind, or solar-powered pumps are present in Ethiopia. Motorized pumps are able to irrigate larger areas of land with a single well.

Currently, the country largely relies on diesel-powered motorized pumps and manually operated pumps for irrigation at the smallholder level. Penetration of clean and cost-effective alternatives in solar and wind power is low. Under the NEP, the Government will incentivize the adoption of renewable energy-powered pumps and substitution of diesel-based pumps with off-grid clean solutions, in line with its Climate and Resilience Strategy for green growth. The transition will also allow for important cost-saving opportunities for farmers, the national economy, the Government, and the global environment.

Diesel pumps and diesel generators for electric pumps are cheaper than solar panels to buy, but costly to operate and more difficult to maintain. A mounting body of evidence suggests that the lower up-front capital cost of a diesel pump is, however, largely due to the high operating and maintenance costs and the short lifespan of the diesel equipment. Solar PV, on the other hand, has no fuel costs and very low maintenance costs and the panel can last 25 years. Though diesel prices are subsidized centrally in Ethiopia, the low centrally set price is often not available in rural areas, where transport, logistics, and intermediation costs inflate the final cost of purchasing fuel by the farmer.

A recent simulation study of a battery of three different sites scattered across Ethiopia, where solar irradiation is representative of the national average, established that the cost-saving potential of introducing solar-powered pumps for drinking purposes is very high.[91] Based on a comparison of annualized life-cycle cost, solar-powered pumps are shown to save about US$0.1 per cubic meter of water pumped. This represents a savings of between 39 and 45 percent of costs over operating with diesel (Table 4.24). A raft of studies from developing countries such as India, Bangladesh, Zimbabwe, Benin, Namibia, and

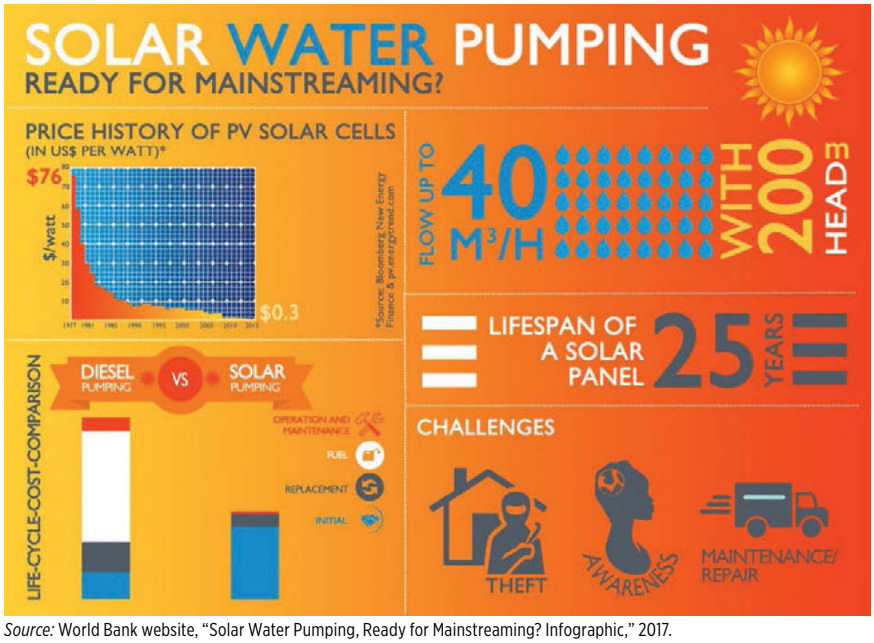
Figure 4.18 Pump types commonly used for smallholder irrigation

	Manual pump	Treadle pump	Engine pump
Drive system	• Rope-and-washer pump • Suction pump 	• Pedal (suction) 	• Typically diesel, electric if power is accessible 
Water source	• Static water level of up to 18 m depth (for irrigation)	• Static water level of up to 6 m depth • Suitable for nearby surface water	• Static water level of up to 3–6 m (suction); up to 12 m if placed underground (suction and pressure) • Suitable for surface water
Price and running costs	• Price: US$100 • 4 h of labor to irrigate 0.1 ha (opportunity costs of ~15 ETB/day)	• Price: US$135 (pressure)/ US$30 (suction only) • 4 h of labor to irrigate 0.25 ha (opportunity costs of ~15 ETB/day)	• Price: US$300–3,000 • Variable costs and irrigable area depending on size of engine, assumed average of 3 ha • Fuel cost 120 US$/ha/yr
	1.9	0.7	0.83

■ = Cost of irrigation (ETB/ha)

Source: ATA, 2014.

Figure 4.19 Solar water pumping ready for mainstream?



Source: World Bank website, "Solar Water Pumping, Ready for Mainstreaming? Infographic," 2017.

Rwanda among others support the conclusion that deploying solar power can shave off even more than half of the cost of pumping shallow groundwater for irrigation purposes.[92]

Substitution of diesel with solar-powered irrigation brings other benefits besides improving livelihoods and yields for smallholder farmers across Ethiopia. Shifting to solar irrigation could also help reduce the country's trade deficit and boost public finances by reducing the forex costs of importing diesel for irrigation purposes and the diesel subsidy costs to the Government.

Table 4.24 Savings modelled under different site conditions from implementing solar-pumping versus diesel powered pumping

		Unit	Siadbere & Wayu (Amhara)	Wolmera (Oromia)	Enderta (Tigray)
Diesel	Annualized life-cycle cost	$	681	561	619
	Water cost	$/m^3	0.2	0.23	0.27
Solar	Annualized life-cycle cost	$	373	340	355
	Water cost	$/m^3	0.1	0.14	0.16
Cost savings solar vs. diesel	Annualized life-cycle cost	$	308	221	264
	Water cost	$/m^3	0.1	0.09	0.11
	% savings		45%	39%	43%

Source: Calculations based on Misrak et al 2015.

Water pumps are already part of the portfolio of technologies financed by the credit line at the Development Bank of Ethiopia, and end-users. The Government has also ensured that these technologies benefit from duty-free importation.[93] The first requests for the importation of solar-powered systems for irrigation under the DBE's market development credit line have already been received.

Based on the results of the productive uses study, the Government intends to leverage the following existing distribution channels in the country for the distribution of water pumps, including private sector ones, which would also be a valuable source for distribution of off-grid solar solutions more broadly to the HHs residing in areas with high economic growth, as well as others:

- **Agricultural Equipment & Technical Service Enterprise (AETE):** Existing core businesses include land development, heavy duty machinery rental service, maintenance services through mobile and permanent workshops and overhaul services, procurement and distribution of agricultural farm implements, and agro-chemicals and chemicals sprayers. Employees have a wide range of expertise, from mechanical and agricultural engineers, to marketing and procurement experts.
- **Ethiopian Trading Enterprise (ETE) wholesale outlets:** The recently established ETE is envisioned to modernize and provide a reliable platform for trade in the country. Currently ETE has 36 wholesale outlets called "Alle Bejimla." The outlets carry different types of fast-moving commodities such as sweets and snacks, beverages, personal care products, cleaning products, and stationary. Through incorporating irrigation pumps in the portfolio, better access could be accomplished where all actors, including Government organizations and private sector actors, as well as smallholder farmers will be able to procure from these outlets. The pumps will be procured through standardized procedures at the Government level to take advantage of tax shields, making prices more affordable for all actors.
- **Private sector:** The private sector supply chain in Ethiopia represents only 13 percent of the current irrigation pump market today, whereas in more mature markets, such as India and Bangladesh, the private sector played a key role in providing adequate irrigation services across the country. Diesel-based solutions are currently provided in areas close to existing roads and markets (about 200 km from major cities), which are considered commercially attractive by private sector off-grid solar service providers. Further, the higher demand of these areas offers advantageous opportunities for PSEs.

Solar pumps for irrigation

According to industry experts from across the developing world, solar pumps for irrigation purposes are now ranked by off-grid business customers as by far the number one productive use application of off-grid technology, for the first time surpassing refrigerators and the cold chain.[94]

The Ethiopian Agricultural Transformation Agency (ATA) has recognized the potential of solar pumps for irrigation in Ethiopia and recommends the deployment of financial support and incentives for the Ethiopian private sector to develop toward the importation and local manufacturing of solar-powered pumps, as well as build the technical environment necessary to maintain the irrigation capital produced or imported.[95] ATA's research shows that momentum is growing across the continent. Makerere University in Uganda is already blazing the path of innovation for African-based manufacture of

solar-powered pumps for irrigation. The private sector active in the African pump market is also pivoting toward this technology. ATA is currently working on an Integrated Shallow Groundwater Irrigation Development (ISGWID) Project, which aims to promote sustainable and efficient shallow groundwater (SGW) irrigation development in the country. ISGWID has five components:

1. Scaling up SGW mapping and building capacity for SGW regulation
2. Irrigation technologies and services supply chain (ITSSC) around SGW development
3. Sustainable irrigation development around high value and nutritious crops
4. Promotion of energy efficient and water saving technologies
5. Capacity building for project handover

The NEP will seek to fully exploit program synergies with the ATA's ISGWID project, in particular components 2–5. While the diesel pump supply chain is well established, and procurement channels are largely Government-led and coordinated, the solar pump supply chain offers a unique opportunity for the domestic private sector to develop at pace in the agricultural ancillary services provision sector. This can only be done in tandem with and with the support of Government in a concerted sectoral approach to develop good regulations design, ensure stringent oversight of quality standards, create linkages between private actors and the financial system thanks to the support of regional bureaus, and leverage university and TVET college efforts to fast-track knowledge transfer.

Beyond irrigation: animal husbandry and the agro-industrial complex

Irrigation is, at the moment, not the only potential application of electric power to agriculture. Access to electricity can transform the animal husbandry sector, whether with grid-powered or stand-alone solar-powered technologies. Stand-alone solar can power poultry incubators and daylight mimicry technologies in the poultry sector, one of the fastest growing livestock sectors in Ethiopia. These devices can greatly enhance poultry meat and egg yields, improving farmer's margins. Automated milking machines can boost productivity on dairy farms, freeing up on-farm labor time for other productive tasks.

Electricity holds even further promise in agro-industrial uses. The necessary development of the Ethiopian cold chain, which is being broadened and deepened thanks to Government-sponsored Agro-Industrial Parks and their network of Rural Transformation Centers in tandem with private investment, is not possible without reliable electric power. The meat and dairy supply chains, currently constrained in their export market opportunities by the low availability and reliability of refrigerated storage services,[96] will benefit from the greater reliability of the grid following the reinforcement of its main transmission lines. The cold chain aside, no modern industrial process is fully functional without electricity, and the development of the domestic agro-industrial and light manufacturing sector cannot be envisioned without a sustainable and reliable supply of electricity from the grid.

The development of demand for electricity for productive uses will be further explored in a forthcoming Technical Study, which will also look at the potential for the development of an off-grid compatible appliances market in Ethiopia, to ensure that enterprises, particularly small and medium enterprises served by off-grid technologies in the pre-electrification and long-term off-grid space, fully leverage the productive opportunities of off-grid access.

An enabling ecosystem for productive uses

The establishment of an enabling ecosystem for productive uses requires the supply of quality products as well as appliances to the Ethiopian population. Indeed, growing evidence in the still infant market highlight the key need for appliance supply, quality, and affordability, to ensure that productive uses and increase in demand are adequately tackled. The Government is already discussing with several DPs the launching of different research initiatives to better understand the nexus between access to electricity services and productivity, in agriculture and beyond.

It is recognized that the initiatives summarized in Table 4.25 are conditions necessary to increase access to appliances compatible with solar off-grid resources. This is particularly relevant for the mid-term pre-electrification and the long-term off-grid segments of the off-grid program. This is also reflected in the potential improvements in the regulatory environment, particularly with respect to lifting and removing barriers at the entry for appliances (e.g., custom duties). All aspects affecting the establishment of an enabling ecosystem for appliances and their affordable distribution to the Ethiopian population will be considered under the Technical Assistance study and will also inform program implementation support activities for ensuring education and awareness of officers about the latest regulations, as well as end-user beneficiaries.

Table 4.25 Demand and supply-side enablers for productive assets

	Supply Side	Demand Side	Institutional
Enablers	• Awareness of market needs • Identification of least-cost electricity technology solutions • Leveraging of distribution channels and multiple business models (public- and private-led) • Adequate product availability (machines and appliances) • Access to finance • Enforcement of standards	• Affordable electricity services • Affordable equipment • Access to finance (e.g., MFIs)	• Institutional and administrative capacity • Identification and tackling of possible regulatory barriers for an efficient and effective productive uses program • Leverage coordination of GoE programs and budgets
Technical assistance and capacity building	• Identify least-cost solution for adequate and reliable power provision for existing and potential productive uses • Assess value chain constraints • Identify appropriate appliances for different productive uses • Identify implementation mechanisms leveraging on existing programs and delivery infrastructure • Identify enabling measures for the development of the appliances market and related access to finance measures	• Demand stimulation and consumer awareness and educational campaigns on productive uses of electricity services and appliances (including demand-side management) • Market intelligence for willingness to pay (WTP) and possible access to finance channels	• Ensure multi-sector collaboration for the design of a productive uses program • Program implementation and monitoring

4.11 IDPs and refugees

Counting internally displaced persons[97] (IDPs), refugees,[98] and asylum seekers,[99] Ethiopia hosts around 3.8 million displaced persons on its territory. This places Ethiopia among the 10 host nations with the greatest domestic population of displaced persons on the planet, a testament to its culture and policy of hospitality and open arms to those fleeing conflict and disasters, either climate induced or non–climate induced.

Refugees and IDPs in Ethiopia face different living and settlement conditions on the Ethiopian territory, due to the differing reasons behind their flight and their differing legal statuses. Refugees are nonnationals of Ethiopia who have fled neighboring countries and are granted the right to stay on Ethiopian territory, away from the persecution they would face back home. Due to their condition, they often face the prospect of a prolonged if not permanent settlement away from their country of origin. The overwhelming majority of refugees and asylum seekers in Ethiopia (almost 92 percent) are hosted in camps.

IDPs are Ethiopian nationals who have fled their place of origin, mostly either due to internal conflict between communities or due to climate-related adversity. IDPs tend to flee to nearby areas that are inhabited by family or clan members or members of the same ethnic group. As a result, almost half of all IDP households for which data are available are not hosted in camps but settled within host communities or families or in dispersed settlements. In many cases, IDPs are able to return to their place of origin, but often after a prolonged period of absence and with significant difficulties hampering their return, including insecurity, loss of food and livelihoods, loss of assets, and damage to their homes.

IDPs

As of November 2018, there were approximately 2.9 million internally displaced people according to OCHA Ethiopia (2019). 500,000 of these are climate induced and, 2.4 million are conflict induced. While the numbers of climate-induced IDPs are shrinking as the consequences of the 2015–2017 drought recede, conflict-induced IDPs rapidly increased in 2018, having doubled since March 2018.

Most new displacements over the course of 2018 were a result of the outbreak of new intercommunal conflict in West Guji and Gedeo along the border between Oromia and SNNPR regions. That conflict

displaced almost a million people between April and July. Efforts of the Government and humanitarian partners are well under way in facilitating the return, reintegration, and resettlement of these IDPs. As of 30 November 2018, the total headcount of displaced individuals in the West Guji-Gedeo area was 560,293: 284,566 in West Guji and 275,727 in Gedeo. 472,152 individuals are living in host communities (210,651 in 89 communities in West Guji and 261,501 in 116 communities in Gedeo) while 88,141 are living in collective sites (73,915 in 49 sites in West Guji and 14,226 in eight sites in Gedeo).[100]

The vast majority of IDPs in the country however, are, still to be found on the 1,000 km long border between Oromia and Somali region where intercommunal conflict broke out in September 2017. IDPs continue to number more than a million. As of June 2018, there were an estimated 656,579 people displaced within their respective regions, mainly pastoralists and agro-pastoralists residing in spontaneous or planned camps/sites along the regional borders. This figure included 428,569 people displaced within their woreda of origin, 49,541 people displaced outside their woreda of origin but within the same region, and 178,469 IDPs who, even if they crossed regional borders, remained close to their areas of origin along the border.

IDPs displaced or expelled from one region to the other are hosted in 27 transit or "collective centers," in 191 other major sites in the Oromia region, and 51 sites (including two large sites: Qoloji 1 and 2) in the Somali region. As of June 2018, there were around 242,600 ethnic Somalis displaced from the Oromia region and settled in Qoloji 1 (34,194) and 2 (41,310) sites on the Jijiga-Harar road, as well as in 14 other major sites; and around 136,400 ethnic Oromos displaced from the Somali region. The groups residing in the "collective centers" were mostly displaced from cities and major towns, and were engaged in various professions.[101]

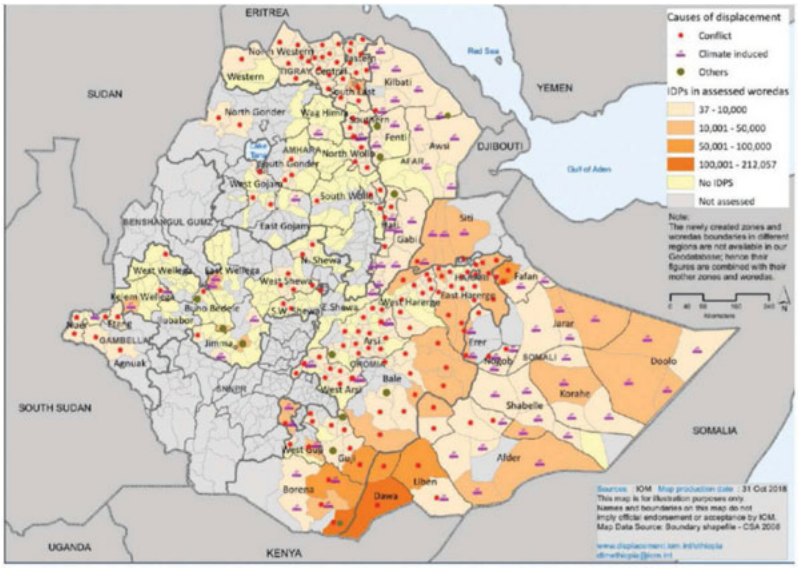
Access to electricity

Electricity access data for IDPs is not available at the household level. Site-level data indicate that 91 percent of all IDPs in Ethiopia live in sites where no IDP has access to electricity. As shown in Table 4.26 spontaneous camps and sites, which host almost half of the country's IDP population and dispersed settlements, face the worst situations as far as electricity access is concerned.

It is also known that lighting conditions are very poor throughout IDP hosting facilities. For sites where data are available,[102] 85 percent of IDPs report living in sites where the lack of lighting is a safety concern. Almost everywhere there is insufficient lighting in sanitary facilities, where these facilities are even available. 50 percent of IDPs do not have access to latrines, and only four out of the other 50 percent, who do have access to latrines, live in sites which report adequate lighting around latrines.

The Government is committed to providing integrated responses to IDPs' needs. With the intent of finding a durable solution to the IDP situation in the country, the Government prioritizes return, where possible, and otherwise supports relocation

Figure 4.20 Map of IDP population



Source: IOM, Ethiopia Displacement Tracking Matrix (DTM), Round 13: September–October 2018, Countrywide dashboard.

Table 4.26 Distribution of IDPs covered by DTM's countrywide monitoring by type of site where they are hosted and access rates prevailing in the site

Rate of Access at the Site	Type of site							All Sites Covered*
	Collective Center	Dispersed Settlement	Host Community/ Families	Other	Planned Camp/Site	Spontaneous Camp/Site	Transit Center/ Site	
0%	45%	100%	84%	71%	92%	98%	72%	91%
1–25%	5%	0%	2%	0%	7%	1%	0%	2%
26–50 %	12%	0%	3%	6%	0%	0%	0%	2%
51–75 %	12%	0%	2%	24%	1%	0%	0%	1%
> 75%	26%	0%	8%	0%	0%	0%	28%	4%
Total population by site type	92,076	165,005	674,139	3,730	134,180	1,001,762	4,386	2,075,278

Source: IOM DTM's countrywide monitoring database.

*Coverage is about 72 percent of Ethiopia's IDP population.

Note: Percentages may not sum to 100 percent due to rounding.

of the conflict-affected IDPs. A simple solar lantern (for about US$6) can help address the sanitation and safety concerns raised by the lack of access to lighting, as well as improve education outcomes for displaced children. Off-grid solutions—from solar lanterns to higher tiers of service, depending on the local needs—could support lighting for sanitation and other needs at night. IDP children could study in the evening hours, helping to mitigate the repercussions of their displacement on their education.

Under the NEP, the Government intends to collaborate with the Humanitarian Development Partners Roundtable on Energy to identify the most effective and efficient solution to support the transitory disruption in life conditions for IDPs and host communities. Off-grid solutions could provide a significant positive impact during displacement, given its transitory nature, and reduce the burden of lack of access to services on the host communities.

Refugees

Ethiopia hosts over 900,000 refugees in its country. Ethiopia hosts refugees of all nationalities of bordering countries, as well as some from countries that do not share a border with Ethiopia.[103]

Refugees in Ethiopia live under difficult conditions. Poverty rates are high, with two in three refugees living on consumption levels of 28 percent below the international poverty line of US$1.9 PPP per capita per day. Many have lost productive assets during their displacement. Access to food is highly dependent on aid, and food insecurity is widespread: on average, two in three refugees are highly food insecure. Access to improved water and sanitation facilities is generally better for refugees in camps than they experienced in their pre-displacement situation. The quality of the shelters they live in is however are poor, with only 20 percent of refugees accessing improved housing and nearly 60 percent of households experiencing overcrowding.

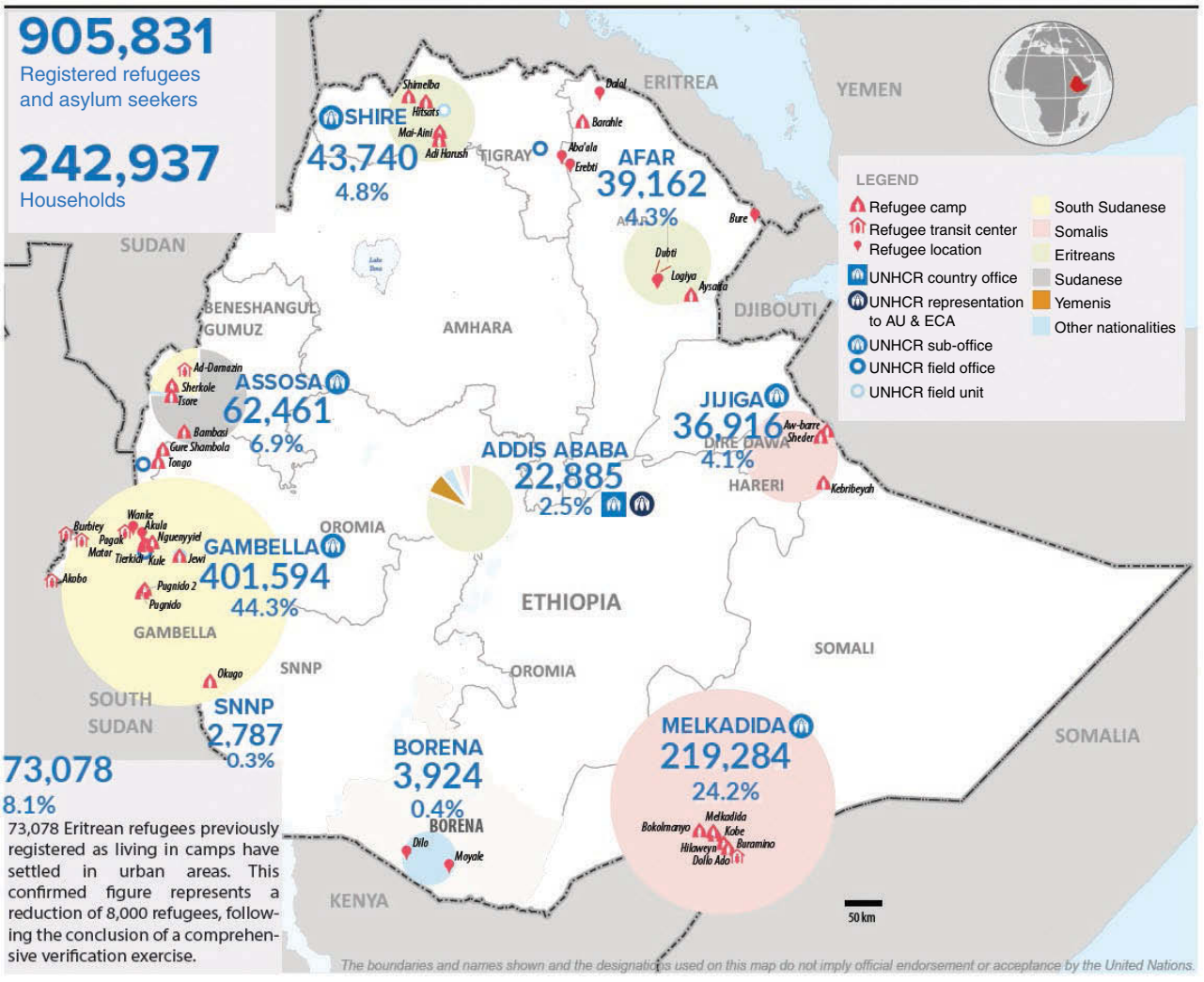
Refugee livelihoods are beset by many challenges. Less than one in ten refugees is employed, and many do not even participate in the labor force. As a result, refugee incomes are largely made up of aid monies, whereas agriculture and wages were the main income sources prior to displacement. Attendance to primary education on the part of refugees is on par with host communities, but only about 13 percent of secondary school-age refugees attend secondary schools, largely because they do not move on from primary schools.

Access to energy

In refugee camps, access to energy is mixed. While access to clean sustainable sources of light for household illumination is in many places good, and street lighting is available in several camps, the lack of clean sustainable energy sources for cooking is widespread. Only two out of 26 refugee camps in Ethiopia are grid connected, the Mai-Aini and the Adi Harush camps in Tigray. Two other camps in Tigray, Shimelba, and Hitsats and two in Afar, Barahle, and Aysaita are under connection.

Recent data from the World Bank's Skills Survey 2017 suggest an estimated 37 percent of refugee households have access to sustainable energy for home lighting. The situation is not uniform across camps, with the camps situated in Benishangul

Figure 4.21 Map of refugee populations



Source: UNHCR.

Gumuz and Gambella regions displaying significantly lower access rates, whereas camps in the Somali region have achieved more than 50 percent access to sustainable home lighting solutions, and in camps in Tigray more than four in five refugee households have access to electricity. The survey also revealed that refugees in camps average about eight hours of access to electricity, which is lower than in host communities, but higher than refugees experienced prior to displacement: the refugees hosted in Gambella and Benishangul-Gumuz provide an exception to this observation, however.

UNHCR data suggest that 39 percent of refugee households have been provided access to street lighting. However, many street lighting systems are in need of replacement, so the actual rate of access to street lighting on the ground is likely to be lower.

As part of the Government commitment to the pledges (Box 4.1) that were undertaken at the Refugee Leaders Summit in New York, held on 20 September 2016 and co-hosted by Ethiopia, and the adoption in 2017 of a roadmap for implementation, the implementation of the NEP will also entail collaboration with DPs to receive support for the implementation of the pledges. As refugee camps are a more temporary solution for vulnerable individuals, several technologies could be taken into account for service provision, as witnessed by the fact that some camps have already been connected to the grid. The humanitarian development partners roundtable on energy will be an important interlocutor in this.

Refugee camps can also become sources of friction with neighboring communities for access to energy sources (and more broadly for competition for scarce

Box 4.1 The Government of Ethiopia's nine pledges taken at the Leaders' Summit on the Global Refugee Crisis on 20 September 2016

Out of Camp Pledge

1. Expansion of the "Out-of-Camp" policy to benefit 10 percent of the current total refugee population.

Education Pledge

2. Increase enrolment in primary, secondary, and tertiary education to all qualified refugees without discrimination and within the available resources.

Work and Livelihoods Pledges

3. Provision of work permits to refugees and to those with permanent residence IDs, within the bounds of domestic law.
4. Provision of work permits to refugees in the areas permitted for foreign workers, by giving priority to qualified refugees.
5. Making available irrigable land to allow 100,000 people (among them refugees and local communities) to engage in crop production.
6. Building industrial parks where a percentage of jobs will be committed to refugees.

Documentation Pledge

7. Provision of other benefits such as issuance of birth certificates to refugee children born in Ethiopia, and the possibilities of opening bank accounts and obtaining driving licenses.

Social and Basic Services Pledge

8. Enhance the provision of basic and essential social services.

Local Integration Pledge

9. Allowing for local integration for those protracted refugees who have lived for 20 years or more in Ethiopia.

Source: ARRA (2017).

resources) particularly for wood availability, and on the contrary could become more self-sufficient though a more sustainable access to services, including support of economic activities, together with social ones.

Further, the implementation of the NEP will look into maximizing service delivery to refugee camps, in line with the recommendations of the Global Compact for Refugees and the related Comprehensive Rapid Response Framework. As camps lack basic services across different sectors, technology solutions that could provide integrated access should be prioritized, for instance power, water, and sanitation, leveraging on the latest technology advances on the off-grid side as well.

4.12 Technical assistance and program implementation support for off-grid scale-up

Table 4.27 summarizes the NEP off-grid program priority implementation support activities for the establishment of a well-functioning market since its inception. The NEP provides for just-in-time and immediate assistance targeted for launching and sustaining the course of implementation of the program for the achievement of about 9 million off-grid connections by 2025. This will achieve not only universal access, but also short-term pre-electrification for those beneficiaries expected to be connected at least cost by 2025 with a grid connection, but they will have to wait until then to benefit from electricity services if no other option is offered. Combined, these interventions will provide the immediate and key policy, operational, regulatory, and monitoring tools for the efficient and effective performance in grid and off-grid connection scale-up.

All of the activities are targeted for completion by 2019 and will inform implementation from 2020 onward (with the exception of sector-wide capacity building, which will be undertaken throughout the years of implementation), and build on the progress achieved in terms of implementation and completion of technical assistance and program implementation support, either completed in 2018 (activities that were prioritized under the first version of the NEP), or ongoing.

All in all, the priority activities comprehensively address performance improvement and implementation capacity for the off-grid program, as well as the

adequate integration of activities and their monitoring for progress and quality supervision.

The technical assistance and program implementation support activities have been identified to support both sides of the trading market for off-grid technologies: supply side and demand side.

Enabling environment activities focus on the following dimensions:

(i) Remove market constraints and barriers for private sector penetration;
(ii) Establish incentives and skill development programs for private sector development at the scale required for the program;
(iii) Establish institutional arrangements for the integration of central and local stakeholders' activities; and
(iv) Ensure affordability of off-grid technologies.

All program implementation and technical assistance activities will ensure gender equality in access to and provision of off-grid solar technologies, as also described in Section 4.7.

Off-grid supply-side implementation support and technical assistance

1. Quality assurance, enforcement of off-grid standards and of removal of custom duties. Counterfeit products are still entering the country, and the Government has taken important steps for the adoption of regulatory standards (Lighting Global) ensuring the quality of off-grid technologies for the Ethiopian population, as well as lifting of customs duties to endure adequate supply to the market. Trainings are envisaged to ensure that the staff at customs is fully empowered and up to date with the latest regulations on technical standards and custom duties policies and can easily recognize the different kind of off-grid technologies and appliances. The training will be conducted in collaboration with relevant Government agencies, such as the Ministry of Revenues and the Ministry of Trade.

2. Off-grid companies licensing. Establishment of a license scheme for off-grid companies to control for quality at entry of actors in the off-grid space, in collaboration with relevant ministries. The introduction of a licensing scheme will include clauses for customer protection (e.g., based on the latest GOGLA Consumer Protection Code)[104] and indication of the grievance redressing procedures to be put in place by the Government. It will also provide clarity on the rules and regulations applicable to off-grid companies and support the overall structuring of the off-grid market. The licensing scheme will also provide clear indication of penalties in case of noncompliance with adequate customer care and after sale services.

3. Access to finance solutions expanded lending capacity and efficiency, and collaboration with commercial banks. In anticipation of a possible expansion of access to finance solutions credit line for increased access to finance lending to PSEs (in support to the scale-up of off-grid technologies from lanterns, scale-out across the country of off-grid solar solutions, and development of mini-grids by private actors), strengthening of internal capacity will be required. In regard to mini-grid developments, access to finance would be facilitated by the assessment of the project as collateral. Capacity building is envisaged to ensure adequate program management, application processing, financial and technical assistance support to local entrepreneurs. In addition, collaboration with commercial banks is also envisaged to support: (a) access to finance solutions familiarization with asset-based financing practices in the country for increased landing and (b) commercial banks familiarization with the off-grid market and progressive increase of commercial lending to PSEs for the establishment of an exit strategy for access to finance solutions. Strengthening of access to finance solutions capacity will also include its support to local companies' business capacity with improved technical assistance (from business plans to mobile payment solutions options).

4. Strengthening of the Ethiopian Investment Commission (EIC) capacity to support off-grid international investors. The EIC has already been receiving increased support requests from international investors interested in participating in the off-grid market, particularly from diaspora companies. Strengthening of the EIC is envisaged to ensure adequate handling of an increased number of requests, and for supporting international investors in understanding and navigating the current policy and regulatory landscape (including for local assembly and manufacturing).

5. Workforce expansion in support of the off-grid market. Training activities supported by GoE for the adequate establishment of local workforce (e.g., technicians, market campaign, agents) supporting market activities including: communication and education campaigns, after-sale and maintenance services, and agents. Training activities will be organized leveraging on the existing TVET and in synergy with ongoing Government programs, the Safety Net and the Agricultural Growth Program, offering new income generating opportunities and/or community

work opportunities (required to receive cash transfers under the safety net program). This workforce will support private sector delivery, offering skilled workers and reducing the burden for them in establishing their businesses. Training activities and related workforce creation will be conducted in collaboration with the REBs, when applicable and adequate as well as in consultation with PSEs to tailor training activities to the skills required in the off-grid market. Activities will ensure a gender balance and incentivize women participation to the off-grid workforce. In addition, other channels will be explored for the growth in local jobs and PSEs entrepreneurship development in support to the off-grid market.

6. REBs support to local distribution and retail of off-grid technologies. REBs have been in the forefront of efforts to ensure distribution of quality products to the Ethiopian population. Under the NEP off-grid program, increased coordination of activities with and of PSEs and MFIs is required to ensure adequate penetration of off-grid solutions, including measures to further de-risk the market. REBs are competitively placed to support coordination, with capillary local offices across the country, and in parallel with activities in support of market demand (described below). Successful experiences in this space, such as in the Amhara region, will be taken into consideration for the assessment of options for improved coordination of activities among the different stakeholders, with the ultimate goal of ensuring adequate supply of products to the population, quality of services, and achievement of the off-grid targets.

Implementation support for deep rural areas (>25 km) service delivery (MTS)

The REBs could also play a significant role for the successful implementation of the MST program, for which capacity strengthening is also envisaged. With local knowledge of the territory and beneficiaries, REBs could support price discovery for private sector companies through provision of information (and data collection when necessary) on the existing infrastructure for product delivery (e.g., roads and markets), to be also included in the tender documents. As the MST program targets remote and dispersed communities far away from the main infrastructure, and are expected to be provided with access at last, the NEP off-grid program intends to leverage on a data driven approach in support to service delivery. The complete list of information useful for private sector delivery will be further discussed in consultation with PSEs, but will preliminarily include, among others: distance from roads, markets and shops, payment points, network coverage, mobile phone penetration, and a preliminary assessment of electricity needs and willingness to pay. This information will support PSEs in tailoring their business plans and requests for subsidy to fill the gap in commercial viability of these areas.

7. EEU MST Contracting Authority and off-grid implementation capacity. Implementation capacity support will be provided to EEU for (i) management of the MST bidding and subsidy award, (ii) EEU implementation support in the off-grid space in case of private sector exit from the MST to ensure continuous quality services to deep rural customers, and (iii) implementation of the mini-grid program. Support will be provided to ensure that EEU expands its capacity and is adequately prepared to manage the new off-grid functions envisaged under the NEP, in parallel to the implementation of the grid program. Particularly during the pilot phases for the MST, support will be required to adapt and improve the mechanism based on market response and allowing for flexibility in the evaluation of the tender documents. Not lastly, support will be provided to finalize the tender documents for both off-grid solar and mini-grid solutions.

8. Establishment of an enabling regulatory environment for mini-grids. Support to EEA and other relevant sector stakeholders for the establishment of an enabling regulatory environment for mini-grid developments. Regulatory interventions will include, among others, establishment of technical standards for mini-grids, not lastly to ensure their possible integration to the grid, establishment of licensing rules and procedures, tariff setting, and overall conditions for the participation of private sector investors.

Technical assistance

1. Remittances study. Detailed assessment and implementation options for leveraging remittances in the off-grid space, which will also support Forex availability. The consultant will review and analyze international best practices with regards to remittances from diaspora communities and ongoing efforts in Ethiopia in the off-grid space; and assess the possibility of facilitating remittances for the achievement of NEP goals and targets. The study will also provide recommendations for inclusion of remittance-based off-grid service delivery into the NEP monitoring and evaluation framework and platform.

2. Local manufacturing study. The analysis will identify a roadmap for the development of local assembly and manufacturing capacity leveraging on skillsets already available in the country across

sectors (e.g., 1-color shipping cartons, retail color printed packaging, wires and cables, plastic injection molding, 10 W to 100 W solar panels, printed circuit boards). The analysis will also indicate possible localization of local manufacturing in support of the different segments and needs of the off-grid supply chain (e.g., from packaging to spare parts).

3. Cost of cash analysis and mobile payments scale-up. Assessment of efficiency gains in cash-based transactions, support to the off-grid solar payment system, and design of options for an implementation roadmap for the adoption of mobile payment solutions (for off-grid solar and mini-grids). The study will include recommendations for increased security and efficiency of cash-based transactions and for increased financial inclusion through off-grid payments. It will be conducted in collaboration with relevant stakeholders and actors and build synergies with ongoing Government programs, including the Financial Inclusion Strategy and the overall process of liberalization of the economy under way.

Off-grid demand-side support

1. Increased MFIs lending capacity. Strengthening of MFIs participation in support to the achievement of the NEP goals including lending and consumer awareness. Lending through MFIs is currently the only option for installment payment plans in the country and a key contributor of affordability of off-grid solutions for end customers. Implementation support is required to strengthen the role of the MFIs and increase their lending capacity (breadth and depth) for off-grid technologies. Implementation support will be provided through an assessment of opportunities for new types of collaboration with PSEs and REBs and barriers and constraints for increased lending. In addition, support will be provided for an improved understanding of the off-grid market and its risk, successful business models as PAYGo, repayment schedules and payment solutions (including digital), and the implementation of a programmatic approach to overcome systemic, financial, and operational barriers to maximize financial intermediation services. The implementation support will be provided in collaboration with relevant stakeholders and building synergies with other Government programs, such as the Financial Inclusion Strategy.

2. REBs demand estimation, program oversight, and grievance redressing. Due to their presence on the territory and knowledge of the off-grid beneficiaries, REBs role will be strengthened and leveraged for the implementation of the NEP off-grid program. Implementation support will be provided to strengthen REBs' role in data gathering and aggregation on end-users' needs, as well as facilitate demand activation and customer registration for off-grid technologies in coordination with MFIs and REBs. REBs have already covered this role in past phases of off-grid solution rollouts. Their experience is valuable for access scale-up and scale out. In addition, REBs would support the federal Government with the establishment of a grievance redressing mechanism to ensure that private sector delivery is on par with international best practice standards and consumers are protected from possible abuses or malfunctioning in the market. That is, the local administration offices at the woreda and kebele levels could become locations for grievance handling. The design and establishment of the grievance mechanisms will further define the role of the REBs, include the possible establishment of a "hot line" for customers, and link to private sector ability to operate in the market (the "strikes system"). The grievance redressing mechanism will be integrated into the M&E platform to be established at MoWIE.

Implementation support for deep rural areas (>25 km) service delivery (MTS)

Demand discovery, aggregation, and affordability of off-grid technologies: Capacity building and program implementation support will be provided to REBs for gathering of local demand and willingness to pay information in deep rural areas, including disadvantaged groups, schools, and clinics. The REBs are expected to be best suited to play this role, in collaboration with EEU as the contracting authority for the MST. The information collected by the REB will also allow the prompt identification of affordability issues that cannot be tackled through MFIs that would hence require additional public support in the form of vouchers through other mechanisms. Affordability issues will be tackled in synergy with other Government programs, particularly the safety net PSNP one, taking advantage of already existing and highly successful distribution and implementation mechanisms directed to ensure affordability and well-being for the poorest of the poor.

Customer registration: Related to demand discovery, REBs will be empowered to support customer registration, building on the experience under the REF program. This activity is primarily envisaged in deep rural areas to inform the tenders and overall private sector delivery but has the potential to be scaled up in commercially attractive areas as well. Customer registration will be provided as a service by the REBs and also inform the monitoring of the off-grid program in

Table 4.27 Summary of technical assistance and program implementation support activities, 2019

Off-Grid Issue Area	Activity	Scope	US$ Million	Leading Agency
Market supply—*Implementation support*				
Quality assurance and standards enforcement	1. Quality assurance, enforcement of off-grid standards, and removal of custom duties	Training of custom officers on adopted regulations and standards for off-grid technologies to ensure adequate quality assurance at entry as well as understanding/ recognition of technologies	1	DoE, in collaboration with Ministries of Revenues and Trade
Quality assurance	2. Off-grid companies licensing	Design of options for the establishment of a license scheme for off-grid companies, including customer protection duties and penalties for noncompliance (associated with grievance mechanisms)	0.5	DoE, in collaboration with trade
Access to finance	3. Access to finance solutions expanded lending capacity and efficiency, and collaboration with commercial banks	Capacity building for improved program management, application processing, financial and technical assistance support to local entrepreneurs. Collaboration with commercial banks will also create synergies and establish a roadmap toward an exit strategy for access to finance solutions.	2.5	DoE, in collaboration with commercial banks
International PSEs participation and local manufacturing	4. Strengthening of EIC capacity to support off-grid international investors	Capacity building to support international private investors' understanding and navigation of the local investment climate, including for local assembly manufacturing	1	DoE
Distribution/retail	5. Workforce expansion in support of the off-grid market	Development of training curricula tailored to the needs of the off-grid market skillsets. Implementation support also involves capacity building to TVETs for the implementation of new activities.	3	DoE, in collaboration of Ministry of Education
Distribution/retail	6. REBs support to local distribution and retail of off-grid technologies	Increased coordination of activities with and of MFIs, PSEs, MST for adequate local supply of off-grid technologies	1.5	DoE
Retail/mini-grids, and customer service	7. EEU MST contracting authority and off-grid implementation capacity	Capacity for EEU to manage the implementation of the off-grid program, for both solar off-grid and mini-grids. Includes capacity for management of the MST and the off-grid public program.	1.5	DoE, EEU
Mini-grids development	8. Establishment of an enabling regulatory environment	Technical assistance and capacity building for the development of a regulatory enabling environment for mini-grids development, from technical standards to private sector participation	0.5	DoE, EEA, EEU
Market supply—*Technical assistance*				
Forex requirements	1. Remittances study	Assessment of opportunities offered by diaspora remittances for the financing of off-grid solutions, and design of possible support mechanisms and financial management	0.5	DoE, in collaboration with the Diaspora Trust Fund
Local manufacturing	2. Local manufacturing study	Assessment of cost and opportunities associated with the development of local off-grid manufacturing capacity and roadmap options for implementation	0.5	DoE
Mobile payments and financial inclusion	3. Cost of cash analysis and mobile payments scale-up	Assessment of efficiency gains and implementation roadmap for the adoption of mobile payment solutions (off-grid and mini-grids). Recommendations for increased security and efficiency of cash-based transactions and for increase financial inclusion through off-grid payments.	1	DoE, in collaboration with Ethio-Telecom and NBE

(continues)

Table 4.27 Continued

Off-Grid Issue Area	Activity	Scope	US$ Million	Leading Agency
Market demand—*Implementation support*				
Affordability	1. Increased MFIs lending capacity	Capacity building for improved understanding of the off-grid market and perspective customer creditworthiness; improve collaboration with REBs and PSEs	3	DoE, in collaboration with MFIs
Demand activation and grievance redressing	2. REBs demand estimation, program oversight, and grievance redressing	Capacity building for improved demand assessment and activation (includes MST), educational campaigns, establishment, and implementation of grievance redressing mechanisms	3	DoE, in collaboration with REBs
Citizen engagement	3. Awareness and education campaign	To be conducted for the whole NEP electrification program	Included in integrated planning	DoE
Market demand—*Technical assistance*				
Affordability	1. Affordability analysis	Nationwide demand estimation and modeling	Included in integrated planning	DoE
Total			**19.5**	

deep rural areas. When applicable, registration activities will be offered in synergy with communication and educational campaigns on the uses, rights, and duties related to off-grid assets ownership.

Notes

50. Standard requirements above 15 Wp are currently voluntary.
51. The off-grid access rate was confirmed by the MTF Survey.
52. Training activities were funded under the World Bank Electricity Network Reinforcement and Expansion Project (ENREP).
53. The classrooms provided with lighting serve students, teachers, and the school director.
54. In contrast to 25 percent for the rest of the DBE portfolio.
55. NRECA Draft Assessment Report, 2016.
56. The 2018 Global Off-Grid Solar Market Trends Report Released, Dalberg Advisors, January 2018.
57. 75 percent of Tier 1 entry-level solar home systems, $100 average import cost; 25 percent of Tier 2 systems, $300 average import cost.
58. Under the credit line currently active at the Development Bank of Ethiopia.
59. Currently, buildings are considered as the main collateral asset.
60. With a down payment currently estimated to range between US$0–10, based on consultations with private sector companies.
61. The Global Findex, World Bank, 2017.
62. Advanced countries have more than 20 branches per 100,000 people, according to World Bank analysis. Countries like Pakistan, India, Indonesia, and Turkey have 10–20 branches per 100,000 people. Nigeria and Kenya have around 5–10 branches per 100,000 people, while a country like Afghanistan has 0–5 branches.
63. One caveat is that many agents are likely inactive, meaning they may have begun facilitating financial transactions, but no longer do.
64. The Growth and Transformation Plan II (GTP II) laid out a goal to double the number of bank branches by 2019/2020, a World Bank Development Policy Credit committed to raising mobile money usage from 0.32 percent percent to 5 percent percent by 2021, and the National Financial Inclusion Strategy laid out the goal of having 80 percent of the population within 5 km of a payment point by the year 2020.
65. The Global Findex, World Bank, 2017.
66. Ethiopia Growth and Competitiveness Programmatic Development Policy Financing, October 2018, World Bank.
67. Including Kenya, Uganda, Tanzania, and others.
68. Ethio Telecom data.
69. Lumos: Pay-as-you-go-solar in Nigeria with MTN, GSMA, October 2106.
70. Tavneet Suri and William Jack, The long-run poverty and gender impacts of mobile money, December 2016.

71. Example 1: OMC in India powers telecom towers (1.5 kW to 12 kW of power) and the surrounding villages with solar mini-grids. Example 2: Zengamina in Zambia runs a hydro mini-grid powering a fruit drying factory with >70 kW of power demand together with the surrounding communities.
72. Example 4: JUMEME's mini-grid on Ukara Island in Lake Victoria (Tanzania) connects 350 customers in Bwisya village. Shops, cafeterias, TV saloons, welding workshops, and wood workshops were established in Bwisya starting months after commissioning of the mini-grid, supplying goods and services to all inhabitants of Ukara. This resulted in an electric bakery in Bwisya delivering bread to outlets on the other side of the island >10 km from Bwisya. Fresh bread had so far not been available on Ukara. A bank opened an agent's office in Bwisya two years after commissioning of the mini-grid. The Tanzanian Revenue Authority increased its activity in Bwisya after mini-grid electrification. All active businesses have been registered and started paying VAT and income taxes.
73. Further described in Section 4.4.
74. As described under Step 1, Access to finance.
75. Monthly payment estimates are based on the Tiers considered for the analysis and private sector consultations conducted for the preparation of the NEP.
76. Several preliminary studies have been conducted for mini-gird developments in the country, providing different ranges of cost per connection. The estimates here reported are based on costing information provided by EEU, preliminary results of the geo-spatial least-cost plan under development with the support of USAID, and consultations with private sector companies.
77. Given that the electricity consumption in mini-grids is 431 kWh per customer and year with 210,000 customers.
78. For more information see also: NREL and Global LEAP (2017), Quality Assurance Framework for Mini-Grids.
79. Based on IRENA 'Renewable Energy and Jobs. Annual Review 2017', and E. Mills, 'Job creation and energy savings through a transition to modern off-grid lighting', 2016.
80. These estimations do not account for indirect employment generated in sectors linked to the off-grid solar value chains through forward and backward linkages, such as technology sectors, mobile money, or appliances to be powered. In addition, these estimations do not include additional employment opportunities for the recipients of off-grid solar products, such as systems for productive use.
81. This represents an increase of about 1,800 schools, about 1,500 primary and 300 secondary schools in 2015–2016 levels (latest data available). The 2015 numbers were presented in the first implementation framework of the NEP.
82. The conclusion of the geo-spatial analysis is based on available information. Main data gaps have been identified for Tigray and SNNP regions, and possibly for Somali Region.
83. Defined by the survey as "power" is routinely available during regular service hours. Ethiopia Service Provision Assessment Plus Survey 2014. Ethiopian Public Health Institute (EPHI). Federal Ministry of Health and ICF International.
84. Ethiopia Service Provision Assessment Plus Survey 2014. Ethiopian Public Health Institute (EPHI). Federal Ministry of Health and ICF International
85. Ethiopia Service Provision Assessment Plus Survey 2014. Ethiopian Public Health Institute (EPHI). Federal Ministry of Health and ICF International.
86. The rollout of the connections will eventually depend on network capacity and on the inputs provided by the REBs on economic and social priorities. The sequencing of the connections along the cost curve represents a data driven approach to electrification based on the location of the majority of the population with respect to the existing grid infrastructure.
87. USAID (2017), Powering Health: Electrification Options for Rural Centers.
88. IEA (2014), Photovoltaic Power Systems Programme. PV Systems for Rural Health Facilities in Developing Areas: A completion of lessons learned.
89. Fitsum and colleagues in a 2009 paper estimate net gross margins to grow to US$323/ha under small-scale irrigation, as opposed to US$147/ha under rain-fed systems. Fitsum et al. "Importance of Irrigated Agriculture to the Ethiopian Economy: Capturing the Direct Net Benefits of Irrigation", International Water Management Instiute Research Report 128, 2009.
90. Abeyou et al. "Assessing potential land suitable for surface irrigation using groundwater in Ethiopia," *Applied Geography, 85*, 2017.
91. Misrak et al. "Feasibility study of a solar photovoltaic water pumping system for rural Ethiopia," Environmental Science, Volume 2, Issue 3, 2015.
92. See, e.g., Agrawal S., and Jain A. 2015. Solar Pumps for Sustainable Irrigation. Council on Energy, Environment and Water, New Delhi, India; IRENA. 2016. Solar pumping for irrigation: Improving livelihoods and sustainability; Magrath J. 2015. Solar irrigation and refrigeration—improving incomes in Zimbabwe, Oxfam Policy & Practice Blog; Shouman et al. 2016, "Economics Analysis of Diesel and Solar Water Pumping with Case Study Water Pumping for Irrigation in Egypt," *International Journal of Applied Engineering Research,* Volume 11, Number 2 (2016).
93. Tariffs can make up a significant component of cost for imported goods into Ethiopia. Liquid pumps—

whether used for water, oil, or gas—as well as their engines and parts are entered into the same import category. The same tariff applies to imported drip irrigation kits, since they are categorized as tubing and ancillary equipment. If purchased through private means, taxes on these include a duty tax and a withholding tax in addition to VAT, totaling about 42 percent rate on an import Climate Investment Fund (CIF) value. Ultimately, these charges comprise about a third of the price of pumps—both motorized and nonmotorized—that are imported via private supply lines.

94. Efficiency for Access, "Off-Grid Appliance Market Survey: Perceived Demand and Impact Potential of Household, Productive Use and Healthcare Technologies: Third Edition," 2018.
95. ATA, "Irrigation Technologies and Services Supply Chain (ITSSC) Study Report," Unpublished, 2018.
96. A USAID value chain study from 2017 states "cold chain and packaging do not meet international buyer expectations. Export abattoirs need to upgrade their packaging facilities and capacity so they can provide market ready vacuum packed individual pieces (2 kg packs), chilled to 0–2 degrees, which would provide a 60–90 day shelf-life." USAID, "Value Chain Analysis: Live Animals & Meat" | Feed the Future Ethiopia Value Chain Activity, October 2017.
97. According to the United Nations Guiding Principles on Internal Displacement, internally displaced persons are "persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized state border." UN Doc E/CN.4/1998/53/Add.2.
98. According to the 1951 Refugee convention, a refugee is "someone who is unable or unwilling to return to their country of origin owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion."
99. An asylum seeker is a person who has left their country of origin and applied formally for recognition as a refugee in another country, though their application has not yet been adjudicated.
100. IOM 2018, "Displacement Tracking Matrix | Ethiopia Mobility Tracking Rapid Response Assessment, Round 4, West Guji and Gedeo Zone, 12–30 November 2018."
101. OCHA. 2018. "Ethiopia: Oromia—Somali Conflict-Induced Displacement, Situation Report No. 4," 20 June 2018.
102. I.e., sites for which DTM data from round 13 has been published—covering approximately 72 percent of the IDP population.
103. The largest group of refugees are the South Sudanese encamped in the Gambella region (44.3 percent of all refugees), with a smaller population being hosted in Benishangul-Gumuz. The second largest group are Somalis, situated in camps across two clusters, one in the north of the Somali region, near Jigjiga (4.1 percent) and one in the south, around Melkadida (24.2 percent). Eritreans form the third largest group, mostly found in camps Tigray, near Shire (4.8 percent), and Afar (4.3 percent), with other prominent groups being Sudanese (largely found in Benishangul-Gumuz) and Yemeni nationals. As of 2010, Ethiopia implements an Out-of-Camp policy (OCP), which has allowed over 13,000 Eritrean refugees to settle in mostly urban areas. In 2016 an expansion of the OCP was announced to encompass nationals of countries other than Eritrea. Refugees of all above-mentioned nationalities are also found in Addis Ababa.
104. For more information please visit: https://www.gogla.org/gogla-consumer-protection-code.

CHAPTER 5

NEP Institutional Framework

Successful achievement of the NEP ambitious goals requires both clear and credible targets and timetables, enabled by a comprehensive and consistent programmatic implementation framework design, and coupled with adequate financing, sustained throughout the program implementation horizon.

Toward this end, the NEP identifies the following key building blocks for the rollout of grid and off-grid connections: (i) clarity of roles and accountabilities of sector institutions, and designated intermediary agents, to ensure efficient and effective planning, management, and operation of the sector; and (ii) monitoring of program progress to address significant deviations in progress toward achieving targets, should they materialize.

Effective and fast-paced performance requires strong sector institutions, enabling policies for designated implementation and intermediary agents—be they public or private—and accountability for results delivery, with commensurate autonomy for the operational achievement of targets. Additionally, a transparent sector-wide coordinating mechanism for performance monitoring will be expanded to the off-grid program for tracking progress in achieving targets.

The NEP provides for technical assistance studies to further inform planning for and targeting of beneficiaries, maximize cross-cutting outcomes (social and economic), and increase over the time sophistication of implementation and monitoring mechanisms. In addition, priority capacity building activities are identified to empower sector stakeholders—both public and private—for the implementation of the integrated electrification program for the timely achievement of the targets, both grid and off-grid. Further, key program implementation support activities are also identified to build adequate capacity for all relevant sector institutions and stakeholders to fill the immediate gaps in implementation and ensure that connectivity scales up and out at the speed required for the achievement of universal access by 2025. These activities also focus on ensuring the steady financial and commercial sustainability of the program—both grid and off-grid—and ensure the efficient use of public finances.

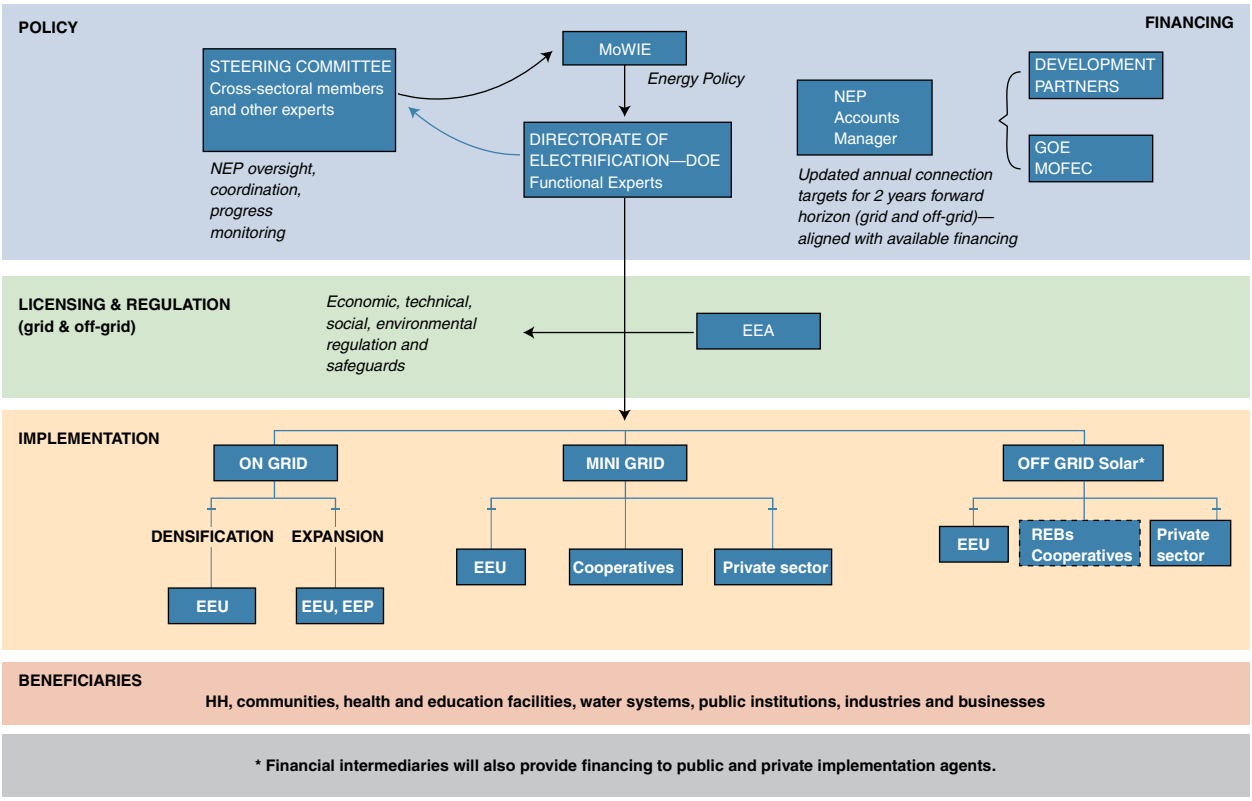
As described in detail in Chapter 4, the NEP will play a key role, not only for service provision of electricity, but in the process, and for its success, it will support and require synergies with other development mandates of the Government, not lastly financial inclusion. All in all, NEP implementation will be key for the development and maturity of the domestic banking and financial sectors and the development of local private sector capacity and entrepreneurship, which are important for the development and diversification of the economy.

The implementation framework for the NEP reflects the commitment of the Government to leverage on all available and best practice implementation modalities and agencies in the Ethiopian power sector context and their local comparative advantages, under the planning, monitoring, and sector enabling role of the Government through MoWIE. The implementation framework further details and expands the institutional arrangements designed within the NEP, integrating the lessons learned from the first year of implementation and reflecting consultations among sector stakeholders as well as the private sector.

Six foundational dimensions are identified for implementation:

1. Policy, planning, and strategic oversight
2. Financing and donor coordination
3. Regulation

Figure 5.1 Institutional framework



4. Implementation
5. Performance monitoring
6. Technical assistance and capacity building

5.1 Policy, planning and strategic oversight

As identified in the first NEP, the overall responsibility for ensuring that the designated implementing agents for the grid and off-grid NEP programs rests with MoWIE. The ministry coordinates and provides oversight for the effective and timely execution of all components of the NEP through two institutional channels—the Steering Committee and the Directorate of Electrification—and, if and as circumstances warrant, facilitate course corrections including updated connectivity targets set for grid and off-grid systems, and within and across the off-grid program components (solar systems and mini-grids).

The ***NEP Steering Committee (SC)*** is chaired, convened, and constituted by the Hon. Minister of MoWIE. The steering committee is comprised of permanent members representing sector institutions and cross-sectoral ministerial delegates, as well as professional experts and sector stakeholders as needed.

The NEP SC provides high-level strategic direction and policy guidance for the implementation of the program, as well as facilitates effective coordination across Government departments and ministries, and monitors the sector level "dashboard" of key indicators of progress and performance. Responsible institutions are held accountable by the SC to ensure the effective and sustainable implementation of the program and its results, also taking into account the experience and concerns of beneficiaries. On an ongoing basis, the SC will review and approve the connection targets (grid and off-grid) submitted by the Directorate of Electrification (see below) with a two-year implementation horizon, and correspondingly authorize funding for implementing agents.

The Directorate of Electrification (DoE)[105] within MoWIE, is composed of a portfolio of functional electrification experts (grid and off-grid) supporting the functions of the steering committee. Specific responsibilities under the DoE include:

Support to the SC: The DoE is responsible for facilitating the day-to-day logistical support necessary

for the effective monitoring and oversight of the NEP. This includes organizing and facilitating quarterly meetings on program progress and impacts (more frequent as and when appropriate); preparing the relevant information, such as progress reports and other briefing inputs as appropriate; circulating in advance the relevant agenda and the supporting information package appropriate for SC deliberations; and drafting of minutes, and special occasional briefs for SC when necessary.

Planning, monitoring, and sector stakeholders' coordination: The DoE is responsible for harmonizing technical, social, and policy inputs for the grid and off-grid connections rollout under the NEP, to be approved by the SC. More specifically, the DoE ensures the integration of EEU's grid rollout connection plans (to be progressively informed by geo-spatial information as they become available, including least-cost connections rollout plans, to be updated on an ongoing basis), with bottom-up information on the number and specific needs of beneficiaries in the areas identified, including households and social institutions (schools and clinics), and reflecting regional policy priorities (e.g., regional quotas and emerging regions).

The identification of grid connections also endeavors, to identify the area candidates for off-grid solutions, gather information about localized beneficiary needs, and support off-grid access provision in coordination with grid expansion, both in the short and in the medium to long term.

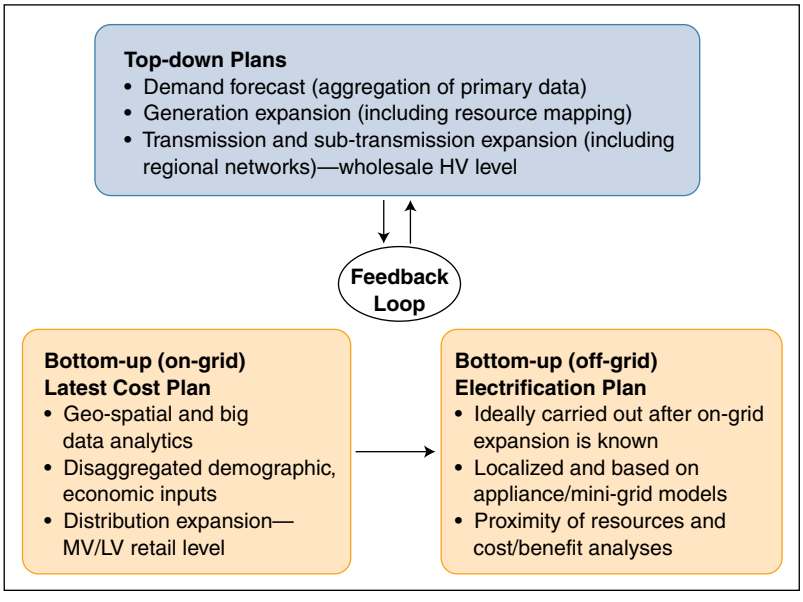
This bottom-up planning approach builds on the best practices experiences worldwide and ensures electrification planning is grounded in local realities and driven by data analyses, from network location and capacity to beneficiaries' electricity needs. Further, it combines a data driven approach to electrification—for the efficient deployment of scarces resources—with local needs, so that equity across the country can also be ensured.

The DoE leads consultations with the REBs for their integration into the planning and implementation of the NEP. In fact, REBs constitute an invaluable source of information and understanding of the territory and segments of the population that they administer. Improved coordination with the REBs was also at the core of the recent EEU business restructuring, and they are also expected to play a key role for integrated grid and off-grid planning and for the overall implementation of the off-grid program (see also below).

The DoE is also responsible for liaising regularly with key sector implementing agents for the assessment of progress toward the targets and updates thereof (near- and medium-term plans, and grid/off-grid program implementation coordination), as well as coordination of information and efforts from a sector-wide prospective, including generation and transmission. In this process, all sector stakeholders play key roles.

Figure 5.2 depicts the strategic approach underlying the adoption of integrated power sector planning. Simply put, generation and transmission plans

Figure 5.2 Power sector integrated planning



have the first and core objectives of serving the Ethiopian population with adequate, reliable, and affordable electricity services. With the design and implementation of the NEP, bottom-up information about electricity requirements and projected loads can be integrated into upstream planning, to ensure the adequate provision of electricity. Further, the geo-referencing of assets—already available for MV lines—allows for the adoption of a monitoring board of the whole infrastructure for the prompt identification of potential issues and faults and related customers affected, to then ensure adequate resilience of the system.

All in all, the planning approach adopted for the NEP provides the following key advantages:

(i) Overall efficiency and effectiveness in sector-wide planning with the integration of bottom-up information into top-down planning, ensuring coordination of electricity access needs, reflected in an increased number of connections and load over time—on time—into generation and transmission plans, which can then be efficiently designed by factoring in other important sector goals, such as exports and regional integration more broadly;
(ii) Integrate grid and off-grid targets and goals based on a data driven approach to planning while ensuring equity at the same time;
(iii) Ensure dynamism of planning over time and updating of plans reflecting developments, as plans can respond and reflect changes in important variables which are being monitored (from connections to other sector KPIs);
(iv) Take advantage of the latest technologies and tools—such as GIS—for asset management and sector planning, for the transparent development of sector plans and accountability to regional contracts as well; and
(v) From a top-down perspective, adequately designed generation and transmission plans ensure to adequately serve customers with electricity services.

Monitoring, evaluation, and course correction (if needed): The DoE will also be responsible for creating a performance-based 'dashboard' for the SC, with inputs from all relevant ministries (e.g., health and education) and geo-referenced information reporting from EEU and off-grid private sector enterprises (see also below).[106] For this purpose, a GIS platform was established in September 2017 at the ministry (as well as within EEU for geo-spatial planning purposes and to report progress to the DoE), which is currently being expanded into a GIS-based monitoring infrastructure for grid and off-grid developments. The DoE responds to MOFEC in the allocation and implementation of activities financed by Development Partners support (when applicable).

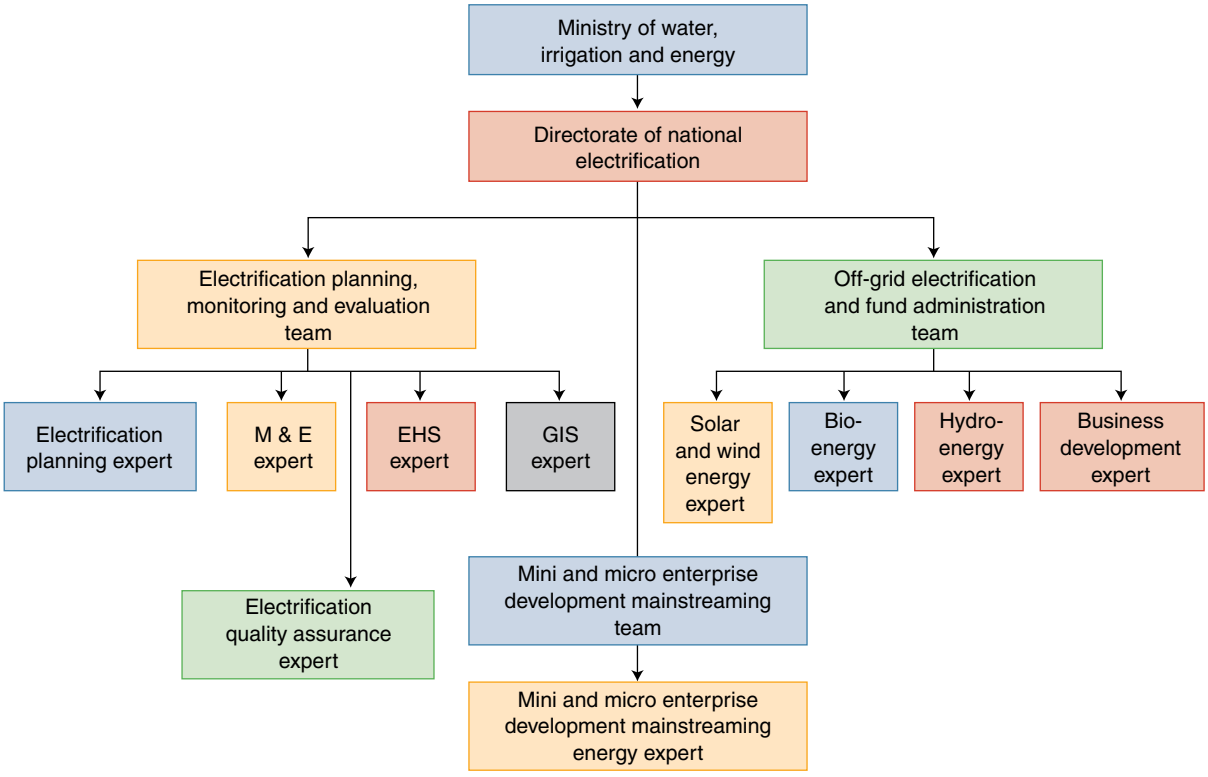
Tracking progress of NEP implementation through quarterly and annual reporting procedures will ensure the prompt identification of possible implementation bottlenecks for the SC consideration. The SC will be responsible for ensuring the addressing of policy, regulatory, and/or financial issues should they arise, and for their prompt tackling at the executive level, if needed. Figure 5.3 provides the preliminary organigram of the DoE structure.

Implementation progress, 2018

During 2018, efforts were directed to fully establish the institutional framework required to the implementation of the NEP. More specifically, the following actions were undertaken:

- Establishment of the Steering Committee
- Establishment of the Directorate of Electrification and hiring of relevant staff, more specifically:
  - NEP program coordinator
  - Procurement specialist
  - Financial manager
  - M&E specialist
- On-boarding of experts and advisors for increased capacity of MoWIE to assist in sector reform and performance improvement, including:
  - Energy economics, legal and regulatory framework;
  - Private sector and IPPs;
  - Renewable energy technology;
  - Regional power integration;
  - Energy project management;
  - Hydropower, dam safety, and control;
  - ICT; and
  - GIS.
- Adoption of monitoring and reporting guidelines for the establishment of a comprehensive M&E system for accountability toward the achievement of the NEP targets and against financial disbursements;
- An independent evaluation system established to improve accountability of procurement, financial management, fraud and corruption, and other NEP key performance indicators reported each year by the designated implementation agents and upon which disbursement of approved financing will be triggered;

Figure 5.3 Organigram of the Directorate of Electrification (DoE)



Source: MoWIE.

- Comprehensive rounds of consultations with private sector companies for the design of the off-grid implementation program, both local and international; and
- Donor coordination roundtables to ensure the targeting and coordination of development financing to meet the needs of the technical assistance and capacity building activities identified in the first NEP and for the off-grid program. Further, DP feedback was taken into account for the design of the overall NEP.

5.2 Financing and donor coordination

The NEP is ambitious, far reaching, and cross-cutting in scope, and hence requires proactive and constructive engagement from the outset of a wide range of stakeholders for its implementation, including federal, regional, and local authorities; EEU; REF; EEA; REBs; woredas; development partners; and private sector agents.

A key building block of the program is a comprehensive sector-wide approach to implementation, including financing. Given the scale of investment required for the achievement of universal access, concessional as well as grant financing from DPs will be essential to complement in-country resources mobilized from the Government/EEU, new customers, and the private sector, particularly in the off-grid space.

Consistent with the 2005 Paris Declaration on Aid Effectiveness, the NEP-IRM implementation design and Investment Financing Prospectus (2018–2022) are organized under the principle of "Many Players, One Team, One Plan" (Figure 5.4).

Under the GoE strategic leadership, all sector stakeholders' activities and financing are being coordinated and harmonized, shifting away from fragmented and piecemeal activities to:

- Align donor program support with the NEP (grid and off-grid) and technical program implementation support components, as identified;
- Leverage DPs respective areas of expertise;
- Increase the magnitude of programmatic flow of partner funds for the implementation of the access program;
- Establish a common sector-wide progress monitoring framework and system—the 'NEP monitoring system'—to foster joint ownership, transparency,

Figure 5.4 Consultative organizing framework—"Many Players, One Team, One Plan"

and mutual accountability (including MTF, EEU Key Performance Indicators, and GIS tracking); and
- Foster harmonization across partner participation and funding with respect to the country systems for procurement, funds flow, and disbursements, and other safeguard arrangements, as appropriate.

This approach will also foster the establishment of an enabling ecosystem for off-grid systems, taking into account different prospective and experiences, for the ultimate attraction and syndication of investments, including climate change financing (see also Chapter 6).

Implementation progress, 2018

Over the year, MoWIE and the DOE:

- Formally established a DPs coordination roundtable chaired by the H.E. Minister of MoWIE focused on the energy sector to engage DPs in the further design and implementation of the NEP 9 pledges, including the design of the off-grid program, and of the sector more broadly; and
- Requested DPs coordination and support tailored to the targets and implementation mechanisms identified and designed by the NEP.

The comprehensive list of activities currently undertaken by donors in support of grid, off-grid, and sector developments is presented in Annex 7.

5.3 Regulation

The Ethiopia Energy Authority (EEA) was established by the Council of Ministers as the sector independent regulator in 2013. Consistent with its mandate, the EEA has licensing and regulatory oversight, including for private sector entry; and across the functional value chain of generation, transmission, distribution, and sales functions within the power sector. The regulator is responsible for establishing standards and regulations required for the implementation of the grid and off-grid programs, including social, safety, and environmental safeguards as well as their compliance. More specifically, the EEA defines and enforces licensing requirements, rights, and obligations of parties, amendments, and certificates of competency, and reflects regulatory policies into directives, including for tariff setting, both grid and off-grid. Within its mandate, it also promotes energy efficiency and conservation, and standards for electric equipment, appliances, and labeling. Finally, it is responsible for settlement of disputes, mediation, and arbitration.

Together with MoWIE, the EEA and other relevant ministries and stakeholders are also responsible for establishing an enabling environment for the implementation of the NEP, which involves both establishing new regulations and reviewing existing ones. For the off-grid space, this will involve:

A. Establishing an enabling environment for mini-grids development and private sector participation. The Energy Regulation currently under consideration by the Council of Ministries foresees mini-grid tariff calculation under a Cost of Service approach. In addition, it contains an umbrella compensation clause for privately/cooperative owned mini-grids that will be detailed through directives.

After the approval of the Energy Regulation, the improvement of the regulatory environment for mini-grid developments will consider:

- Simplified licensing application processes for small mini-grids (up to 5 MW of distributed power) with an integrated generation, distribution, and sales license;
- A clear and transparent tariff calculation methodology for mini-grid tariff setting, and potential fixed aspects to be contained in the licenses issued (i.e., a fixed payment and kWh based);
- Compensation clauses, and related calculations, for grid arrival and integration of mini-grids into the main grid to ensure proper risk management of mini-grid investments. Methodologies used in other countries' experiences will be taken into

account, such as calculating the compensation using the equivalent of the current value of the assets according to depreciation tables plus the revenue of the last twelve months; and
- Safety, reliability and environmental protection.

B. Reviewing existing regulations that could highly negatively impact the achievement of the scale and speed required for providing services to about 9 million beneficiaries (including short-term pre-electrification) in seven years. In fact, the implementation of the off-grid program is cross-sectoral in nature, as from a regulatory standpoint it involves private sector development, international private sector participation, imports, local manufacturing, forex allocations, and telecom. It therefore involves rules, regulations, and activities under several ministries and agencies, including the Ministry of Trade and the Ethiopian Investment Commission.

More specifically, the Government will conduct necessary consultations and consider the amendment or improvement of those regulations that have been identified as the most daunting for the scale-up of off-grid solutions and negatively affecting the timely achievement of the off-grid targets, more specifically are:

- **Federal and regional licensing of off-grid companies:** The Government is considering the establishing of a uniform licensing system to ensure service delivery of quality products to the Ethiopian population without limiting private sector penetration or market competition. The licensing scheme will include customer protection clauses (building on the GOGLA Consumer Protection Code) and be linked with the grievance mechanism and procedures to be established under the NEP. Ensuring quality at entry of private sector actors under the overall Government oversight of the program will ensure adequate scale-up of private entrepreneurship for the achievement of the off-grid targets. The establishment of a uniform licensing scheme will also reduce the financial and transaction costs for private companies to operate in the market and consequently reduce the costs of service delivery for end-users.
- **Constraints for foreign private sector companies for importing finished goods and operating as wholesalers, distributors, and retailers:** Foreign companies can currently only import the components needed to manufacture locally, are required to provide proof of local assembly and manufacturing in order to import, and are not allowed to directly serve customers. To ensure that local private sector companies can benefit from the know-how and access to financing provided by experienced internal off-grid companies (including to forex), technologies, and adequate service provision to consumers within the PAYGo business model (through engagement in retailing and after sale services), the Government is considering measures to support the participation of international companies in the Ethiopian market.
- **Fragmented supply chain:** Regulations currently do not allow for the establishment of an integrated supply chain, but instead segment the market among importers, wholesalers, distributors, and retailers, all requiring a license. It is acknowledged that this reflects into higher costs for service delivery and hence for the consumers (detailed in Chapter 4), as every actor adds a mark-up at each step of the value chain. In addition, fragmentation does not allow for control over the customer experience nor after sale services, which are key for ensuring quality service delivery to end-users and affordability of off-grid technologies though PAYGo installment sales.
- **Limits to financial services provision:** Only financial institutions (banks and MFIs) are allowed to provide mobile banking services.[107] Digital payment service providers and mobile network operators cannot facilitate financial services, including payments for off-grid. The Government is currently working on the regulatory definition of payments for off-grid technologies to enable PSPs and MNOs to facilitate payments for solar using airtime. This would allow to leverage on the more than 100,000 airtime resellers around the country and reduce cash management, logistics, and transportation costs of off-grid electrification.

Digital payment providers operate as technology service providers for banks and MFIs only: digital payment providers cannot recruit agents nor manage payment transactions not linked to bank accounts, limiting the number of costumers that can benefit from off-grid technologies services.[108] The Government will work with relevant counterparts to support non-bank financial service providers, like PSPs and MNOs, to manage payment agents. These regulatory barriers were identified through a comprehensive assessment of the cross-cutting nature of off-grid service delivery, and in consultation with all stakeholders involved, including: NBE, CBE, other commercial banks, Ethio Telecom, EIC, Trade, and REBs, as well as local and international private sector companies.

A collaborative platform for dialogue has therefore already been established for the prompt tackling of these regulatory constraints as they are also impacting financial sector development and financial inclusion and local private sector entrepreneurship. That is, successfully addressing the regulatory ecosystem is not only a priority for the sector, but for the whole financial and economic development of the country, to unleash its potential, support a new generation of entrepreneurs, and increase the value of local enterprises. Consultations are being held under the overall umbrella of economic liberalization of the country under the auspices of the Prime Minister, and the related development policy financing approved in the fall of 2018 in support of energy, telecom, trade, and logistics reform, which is in turn within the overall goal of achieving middle-income status by 2025.

In addition, the following regulatory measures are currently being taken into account to improve the quality and quantity of off-grid supply in the country:

(i) Extend streamlined importation procedures to products with solar panels larger than 15 Wp by making the current voluntary quality standards applying to products up to 350 Wp mandatory.
(ii) Fully streamline importation procedures by implementing PVOC; eliminating sampling, fees, and deposits, and 'green lane' expediting of arrival clearance for all products up to 350 Wp;
(iii) Import duties and value added tax (VAT)/sales taxes removal for spare parts;
(iv) Import duties and value added tax (VAT)/sales taxes removal for AC compatible appliances to ensure their affordable availability in the market. Recent research highlights a positive correlation between access to appliances and an increase in productive uses.

5.4 Implementation of the NEP access program within an enabling ecosystem

The implementation mechanisms identified for the successful implementation of the NEP build upon the strategic drivers identified as the core of the electrification program, both grid and off-grid, where for the latter their importance is even higher given the relatively less experience in the country compared to grid-based service delivery.

Given the scale and the speed required to provide about 9 million connections with off-grid technologies by 2025 across the whole country, both public and private initiatives will be leveraged and scaled up to respond to speed and scale imperatives. The implementation of the NEP leverages on all possible implementing agencies operating in the Ethiopian power sector context and their local comparative advantages, under the overall planning, monitoring, and sector enabling role of the Government.

All sector stakeholders will have key roles to play, and implementation support is envisaged to improve the readiness of implementing agents as well as the overall environment in which they operate. Key supporting activities and measures have been identified to tackle the key main existing barriers to the scale-up and off-grid solutions in particular, both on the supply and the demand side, and taking into account the different challenges affecting service delivery and access posed by the geographic location where communities reside. That is, the design of NEP takes into account—both on the grid and off-grid sides—the time lag that could affect access delivery due to remoteness and isolation, as well as the increased costs associated with establishing a supply of services (whether through a grid connection or off-grid technologies) with increased distance from either the existing grid network infrastructure (for the grid program) or from the key infrastructure required for off-grid delivery, including economic centers (i.e., main urban centers), roads, retail, and payment locations.

The roles and mandates of public institutions and their implementation support reflect the intent to rely and leverage private sector delivery and the role of the Government to establish an enabling environment for their operation. At the same time, it also reflects the commitment of the Government to support private sector activities in a still nascent off-grid market and ensure scale and speed of implementation of the program. Public institutions will be key to supporting both the supply of and the demand for off-grid solutions and are adapted to serve both commercially attractive and deep rural areas.

I. ***Grid connectivity scale-up and network extensions component***—EEU will be responsible and accountable for network planning, design, and implementation of the grid component. EEU has prepared an operations program manual as the umbrella framework to plan, procure, organize, construct, and connect new customers to the distribution network, irrespective of the funding source, while proceeding with the extension of the grid. REBs are expected to continue providing bottom-up information for ensuring the harmonization of least-cost technical targets (for grid and off-grid rollouts) with the Government's

regional socioeconomic priorities, for a combined data-driven and equitable approach to electrification.

II. *Off-grid program*—through public and private sector agents, encompassing:

- *EEU service delivery in commercially attractive areas*, where and when appropriate and to be flexibly determined based on implementation progress and lessons learned, and with a focus on supporting productive uses and access to basic education and health services;
- *MST system with EEU as the Contracting Authority and* service provision in case of nonperformance of private sector enterprises within and/or after the MST time frame;
- *Public sector support for the mini-grids program*—EEU is already operating 31 diesel mini-grids and has established a mini-grids unit for the scale-up of efforts starting from the most remote communities and in support of social and productive uses, including for pre-electrification. All new mini-grids will be at least hybrids and on par with the most up-to-date technologies and standards for long-term functioning as well as integration to the main grid;
- *Private sector market-based supply, delivery and, after-sales service chains in proximate/commercially attractive rural areas* for beneficiaries that are not located "under the wire," with focus on solar systems and in close collaboration with MFIs and REBs; and
- *Private sector and cooperatives mini/micro grids for deep rural and pre-electrification.* The Government intends to apply uniform network design and equipment standards, appropriate for rural areas mini/micro grids, to ensure their technical integration into the network when the grid arrives. The Government will also address explicitly in the regulatory framework the adequate provisions to address in a fair, equitable, and transparent manner any "stranded assets" of private operators, should that circumstance occur.

Together with MFIs, ***the Regional Energy Bureaus (REBs)***—especially the strong and more dynamic among the ones with capacity—are expected to play an important role in the implementation of the NEP off-grid program, and implementation support funding is earmarked for both, as detailed in Chapter 4. REBs have already covered similar roles in the past, and their experience is valuable for nationwide off-grid access scale-up. Public consultations with REBs are detailing their final roles and responsibilities for the implementation of the NEP, as summarized in Table 5.1 and described in detail in Chapter 4.

In addition, REBs would support the Federal Government with the establishment of a **grievance redressing** mechanism to ensure that private sector delivery is on par with international best practice

Table 5.1 Summary overview of REBs possible roles and responsibilities for the implementation of the NEP off-grid program

Supply	Demand
Establishment of enabling ecosystem: streamlining of requirements for private sector regional penetration in collaboration with MoWIE and other relevant ministries	Demand discovery to support private sector delivery
Local workforce development: support for development of local entrepreneurs and technicians, including information on access to finance options	Customer registration (possible expansion to commercially attractive areas)
Maximize service delivery: improved coordination of private sector enterprises, MFIs, PSEs, and customers	Consumer awareness and education for demand activation (program advertising), includes quality standard awareness and empowerment of prospective customers to make informed decisions on off-grid technology options
Implementation support in deep rural areas after the MST in case operations become public responsibility	Customer protection: grievance redressing mechanisms to keep private sector companies accountable for service delivery—associated with a mechanism for disqualification
Coordination and synergies with other GoE programs (e.g., safety nets)	Enforcement of quality standards at the local level as part of the quality assurance efforts
Collection of local information for the design of incentive mechanisms for private sector penetration in commercially attractive areas	

standards and consumers are protected from possible abuses or malfunctioning in the market. The design of the grievance mechanisms will further define the role of the REBs, include the possible establishment of a "hotline" for customers, and link to private sector ability to operate in the market. Private sector companies will lose their certification if their performance becomes unacceptable, and they will be held accountable. The establishment of the grievance mechanism will also provide a further basis to reduce the regional requirements to operate. The mechanisms and options for grievance redressing will be described as part of the communication and educational campaigns and will ensure that customers can "voice" their concerns, irrespective of where they reside, when in possession of a mobile phone. For instance, the local administration offices at the woreda and kebele levels could become locations for grievance handling.

Expanding distribution channels for off-grid solutions

The Government will also support the expanded scope of the public distribution channels currently employed by off-grid distributers and retailers, such as post offices, which could provide, for instance, warehouse services. In addition, the Government will pursue agreements with the major distribution channels in the country. Collaboration between local entrepreneurs and these major distribution channels will not only provide logistical support and reduce operational costs, but provide knowledge sharing for the increased efficiency of the value chain. The leveraging of these distribution channels will also increase the number of potential payment points in the country, all in all contributing to the supply infrastructure.

Expanding installment sales options for affordable off-grid technologies

The GoE will also pursue synergies with the Federal Cooperative Agency (FCA) in Ethiopia, which supervises the large number of Savings and Credit Cooperative Organizations (SACCOs) within Ethiopia, to expand financial sector support for electrification. A consultant will look for synergies between the FCA and off-grid solar providers to help finance the expansion of solar power throughout the country. This may also include training and capacity building within the FCA to create sustainable continued support for SACCOs in the financing of solar power, and to improve solar affordability for rural SACCO customers.

All in all, the Government believes that the success of the implementation of the NEP—as well as the overall sector—will depend on a positive feedback loop coming from implementation experience to ensure the dynamic approach to service delivery and adapting to changing local realities and sector circumstances. In this spirit, the NEP is meant to be a living document that is updated on an annual basis.

5.5 Performance monitoring and evaluation

In 2018 NEP monitoring and reporting guidelines were prepared by the DOE in close collaboration with relevant sector stakeholders and based on the lessons learned from international best practices. For the adequate supervision of progress and identification of implementation bottlenecks to be promptly tackled, should they arise, the guidelines require the provision (from EEU and other relevant ministries, if and when applicable) of Quarterly Performance Reports (QPRs) in line with the other reporting duties of EEU and MoWIE.

The scope of the QPRs covers four main dimensions: (i) the overall NEP performance in the last quarter and cumulative performance trends since program start (dashboard indicators); (ii) overall NEP performance (and other sector indicators deemed relevant for implementation) in the last quarter and cumulative performance trends since program start (dashboard indicators); (iii) NEP performance tracking under the three components (grid, off-grid, and TA) against approved targets during the last quarter as well as cumulative performance since program start (other sector KPIs as deemed necessary); and (iv) adequacy of power supply (demand and energy balance projections by quarter for the next two quarters; and by year for the following two years), as well as other main sector KPIs critical for the successful implementation of the NEP. The M&E guidelines reflect broader sector monitoring of KPIs, also in line with GTP reporting duties.

In 2019, the DoE aims at further detailing the M&E system established to ensure its comprehensive and standard operating reporting procedures. The guidelines have been developed taking into account the MTF multidimensional approach to electricity service delivery, and hence the adequacy, quality, reliability, and affordability of electricity services. The quarterly and annual reporting guidelines include program progress, analyses of impacts, and the creation of a

performance-based dashboard with inputs from relevant ministries (e.g., health or education).

The establishment of a comprehensive M&E system for the monitoring of key performance indicators for efficiency, effectiveness, and progress against grid and off-grid targets and for course adjustments as and when appropriate by relevant actors (e.g., EEU, DoE, REBs) will further integrate GIS and the MIS information based on the platform already established. This will be done so that progress—or potential lack thereof—can be monitored on a local basis and tackled specifically when appropriate. The development of a digital payment system for EEU bill collection will also become part of the overall monitoring system for the grid program, as well as customer care and commercial performance. Indeed, while there is a culture of payment in the country, there is still space for improvement that would be leveraged, starting with bigger customers. This is also in line with the sector reform requirements for improved performance efficiency.

For the off-grid program specifically, an M&E system will be developed to ensure integration of progress into the overall NEP targets, allowing the SC and MoWIE to have a comprehensive view and dashboard of on-the-ground developments for the integrated achievement of the grid and the off-grid targets. The monitoring and reporting of the off-grid program will learn from the warranty tracking service piloted under the DBE (Box 5.1) while ensuring the integration into the GIS and MIS systems. The tracking system does not require SIM cards, hence would not increase the costs of off-grid technologies and is less dependent on network quality.

The monitoring system will be developed in collaboration with PSEs, which would be requested to

Box 5.1 DBE warranty tracking service

The Development Bank of Ethiopia needs reliable access to data to administer its credit line for off-grid solar systems. To improve the administration, management, and data collection of the credit line, the DBE is establishing a warranty tracking service. This tracking service will track the status of solar home units and solar lanterns, from delivery to installation to after-sales service, in a simplified and standardized manner. It is designed to work, even in low-connectivity environments. The service will also help information sharing between different stakeholders, including customers, micro-technicians, private lighting providers, the Ministry of Water, Irrigation, and Energy, and others.

For solar home systems, micro-technicians will enroll customers and products using an android-based app. The technicians will record the serial number of the product and GPS coordinates of the home. The app can work in places with no access to mobile networks, with off-line data entry that will update when the app reconnects to the mobile network.

Solar lantern users, on the other hand, will be able to register themselves using a USSD-based program that will work even in low-connectivity environments. The system works on 2G networks and doesn't require access to mobile data services like 3G and 4G that are more common in urban areas.

For both solar home systems and solar lantern users, the system will come equipped with a complaint mechanism to alert companies when there is a problem with the product. Companies will be able to understand better when there is an issue with the system, and to address problems in a timely way.

Stakeholders, including retailers, private companies, and others, will then be able to monitor problems, look for trends, and address systemic issues more effectively. Relevant stakeholders will be able to see when a product has been imported, sold, and installed under the DBE program. They will also be able to see complaints in the system and adjust accordingly.

This system could yield benefits for all parties involved, including:

Stakeholders:
Better access to data
Better systems administration and data collection

Private companies:
More streamlined, standardized data entry
Better data for customer service
Better communication with stakeholders, including the DBE

Customers:
Improved access to complaint systems and dispute resolution
Better customer service from private companies
More consumer protection for solar products

provide information on customer services, where the information required for reporting will be agreed upon in consultation and become part of the PSEs licensing requirements. The reporting requirements will also involve MFIs on a similar basis, and the progressive transition to digital solutions will support increased data collection as well as its efficiency. The monitoring system will also keep track of consumer complaints under the grievance redressing system and of private sector performance linked to the system of licensing. In addition, the system will be linked to the establishment of the customer database under the warranty scheme and monitoring quality of services under the DBE, and will be expanded to relevant public institutions.

Notes

105. The establishment of the DoE was specifically recommended by the National Electrification Strategy (NES) issued in June 2016. The NES constituted the first building block toward the adoption of the NEP in 2017.
106. The collection of relevant geo-referenced information is being conducted on a progressive basis and is also part of the identified Technical Assistance and program implementation support activities.
107. Regulation of Mobile and Agent Banking Services Directives No. FIS/01/2012 (National Bank of Ethiopia, 2012).
108. NBE Circular No. FIS/01/2014 (National Bank of Ethiopia, 2014).

CHAPTER 6

Financing Requirements for Universal Access

The achievement of universal access will require overall investments for about US$5.75 billion. As Table 6.1 summarizes, the breakdown indicates about US$3.2 billion for the grid (8.2 million new connections and regularization of 3.8 million customers) and US$2.5 billion for the off-grid (9.2 million connections), and about US$50 million in program implementation support and technical assistance activities for integrated grid and off-grid planning, grid and off-grid connectivity scale up. Total investment therefore equals about US$800/year (where additional program implementation support may be required to sustain progress and implementation adjustments over time).

6.1 Achieving universal access with a sector-wide approach

Table 6.2 provides the breakdown for the grid and off-grid programs of total investment requirements and related investment financing gaps. As indicated, the achievement of universal access will require about US$5.7 billion in investments. The NEP adopts a sector-wide approach for the design, implementation, and syndication of financing requirements. It intends to coordinate activities and investments leveraging on public, private, and DP support.

As comprehensively described in Chapter 4, the private sector will have a key role to play for the development of the off-grid program, and comprehensive consultations with local and international private sector enterprises also serve the purpose of ensuring their increased participation to the call for action embedded in the universal access efforts.

Development partner activities have been strongly coordinated after launching the first NEP, and the design of the off-grid program in partnership and dialogue with all DPs reflect the intention of the Government to ensure buy-in and support to the electricity access effort. Indeed, several DPs are already supporting activities in the off-grid space and coordinating with the investment requirements detailed in this electrification program.

Table 6.1 Summary of the NEP universal access program financing requirements (2018–2025) and public share

	Investment (US$ million)	Public Share (US$ million)
Grid total investments[a, b]	3,200	480
Off-grid	2,500	1,000
Program implementation support	50	20
Total	**5,750**	**~1,500**

[a]Include new connections and the regularization of meter loading investment requirements. Exclude funding already syndicated for grid investments.

[b]Order of magnitude estimate, not including: (i) capex for MV network strengthening and reinforcements in all 15 regions necessary to enable densification of customer connections (i.e., network capacity); (ii) transmission investments for adequate and reliable transfer capability; (iii) capex required/payment obligations for increased generation capacity. These investment requirements will be provided by the updated of the Master Plan currently under procurement.

Note: Limited rounding applied.

Table 6.2 also illustrates one scenario for potentially mobilizing (syndication) the financing requirement for the grid and off-grid programs. For the grid, two main sources are envisaged, that is, within the sector—50 percent—and the balance—50 percent—syndicated from Development Partners under concessional terms and grants. Within the sector, the two main financing groups and revenue sources are identified with customer contributions (the revenue from customer connection is currently estimated at US$50 and progressively increasing by tariff brackets, with no contribution expected from the bottom 20 percent quintile of the population), and the Government's equity contributions.[109]

More specifically, almost US$1.1 million revenues are projected to be sourced within the sector from the one-time connection fee, and US$480 million from the Government's equity contribution channeled via EEU over seven years of NEP implementation. The remaining US$1.6 billion (50 percent of financing requirements) are projected to be raised from Development Partners.

For the off-grid program, preliminary estimates of the public share contribution to overall financing requirements is US$1 billion, or 40 percent of overall requirements.

NEP grid program

Overall grid investment requirements constitute the most up-to-date information about the investment requirements and already syndicated financing, and reflect the latest information provided by the geospatial analysis. Table 6.3 provides the breakdown. The total investments in new connections account for US$3.2 billion for densification and intensification at an average connection cost of US$370. In addition, about US$380 million are expected in investments to regularize about 3.8 million current consumers without an official account with EEU (meter-loading).

In addition, investment requirements reflect the successful syndication of US$375 million in 2018.[110]

Therefore, the overall investment gap for the achievement of universal access by 2025 is of US$2.1 billion, out of which the public share is expected to be about US$480 and syndication through public and DPs sources will be required for the remaining US$1.6 billion, with the breakdown provided in Table 6.2.

NEP off-grid program

The newly designed off-grid program is expected to require for its implementation a total of about US$2.5

Table 6.2 Breakdown of grid and off-grid investments and syndication scenarios for universal access, 2025

	Investment (US$ million)	GoE Contribution (US$ million)	Syndication (US$ million)
A. Grid program			
Grid total investments*	3,200		
Costumer contribution (–)	(1,100)		
Total	**2,100**	**480**	**1,620**
B. Off-grid program			
Access to finance (with a revolving fund)	1,760	530	1,240
End-user subsidy	72	72	-
Social institutions	230	70	160
MST off-grid solar	133	41	92
Mini-grids (MST and EPC)[a]	300	280	20
Off-grid total investment syndication	**~2,500**	**~1,000**	**~1,500**
Program implementation support	50	20	30
Total Investment syndication (A + B)	**~4,650**	**~1,500**	**~3,150**

*Excludes Ethiopian Electrification Program (ELEAP) and includes regularized connections. Based on the connection cost average for the program of US$370 and excludes connection fees coming from regularized connection and lifeline customers. Numbers do not reflect investments in transmission and distribution network upgrading and modernization nor expanded generation capacity These investment requirements will be provided by the updated of the Master Plan currently under procurement.

Note: Limited rounding applied.

[a]Overall financing requirements, public and private shares are an average of the different business models identified in Section 4.6.

Table 6.3 Breakdown of grid investments, by 2025

	Connections, Million	Investment (US$ million)	Customer Contribution (US$ million)	Syndicated (US$ million)	Financing Gap (US$ million)
Densification and intensification (new)*	8.2	3,200	1,100	375	1,725
Regularization (existing)	3.8	380			
Subtotal		**3,580**	**1,100**	**375**	**2,100**

*Order of magnitude estimate, not including: (i) capex for MV network strengthening and reinforcements in all 15 regions necessary to enable densification of customer connections (i.e., network capacity); (ii) transmission investments for adequate and reliable transfer capability; (iii) capex required/payment obligations for increased generation capacity. These investment requirements will be provided by the updated of the Master Plan currently under procurement.

billion, as indicated in Table 6.4. These investments reflect the urgency of providing access to services in coordination with and complementing grid developments. By 2025, it is expected that about 35 percent of the population will be provided with mid-term-pre-electrification or long-term off-grid solutions. The overwhelming majority of these beneficiaries will be connected through the grid after 2025, whereas a small segment (about 1 million) are not expected to see a grid connection in the foreseeable future.

In addition, about 3.3 million beneficiaries are considered candidates for short-term pre-electrification solutions, as they are expected to be connected through the grid program only during its last phases of implementation (by 2025) and are hence candidates for interim solutions. These beneficiaries could then use the off-grid solar systems as a back-up solution—as is already happening in several urban and peri-urban areas of the country—in case of grid unreliability. Cumulatively, the NPE off-grid program targets off-grid access of about 9.2 million beneficiaries by 2025, across the different segments described and serving different purposes: short-term pre-electrification, mid-term pre-electrification, and long-term off-grid access.

The design of the NEP off-grid implementation took into account the best practices as well as the most recent experiences (positive and negative) in the off-grid space. This approach has led to a thorough assessment of the country challenges and opportunities, and a systemic analysis of both at every individual step of the trading market for off-grid solutions. The investment requirements and the program implementation support activities reflect the professional assessment of immediate interventions required to serve the Ethiopian market at a steep acceleration.

Investments and program implementation support activities recognize the need to support both market supply and demand for service provision. Based on private sector consultations and the technical assessment conducted over 2018 (see Chapter 4), they include access to finance investment requirements encompassing forex, working capital, and capex, and operating expenses associated with customer outreach; as well as financial support to the poorest of the poor.

An MST mechanism is in place for deep rural areas (mostly long-term off-beneficiaries) to ensure the country is served nationwide, regardless of the cost

Table 6.4 NEP off-grid program for off-grid market supply and demand support, by 2025

	Investment (US$ million)	Public Share (US$ million)	Syndication (US$ million)
Market supply			
Access to finance (with a revolving fund)	1,760	530	1,240
Social institutions	230	70	160
MST off-grid solar	133	41	92
Mini-grids (phase I)	300	280	20
Market demand			
End-user subsidy	72	72	
Total	**~2,500**	**~1,000**	**~1,500**

associated with service delivery. The MST establishes a competitive mechanism for service delivery in deep rural areas covering for the capex and operating expenditures, as well as for the additional working capital required for reaching out to these areas. Minigrid developments will be pursued when adequate, based on further assessments of the territory. The funding reflects an average among the business models identified in Chapter 4 for public contribution.

A tailored social institutions investment program has been identified, to be further designed in collaboration with relevant ministries. The investment prospectus for social institutions is based on priority given to those locations that are not expected to receive a grid connection by 2025, and the estimates are cash based. Based on the social institutions demand assessment provided for under the NEP, the figures will be updated, including potential for PAYGo systems and inclusion in the public grant funding mechanism for operational expenses already ongoing.

Program implementation support activities also support both sides of the market and provide for the required capacity building that sector institutions would need to become a skilled ally in the achievement of universal access, as well as to support the job creation potential in the country associated with serving the off-grid market.

6.2 Climate financing

Ethiopia has been an outliner in the East Africa region, with 90 percent of its power generation coming from clean energy sources, and the Government is committed to ensuring green growth for the future. The country has a significant comparative advantage for attracting climate financing, of which it is already a recipient.

Given the scale of financing requirements for the achievement of the targets set in the NEP-IRM, the Government strongly intends to also pursue climate funds, building on and expanding the partnerships already established.

Ethiopia is already participating in the Pilot Program for Climate Resilience (PPCR) and the Scaling Renewable Energy in Low Income Countries Program (SREP) launched under the Climate Investment Funds (CIFs),[111] which provide developing and middle-income countries with urgently needed resources to manage the challenges of climate change and reduce their greenhouse gas emissions. In 2012, Ethiopia became the recipient of US$50 million endorsed for the development of the geothermal sector, and through Lighting Ethiopia and under the Global Environmental Facility (GEF), the country has already received US$461 million.

Furthermore, under the Reducing Emissions from Deforestation and Forest Degradation (REDD) framework, the country has been the beneficiary of US$13.6 million,[112] and a grant of US$18 million (with further disbursements based on results up to US$50 million) was provided under the Bio-Carbon Fund Initiative for Sustainable Forested Landscape.[113] In 2016, Certified Emission Reduction Purchase Agreements for a total amount of US$20.17 million (2016–2024) were signed.[114] Finally, the CRGE facility is receiving technical and financial support from several Development Partners, including the World Bank (US$4.5 million under the Bio-Carbon Fund), UNDP, Global Green Growth Institute, and the Government of the UK.

The country is also registered under the Green Climate Fund,[115] but hasn't become a beneficiary of the institution yet.

Preliminary estimates indicate significant emission-saving potential associated with the off-grid program, as shown in Tables 6.5 and 6.6, with related potential for Construction Design and Management (CDM) credits to be attracted for syndication of the NEP off-grid program.

Table 6.5 CDM units and emission potential reductions associated to the off-grid program, by 2025

CDM Units—Cumulative							
Tier 2 Solar Home Systems (25% Assumed)	77,500	327,500	677,500	1,127,500	1,627,500	1,927,500	2,302,500
Tier 1 Solar Home Systems (75% Assumed)	232,500	982,500	2,032,500	3,382,500	4,882,500	5,782,500	6,907,500
Total	**310,000**	**1,310,000**	**2,710,000**	**4,510,000**	**6,510,000**	**7,710,000**	**9,210,000**

Table 6.6 Cumulative emission reductions of the off-grid program, by 2025

Year	2019	2020	2021	2022	2023	2024	2025
Yearly connections	310,000	1,310,000	2,710,000	4,510,000	6,510,000	7,710,000	9,210,000
Yearly emissions reductions	21,744	135,373	417,341	923,761	1,696,719	2,694,128	3,880,919
Carbon price—low	39	40	41	42	43	44	45
Carbon price—medium	59	60	62	63	65	66	67
Yearly value of emissions reductions—low price US$	848,009	4,545,158	11,560,692	21,269,654	33,237,166	43,886,021	53,405,601
Yearly value of emissions reductions—medium price US$	1,272,013	8,122,365	25,666,463	58,196,955	109,438,345	176,465,391	260,021,589

Note: World Bank guidance (available at http://documents.worldbank.org/curated/en/621721519940107694/Guidance-note-on-shadow-price-of-carbon-in-economic-analysis) provides a Low and a High price for carbon. To be conservative, estimates are shown using only the World Bank low and a medium price, calculated as the average of the World Bank low and the high price.

Notes

109. Customer contributions are estimated based on new connections only, for an average of US$150/connection. They exclude payment of the connection fee for the bottom quintile and reflect progressive connection fees across the different consumption brackets (second bottom decile was kept at US$50 as current practice for densification). The average fee per connection hence reflects a range of connection fee payments across the consumption brackets from US$0–370 (i.e., the average estimated connection cost for these beneficiaries). Customer contributors will be updated based on the ongoing cost of supply and connection cost study and will reflect the result of the affordability study earmarked for 2019.
110. Received by the World Bank with ELEAP.
111. For more information, visit: https://www.climateinvestmentfunds.org/
112. Out of which US$3.6 million was provided for the Forest Carbon Partnership Facility (2013–2016) and US$10 million under the Bio-Carbon Fund (2014–2018).
113. For the Oromia Forested Landscape Program. Funding was provided, among others, by the Governments of Norway, UK, and the U.S.
114. Under the World Bank Carbon Initiative for Development (Ci-Dev).
115. The Green Climate Fund was established within the UNFCCC as a mechanism to assist developing countries in their adaptation and mitigation practices. For more information, visit: http://www.greenclimate.fund/home

ANNEX 1

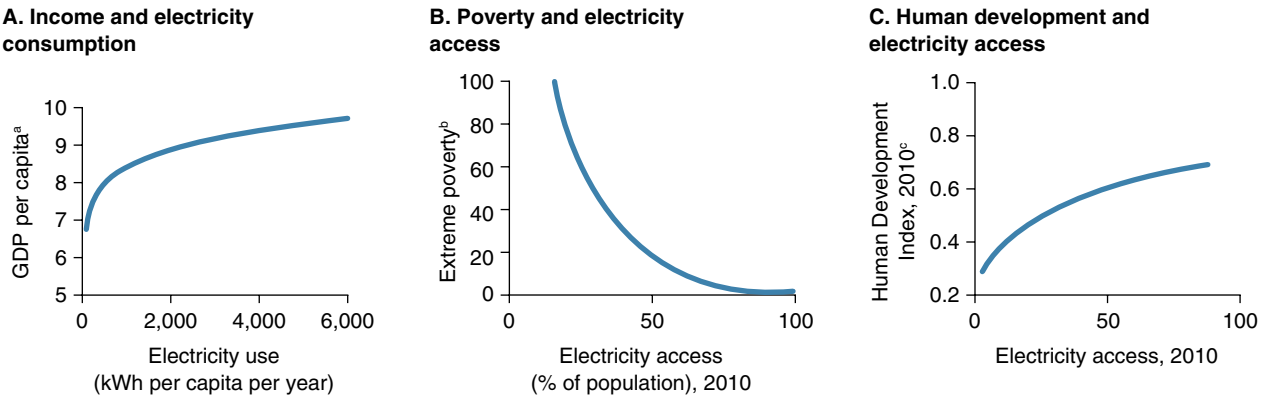
The Electricity Development Nexus

Adequate, affordable, and reliable access (connectivity) to electricity is vital for enabling structural transformation of Ethiopia's economy and society, including further poverty reduction and a shift toward higher productivity rates and industrialization. Simply put, without electricity Ethiopia cannot develop a domestic manufacturing capacity adequate for local needs and exports, industrial parks, private sector entrepreneurship, the information and communication technology (ICT), and financial sectors—nor graduate to a middle-income country. Indeed, the highly correlated and mutually reinforcing relationship between electricity use, economic growth, and human development is widely accepted from irrefutable established worldwide experience (Figure A1.1).

Directly or indirectly, electricity is central to achieving progress on almost all dimensions of human welfare and development. Electricity access is crucial for achieving almost all of the Sustainable Development Goals (SDGs), from its role in the eradication of poverty through advancements in health, education, water supply, and industrialization, to mitigating climate change.

The Government's commitment to the provision of electricity services dates back to the launching of the Universal Electricity Access Program (UEAP) in 2005. The UEAP now ranks among the most successful grid electrification programs in Africa, with the extension of the MV grid network to about 60 percent of towns and villages in the country (2005–2015), and an estimated 87 percent of the national population spatially located within 60 km of the existing 'MV grid radius'. The UEAP program investments undertaken have set the stage for technically enabling the

Figure A1.1 Socioeconomic indicators and electricity



[a]GDP per capita, purchasing power parity (PPP; constant 2011 international).

[b]Poverty headcount ratio at $1.25 a day (PPP) (percent of population).

[c]Human Development Index, 2010.

Source: World Development Indicators (2010), United Nations (2012), Human Development Index.

major shift in strategic priority going forward under the NEP-IRM: from infrastructure development to service delivery (implementing electricity connectivity in all Ethiopian homes, businesses, and social institutions, and fast).

Specifically toward realizing this shift, the GoE has undertaken the following key steps for setting the stage for preparation of Ethiopia's National Electrification Program-Implementation Road Map (NEP-IRM), for implementing the goal of universal access (connectivity) by 2025:

- Ethiopia joined the Sustainable Energy for All (SE4ALL) Initiative in 2011, and the Ministry of Water, Irrigation, and Energy (MoWIE), with support from the European Union and in consultation with key stakeholders, ***prepared 'The Ethiopia SE4ALL National Action Plan' (2012–2013),*** for achieving universal electricity access by 2025.
- ***National Electrification Strategy (NES) issued June 2016—***which formally shifted the strategic focus and priority of the Government from the development and expansion of the network distribution infrastructure to last-mile delivery and connections for all. Specifically, the NES broadly identifies the three key categories of challenges in the sector—Institutional and Policy, Planning and Technical, and Financial—and recommends strategic direction(s) to inform preparation of Ethiopia's National Electrification Program (NEP).
- ***Multi-Tier Framework (MTF) for measuring and tracking access connectivity indicators on-grid and off-grid.*** The Government launched the nationwide MTF Energy Access Survey, being implemented by the World Bank in its partnership role under the SE4ALL Initiative. The MTF instrument provides a more granular baseline measurement of electricity access differentiated by "tiers" representative of the range of delivery modalities on-grid and off-grid (solar products, solar systems, mini-grids, and main grid).
- ***National Electrification Program*—Implementation Roadmap,** launched by the Government in November 2017 as the first programmatic approach to electrification, now updated by this version of the Program.

ANNEX 2

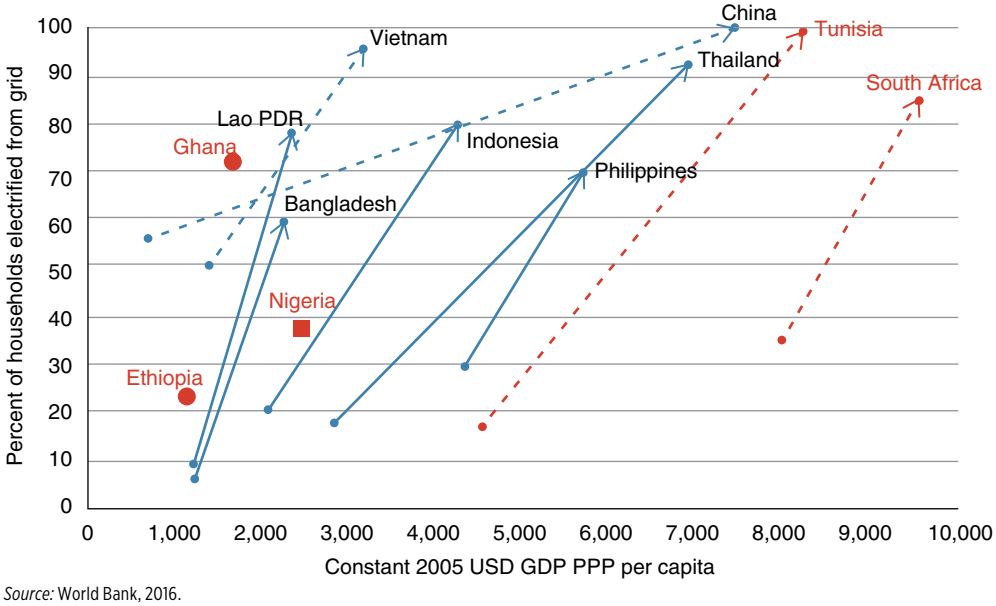
International Best Practice in National Electrification Programs

Several countries worldwide that have achieved very-high/near-universal access (grid connections) started their national electrification programs at a time when they were in the low-income category (Figure A2.1). Noteworthy within the Sub-Saharan Region of Africa, are Ghana (72 percent access), and in recent years, impressive progress in scale and pace of implementing grid connections achieved in Rwanda and Kenya.

Each of these nations developed their national electrification rollout program suited to their unique conditions and circumstances; and no single "model of success" can be attributable to all of them. Nevertheless, all of these programs have demonstrated, albeit to a different extent, adherence to a few common underlying principles and drivers. At the core these are:

A. Government's visible hand makes the big difference, and the following aspects are essential: devoted and purposeful leadership, sustained commitment and high level oversight, facilitation of implementation progress toward achieving universal electrification, and staying the course.

Figure A2.1 Several countries have scaled up access at relatively low levels of GDP per capita (PPP in constant US$)



Source: World Bank, 2016.

B. Putting in place the enabling policy, institutional, and regulatory frameworks, with due autonomy as well as commensurate accountability for results (targets), and ensuring efficient and effective management and operation of the sector by designated implementation agents (for grid and off-grid service).

C. Sustained public funding is needed over the entire duration of the electrification program for the portion of investment costs for access scale-up that cannot be recovered from consumer tariff revenues.

D. Sector-wide organizing architecture and consultative process led by the Government, bringing together all key stakeholders under the organizing architecture of "Many Partners, One Team, One Plan."

The NEP-IRM takes into account all of these drivers of successful performance, as anchored in the first publication of the NEP and as embraced during the first years of implementation. Furthermore, although the NEP-IRM constitutes an ambitious, fast-paced acceleration and quantum change from the past in grid connectivity, as shown in Figure A2.2, many countries have undertaken an impressive acceleration in speed, breadth, and depth of access scale-up.

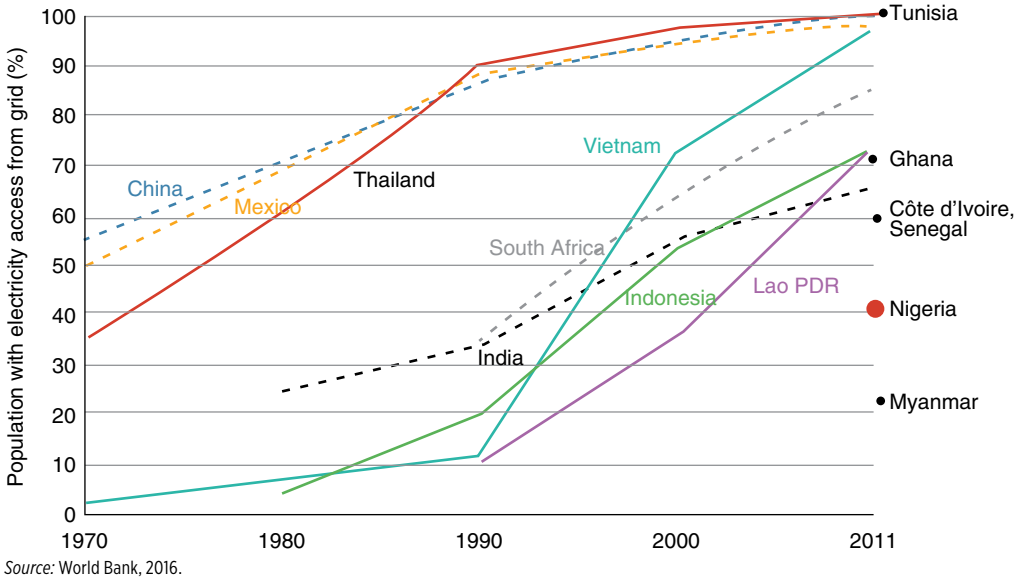
Noteworthy for fast-paced and scaled up grid rollout programs are the cases of Indonesia, Kenya, and Rwanda; highlights include the following:

- **Indonesia:** The national electrification rollout program is noteworthy for a sustained annual scale of implementation at levels called for in Ethiopia. Indonesia's national utility—Perusahaan Listrik Negara (PLN)—has averaged around over 2+ million grid connections/year historically, and in recent years it has ramped up that rate to well over 3 million connections per year.
- **Kenya and Rwanda:** In both instances, implementation of their national electrification programs has been guided by a comprehensive geo-spatial least-cost national rollout plan (for coordinated grid and off-grid activities), and the financing gap has been filled by Government-led syndication with participation from a wide range of development partners. The achievements to date are impressive in both country examples in terms of a cumulative increase in national grid access, and the steep gradient in the increase in the annual new connections implementation capacity. In Kenya, KPLC reportedly connected over 1 million new customers on-grid in 2016; up from 50,000 connections in the years 2009–2010.

In respect of **off-grid program** scale-up experiences, the following national programs for standalone solar system scale-up are notable for good practices (mini-grid developments are still at an early stage worldwide):

- **Bangladesh** deployed a strategy and operational program design that has sustainably achieved rapid expansion in market scale to about 500,000 quality

Figure A2.2 Fast-paced national electrification grid rollout programs—selected country examples



Source: World Bank, 2016.

verified solar systems per year, and on a commercial market development basis.

- **Kenya,** with its Lighting Africa Program approach, has demonstrably contributed to rapidly growing the market share of off-grid access from 2 percent in 2009 to 30 percent by 2012. In 2014, it was reported there were just fewer than 1 million quality certified product sales of solar lamps (compared to 210,000 in 2012). Cumulatively, about 4.5 million lighting products (solar lamps) have been sold over a five-year period (averaging close to 1 million per year).
- **Brazil's** "Programa LUZ Para Todos" (Light for All) program was very successful and connected 15 million people (over 3 million households in deep rural areas) over 10 years (averaging 1.5 million annually). Led by the national Government through its Ministry of Energy (responsible for planning, design, arranging implementation, and supervision)—with support from state Governments, NGOs, communities, and local Governments—the implementing agents were distribution utilities (public and private) with the technical expertise and institutional program management capacity and their regional operational offices, with the best knowledge of local areas for cost-effective service delivery, including maintenance, and spare parts, etc. Indeed, it was common practice for the distribution companies to undertake detailed preparation of project proposals—designs, costing, and implementation plans—on behalf of the Ministry of Energy for their review and authorization of funding as well.
- **Argentina,** and **Peru,** as well as some of the regional utilities, have served as designated Program Management Agents (PMAs) on a cost reimbursement basis, for off-grid program activities sponsored by the provincial and national Government authorities and ministries. In Peru, PMA functions are now taking over all solar home systems installed (handover, verification of technical specifications, and installation standards) and providing after-sale services, including billing, battery replacement, and maintenance.

More information on and lessons learned from the latest experience in off-grid electrification are presented in Annex 6.

ANNEX 3

The Multi-Tier Measurement Framework

The Multi-Tier Framework (MTF) is used to assess the access of households in Ethiopia to various sources of electricity and improved cooking solutions using technologies, attributes, tiers, and key indicators to classify households within the framework. The framework was developed by the World Bank within the Sustainable Energy for All (SE4ALL) initiative in 2016, which redefined energy access from a traditional to a multidimensional and comprehensive definition of access as the "ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy, and safe for all required energy services across households."

The MTF thus allows us to go well beyond the binary assessment of energy access of having or not having an electricity connection or using or not using a modern energy cooking solution.

This was achieved by capturing the many dimensions of energy access, and the wide range of technologies that households use for power and for cooking. Figure A3.1 illustrates how six tiers, ranging from Tier 0 (no access) to Tier 5 (full access) along a continuum of improvement, were developed based on seven attributes that capture key characteristics of the energy supply, which in turn affect user experience. Higher tiers are defined by higher *Capacity* and longer *Availability* of supply—enabling the use of medium—and high-load appliances (such as refrigerators, washing machines, and air conditioning)—as well as by *Reliability, Quality, Affordability, Formality,* and *Health and Safety*.

The MTF household survey was conducted nationally across Ethiopia in 2017—in both urban and rural areas—for the development of baseline indicators to track progress toward the achievement of universal access to electricity.[116] Further details of the survey including survey sample, timeline of the survey, and survey implementation, are provided in Box A3.1.

Key findings of the survey

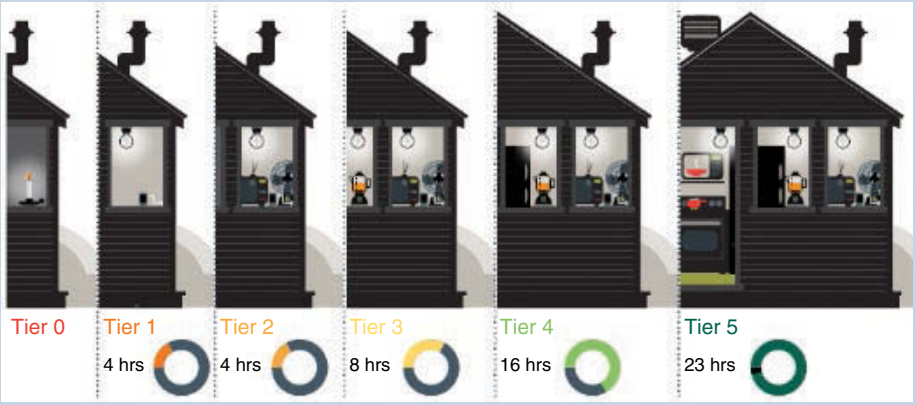
In Ethiopia, **44.3 percent** of households within the country fall within Tier 1 or higher for access to electricity. The remaining 55.7 percent of households either have no electricity source, they rely on dry cell batteries, or they have a grid or off-grid electricity supply that does not provide basic energy service (ability to light the house and charge cell phones, available for at least four hours a day, and one hour in the evening) and hence are classified under Tier 0. Households with no access to electricity or access to some on- or off-grid electricity, but not sufficient enough to meet the criteria to be in Tier 1—usually because of capacity or availability—contribute to a national proportion of 12.7 percent. Therefore, households with access to at least one source of electricity make up for 57 percent (sum of 44.3 and 12.7) of the households in total, out of which 33.1 percent have access through the grid, and 23.9 percent have access through off-grid solutions. Among these, a majority (54 percent) have access only to a solar lantern, keeping them in Tier 0 due to capacity and availability (Figure A3.2).

Regional distribution of electricity

Almost all households (99.9 percent) in Addis Ababa are connected to the grid, while there is a sizeable penetration of off-grid solutions in Tigray (36.9 percent—solar lantern, 16.6 percent and SLS, 20.2 percent); Oromiya (36.3 percent—solar lantern, 6.0 percent, SLS, 30.3 percent, and SHS, 12.6 percent); and Amhara (22.5 percent—solar lantern, 8.7 percent, SLS, 13.7 percent, and SHS, 1.2 percent) (Figure A3.3).

Figure A3.1 The Multi-Tier Framework for measuring access to household energy supply

Attribute	Question answered
Capacity	What appliances can I power?
Availability	Is power available when I need it?
Reliability	Is me service frequently interrupted?
Quality	Will voltage fluctuations damage my appliances?
Affordability	Can I afford to purchase the minimum amount of electricity?
Formality	Is the service provided formally or by informal connections?
Health and safety	Is it safe to use my electricity service or do I risk injuries from using it?



Tier 0	Tier 1	Tier 2
Electricity is not available or is available for less than 4 hours per day (or less than 1 hour per evening). Households cope with the situation by using candles, kerosene lamps, or dry-cell-battery-powered devices (flashlight or radio).	At least 4 hours of electricity per day is available (including at least 1 hour per evening), and capacity is sufficient to power task lighting and phone charging or a radio. Sources that can be used to meet these requirements include an SLS, a solar home system (SHS), a mini-grid (a small-scale and isolated distribution network that provides electricity to local communities or a group of households), and the national grid.	At least 4 hours of electricity per day is available (including at least 2 hours per evening), and capacity is sufficient to power low-load appliances—such as multiple lights, a television, or a fan—as needed during that time. Sources that can be used to meet these requirements include recharge-able batteries, an SHS, a mini-grid, and the national grid.

Tier 3	Tier 4	Tier 5
At least 8 hours of electricity per day is available (including at least 3 hours per evening), and capacity is sufficient to power medium-load appliances—such as a refrigerator, freezer, food processor, water pump, rice cooker, or air cooler—as needed during that time. In addition, the household can afford a basic consumption package of 365 kWh per year. Sources that can be used to meet these requirements include an SHS, a generator, a mini-grid, and the national grid.	At least 16 hours of electricity per day is available (including 4 hours per evening), and capacity is sufficient to power high-load appliances—such as a washing machines, iron, hair dryer, toaster, and microwave—as needed during that time. There are no frequent or long unscheduled interruptions, and the supply is safe. The grid connection is legal, and there are no voltage issues. Sources that can be used to meet these requirements include a diesel-based mini-grid.	At least 23 hours of electricity per day is available (including 4 hours per evening), and capacity is sufficient to power very high-load appliances—such as an air conditioner, space heater, vacuum cleaner, or electric cooker—as needed during that time. The most likely source would be a mini-grid or the national grid.

Source: Bhatia and Angelou. 2015. Beyond Connections: Energy Access Redefined.

Box A3.1 The Multi-Tier Framework (MTF) Energy Access Household Survey

The **main objectives** of the survey were:

- Development and collection of key baseline indicators
- Preparation of a GIS database consisting of the GPS coordinates of survey units

Timeline of the survey: January–April 2017

Survey implementation: The survey was implemented by the BDS Center for Development Research.

Survey sample: The MTF survey sampled 4,317 households across 11 regions in Ethiopia. The data are representative at the national, urban and rural, and province levels. The sample also included an oversample of 708 households from selected urban areas in Addis Ababa to identify issues related to energy access specific to the urban dwellers.

Sampling procedure: The household sample selection was based on a two-stage stratification strategy, with equal allocation between urban and rural areas and equal allocation between electrified and unelectrified households for the tier analysis. The purpose of implementing the two-level stratification was mostly to obtain consistent and uniform levels of significance during data analysis.

The MTF survey provided three types of data disaggregation: by urban-rural, by quintile, and by gender of household head.

Figure A3.2 MTF electricity access

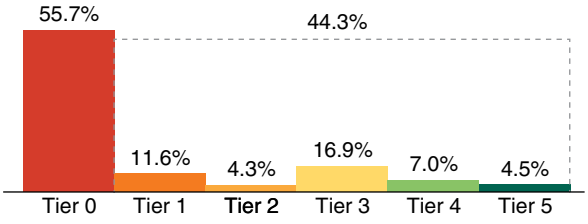
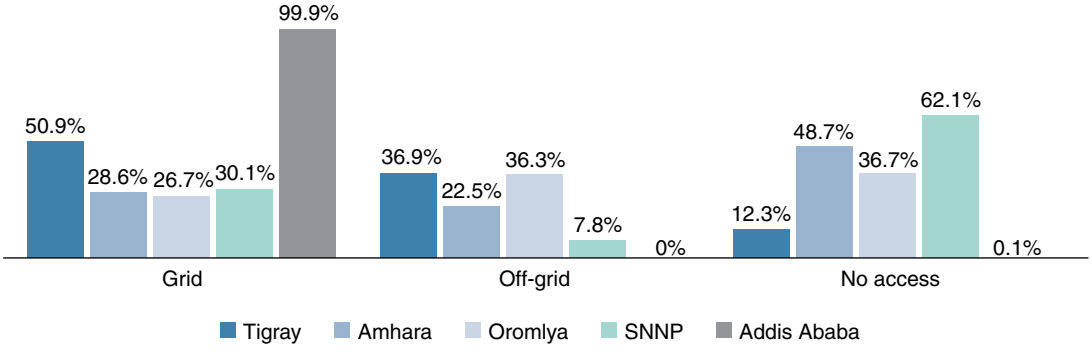


Figure A3.3 Access to various sources of electricity in different regions in Ethiopia



Grid access

Grid-connected households are those that belong to Tiers 2–5 for access to electricity, and account for **33.1 percent** nationally. These households are considered to receive high-capacity electricity (over 2,000 W) placing them all in Tier 5 for capacity. Other dimensions of access (mainly availability) relegate a majority of grid-connected households to Tier 3, however.

Attributes of access in Ethiopia

The value of electricity access for households is defined by analyzing the following MTF attributes, for which data were also collected in the MTF survey. The findings for Ethiopia are mentioned below:

Capacity

For capacity, 96.2 percent of urban households and only 12.2 percent of rural households fall under Tier 5. Over 71 percent of rural households are in Tier 0, and 16.8 percent of them are in Tier 1—due mostly to the penetration of off-grid solutions.

Availability

The availability of electricity supply prevents some grid-connected households from moving to a higher tier. According to the survey, electricity is available at least 23 hours a day, seven days a week for 20.9 percent of households, while 5.2 percent receive less than four hours of service per day. In rural areas, limited availability is more acute: only 9.6 percent of rural households receive more than 23 hours of supply a day, and over 60 percent receive less than eight hours a day. Overall, 55 percent of households nationwide receive electricity for four hours during the evening when lighting is the most necessary.

Affordability

Almost all grid-connected households nationwide and in rural and urban areas pay less than 5 percent of their household spending for basic electricity services (at least 1 kWh a day and 365 kWh a year). Electricity tariffs in Ethiopia are affordable,[117] so over 99 percent of grid-connected households can pay for the minimum level of service to satisfy basic electricity needs.[118]

Reliability

In Ethiopia, 57.6 percent of grid-connected households face 4–14 outages a week, and 2.8 percent of households face more than 14 outages a week.

Quality

The number of households facing voltage shortages—such as low or fluctuating service—that limit their use of appliances, is 15.8 percent. Voltage issues show similar trends in rural and urban areas. Electric appliances generally require a certain voltage supply to operate properly, and low voltage supply tends to result from an overloaded electricity system or from long-distance low-tension cables connecting spread out households to a singular grid.

Formality

Only 6 percent of grid-connected households report having an informal grid connection. Reporting on formality is challenging because households may be sensitive about disclosing such information in a survey. Indeed a comparison between the household access rates provided by the MTF results and those implied by the EEU customer records suggest that approximately 19 percent of households engage in meter loading.[119]

Health and safety

Since the survey only 0.5 percent of households reported a serious injury such as permanent limb damage or death caused by electrocution over the past year. Hence, electricity supply from the grid is generally reported to be safe.

Use

On average, electrified households report to have been connected to the grid for 11 years and consume 120.7 kWh of electricity per month.[120] Urban households consume more than three times as much as rural households. Households spend on average 60.1 birr or about US$2.70[121] a month on electricity bills, which accounts for 4.3 percent of the average household's expenditure. Rural households spend proportionally more (5.2 percent of their expenditure) than urban households (1.9 percent) on electricity, even though they spend less overall, pointing to a sustained willingness to pay for electric services even in rural areas.

Off-grid access

Most households that use off-grid solutions are in Tiers 0 and 1. The majority of households in Tier 0 that have access to electricity use a solar lantern, which does not provide the minimum level of service needed for the household to reach Tier 1. A small fraction of households that use a solar home system

(SHS) are also in Tier 0 because they receive less than four hours of supply a day.

Among households that use an off-grid solar device in particular, almost all (98.1 percent) use no more than very low-load appliances such as task lighting, phone charging, and radio. This contrasts with grid-connected households among which 29.8 percent use medium- or high-load appliances such as a refrigerator or an iron (Figure A3.4).

Off-grid solutions are more common in rural areas, where there is limited access to the grid: **31.6 percent** of rural households use off-grid solutions as their primary source of electricity, with the majority using solar lanterns (approximately 17 percent of households use solar lanterns, 7.7 percent use SLS, and 6.5 percent use SHS in rural areas, as shown in Figure A3.5).

The divide between electricity in the rural and urban areas, and the distribution of tier access can be seen in Figure A3.6.

Off-grid solar solutions for households are a recent phenomenon in Ethiopia—82 percent of households that use one as their primary source of electricity have acquired it within the last three years. Households that use an off-grid solar device use electricity mostly for phone charging (47.6 percent) and radio (11 percent), in addition to lighting.

Considering that off-grid solar solutions are a recent phenomenon in Ethiopia, their fast expansion is proving a promising avenue for moving households from Tier 0 to Tier 1.

'Capacity' is reported as the main constraint to households that use an off-grid solar solution: 54.6 percent of households use very low-load appliances (Tier 1 level) with their solar devices (Figure A3.7). Thus, off-grid solar devices are used mostly for evening lighting purposes: 69.8 percent of households receive four to eight hours of supply a day (placing them in Tier 2 for daily availability) while 66.7 percent of households receive at least four hours of supply in the evening (placing them in Tier 5 for evening availability).

In addition to capacity, availability was the other main issue cited as impacting the use of off-grid devices. Other issues such as the quality of light appear to be minor.

Figure A3.4 Maximum power load of appliances owned by households

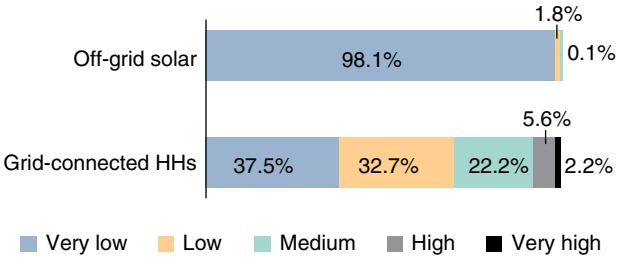


Figure A3.5 Off-grid solutions are more common in rural areas

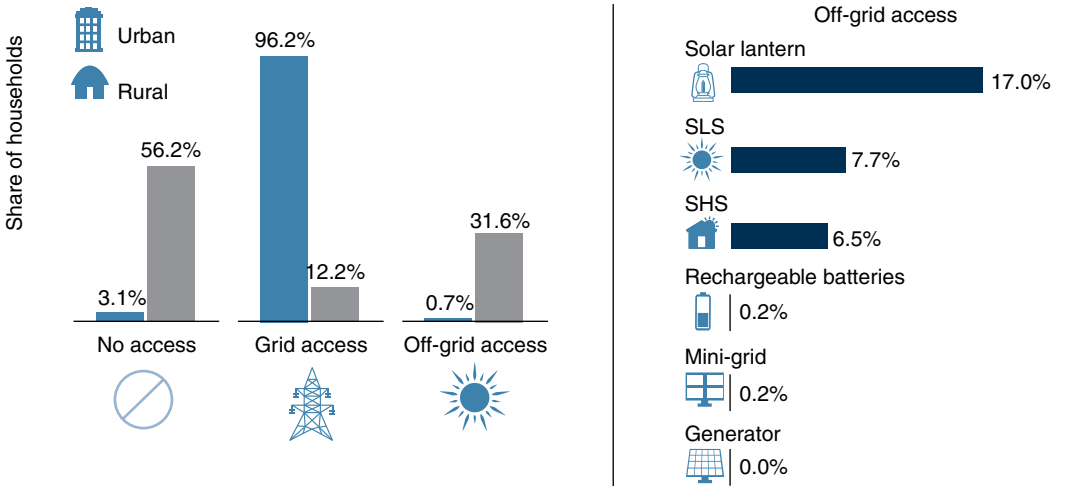


Figure A3.6 Electricity access in Ethiopia is primarily a rural challenge

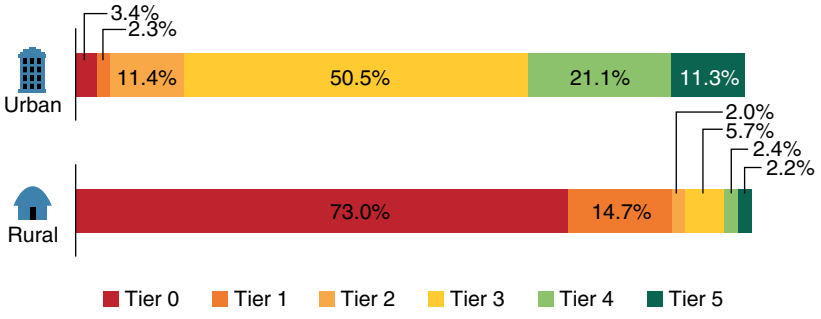
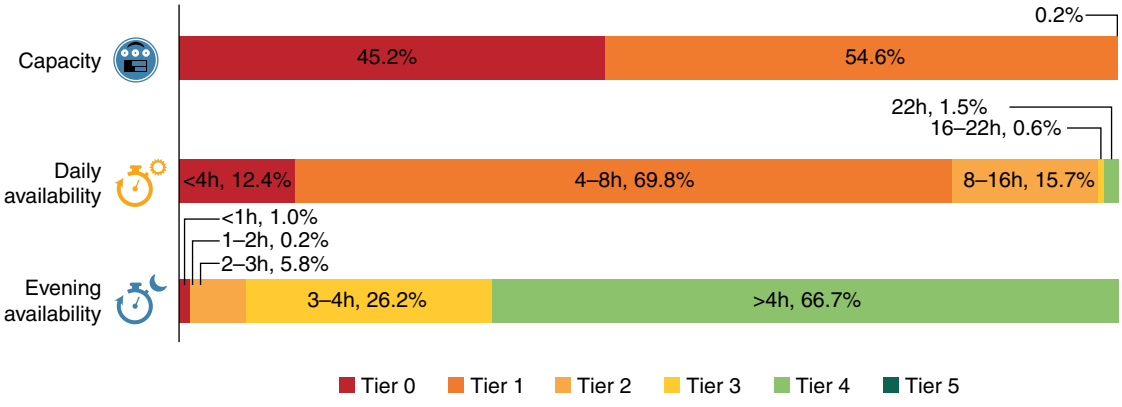


Figure A3.7 Capacity is the main factor constraining households that use an off-grid solar solution



Grid penetration

The grid is the leading technology for households in the top expenditure quintile, with 55.9 percent of households connected to the grid. Off-grid penetration is spread out uniformly among all income quintiles nationwide (Figure A3.8).

Most of the off-grid penetration is led by rural households. 46.9 percent of households in the top expenditure quintile in rural areas have off-grid solutions, while 22.5 percent in the bottom quintile use off-grid for their electricity needs (Figure A3.9).

Figure A3.8 Grid penetration goes up with income

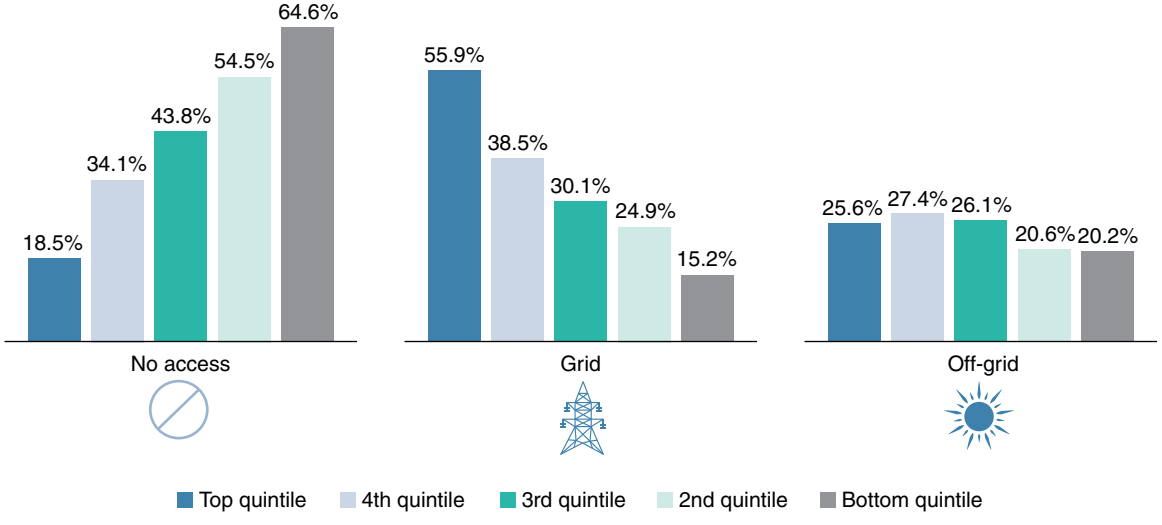
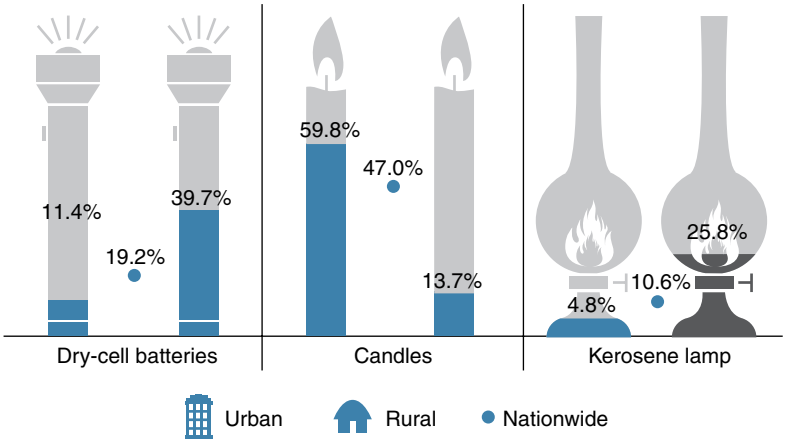


Figure A3.9 Technology by expenditure quintiles (urban/rural to cope with insufficient hours of service and power outages, households' main backup solutions for lighting are candles (47 percent) and torches/flashlights (19.2 percent). Urban households rely heavily on candles as a backup solution, while rural households rely more on dry-cell batteries and kerosene lamps. 7.7 percent of grid-connected households also use some solar product mainly as a backup solution.

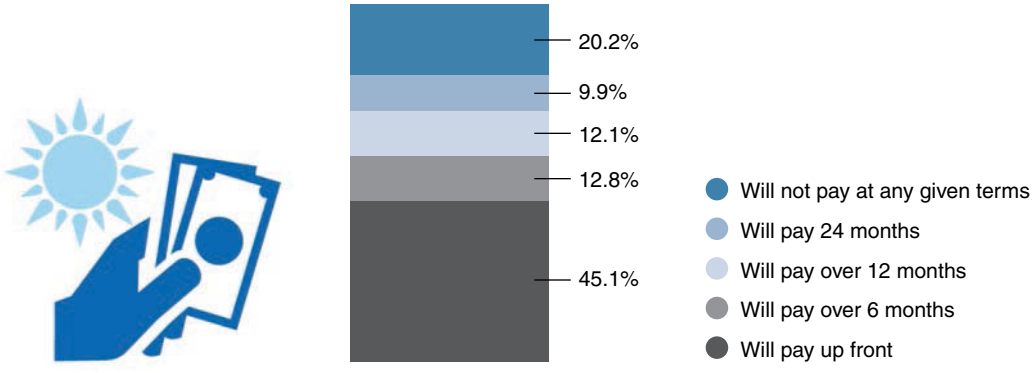


Technology by expenditure quintiles urban/rural to cope with insufficient hours of service and power outages, households' main backup solutions for lighting are candles (47 percent) and torches/flashlights (19.2 percent) (Figure A3.9). Urban households heavily rely on candles as a backup solution, while rural households rely more on dry-cell batteries and kerosene lamps. 7.7 percent of grid connected households also use some solar product mainly as a backup solution.

Willingness to pay

Data suggests that willingness to pay for a Tier 2 solar product is high, and adoption of SHSs can increase further when a financing option is offered. When households were asked if they would be willing to pay for a Tier 2 solar product (with capacity to power appliances such as a fan or television) for the full price of 13,200 birr (about US$582),[122] 45.1 percent said they would be willing to pay up front, while 34.8 percent would be willing to pay with a 6- to 24-month payment plan. The remaining 20.2 percent said they would not be willing to pay for a device with the given options, as 68 percent of these households said they find it very expensive to buy the device even with a payment plan, and 26 percent were not convinced that the electricity service from this device would be reliable (Figure A3.10).

Figure A3.10 Nearly 80 percent of households are willing to pay for a Tier 2 solar product



Even with such a higher declared willingness to pay for a larger capacity solar home system, the penetration of such products is still very low in Ethiopia, and most off-grid solar products owned by households only have Tier 1 capacity. One barrier could be lack of financing mechanisms; providing a payment plan (such as the pay-as-you-go system in Kenya) could rapidly expand higher capacity solar products, thereby increasing access to electricity. Another reason for low availability of such products in the market, that needs to be explored further, could include administrative barriers to market entry for solar off-grid providers.

Gender analysis

The multi-tier approach provides a thorough gender analysis on several gender-related aspects concerning access to electricity nationwide and disaggregated for urban and rural areas.

Nationwide, **18.9 percent** of households are headed by women. Geographically, 39.6 percent of households are female-headed in urban areas, compared with 12 percent in rural areas[123] (Figure A3.11). This suggests that female-headed households are more likely than male-headed households to live in urban locations.

Grid access

Data suggest that female-headed households have higher access to on-grid electricity services, that is, nationwide 58.8 percent of female-headed households are connected to the grid compared with only 27.1 percent of male-headed households. This, however, is driven by the fact that more female-headed households are disproportionately located in urban areas, where electrification the rate is high anyway. Analyses of only the urban areas indicate that 96.7 percent of both female- and male-headed households have access to grid electricity. Within rural households, 23.8 percent and 15 percent of female and male-headed households have access to grid electricity, respectively.

Off-grid access

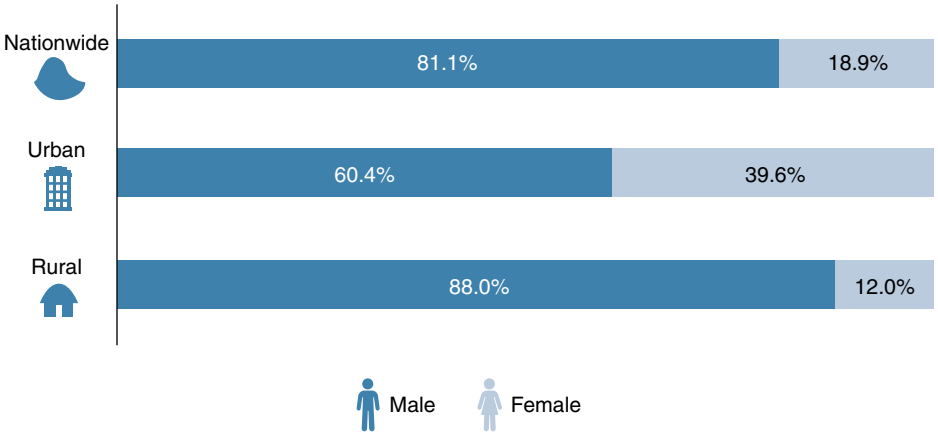
Among households that use an off-grid solar solution as their primary source of electricity, 37.1 percent of female-headed households use a solar home system (SHS) or solar lighting system (SLS), compared with 46.5 percent of male-headed households—implying that male-headed households are more likely to have a larger capacity system than female-headed households.

Within unconnected households, more female-headed (25.3 percent) than male-headed households (18.8 percent) are in the bottom 20 percent of expenditure quintile. Such a gap in wealth level is consistently found in rural as well as urban areas. This expenditure gap shows that a larger share of female-headed households may have less ability to pay for access to electricity (either on or off-grid solutions) than male-headed households

Willingness to pay

Data on willingness to pay for a grid connection and a Tier 2 off-grid solar device indicate that female-headed households are less willing to pay for both energy

Figure A3.11 Households by household head (whether male or female)



solutions, in comparison to male-headed households. 15.5 percent of female-headed households said that they would never accept the offer of being connected to a grid and 30.5 percent were against purchasing a Tier 2 off-grid solar product on any given terms. In comparison, 2.6 percent and 18.6 percent of male-headed households said that they would never accept the above offers, respectively.

The MTF findings do not therefore identify a substantial gender gap in access to electricity. However, the disadvantage of female-headed households in the income distribution of unconnected households appears to result in a lower willingness to pay on their part. This means that gender-targeted awareness efforts and financing mechanisms may be required to incentivize female-headed households to obtain a grid connection or move to a higher tier of solar device.

Figure A3.12

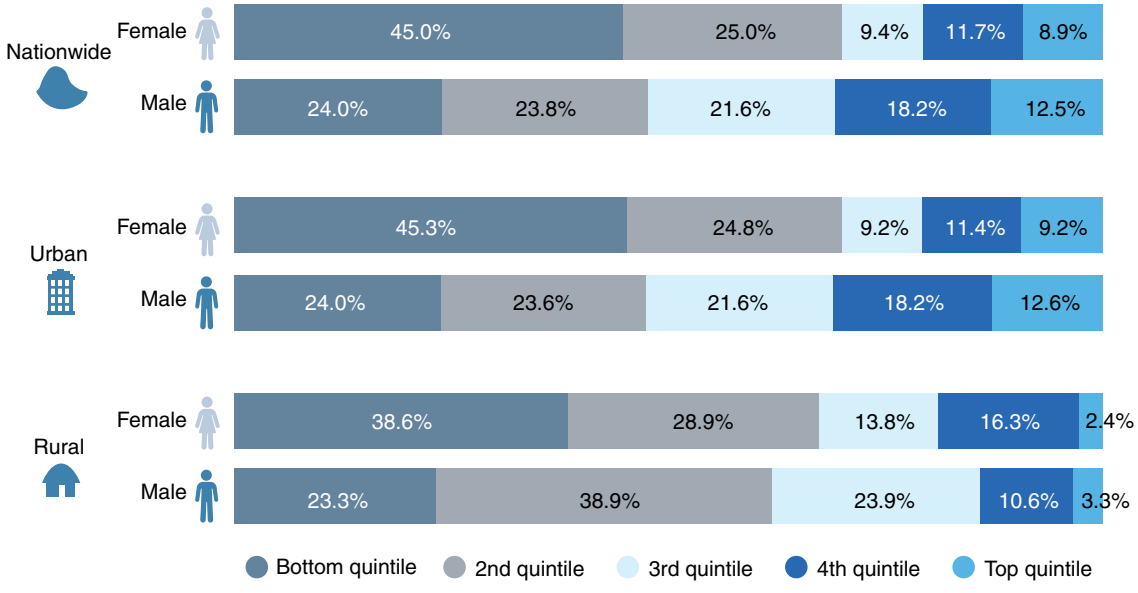
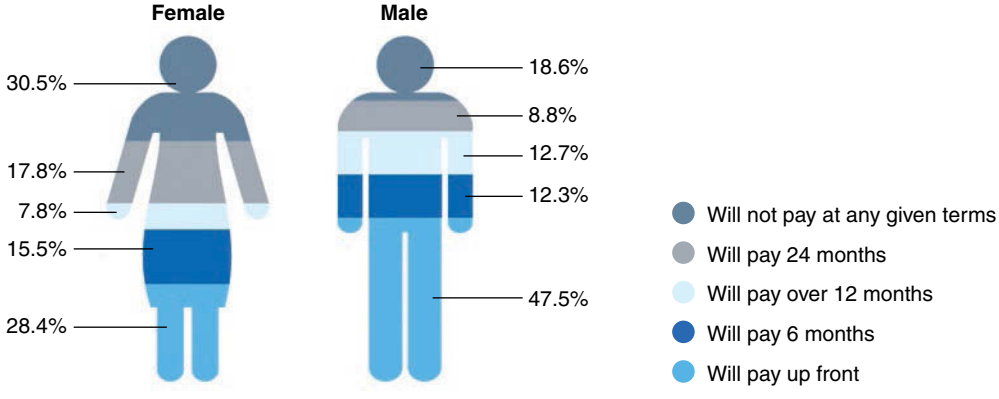


Figure A3.13 Women are significantly less willing to pay for Tier 2 off-grid solar devices than men



Notes

116. The MTF survey was conducted with the support of the World Bank.
117. The average tariff, last revised in 2006, is $0.03 per kWh, below the full cost of service, which is estimated at $0.06–$0.07 per kWh.
118. Basic energy needs as defined in Bhatia and Angelou. 2015. Beyond Connections: Energy Access Redefined.
119. The number of meter-loading households implied by a comparison of the grid-access rates revealed by MTF and the number of EEU household customers in Ethiopia is 3.8 million, against a total number of households of 20.4 million in 2018.
120. Consumption figures were taken from those reported in the electricity bills from the charged household.
121. 1 US dollar = 22.6615 Ethiopian birr (average exchange rate, April 2017).
122. 1 US dollar = 22.6615 Ethiopian birr (average exchange rate, April 2017).
123. Gender of household was not considered as a separate stratum during the sampling for the MTF survey so results may not be totally representative of the actual gender distribution in the country.

ANNEX 4

The Importance of Demand Estimates

A demand estimate (residential and commercial/industrial) is the most critical modeling parameter affecting modeling and electrification planning, from geo-spatial least-cost plans, to overall power sector planning. Across the board, a demand sensitivity analysis is the common denominator—or better caveat—to any electrification planning effort, directly impacting investment recommendations and prospectuses.

This is because demand (load) fundamentally impacts the relative cost-effectiveness of various technologies with very different balances of initial and recurring costs. Grid electrification typically has relatively high initial costs (for wire, transformers, connections) but lower recurring costs (since the "bus bar" cost of power tends to be low due to larger and more efficient generation, typically from cheaper sources, like hydro, coal, and natural gas). In contrast, solar photovoltaic systems tend to have lower initial costs, at least for small, remote communities, since they do not require medium voltage lines, but solar has relatively high recurring costs due to the need to continually reinvest in battery storage (within a long-term perspective). Mini-grids typically offer an intermediate option to meet demands that are too high to be met cost effectively with solar home systems, but not large enough (and/or too remote) to justify connection to the full grid. The effect of varying demand can be seen in the type of system recommended by the electrification modeling tools: high household/customer demand typically favors grid electrification, and low demand favors non-grid options like mini-grids and off-grid/solar home systems.

Improved demand estimates disclose the electricity needs of prospective beneficiaries, incorporating and modeling them, as well as growth projections (including population growth), into planning and implementations mechanisms that are tailored to actual and forecasted electricity needs. In turn, efficient tailoring of technology and service solutions avoids under- or overplanning.

The integration of agricultural electricity demand into the electrification planning and implementation process has the potential to improve the effectiveness of access programs and planning exercise—both in terms of matching supply to demand and improving the economic benefits delivered. Leveraging complementarities in rural development across the electricity and agricultural sectors would likely result in higher revenues for utility companies and increased agricultural productivity in rural areas. Coordinated planning of rural electrification would require accounting for potential growth in energy-intensive agricultural activities and development programs in the pipeline. Existing and potential demand for electricity from agricultural activities has been missing from demand-side estimations. This is partly due to the challenges in measuring, forecasting, and geo-locating the relatively dispersed demand (compared at least to industrial loads). However, improvements in satellite and big data availability have created opportunities to explore innovative ways of including both existing and potential electricity demand into the geo-spatial electrification planning process.

Commercial and industrial demand estimates and forecasting represent the new frontier for fostering productive uses of electricity and maximizing the economic impact of access to adequate and reliable services on the broader economy. The relationship between access to electricity and income generation can still be explained only through a correlation, not a causality, and more research needs to be conducted to model the economic impact of access to electricity on existing economic activity, and for prioritizing access to potential new economic and commercial centers.

In turn, the integration of commercial and industrial demand estimates for overall national least-cost electrification planning would allow: (i) integrating electrification planning into a wider economic development perspective, with strategic prioritization of high-return existing and new customers (based on the local context), (ii) improved connection rollout planning for the utility, strategically balancing big customers—existing and nascent ones—with low-income end-users for the financial viability of the utility itself, and (iii) translating a more efficient, cost-effective approach into service delivery, supported by an improved cash inflow.

From a power sector planning perspective, demand estimates and forecasting are keys for establishing a positive feedback loop between local realities—geographically based—and generation and transmission investment needs. The integration of local current and projected service needs allows for more efficient upstream planning for adequate power supply and related sizing of investment requirements. Therefore, the integration of bottom-up information into top-down planning leads to efficient and effective sector planning, tailored to the economic development of the country, and ensures the sustainability of electrification programs. Current demand estimates are based only on GDP projections, which are not grounded and anchored into local realities, that is, into the service needs of residential and commercial/industrial current and forecasted loads.

ANNEX 5

Achieving Gender Equality and Engaging Citizens within the Grid Program: 2018 Implementation Progress

Several activities were conducted since the launching of the NEP-IRM in November 2017 to improve gender equality and citizen engagement, all under the leadership of the Women, Children and Youth Affairs Directorate (WCYAD). The directorate was established in 2014 to promote gender equality, institutionalize gender mainstreaming, and advocate for the rights of women employees. The directorate consists of a director, an office manager, and three full-time gender experts and sits in the CEO's office, indicating its perceived importance within the EEU. To date, Women, Children and Youth Affairs Directorates have also been established in EEP and MoWIE, and various gender-specific targets and goals have been set in each institution.

The following actions and activities were undertaken in 2018 under the implementation framework of the National Electrification Program:

- **Steering Action:** Decision-making bodies, such as a Technical and Steering Committee on Gender Equality, have been established at EEU to track the delivery of key priorities by senior management. A key focus of these committees is ensuring that the objectives under the NEP are implemented over the next five years through strategic planning, actions on implementation, annual reporting, and continued monitoring and evaluation.
- **Strategy Adopted:** EEU adopted an ambitious five-year strategy of Gender and Citizen Engagement in July 2018, which charters the path from ad-hoc actions to a programmatic yearly plan to close key gaps in areas such as women's employment and child care provision. The work program lays out the key priorities and actions to be taken on progress toward gender equality and citizen engagement as part of overall energy sector engagements, including annual targets and the required budgets.
- **Women's Leadership Gap:** Leadership skills gaps are also being addressed through a needs assessment carried out with 76 senior and middle-level women managers that identified the gaps in leadership, management, and gender mainstreaming skills beyond technical knowledge. In August and September 2018, all senior and middle-level women managers went through a one-week training in Awassa on leadership skills and assertiveness skills.
- **Addressing Gender-Based Violence (GBV):** The EEU is also committing to assess and address GBV at the program and institutional level, and a consultant has been hired to provide further technical assistance. There is currently no policy in place on GBV at EEU. No sexual harassment complaints have ever been lodged by staff. This is more an indicator of a lack of awareness of sexual harassment and formal processes for reporting and redress, rather than a workplace free of sexual harassment. Two activities will be conducted: (1) sensitization of contractors, beneficiaries, and communities, and (2) strengthening the institutional response to GBV. This focus spearheads thinking on what state-owned enterprises can deliver in a vacuum of national policy for GBV.

- **Child Care:** In the coming months, EEU will inventory needs, enact policies, and build infrastructure to support working parents. Among the priorities identified at EEU to advance gender equality, the establishment of child care services is a top priority. Considering the business case for child care provision at EEU, senior management is working closely with the World Bank and IFC on the establishment of child care services at EEU headquarters, and in 10 regional and subregional offices. This is also in line with the Federal Civil Servant Proclamation No. 1064/2017 which proclaimed the establishment and implementation of child care service provision in all government institutions.
- **Internship Program:** The EEU is developing a women's mentorship program and is putting a spotlight on women role models in the electricity sector (launched in November 2018). Recognizing the value of role models and coaches in shaping career aspirations, the EEU is developing a nine-month women's mentoring program for middle managers who will be matched with senior managers. Mentees will need to submit a formal application that includes their motivation for participation and career goals. The EEU also continues to spotlight female leaders in Ethiopia's electricity sector at events such as the International Women's Day celebrations every March.

Citizen engagement

The Government is committed to ensuring the participation, involvement, and empowerment of its citizen during the implementation of the NEP. Both in urban and rural areas, a battery of citizen engagement activities has been carried out with the key objectives of setting the right expectations on timing of grid rollout, awareness-raising about the benefits of electricity, and improving customer service through the following:

(i) Adequate management of expectations concerning the timing of grid rollout (and connectivity), with a specific focus—but not limited to—prospective customers on the paid and unpaid waiting list, as well as service standards' expectations in the case of the off-grid, mostly pre-electrification, program. These activities ensure the integration of citizen voice into service delivery during the implementation of the NEP.

(ii) Education and awareness of various stakeholders, ranging from households, communities, and institutions, about the role that electricity can play for their economic and human development, as well as related safety issues, and cost of service. This engagement is laying the foundation for fostering and establishing a culture of payment, particularly in the case of currently unelectrified communities and in the event of meter loading and illegal connections. Specific emphasis is being placed on poorer community members and women (including girls) who may have less access to information and resources and have a lower ability to voice concerns and preferences but are often the primary energy producers for the household.

The overall engagement has built on the activities and processes that EEU has already launched in this field, with the possible involvement of REBs and cooperatives, based on the local contexts and comparative strengths of involved agents. As regards EEU, centrality of customer service ranks among the top four priorities of the utility's strategic themes, as customer engagement is key for: new connection/electrification, billing and collection, maintenance, and complaints management.

Box A5.1 Institutionalizing Gender Equality Timeline

The following activities have thus far been implemented to institutionalize gender equality at the EEU:

- 2014: Women, Children, and Youth Affairs Directorate established, reporting directly to the CEO
- 2014: EEU drafts Women's Affairs Policy and Procedures for 2014–2019. Adopted formally in 2016
- 2017: One-day workshop on gender and citizen engagement convened by World Bank with senior EEU members in February 2017
- 2017: Institutional gender assessment of EEU completed mapping key gender gaps[124]
- 2018: Gender Steering Committee established in March 2018 with a mandate to make decisions and provide oversight and strategic guidance on implementing actions to close gender gaps at EEU; chaired by CEO and comprised of senior management representatives
- 2018: Gender Technical Committee established with a mandate to lead all actions to close gender gaps; chaired by WCYAD director and comprised of select department and unit heads, including a labor union representative
- 2018: Five-year Gender and Citizen Engagement Work Program approved by the EEU Board in July 2018

Based on consumer interface and feedback, EEU has mapped five key areas of customer dissatisfaction: power outage and quality; delays in rollout of new connections; rent-seeking attitude and behavior; wrong billing; and employee capabilities to deal with consumer complaints and customer interface.

EEU has focused on various public relations and communications activities through its Corporate Public Relations Department, which has been working on mainly addressing concerns and questions related to service interruptions. Communication channels so far have included short TV broadcasts developed together with the Ethiopian Broadcasting Corporation and radio announcements containing details. The utility has also established various mechanisms for citizens to provide feedback and raise concerns, including public forums, suggestion boxes, call centers, and a vigilance office. Key actions have included, among others:

- Citizen Charter: A Citizen Charter was approved (2016) and implemented. The charter outlines the service standards to which customers are entitled to, as well as the requirements they need to meet to get access to the services, and the procedures to obtain redress of grievances. The customer charter was made public on large and visible banners and posted in all EEU service centers and was disseminated through discussions with EEU customers. Both in urban and rural areas, citizen engagement activities are being rolled out.
- Customer Satisfaction Survey: In 2018, EEU drafted and launched an annual customer satisfaction survey that targeted households, businesses, industries, and social institutions (all information collected is kept confidential and aggregated to ensure privacy), which has been piloted in a number of regions. These surveys focus on getting customer feedback on the key EEU service areas, including new connections, sustained and quality power supply, billing, complaint handling, maintenance, efficiency/courtesy of call centers, accessibility of service centers, customer care, and staff competence and accountability and transparency. Moving forward, in-house customer satisfaction surveys are planned to be carried out in all EEU regions on a biannual basis with a view to reach out to its customers and mobilize their support and participation in meeting goals and objectives. This will be complemented by building in-house staff capacity at the EEU central office and regions to guide and manage external customer satisfaction surveys, using the results for improving EEU services, and enhancing transparency and accountability to customers.
- Public Forums: Over the course of 2018, 177 public forums were held across the country with 12,216 participants. In addition, EEU drafted and adopted guidelines with the procedures for complaint handling and grievance redressing. This guideline will help make complaint filing and handling procedures at EEU transparent, accountable, and consistent across regions and work units. Besides acting as open platforms for sharing EEU's activities with customers and providing them with a space to air out their requests and complaints on EEU service delivery gaps, the forums serve as mediums for sharing valuable information on efficient energy use, safety, and protection

The implementation of the NEP will ensure that the standards set out in the EEU Citizens Charter are met, and that best practices in citizen engagement are taken into account for the safe, effective, and sustainable rollout of grid connections. Focus will be given to strengthening citizen engagement mechanisms at the community level, citizen aspects related to payment for electrification, and targeted energy education; and building the institutional capacity of energy bureaus on citizen engagement.

Note

124. Power Africa supported.

ANNEX 6

Off-Grid Market Development and NEP Design: Deriving Best Practice from Case Studies

The NEP is informed by the experience of electrification programs throughout the developing world and distils and deploys the best practices that these programs showcase. This annex gathers five case studies of market development strategies for off-grid solar sector development drawn from other countries around the developing world. Based on these, it draws conclusions, both broad and narrow, about the design of the NEP program going forward. The five case studies are taken from Kenya, Myanmar, Togo, Bangladesh, and Nigeria and are not meant to be comprehensive of all off-grid activities currently ongoing in these countries, but provide a point of reference and lessons learned for the structuring of the NEP off-grid program. In addition, latest best practices in the off-grid space as identified by GOGLA are also described.

1. Kenya—Results-based financing and working capital to reach underserved areas

Kenya is unique in the world in terms of the depth and dynamism of its off-grid solar market. Since 2009, 2.7 million solar lanterns and home systems have been sold, including more than 700,000 in 2015/16 alone. Kenya's off-grid solar market growth has been underpinned by the country's political stability, economic growth, ease of doing business, and supportive policy environment. Market growth has also been enabled by the widespread use of microfinance, mobile phones, and more recently, by widespread adoption of mobile money, which plays a key role in many pay-as-you-go business models.

Underserved counties were identified by the government of Kenya's Commission on Revenue Allocation (CRA), which defined criteria for identifying marginalized areas and sharing of 'equalization funds', based on a wide range of economic and social indicators. Individual county profiles were provided through CRA research, which, combined with data from the 2016 FinAccess Household Survey and the National Census, gave a sense of the total unelectrified population by county and income bracket.

Commercially viable and nonviable areas were identified based on geo-spatial mapping, the MTF survey, a willingness to pay survey, analysis of existing market trends, and consultations with companies. With World Bank support, Kenya undertook a geo-spatial mapping exercise and a multitier framework survey. Geo-spatial mapping enabled the Government to determine the most appropriate 'least-cost' solution for meeting current levels of demand around the country, while the multitier framework survey provided a detailed analysis of the quality of energy access and demand estimates. Based on this analysis, plans for grid extension, mini-grid deployment, and the promotion of stand-alone, off-grid solar solutions were developed.

These activities were complimented by a willingness to pay analysis, and a bottom-up needs assessment, undertaken specifically to inform project design. This showed that there was a considerable subset of the population who could theoretically afford a Tier 1–level SHS (in this scenario, a three-light point system with phone charging capabilities,

offered on a monthly cost of KES 500 and paid off over 36 months). Simulations using 2013 FinAccess household survey data show that in a scenario where 7 percent of household expenditures are assumed to be made on stopgap lighting, over 500,000 of the 1.3 million off-grid households could afford this energy service offering.[125]

Project funds for mini-grids and stand-alone off-grid solar were allocated to specific 'service territories' according to a formula which factored in poverty, need for electricity services, and the cost premium for infrastructure development as a result of low population density. The aim was to: (a) achieve maximum impact with limited resources; (b) deliver services where need is greatest; (c) consider additional costs due to low population density; and (d) consider the principle of equity, ensuring that all counties benefited in a similar manner.

KOSAP includes a US$42 million household solar component, made up of a US$12 million results-based finance facility and a US$30 million debt facility, which are managed by independent Facility Managers. A further US$25 million is allocated to fund stand-alone solar servicing of community facilities. Finally, fully US$22 million are dedicated to implementation support and capacity building, as well as for engaging citizens. The target counties are divided up into service territories, the geographic units of reference for the scheme. In addition, US$40 million were allocated for mini-grid developments.

2. Myanmar—Combining private and public sector-led delivery models

When the off-grid program was launched, 5.5 million households were projected to remain without access to the grid by 2021, 1.3 million of which were in remote states and regions.[126] The off-grid component targets communities in these areas which are unlikely to receive grid access in the next 10 or more years, and where the private sector is less active due to high operating costs and low ability to pay.

The program includes an $80 million off-grid pre-electrification component, implemented by the Department of Rural Development (DRD), which supports solar home systems and mini-grids. Public procurement has been rolled out in three phases targeting households, schools, clinics, and religious facilities, as well as street lighting. The public model is considered to have merits in terms of price and quality standards but is limited by high administrative costs and scarce public resources. Partnership with the private sector is also considered to be critical for achieving the government's target of universal energy access by 2030.

Although a few companies have entered the market with Lighting Global certified products, private sector–led quality off-grid solar market development

Table A6.1 Summary of off-grid components for underserved territories

Component	Results-based Finance	Debt Facility	Community Facilities
Target	Households	Households	Health, education facilities, and administrative offices
Implementing body	Independent facility manager	Independent facility manager	KPLC, a national utility company
Objective	Compensate companies for costs associated with expansion into underserved counties	Cover up-front costs and forex risks of product manufacture and importation, as well as the medium-term financing needs of the supply chain	Electrify around 1,100 community facilities in targeted counties
Mechanism	For each service territory, companies bid in a reverse auction where the bids meeting the technical conditions with the lowest request for incentives win—multiple winners ensure competition. After an initial payment (30%), disbursements are results-based (60%) and after demonstrating sustainability (10%)	Long-term loans in Kenyan shillings differentiated for cash-based sales and having relatively lower financing needs and operators offering pay-as-you-go, which require longer term loans	Based on a tender that includes "minimum package" requirements for each facility, one contractor per service territory will be competitively selected to supply, install, operate, and maintain stand-alone solar solutions. KPLC takes retail risk of facilities not paying, but guarantees are offered in the form of funds that KPLC can access in case of default (up to 6–12 months' costs).

Table A6.2 Summary of the off-grid components in Myanmar

Component	Public Procurement Scheme	Results-based Financing (RBF)
Target	Households, schools, clinics, and religious facilities	Households
Amount	US$80 million	At pilot stage
Implementing body	Myanmar Government Department of Rural Development	To be determined
Objective	Providing subsidized solar home systems and mini-grid systems to targeted end-users	Provide incentives for private sector actors to provide affordable high-quality solar products in low viability areas
Mechanism	Subsidized sales to end-users with subsidies up to 87% of product cost. International, competitive tenders—one for each of the 12 regions in scope—identify firms that supply, install, and maintain a range of systems. Winners are required to meet specific technical requirements, including for system quality, installation and maintenance, repair under warranty, and the provision of spare parts. DRD is establishing maintenance centers to ensure access to maintenance services.	RBF from DRD to PV Solar providers who sell Lighting Global certified products and are audited by an independent verification authority. Subsidy amounts will be based on system performance and may also include geographic targeting. DRD is providing information on existing and planned grid and off-grid interventions to ensure coordination between the public and private sector mechanisms.

is still at an early stage. The IFC has provided market development support under the Lighting Myanmar initiative, and now a results-based financing (RBF) facility for off-grid solar has been developed, which aims to accelerate market development. While low-quality, cheap products are already commonplace, RBF will promote a range of high-quality products at price points that are in line with customer ability to pay and provide both access to end-user finance and after-sale service. The RBF is seen as a more sustainable, private sector–led approach that has a lower administrative cost to government than the public procurement model.

3. Togo—Concessions to attract companies into a small market

The Government of Togo has developed a unique approach to building the off-grid solar market, with support from the AfDB. A national electrification strategy was developed with support from the International Finance Corporation that includes a target to electrify 555,000 households with off-grid solar by 2030. Support to the off-grid solar sector is being provided through the CIZO project ('Light up' in the Guin language). Licensees benefit from a duty waiver as well as logistical support, which includes low-cost transport and warehousing nationwide, provided by the Togo Post Office.

In return, companies must commit to meeting Lighting Global quality standards, and to providing sales, energy consumption, and repayment data to the government for monitoring and reporting purposes. The data could be useful in the future for launching other initiatives in rural areas, for example around access to water or financial inclusion.

As of September 2018, 4,500 kits were sold by the first licensee under the CIZO project. The aim was to sell 10,000 by the end of 2018. It is envisaged that only three to five licenses will be granted between now and 2030. This way the Government ensures that the potential market available to a licensee is big enough to justify market entry despite the fact that Togo is a small country. The risk of market distortion is considered to be minimal since licenses are not geographic, the benefits of being a licensee are identical and licensees are encouraged to compete within the country.

To promote quality, the Government of Togo is planning to adopt Lighting Global quality standards as national standards, but there is a recognition that borders are highly porous, and this alone is unlikely to prevent the influx of generic or substandard products.

To support access to finance, the Government of Togo is also assisting CIZO licensees with access to finance, facilitating working capital loans for licensees. Access to finance is not expected to be a major constraint in the future since concessional financing is likely to be made available through the World Bank West Africa Regional Off-Grid Energy project (ROGEP), as well as AfDB and other development finance institutions.

Under CIZO, companies are licensed to sell solar systems delivering a minimum of 20 W with the possibility of upgrade. This is equivalent to a level of service between Tier 1 and Tier 2 according to the SE4ALL Global Tracking Framework. Systems must use machine-to-machine connectivity and have the possibility of connecting directly to the government's data tracking platform, which collects information on sales, payments, and energy consumption.

Licensees are being selected through a competitive call for proposals, based on the quality of service they are able to provide and the number of customers they are likely to be able to reach. There is a long-term preference for 'energy as a service' models which envisage long-term customer relationships and upgrades leading to higher tiers of energy access.

Subsidies are primarily provided through the Value Added Tax (VAT) and duty waivers provided to CIZO licensees. CIZO licensees benefit from a 20 percent discount on the use of the Togo Post Office (for transportation, storage, and displaying products in post offices) and public awareness campaigns, as well as training of commercial agents. No consumer-facing subsidies exist to date, although the Government of Togo has also launched a program providing subsidies that target the poorest.

Provision of after-sales service is a requirement under the CIZO project, and a key criteria for the selection of CIZO licensees has been a commitment to building long-term customer relationships, including offering repair or replacement in case of product failure and the possibility of system upgrades in the future. The Government has planned the establishment of a solar academy to train technicians, as well as the possibility of training users on the use of solar kits.[127]

4. Bangladesh IDCOL project—Using microfinance to make products affordable

The IDCOL SHS program was launched in 2003 and is now widely seen as the most successful off-grid solar energy initiative in the world. By May 2017 about 4.12 million solar home systems had been installed through the program in remote off-grid areas. The program delivered basic electricity to 18 million people—about 12 percent of the population—who had previously been using kerosene for lighting. The program is now being wound down, as the grid is being extended to areas previously served by solar home systems. Given the high population density, it is estimated that the vast majority of households can be reached by the grid. IDCOL is now supporting mini-grid provision for isolated communities that cannot be connected to the grid, such as river islands. The role of SHS as pre-electrification has been completed.

IDCOL initially received credit and grant support from the World Bank and GEF to start the program. Later, GIZ, KfW, ADB, IDB, GPOBA, JICA, USAID, and DFID all came forward with additional financial support for expansion of the SHS program. IDCOL's total investment under the program was US$696 million out of which US$600 million was a loan and US$96 million was a grant.

The project took advantage of Bangladesh's high population density and the fact that Bangladesh had one of the world's most advanced microfinance sectors to make SHS affordable. By 2017, 56 microfinance 'Partner Organizations' (POs) were implementing the program. IDCOL provided grants and soft loans as well as technical assistance to the POs. POs selected customers and extended loans. Installation of systems and after-sales service was provided by POs, with some choosing to outsource installations to SHS companies. POs reported an average loan-collection efficiency of more than 90 percent, while they serviced their debts with IDCOL on time. This reduced dependence on subsidies. Deliveries via POs, which were already active in rural areas and selected through a competitive process, allowed customers to borrow money from POs to purchase SHSs, making affordable, regular payments over three years or longer in some cases.

During the initial years of the program, grid expansion was very slow due to a shortage of energy supply, which created an opportunity for the SHS market to expand in areas where grid extension would also have been economically viable. Over time the area where IDCOL operated was scaled back to reflect extension of the national grid. The IDCOL program, however, allowed millions of rural households to access electricity more than a decade earlier than the grid extension could bring. In the future, the program will focus more on providing electricity for productive uses, such as irrigation, cold storage, refrigeration or transport, as well as mini-grids. SHS experience was also used to inform a large dissemination program for clean cookstoves.

IDCOL set comprehensive technical standards, and certified products, with testing and certification organizations trained and accredited to undertake testing on behalf of the program. Most systems were intended to provide users with the systems capable of supplying power to lights, radio, or TV for three to five hours per day. The systems were designed to run for three consecutive days without charging and for ease of maintenance by users and technicians.

All components were covered by warranties of up to three years, five years for batteries, or 20 years in the case of the PV module.

In 2017, the US$420 cost of each SHS was financed by a three-year loan to the end-user at 12 percent pa with a 15 percent down payment and a monthly instalment of US$12. This was supplemented by refinancing from IDCOL of US$250 of the cost over five to seven years at 6–9 percent pa, with a one- to two-year grace period. The terms in the earlier years had been much more favorable, including a subsidy, but as the market developed, the level of support has been scaled down.

After-sales service, including repairs and replacement of components, both under warranty and outside of warranty periods, was conducted by POs. Over 395,000 households were trained in how to use and maintain an SHS, while extensive training was also provided to PO staff and local technicians. Customers also benefited from extensive awareness campaigns and a nationwide customer call center. IDCOL closely monitored the quality of after-sales service provided by POs. Quality control was addressed through 12 offices with 120 quality inspectors and 11 field auditors.

The project also generated a positive impact on the local manufacturing industry. Initially, batteries were the only component produced in Bangladesh and were sold as part of an SHS. However, gradually all components (including solar panels) began to be produced locally. This contributed to the growth of the renewable energy market in Bangladesh as a whole, which employed 114,000 people in 2013.

5. Nigeria

Nigeria is applying a minimum-subsidy tender approach to mini-grid development, in the context of the country's electrification drive. This is part of a much wider portfolio of financial incentives and regulatory reforms that aim to develop the domestic sector and improve access to electricity country wide.

In July 2016 the President of Nigeria approved the Rural Electrification Strategy and Implementation Plan (RESIP), with the primary aim of expanding access to electricity cost-effectively and rapidly, using both grid and off-grid approaches. Among the off-grid approaches, significant space is given to the deployment of mini-grids. Mini-grids have been the object of comprehensive regulatory reform efforts by the Nigerian Electricity Regulatory Commission, which issued a regulatory framework in support of mini-grid market development in May 2016. These regulations remove barriers to mini-grid development. They adopt mechanisms and standards for the integration of mini-grid sites into the main grid that ensure assets do not become stranded and enable mini-grid developers to charge cost-reflective tariffs to customers, protecting the financial sustainability of the sector.

Notwithstanding the conducive regulatory environment, mini-grids face significant financial viability challenges in Nigeria. This has made a subsidy program necessary to attract private operators to market at the scale required by the country's access expansion targets. The project aims to catalyze large-scale investments across both the mini-grid and the solar-home-system marketplace. In the off-grid space, the project combines one-off capital expenditure (capex) subsidies, to be allocated through a minimum-subsidy tender for mini-grid developers. In parallel, performance-based, viability gap grants are offered to qualified companies, with financial rewards to operators on a per connection basis. Together these instruments are designed to deliver the development of 850 mini-grids and connect 300,000 households, and 30,000 micro-, small and medium enterprises, by leveraging a total of US$330 million in investment.

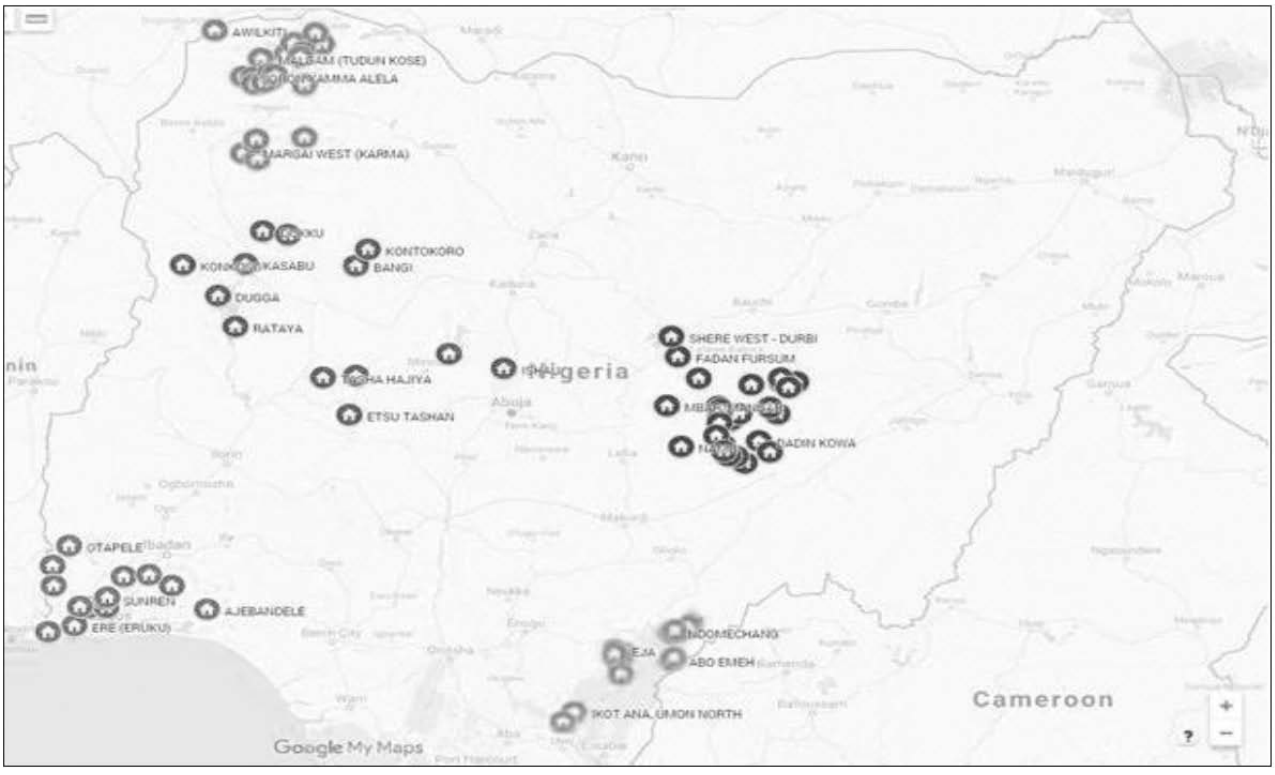
The minimum subsidy tender for capex subsidies to mini-grid development

To kick-start development of the first 250 mini-grids, US$70 million's worth of one-off capex subsidies will be allocated in a tendering process based on the minimum-subsidy bidding model (see above). For this purpose, Nigeria's Rural Electrification Agency (REA) will prioritize 250 sites among a long list of 8,000 with high potential for mini-grid electrification. The prioritization will be based on geo-referenced data on population clusters and load centers, including population density, number and type of productive end-uses, and the presence of community infrastructure such as schools, water pumps, and health facilities—validated by field-surveys. The site selection process was designed to help ensure maximum economic impact and financial viability of mini-grid sites tendered out, also maximizing attractiveness to the private sector.

Market information

Several steps have been taken to de-risk and enhance private interest in participating in the tenders and more widely in the nascent mini-grid market. Synergies with other development projects around Nigeria, particularly for agriculture and livelihoods are being leveraged to identify agricultural loads and derive insights on likely load profiles, thereby enabling better-informed and better-targeted bids. REA has data on location, energy demand profiles,

Figure A6.1 Candidate sites for minimum-subsidy tender in five states



Source: World Bank. 2018. Nigeria Electrification Project (P161885): Project Appraisal Document.

and fuel provisioning arrangements of telecom towers that may serve as anchor loads for mini-grids and has incorporated the data into existing databases and geo-spatial analysis. Also the MTF surveys are expected to provide further insights for the location of mini-grid sites.

Technical requirements

Technical requirements applicable to bids will help ensure high standards of service and proper, sustainable functioning of the market. A Project Implementation Manual has been drafted by the REA, which includes eligibility criteria for qualification of mini-grid project developers, application and evaluation procedures, and verification protocols for disbursement, as well as model contract agreements between REA and the participating companies. The Manual also specifies the institutional arrangements for mini-grid development along with environmental and social safeguard requirements and monitoring and evaluation arrangements. Prepaid metering and smart-meter systems will be required in any mini-grid design to mitigate revenue collection risk and enhance the bankability of the mini-grid sub-projects. High-capacity mini-grids will have to be built to Nigeria's grid code standard in order to allow for integration with DISCOs grid when the latter is extended to reach a mini-grid's site. However, to reduce regulatory burdens, mini-grids of small sizes (<100 kW) will be allowed to go through a light-touch registration process and will be allowed greater leeway in tariff setting, but granted fewer compensation rights in case of the grid's arrival.

The tendering process

For the tendering process, the 250 rural load centers will be lumped into lots, to encourage economies of scale in procurement and efficiency in operation and maintenance. A large number of sites in a geographic cluster could comprise such a lot and will be tendered on the basis of minimum subsidy requirements. By increasing the deal size, this window aims to attract some of the international private developers to enter the mini-grid market in Nigeria. The lots will also include a requirement to make available (on a lease to own basis) a certain number of productive use and household appliances that will be specified in the bid documents. This will help promote productive uses and bolster demand.

Bid packages will give significant commercial choice to the bidders, including:

- specifying the tariff, subject to a tariff ceiling based on commercial tariffs from existing mini-grid operators;
- selecting the technology, subject to minimum technical specifications;
- selecting clients, subject to a minimum population that will need to be connected; and
- promotional sales campaigns, subject to a minimum adoption of productive use appliances.

Bidders will have the discretion to propose minor modifications to the standard configuration indicated for each mini-grid but will have to comply with the major parameters in order to allow comparison and evaluation of bids.

For each lot, bidders will therefore have to submit their proposed approach to build, own, and operate a portfolio of mini-grids that serve the load centers with the standardized design configuration that best fits the demand profile across the lot. The bid that meets the technical criteria and requests the lowest amount of subsidy will win the tender and will be allowed to develop the mini-grids in the lot.

A. Lessons learned: Market segmentation

A key step in the design of an electrification program is to segment markets to identify the most appropriate least-cost technology for specific geographical areas, and to determine the right service delivery approach to use—be it private, public, or a mixed 'hybrid' model. The main tools used to undertake this kind of analysis for Ethiopia include geo-spatial planning and multi-tier framework surveys. These analytical tools have been complemented through more informal stakeholder consultation, in particular with mini-grid developers and off-grid solar companies.

Geo-spatial Electrification Planning: This approach was first developed by the World Bank Energy Sector Management Assistance Program (ESMAP) and has been rolled out in 11 countries—including Kenya, Rwanda and Myanmar—since 2013 as part of SE4ALL technical assistance. This approach has been used to analyze a range of factors which influence the most cost-efficient way to connect communities—including the size of the community, population density, distance to national grid, terrain, electricity demand, and level of economic activity. Based on such analyses, governments have been able to make more informed decisions about the most appropriate 'least-cost' solution to deploy in specific areas.

Geo-spatial planning has many advantages. The approach is inclusive of both grid and off-grid solutions. It is a bottom-up approach to planning based on electricity demand, which is dynamic, so that plans can be easily adjusted if situations change. It means policy and investment decisions can be more effectively targeted at achieving government objectives, thereby improving efficiency. It fosters transparency and rationality in Government planning, allows for donor coordination and investment syndication, and reduces risk for off-grid private investment through creating predictability and improving the availability of data.[128]

Multi-Tier Framework (MTF) Surveys: A multi-tier framework for defining and measuring energy access was initially proposed in the first SE4ALL Global Tracking Framework report, published in 2013.[129, 130] MTF surveys are now being undertaken in around 10–15 high access deficit countries. This framework is broader than previous binary metrics, such as whether a household is connected or not to the electricity grid. Building on this work in Beyond Connections: Energy Access Redefined, ESMAP—in its role as SE4ALL Knowledge Hub—defines 'meaningful' energy supply as having the following attributes. It must be adequate in quantity; available when needed; of good quality; reliable; convenient; affordable; legal; healthy; and safe.[131] It recognizes that energy access covers energy for households, productive uses, and community facilities, and focuses on both the quantity and quality of energy being accessed. Crucially, MTF surveys can be used to undertake a 'gap analysis', which helps to identify what is holding a country back in terms of moving up the energy access tiers.

Revealed Willingness to Pay Surveys: These surveys can be used to provide a detailed understanding of the affordability of different electricity access options. This is vital in determining which areas should be classified as commercial, semi-commercial or noncommercial, and therefore would be best reached through a private sector, hybrid, or public sector delivery approach.

Rural and peri-urban households have an energy budget, just as they have budgets for food, clothing, and other necessities. This budget does not change if the homeowners have grid service, mini-grid service, or solar home systems—unless they are able to engage in more economically productive activities, in which case budgets change slowly over time.

Surveys are therefore based on 'revealed' willingness to pay rather than 'expressed' willingness to pay. They focus on evaluating existing energy expenditure patterns, since this is a better predictive indicator

than simply asking people what they would be willing to pay for a given level of service, and measuring energy spending patterns across a wide variety of energy services and fuel types.[132]

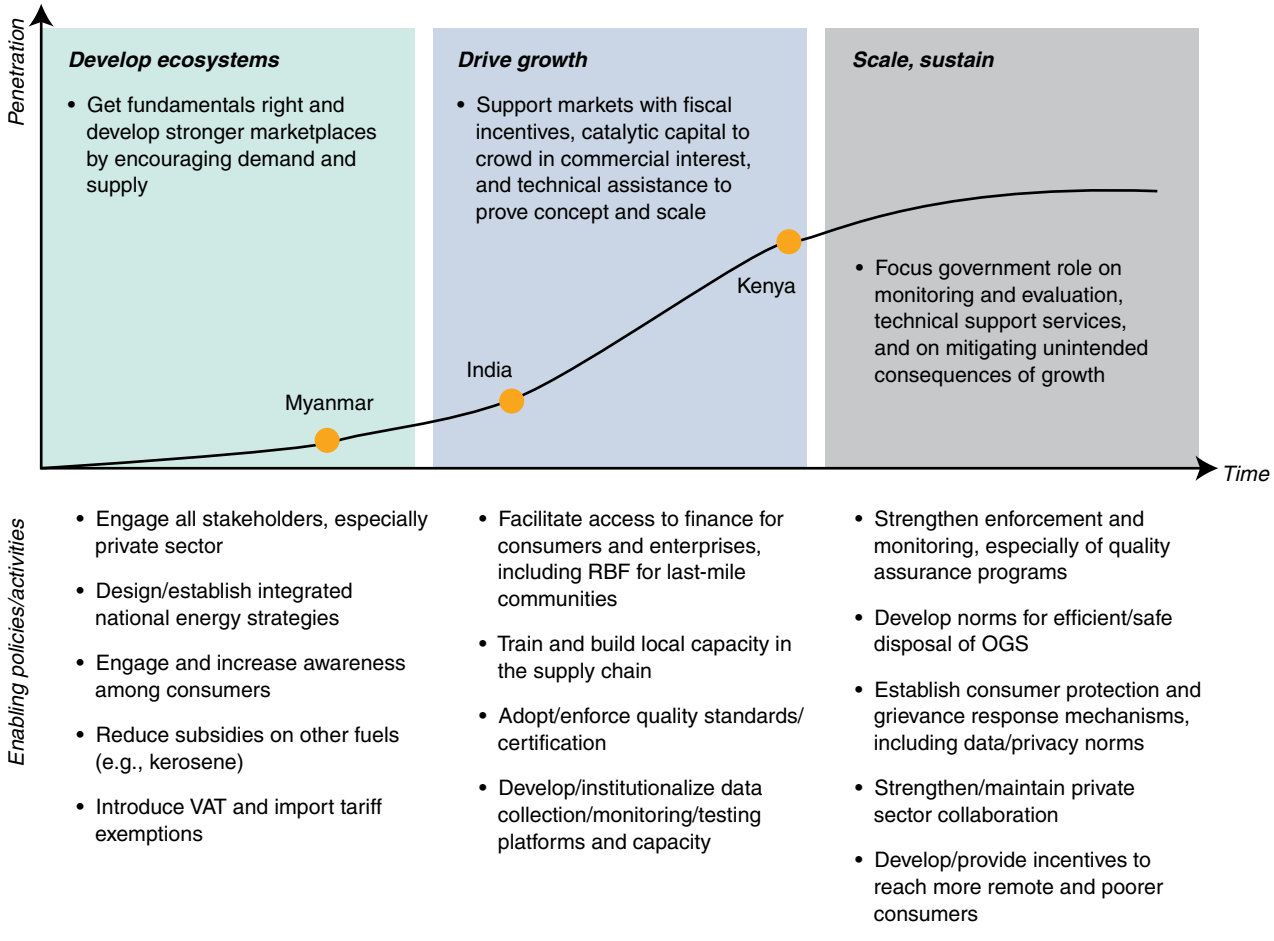
B. Lessons learned: The use of subsidies

Special assistance is likely needed to extend energy access to remote and/or low-income populations. Yet it is important to design the assistance in a self-sustaining way that prioritizes market-based delivery. This ensures that customers pay a reasonable, affordable amount for services provided, and that the participation of private sector companies and investors is maximized, helping to minimize the cost and administrative burden for government.

As the above country case studies demonstrate, end-user price subsidies should be minimized and, if necessary, carefully applied so as not to negatively affect the behavior of companies' current or potential customers. In Rwanda, prior to the design of the new RBF, the expectation of free distribution had the opposite of its intended effect—elongating the timeline for achieving energy access, as households were postponing purchasing decisions hoping to receive systems for free. To avoid these risks, and ensure an effective and efficient combination of private, public, and hybrid delivery models to reach all citizens, three approaches can be proposed. For all approaches, effective communication is needed to avoid expectations from the population that cannot be met.

Proper identification and targeting of in-need segments: Using a combination of geo-spatial analysis, MTF surveys, and revealed willingness to pay surveys, it is now possible to segment and map the population effectively according to people's energy access needs. In addition, governments can leverage existing social programs that pre-identify the "poor" to target subsidies, e.g., in the form of vouchers or cash transfers. Investments in monitoring and evaluation are also important to ensure accountability.

Figure A6.2 Illustrative evolution of policy and regulatory support for off-grid solar markets



End-user subsidy schemes are only as good as the citizen categorization systems on which they depend, which could become a key factor for implementation success.

Design should minimize market distortion and define a clear exit strategy for the government in a way that does not shock the commercial market. This can be done in a variety of ways, including designing a system of cascading subsidies so that over the long term, market prices prevail. Alternatively, innovative approaches can be employed, such as results-based financing mechanisms that focus on incentivizing the private sector to service last-mile segments or providing vouchers to eligible population, allowing them to participate in the market.

Subsidies may enable governments to reach people quickly in the short term, but risks of market distortions need to be avoided, especially if: (a) subsidy schemes take place in the same geographical areas as companies are seeking to sell at commercial prices; (b) subsidy schemes are taking place at the same time as companies are seeking to sell; and (c) there is no consumer awareness campaign to ensure all citizens are fully aware of who is eligible for and likely to receive a subsidy, and who is not.

Bangladesh's IDCOL program has successfully distributed more than four million SHSs since 2003. IDCOL deployed a set of progressive subsidies whereby smaller systems that are more affordable to the poorest populations received a higher subsidy relative to larger systems. In addition, to encourage a transition toward a commercially oriented SHS market in the country, the subsidy elements and the concessional rates of IDCOL's refinancing program have gradually been reduced.

C. Lessons learned: Program design and delivery should coordinate with the private sector

Scale will only be reached if private companies are successful. For this reason, extensive consultations were held by the Government with both local and international private sector companies to ensure that the NEP provided solutions for the major challenges affecting service delivery with off-grid solutions.

While there is no one-size-fits-all solution, the off-grid solar sector's experience over the last 10 years suggests public policy needs to focus on different elements at different stages of a market's growth, as outlined in the figure below.[133]

Notes

125. Financial Access (FinAccess) surveys provide information to policy makers about the main barriers to financial access and inclusion, for example, geographic or socioeconomic factors. Three nationally representative FinAccess surveys have been conducted in Kenya: in 2006, 2009, and 2103.
126. Project Appraisal Document for Myanmar National Electrification Project, World Bank, 2015.
127. Togo Electrification Strategy, http://energyaccess.org/wp-content/uploads/2018/08/Electrification-Strategy-of-Togo-Full.pdf
128. Yann Tanvez. 2017. The Rise of Geo-spatial Planning in Developing Countries.
129. Global Tracking Framework. 2013. International Energy Agency and World Bank.
130. Ibid.
131. Bhatia and Angelou. 2015. Beyond Connections: Energy Access Redefined.
132. NRECA International. Guide for Electric Cooperative Development and Rural Electrification.
133. Dalberg. 2018. Off-Grid Solar Market Trends Report.

ANNEX 7

Overview of Development Partners Activities in Ethiopia: A Coordinated Effort to Support the Sector-Wide Approach

The NEP adopts an integrated, sector-wide approach to achieve the ambitious goals it sets for the electrification of the country. This approach encompasses a number of development partners (DPs), namely the World Bank, the European Union (EU), the United Kingdom's Department for International Development (DFID), The United States Agency for International Development (USAID), The African Development Bank (AfDB), The French Agency for Development (AFD), The United Nations Development Programme (UNDP), The German Agency for Co-operation (GIZ), The Swedish International Development Co-operation Agency (Sida), and the European Investment Bank (EIB). The adopted sector-wide approach has enabled different development partners to focus on their areas of particular expertise, leveraging each agency's respective strengths in technical, financial, and advisory assistance for the purpose of comprehensively addressing the Government's needs for program support.

Table A7.1 details the activities that various DPs are undertaking or are able to undertake to support delivery of the NEP. Grouped under four broad themes, they are: policy, strategy and planning development—which coordinates and integrates the more strategic pieces of policy development and analytical work that cut across both grid and off-grid programs; on-grid electrification and off-grid electrification, each of which focuses on the immediate implementation activities, including financial and design support; market development and capacity building requirements of the Government's grid investment and procurement arrangements and with respect to the Government's objectives for aggressive development of a private-led off-grid sector.

Table A7.1 Sector-wide prospectus of planned development partner activities in support of the NEP

Support Area	Partner	Program	Timeline
Policy, strategy, and planning development	World Bank	• National baseline survey for electrification under the Multi-Tier Framework (MTF) for Access program. • Technical assistance for development and launching of National Electrification Program (NEP). • Technical assistance for revisions focusing on off-grid sector under Second National Electrification Program (NEP 2.0). • National Geospatial Information System (GIS) platform for electrification and power sector planning (MoWIE and EEU). • Gender and citizen engagement programs (EEU).	FY18 FY18 Launch in March 2019 FY18–20 FY18–23
	EU Delegation to Ethiopia	• Blending for electrification (support private investment in off-grid electrification and infrastructure investments to support electrification, split to be defined).	TBD
	USAID	• Support for MV line and population digitization under GIS platform and development of a nationwide geospatial least-cost plan. • Gender and citizen engagement programs.	FY18–19 FY19–22
On-grid electrification	World Bank	• Investment in last mile electrification (densification and regularization) and institutional capacity under results-based financing facility. EEU connexion rollout plan.	FY18–23
	AfDB	• Investment in last mile electrification.	TBC
	USAID	• Continued capacity building for improved use of geo-spatial platform for analysis and planning. • Technical assistance to improve EEU procurement procedures, including standard bidding documents. • Technical assistance to EEU to reduce the cost of connections and time required.	FY18–22 FY18–22 FY19–22
	EIB	• Potential contribution to ELEAP2 component Connection Program and/or Network Strengthening—to be confirmed.	TBC
	AFD	• Proposed investment in urban network modernization, to be confirmed.	TBC
	DFID	• Scaling-Up Renewable Energy Programme (SREP).	FY2019
Off-grid electrification	World Bank	• Investment in pilot-scale stand-alone solar and mini-grid projects under results-based financing facility. • Credit Facility at Development Bank of Ethiopia (DBE) to provide access to financing to support off-grid SMEs (stand-alone solar and mini-grids) as well as households affordability through MFIs. • Technical assistance (World Bank and IFC Lighting Africa Program—$1.6 m from DFID funding) for off-grid based private sector market development.	FY18–23 FY19–23 FY19 (tbc)
	EU Delegation to Ethiopia	• SE4ALL Technical assistance to MoWIE/EEU for draft tender document development for minimum subsidy tenders (MSTs) and mini-grid pre-feasibility studies. • Off-grid programs to support stand-alone solar and mini-grids (implementation GIZ). • Clean cooking and biogas programs—NBPE+ (implementation SNV).	FY17–19 FY16–19 FY16–21
	AfDB	• Potential support to private investment in off-grid electrification—to be confirmed.	TBD

Support Area	Partner	Program	Timeline
Off-grid electrification	DFID	• Technical assistance for development of local entrepreneurship (Africa Enterprise Challenge Fund). • Green Minigrid Regional Facility (TA provided through WB and AfDB). • Technical assistance for affordability of off-grid technologies.	FY16–20 FY2020 TBD
	UNDP	• Off-grid programs to support stand-alone solar and clean cooking.	TBC
	GIZ	• Off-grid programs to support stand-alone solar and mini-grids for HHs, SMEs and social infrastructure—including capacity building & market development—funded by EU & EnDev. • Improved cookstoves dissemination, promotion and alternative fuel supply, including innovative financing for cookstoves (CDM)—funded by EU & EnDev. • Rural schools electrification project (funded by Norway Government & EnDev). • Korea Foundation for International Health (KOFIH): Off-grid health center solar electrification and water supply. • Irish Aid improved cookstoves, solar market development and off-grid solar electrification for social institutions, including innovative private sector financing for cookstoves (Results Based Financing, RBF).	FY 2017–2020 FY 2017–2020 FY 2017–2020 FY 2016–2019 FY 2014–2020
	USAID	• Business models for mini-grid development (Beyond the Grid study—already complete). • Technical assistance to EEA for national off-grid policies and regulations, and improved regulatory structures for micro-grid companies. • Technical assistance for off-grid companies, particularly SHS and micro-grid companies. • Technical assistance to optimize productive use appliances and equipment. • Technical assistance to investors to help mobilize more private financing for off-grid companies and projects.	FY17 FY19–22 FY19–22 FY19–22 FY19–22
	AFD	• Proposed technical assistance and capacity building to EEU for NEP implementation, to be confirmed.	FY20–23, TBC
	SIDA	• Support to SMEs in off-grid.	TBC
Electrification ecosystem development	World Bank	• Technical assistance and capacity building under NEP/NEP2.0.	FY19–21
	AfDB	• TBC.	TBC
	USAID	• Technical assistance and capacity building under NEP/NEP2.0.	TBC
	DFID	• Energy Africa (for Africa Energy Compact) demand-driven TA, covers 14 countries in Africa, but Ethiopia can bid.	2016–21

ANNEX 8

International Best Practices in Digitizing Person-to-Government and Utility Payments

Several countries around the world have achieved large efficiency gains using digital technology to facilitate payments for utilities, taxes, and other government services.[134] East Africa specifically has made rapid progress in the digitization of revenue to the government and parastatal entities, including national utilities. Much of this is through the use of mobile money, a digital technology that takes advantage of cell phone networks to facilitate payments.

Each country is creating its own model uniquely suited to the country's contexts. That said, taken as a whole, these programs are providing emerging evidence that digital payments are helping make person-to-government payments "faster, more secure, less expensive and more transparent compared to traditional means like cash."[135] Digital person-to-government payments are providing real benefits for both governments and citizens alike.

The NEP takes advantage of these digital payment trends and technologies, as described in detail in Chapter 4. Beyond electrification, McKinsey estimates the digitization of government payments could boost government income by US$110 billion over the next decade.[136] The NEP is designed to harness these benefits for the benefit of Ethiopia as a whole.

Benefits for the government of Ethiopia

In other countries, the digitization of payments has shown promise in increasing government revenues. For example, it has been estimated that digitizing tax payments could increase Tanzania's revenue by about US$477 million per year.[137]

Much of this increase in revenue will come from voluntary compliance and the ability of government services to reach more citizens. For example, Kenya's e-citizen platform has saved the country approximately US$18.2 million between 2014 and May 2016, thanks to the growth of voluntary applications by citizens to services like public driving tests and licenses.[138] These efforts have also allowed the Kenyan National Transportation Safety Authority (NTSA) to double its revenue collection between July 2015 and October 2016—from an average of US$1.1 million to US$2 million per month.[139]

Digitized payments can also help governments and utilities save money through increased efficiency. In Tanzania's capital, the Dar es Salaam Water and Sewerage Corporation believes that its collection rates have increased due to digital payments. The utility has reported an 85 percent collection efficiency, with the help of mobile money.[140]

Governments have also been able to increase transparency and visibility into those revenues using tools provided by digital payments. By reducing the movement of cash, and increasing the amount of reliable data, governments have been able to reduce the amount of petty corruption in the system.[141] The tools have also enabled utilities and governments to reconcile payments with services, improve financial planning, retrieve records, and settle disputes more quickly and easily.[142] The Kenyan government, for example, has saved about US$290 million in compliance costs over a four-year period.[143]

There is also evidence that these cost savings will not come at the expense of government jobs, but will rather create better jobs for government workers. In Tanzania, massive cost savings haven't reqsulted in mass public sector layoffs. Instead, staff have gained more modern technological skills, and the government has begun employing more skilled ICT professionals.[144]

Benefits for Ethiopian citizens

Digital payments have shown promise in saving citizens large amounts of time when paying bills. In some cases, citizens don't have to travel for long distances, or to stand in line, in order to pay their bills. The Tanzania Revenue Authority, for example, found that it has saved taxpayers hours or days of waiting. This may be one of the reasons why digital payments have increased the number of people paying taxes, and decreased the levels of tax avoidance, in Tanzania.[145]

Users have also been able to save money by paying for government services digitally. According to one study, mobile money can reduce citizen costs by more than 75 percent, including travel costs. While there are often fees associated with paying for services digitally, studies have indicated that the costs savings more than make up for the added fees.[146]

Implementation

The government understands that payment digitization for electricity cannot take place in isolation, and needs to be part of a larger strategy. As discussed in Chapter 4 and Annex 10, digital payments are part of a complex ecosystem involving technology providers, financial service providers, and government regulators. There is emerging evidence that countries require a number of different elements to set the stage for a successful program of payment digitization. These elements include:

- Strong government and private sector buy-in: Creating a strong program for government-to-person payments will require investments of time and money from the Government of Ethiopia and private sector actors, including banks and mobile network operators.
- Reliable infrastructure: There will need to be reliable mobile networks and a network of cash-in and cash-out points throughout the country. Much of this is discussed in Chapter 4.
- An enabling policy environment: The Government will consider revising laws and policies to enable greater access to digital payments.
- Indications of consumer readiness: Ultimately, the consumer will need to adopt this technology. Therefore, steps may need to be taken to stimulate customer demand, including above-the-line and below-the-line marketing programs.

Notes

134. Example countries in this document include Tanzania, Kenya, Pakistan, and others.
135. Person-to-government (P2G) payment digitization: Lessons from Kenya, GSMA, September 2017.
136. Digital Finance for All: Powering Inclusive Growth in Emerging Economies, Mckinsey Global Institute, September 2016.
137. Person-to-government payments: Lessons from Tanzania's digitization efforts, Better than Cash Alliance, September 2016.
138. State of the Industry, 2017. GSMA. 2016.
139. Person-to-government (P2G) payment digitization: Lessons from Kenya, GSMA, September 2017.
140. Global Landscape Study on Digitizing P2G Payments, Karandaaz. 2016.
141. Aaron Krolikowski, Can Mobile-Enabled Payment Methods Reduce Petty Corruption in Urban Water Provision?, Water Alternatives. 2014.
142. Person-to-government (P2G) payment digitization: Lessons from Kenya, GSMA, September 2017.
143. Global Landscape Study on Digitizing P2G Payments, Karandaaz. 2016.
144. Person-to-government (P2G) payment digitization: Lessons from Kenya, GSMA, September 2017.
145. Global Landscape Study on Digitizing P2G Payments, Karandaaz. 2016.
146. Ibid.

ANNEX 9

Potential for Lowering Capital Costs of the NEP Implementation—Introducing Low Innovative Low-Cost Designs and Practices

The adoption of low-cost network design standards and technologies will play a key role for lowering capital investments, allowing EEU to promptly scale up the pace of connections without sacrificing service quality or safety.

Cost reductions in the order of 20–30 percent are realizable through improved engineering and material selection, and by simplifying the design of low voltage networks, without compromising safety and security. The international experience of countries that has successfully and rapidly implemented nationwide electrification programs offers a variety of measures to be taken into consideration.

Table A9.1 summarizes the best practices emerging from the experience of countries that have successfully improved distribution network efficiency, such as Tunisia, Ghana, South Africa, Zambia, Mozambique, Tanzania, and Uganda, as well as Australia and New Zealand.

For the highest impact, cost reduction methods will be evaluated as part of a comprehensive approach to cost reduction, encompassing: standardization of technical features and all equipment and components used for construction of distribution systems; better procurement methods (e.g., centralization of procurement processes and bulk purchases); warehouse

Table A9.1 Overview of cost-reduction potential in distribution network design and construction

	Description	Cost Reduction Potential (percent)	Best Practices
MV grid extensions	SWER, two-wire single-phase metallic return and low-cost three-wire three-phase systems	25–40	Tunisia, South Africa, New Zealand, Australia, Brazil, Peru, Uruguay
Shield Wire System (SWS)		30–50	Ghana, Brazil, Laos
Poles	Span, length, height, and material	25–50	
LV lines	Single phase networks and voltage upgrade	15–25+	Tunisia
Consumer connections	Ready boards, suited meters	50–75	South Africa, Swaziland
Operations and maintenance		10–20	Tunisia, South Africa
Construction and operating costs	Decentralization of labor, depots; load limitations	30–50	Tunisia, South Africa

Source: World Bank, 2006.

management and quality control; reliance on locally manufactured materials (often cheaper than imported materials); and efficient construction work.

Low-cost network design and construction

To inform the specific combination of low-cost methods to be employed by EEU, particular attention will be devoted to the key low-cost methods that allow highest cost-saving returns, as have emerged from best practices:

1. Appropriate design engineering and development of a cost-cutting culture;
2. Single Wire Earth Return; and
3. Shield Wire Systems.

1. Appropriate design engineering

As noted, EEU, with the support of the DoE, MoWIE, and EEA, will adopt a holistic approach to reducing the cost of implementation of the NEP. Cost savings will be realized though looking at the entire network investments: from the MV lines taking power into the region through the transformer tap offs and LV house connections, continuing all the way through the house perimeter including metering, fuses, switches, house wiring, and demand-side management measures.

Courageous changes in network design and construction procedures and abandonment of "business-as-usual" methods will be undertaken to programmatically ramp up connections.

A key cost reduction measure to be taken into account by EEU regards network design and equipment based on local load forecast—**single phase networks, transformers, small size conductors**—to avoid establishing overdesigned distribution systems while ensuring flexibility for future upgrades. When combined with adequately manufactured, sized and located poles, this approach can save up to **50 percent** of construction cost.

As poles currently represent up to **25 percent** of EEU's total investment costs, the implementation of the NEP will entail the development of local manufacturing capacity, and preference will be given to the procurement of locally manufactured equipment, when possible. Furthermore, to achieve cost reduction of **30–50 percent** in construction and operating expenses, strategic location of poles manufacturing facilities will be taken into account, as well as production processes allowing for "mobile factories" that are easily dismantled and relocated to follow the progress of construction as the network spreads out farther.

A third key measure to save costs up to **75 percent** entails the deployment of **ready boards,** which can provide cost savings for poorest customers and a key solution for premises that would normally not be approved for electrical installations. Ready boards do not require fixed wiring needs to be provided in the household premises nor seek inspection, and will incorporate a meter.[147]

2. Single wire earth return (SWER)

Single Wire Earth Return provides up to **40 percent** reduction in costs compared to three-phase configurations and roughly **50 percent** of an equivalent 2-wire single-phase to remote areas at low cost. They constitute a potential key cost reduction component as their design is simple, easy to be constructed,[148] provides reliable services with low maintenance costs, and has no issues for household uses[149] (e.g., refrigerators, color televisions) or small motors (e.g., electric pumps, manual tools). SWER is used to convey power up to 100 km from the source along the line and for 20 km on each side of the line for use by rural communities.

Alternatively, and/or in combination with SWER, a single-phase network with neutral conductor can provide savings of **30–50 percent** compared to three-phase standards. It carries higher loads than the SWER-based systems and can easily be upgraded.

Figure A9.1 SWER in New Zealand

3. Shield wire system (SWS)

Shield Wire Systems can reduce cost by **30–50 percent**[150] when serving remote towns. An SWS uses the existing shield wires on the top of the transmission lines as power conductors as well as shield wires.

Box A9.1 EEA Draft Energy Efficiency Standards and Labeling Guideline

Energy efficiency and conservation are part of the Growth and Transformation Plans I and II, the 2013 Energy Policy, and Ethiopia's Climate Resilient Green Economy Strategy. The GoE is committed to raising the efficiency of the energy sector and developing the necessary institutional and manpower capabilities by introducing appropriate incentive measures. It is currently evaluating several energy efficiency measures to be developed with a national program, such as: CFL scale-up, loans for customers buying energy efficient appliances, energy audits for industries and commercial centers, voluntary agreements on energy efficiency with industries and the public sector, establishment of an energy saving fund for subsidies, grants, rebates for energy efficiency projects, tax breaks, and energy efficiency advice centers.

In 2015, the Government issued the Draft Energy Efficiency Standards and Labeling Guideline as a milestone laying the foundation for the launching of an Energy Efficiency Labeling and Standards Program aimed at reducing capital investments in the electricity supply infrastructure.

In the industrial sector, in particular, demand is growing at a pace that will lead demand to exceed supply, unless proper measures are put in place. The Government, being the sole supplier of electrical energy, is striving to make sure that new power plants enter the system as fast as possible to mitigate the possible power deficit and is tackling, among other things, inefficient consumer appliances.

Shield Wire Systems address the issue of serving remote towns from high-voltage grids through existing shield wires on the top of the transmission lines as power conductors as well as shield wires.[151]

The implementation of Energy Efficiency Standards and Labeling programs targets the energy efficiency of selected consumer appliances, chosen according to their energy consumption, to reduce capital investment required for the development of power supply infrastructure. Guidelines currently cover the biggest energy consuming appliances, such as injera baking ovens, refrigerators and freezers, and electric motors.

Reducing cost of electricity consumption

The implementation of the NEP will also entail looking at decreasing the cost of electricity consumption to reduce customers' bills, as well as to improve the balance between electricity supply and demand to increase the outreach of new connections.

Notes

147. With ready boards, the expensive circuit breaker and its housing may be replaced by a fuse or even a piece of fuse wire, and the cable to the house should be an aerial conductor of flat twin and earth construction (dumbbell) cable.
148. Smaller lengths of conductor and fewer pole top assemblies are required, as fewer poles are needed between conductors before being limited by clearances.
149. Adaptations and conversions will have to be made to serve large motor (above 7.5 horsepower), agro-industrial, and deep borehole irrigation loads.
150. In some cases, cost savings have been 85 percent. For more information, see: World Bank. 2006. Sub-Saharan Africa: Introducing Low-cost Methods in Electricity Distribution Networks, ESMAP Technical Paper 104/06, Washington D.C.
151. The shield wires are insulated using standard insulators, and optical ground wires may also be used so that there is no restriction on using the shield wires for communication. For more information, see: World Bank. 2006. Sub-Saharan Africa: Introducing Low-cost Methods in Electricity Distribution Networks, ESMAP Technical Paper 104/06, Washington D.C.

ANNEX 10

Mobile Money and PAYGo Systems

In recent years, two factors have emerged as key enablers for off-grid electrification in East Africa: Mobile money and PAYGo technology. These two operational, technological, and business model innovations are responsible for an upsurge in electrification rates in Kenya, Tanzania, Uganda, and other places around the world. The NEP will harness the opportunities offered by mobile money and PAYGo to create universal electrification in Ethiopia.

What is mobile money?

Around the world, 690 million people have registered to use mobile money,[152] a system of digital payments that uses mobile phones to connect users with financial service providers. Some 338 million users are in Sub-Saharan Africa, with 56.4 percent of those in East Africa. The number of East African users continues to grow at 13.6 percent per year.[153]

Mobile network operators are the cornerstone of the mobile money industry. Users need mobile network connections to use mobile money, and many use the Unstructured Supplementary Service Data (USSD) channel—the codes like *123# that are sometimes referred to as "Quick Codes"— to communicate with mobile money systems.

Banks, MFIs, and financial technology providers have also used mobile money to offer more advanced financial services. Financial institutions have used mobile money to offer loans, insurance, savings, and other products that deepen financial inclusion.[154] The greater participation in financial institutions can strengthen financial institutions, improve savings, and help reduce poverty.[155] Mobile money has also enabled PAYGo operators to grow their businesses and increase electrification.

What is PAYGo?

'Pay-as-you-go' or PAYGo is a metering and finance technology that enables customers to pay for solar lights and home systems over time, rather than paying the entire cost up front. Customers pay a deposit, typically 10–20 percent of the cost of ownership, and commit to making ongoing payments by signing a lease with a solar operator.[156] The lower up-front cost enables customers to access higher-value solar systems, delivering higher levels of electricity service, than they would otherwise be able to afford. Companies are able to significantly reduce the risk of customer default using technology that allows them to deactivate products if customers do not make repayments. More than 40,000 PAYGo solar units are installed every month, and the PAYGo model is already responsible for a significant expansion of electrification.[157]

Mobile money is a key enabler of PAYGo technology. Without mobile money, PAYGo companies would have to build their own cash management infrastructure, and customers would be forced to travel to centralized payment points.[158] By using mobile money, PAYGo companies can avoid the use of cash, dramatically reducing transaction costs and improving the safety and security of transactions. And, the instant notifications and flexible financing provided by mobile money give off-grid customers more control over when and how they pay for energy. By one estimate, financial innovation has made electricity up to 65 percent more affordable than before.[159]

How do countries scale mobile money?

There are currently more than 270 mobile money deployments in 90 countries around the world.[160] Some of these deployments have scaled to a

significant number of people; many have not. International best practices have emerged on how successful mobile money deployments have scaled. These include:

- Expand the cash-in/cash-out network
- Create a compelling product offering
- Maintain corporate commitment
- Create a conducive policy environment

Any digital payment network needs an efficient, low-cost, and convenient way of putting value into the system and taking value out. For mobile money deployments, this means creating a network of agents around the country that can provide cash-in/cash-out (CI/CO) services.

Building a CI/CO network can be expensive and difficult. Digital payment networks need to find, recruit, and manage the agent networks. The cost of managing the CI/CO network can be more than half of the total revenue of the system.[161] One of the most successful ways to grow the CI/CO network is to allow non-bank actors to participate. Telecommunications companies, for example, have large networks of airtime resellers, which can be converted into mobile money agents. There are currently fewer than 15,000 bank and MFI branches and agents in Ethiopia, while there are more than 100,000 airtime resellers in the country.

Other countries have created regulatory environments that allow telecommunication networks to facilitate cash-in and cash-out transactions for mobile money. Kenya, Tanzania, and Uganda have different regulatory regimes, but telecommunication networks in all three countries provide cash-in and cash-out services. As shown in Figure A10.1, the result has been a rapid increase in the number of people in the country with a financial account.

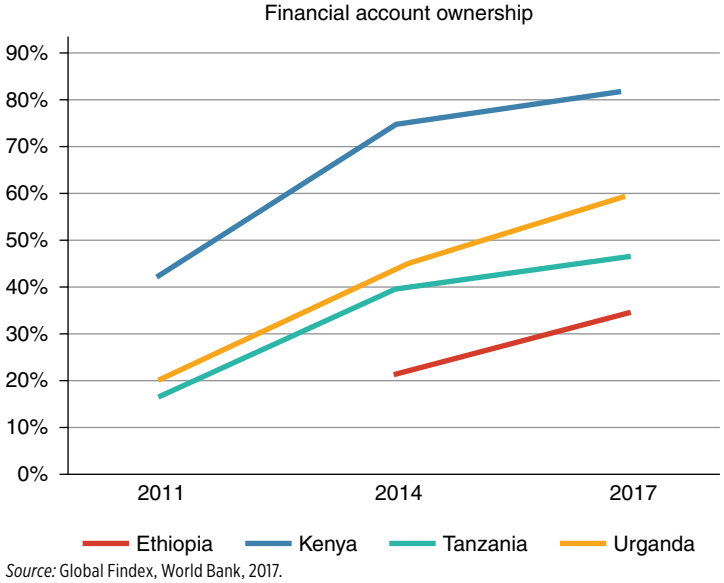
Ethiopian regulations currently prevent telecommunication providers from participating in the CI/CO networks, as agents must be affiliated with a bank or MFI.[162]

Create a compelling product offering

Digital payment networks need a strong, immediately recognizable product offering that will compel potential customers to use the service. In Kenya, the marketing of "Send Money Home" created an immediate reason for people to begin using the M-Pesa internal remittance product.[163]

The NEP creates an opportunity for mobile money providers to create a compelling offering around payments for solar electricity. By some estimates, 30–50 percent of PAYGo solar users are entirely new to mobile money.[164] Digital payments for on-grid electricity could also allow users to "skip the line" and pay from their phones, rather than stand in line to pay their utility bills. As Ethiopia moves toward universal electrification, digital payment providers will be able to expand their customer base to more users, while electricity providers can benefit from improved efficiency in payments and cash management.

Figure A10.1 Effects of telecom support on mobile payments expansion



Source: Global Findex, World Bank, 2017.

Maintain corporate commitment

Digital payment companies need to invest significant resources into building and growing their businesses. Whether banks or mobile networks are trying to launch digital payments, the parties involved need to invest money up front for an uncertain future return. Often this means investing in agent networks, staffing, technology, and marketing before the revenue begins to cover the costs.

Hence, corporate entities need to make a strong, long-term commitment to building digital payments before the network launches. The GSMA estimates that it can take four to five years for mobile money networks to begin making modest, positive net margins. However, the same study found that the capital expenditures and operating expenditures can be worth the costs.[165]

Create a conducive policy environment

Government regulation can help or hurt the scaling of digital payments. According to studies, "Mobile money services without enabling regulation have activity rates 30 percent lower on average than those with an enabling regulatory environment."[166] Different countries have developed different regulatory regimes governing the use of digital payments, mobile money, and financial services more generally. These regulations could include the use of non-bank actors, like mobile network operators, in the payment system.

As mentioned in Chapter 4, the Government of Ethiopia will work together with relevant stakeholders to examine the policy environment for digital payments.

How Ethiopia can use PAYGo and mobile money to scale electrification

There are a number of banks and other digital providers working to scale mobile payments in Ethiopia. Chapter 4 of the National Electrification Program details some of the technical assistance and program assistance being provided to advance the use of digital payments for electricity inside of Ethiopia. Synergies will be pursued between banks, Ethio Telecom, the private sector, electricity providers, and relevant stakeholders within the government. At the same time, the Government is improving the cash payment system to ensure that all modes of payment are explored, and no one is left behind.

Notes

152. 2017 State of the Industry Report on Mobile Money, GSMA. 2018.
153. Ibid.
154. Max Mattern and Claudia McKay, Building Inclusive Payment Ecosystems in Tanzania and Ghana, CGAP, June 2018.
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159. Jacob Winiecki, Financial Innovation and Solar Power: Conquering Energy Poverty, CGAP, May 2015.
160. 2017 State of the Industry Report on Mobile Money, GSMA. 2018.
161. 2017 State of the Industry Report on Mobile Money, GSMA. 2018.
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163. Ignacio Mas and Dan Radcliffe, Mobile Payments go Viral: M-PESA in Kenya, Bill & Melinda Gates Foundation, March 2010.
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165. Mireya Almazán and Nicolas Vonthron, Mobile Money Profitability: A Digital Ecosystem to Drive Healthy Margins, November 2014.
166. 2017 State of the Industry Report on Mobile Money, GSMA. 2018.

ANNEX 11

Achieving Gender Equality and Engaging Citizens in the Off-Grid Space

Thus far, the focus on off-grid has been focused on tackling gender gaps in access to finance and entrepreneurship in the DBE Market Development for Renewable Energy and Energy Efficient Product Credit Line (US$45 million). In 2016, 28.6 percent of loans were accessed by female applicants through MFIs which increased to 35 percent by June 2017, indicating that the gap is closing. During 2017, in-depth consultations took place with MFIs to understand their challenges in reaching female consumers. This year, women's business associations and female entrepreneurs have been engaged on the opportunities available in the off-grid sector together with the IFC and the Ethiopia Climate Innovation Center (ECIC). Summary of key engagements include:

- **Dialogue and capacity building on access to finance:** The World Bank and DBE hosted a workshop on 14 February 2017 to discuss gender gaps in the energy sector associated with the DBE Credit Line. The focus was to better understand challenges faced by MFIs in reaching women consumers and entrepreneurs with credit products for off-grid technologies, and to identify areas for technical assistance and/or greater coordination with other technical partners and resources under the project (in the areas of product developing, marketing, staff training, client capabilities) to address these challenges.
- **Advertising and pitching credit line:** Currently there is low engagement among female entrepreneurs under the DBE Credit Line. Various women's business associations and women's banking products exist in Ethiopia. In January 2018 an information session with 40 participants including key DBE staff and various women's business association, e.g., Association of Women in Business/ WEDP clients together with IFC and the Ethiopia Climate Innovation Center (ECIC). Over the past months, four female entrepreneurs have come forward to apply for a total of US$1.5 million of funding to import off-grid technologies, from a baseline of only nine male headed entrepreneurs accessing finance.
- **Training expanding access to women's financial services:** As part of the technical assistance for MFIs under the DBE Credit Line a specific module focused on reaching more women with financing solutions has been delivered in January 2019 to all MFIs actively engaged in consumer finance aspects in off-grid. The training focused on the business case for reaching women, case studies globally on what works, and designing new approaches that focus on women as target market segment.

Outlined below is a matrix of entry points on gender across the off-grid market mapped out across the value chain from market assessment to HR issues. Key considerations in the Ethiopian context are outlined across the business challenge, the specific gender gaps in country, and the possible interventions and outcomes.

Table A.11.1 Gender entry points in the off-grid space

	Market Assessment of Products and Services	Access to Credit	Marketing	Sales and Distribution	Human Resources
Business challenge	• Gain information about customer segments, customer needs and demands, and competition in new and existing market locations	• Constrained access to credit for businesses and consumers • Limited experience of financial institutions with credit provision for off-grid technologies	• Create market and consumer awareness that reaches specific customer segments, e.g., deep rural or women • Determine the marketing methods that work best to reach diverse customer segments • Identify quality partners that can provide quality practices and sustainable services in areas needed	• Increase the efficiency of sales strategy • Increase market share	• Limited labor force in new market • High recruitment costs and access to right talent • Lack of HR policies and practices
Gender gaps to consider	• Lack of sex-disaggregated information about the women's segment or product demand, which can lead to missed segment and missed opportunity	• Women face unique barriers in accessing finance for productive and consumption purposes such as poor product design, low financial literacy, and additional sociocultural normative barriers • Limited tailored products and services (savings, loans, and skills training) to meet the needs of different segments of women in the market	• Limited use messaging that draws from knowledge about women's preferences and needs, and other factors such as literacy levels, etc. • There is a need for a concerted consumer awareness and demand creation effort if the use of off-grid technologies is to be scaled up. This cannot be done by MFI's or suppliers alone. In Ethiopia, over 240,000 people are part of facilitated Savings Groups (SG) that were created by NGO's such as CARE, World Vision, Mercy Corps, Plan, etc., and approximately 60% of the members are women. • Women led business and groups may have limited information and awareness on market opportunities	• Women and male sales staff may face different challenges conducting sales, e.g., mobility, time, safety, etc.) • Selling to women and men may require different strategies depending on the context	• Informal HR policies and management can particularly impact women • Skills gaps and different access to information to new job opportunities between women and men • Cultural beliefs or norms in off-grid sector that limit ability to access and retain talent • Missed opportunity to hire and retain talented women due to lack of policies and programmes tailored to the needs of women employees

Table A11.1 Continued

	Market Assessment of Products and Services	Access to Credit	Marketing	Sales and Distribution	Human Resources
Interventions	• In-depth market segmentation exercise to understand and identify issues around women's product preferences, their affordability constraints, etc. Using tools such as customer journeys and rapid prototyping, potential solutions can be tested.	• Drawing on the results of market segmentation and landscape review, identify potential asset financing models (micro-consignment, leasing, etc.), partnerships (with PSEs), and business models that can increase access to off-grid energy products for women • The use of digital payments can further reduce access barriers for women. In the key activities related to digital payments under the NEP, attention will be paid to ensure that the women's segment is not left behind in access to energy services, digital payments, and other financial services, such as bank accounts that would possible be linked. • Key will also be exploring synergies between diverse off-grid technologies, e.g., stoves (which are typically used by women in Ethiopia) and modern off-grid lighting • Interventions could include setting up an entrepreneurship incubator that helps identify new and early stage entrepreneurs and helps them develop their business ideas for investment. The incubator will provide a space for budding entrepreneurs to network with investors and technical experts, and fill knowledge and skill gaps. Once they refine business plans and business models, they seek funding from DBE or other sources.	• There is an opportunity to partner with SG promoting organization to create awareness about off-grid energy products, the financing options that are available in their area—whether through MFIs or direct links to PSEs, as well as consumer rights and recourse mechanism. The groups can also be means of increasing affordability of the products, as members could use their savings as a down payment for the products. Several MFIs do provide financial literacy training and adding modules related to financing household assets can be added. • The use of off-grid and energy efficient solution requires consumer behavior change • Several actors working on the promotion Clean Cookstoves have focused on developing behavior change communication tools and materials that support demand creation. These include printed materials, radio programs, role plays and demonstrations, as well as television programs. Similar behavior change communication tools, especially radio, can be useful in creating mass awareness and demand.	• Design measures to overcome sales process for female agents, e.g., provide transport or focus strategy on last mile community sales • Conduct gender analysis of sales agent performance • Possibly provide supplemental start-up grant or capital for sales agents • Beyond product design and business models, MFIs also face institutional capacity challenges in working with women clients. This includes low staff capacity and gender awareness and systems that are not designed to focus on serving women clients. In order to ensure that women clients are a business priority, addressing these institutional challenges is essential. • Undertaking gender audits to understand current diversity and inclusion at institutions (e.g., most loan officers are men) can make them aware of the areas for improvement, which can then be addressed through the provision of technical assistance	• In addition to supporting women entrepreneurs at the wholesaler and distributor level, all manufacturers and distributors will be encouraged to employ women in the last mile delivery of the products in rural areas. Technical assistance will be made available to enable manufacturers and distributors to get guidance in terms of HR, recruitment strategies, and training women to become employed as, e.g., sales agents. • Having women sales agents and local suppliers will create opportunities for women buyers to feel more comfortable interacting with them • A list of possible enterprises will be drawn up to aid the partnership between enterprises and the off-grid value chains, and manufacturers and distributors nationally.

(continues)

	Market Assessment of Products and Services	Access to Credit	Marketing	Sales and Distribution	Human Resources
Interventions		• There is a lack of awareness among entrepreneurs about the credit line and collateral support. Partnering with networks such as the Ethiopian Chamber of Commerce, Alliance of Women Enterprise Program (AWEP), and Association of Women in Business (AWiB) is key to creating awareness about the credit line among women entrepreneurs. At the institutional level, advisory service will be provided to the DBE team to help them develop better processes for assessing credit worthiness of women entrepreneurs and potentially revising the requirements to ensure women entrepreneurs can access and use the credit.			
Expected impact	• Findings will lead to strategies that will effectively reach women better by addressing their specific needs, i.e., identifying the products in most demand, understanding how much they can afford to pay, identifying any technical training needs, etc. through proper design features	• Enhanced market share at consumer level • Increased share of female-led enterprises in off-grid market and possible enhanced last-mile customer base	• Increased customer engagement leading to increased sales and enhanced consumer confidence in off-grid products • Cost savings from customer care time per customer • Enhanced after-sales services, e.g., systems better maintained—diversifying the supply chain can reduce risks/increase opportunities across the value-chain and increase opportunities for women	• Increased sales to wider or more targeted customer base • Adapted sales strategy based on feedback from consumers (both women and men)	• Increased rates of employee satisfaction and retention • Cost savings in recruitment • Enhanced talent pool in off-grid and job growth

ANNEX 12

Geo-Spatial–Aided Positioning and Costing of Social Institution Connections

The NEP has harnessed the power of geo-spatial positioning data to achieve an estimate of the spatial distribution of connections at a degree of geographical precision never before attempted in integrated energy planning exercises around the world. Geo-spatial data are woven into the fabric of the entire program, from the grid rollout plan to the off-grid investment prospectus and subsidy scheme to, crucially, the segmentation and costings of the social institutions connections program. The NEP targets an aggressive program of connections that prioritize education and facilities for accelerated access. This section outlines the methodology employed to segment the access challenge by geographical location and presents the data outputs at the regional level for schools, and at the national level for health facilities with sufficient data.

Purpose and scope

An understanding of the country-wide spatial distribution of health and education facilities with respect to grid infrastructure is an important step toward progressively tighter planning and budgeting needs of the social institution connections program. Geo-spatial data are pivotal in this sense, and if quality is sufficiently high, it can completely revolutionize the cost-effectiveness of connections rollout strategies, both on- and off-grid. With this ultimate goal, an initial segmentation analysis of social institutions was carried out for the NEP. Due to data limitations, not all types of social institutions fall within the scope of this analysis.

From a comparison of the ministerial data on facility numbers and the facilities documented in geo-spatial data, an estimate of geo-spatial data coverage of the actual number of facilities was drawn. Geo-spatial data on primary and secondary schools were available with acceptable coverage (59 percent and 35 percent of facilities, respectively), and on hospitals (54 percent) and health centers (76 percent) showed relatively good coverage. These four facility types fall within the scope of the analysis.

Data assembly

The analysis interacts with three main sets of data: geo-referenced data on facility locations, by type and region; administrative data on facility numbers, by type and region (where available); and survey data on access rates of facilities by type and region. Geo-referencing data from the Universal Energy Access Program and Vital Wave's Ethiopia Master Facility Registry, respectively, for schools and health facilities was used to pinpoint the location of the country's social institutions in scope. Geo-referenced data for the country's medium voltage (MV) grid infrastructure were then overlaid in order to assign facilities to nine "distance zones" that segmented facilities according to their distance from the grid. Health facilities location data covered hospitals and health centers but not health posts. School data covered both primary and secondary schools, which are the priority targets among educational institutions for the connections program.

Data on the number of primary and secondary schools by region was gathered from the Ethiopian Ministry of Education's Education Statistics Annual Abstract 2008 E.C. (2015/16). The latest available data on the number of health centers and hospitals in

the country were taken from the Ministry of Health (MoH) and the Ethiopian Public Health Institute's (EPHI) Service Availability and Readiness Assessment (SARA) of 2018, and the MoH, EPHI, and ICF international Ethiopia Service Provision Assessment Plus—Census 2014.

Data on institutions' access to electricity were gathered from the latest available Government reports in the education and health sectors at the highest level of geographic differentiation available. Access data for health facilities were taken from the SARA report of 2018. Access data by facility type were only available at the national level, which has limited the scope of the analysis to the national level. Access data for education facilities at the regional level were taken from the Ministry of Education's Education Statistics Annual Abstract 2008 E.C. (2015/16).

Analytical approach

A comparison of the geo-spatial data with the administrative data on the number of facilities by type revealed the geo-spatial estimates to consistently underestimate the actual total number of facilities. The proportional distribution of facilities by distance was thus lifted from the geo-spatial data and applied to the ministries' data on health and education facilities, by type.

The geo-referencing of education and health facilities for the country is not comprehensive, and is lower than the numbers officially reported by the Ministries of Health and Education. While the NEP provides for an earmarked TA study to complete the geo-referencing and assess electricity needs, as well as the current adequacy and reliability of services provided to those with access, a further analysis was conducted to inform the sizing of the grid and off-grid programs for social institutions.

When a discrepancy was found in the number of social institutions (hence preventing the location of the additional ones reported by the Ministries of Health and Education), the total number of facilities with access (whether or not grid-connected) was computed proportionally to the known located access rates, starting from the closest "distance zone" and moving to the more distant zones until the total number of facilities with access was reached. This center-to-periphery access attribution approach assumes that the closer the facilities are to MV lines, the more likely they are to have access. In addition, EEU has already integrated annual targets for social institutions within their rollout plans to ensure primary grid connectivity to these important facilities providing basic needs.

This approach is conservative in that it is possible that a number of facilities located at a relatively far distance from the grid may already have access and therefore, it tends to underestimate the number of facilities near the grid requiring a connection. Conversely, the number of those farther from the grid may be overestimated. Inasmuch as facilities farther from the grid are likely to cost more per connection, this will tend to generate an overestimation of the costs and the challenges of rolling out the plan, helping to ensure that the NEP is scoped at the right scale while awaiting further information.

Table A12.1 Share of all primary and secondary schools that do not have access to electricity, by distance from the MV grid and by region, 2018

	Region	Distance	Primary	Secondary	Region	Distance	Primary	Secondary
Grid extension	***Nationwide***	< 1 km	9.1%	0.2%	*Amhara*	< 1 km	None	18.9%
	Nationwide	1–2.5 km	13.3%	6.0%	*Amhara*	1–2.5 km	13.7%	3.0%
Pre-electrification	***Nationwide***	2.5–5 km	21.0%	7.6%	*Amhara*	2.5–5 km	23.1%	2.3%
	Nationwide	5–10 km	17.9%	10.1%	*Amhara*	5–10 km	19.7%	1.6%
	Nationwide	10–25 km	10.2%	3.2%	*Amhara*	10–25 km	9.8%	0.7%
Long-term off-grid	***Nationwide***	25–50 km	2.2%	1.3%	*Amhara*	25–50 km	1.1%	0.9%
	Nationwide	50–100 km	0.8%	0.7%	*Amhara*	50–100 km	None	None
	Nationwide	100–200 km	0.5%	0.2%	*Amhara*	100–200 km	None	None
	Nationwide	> 200 km	1.0%	0.6%	*Amhara*	> 200 km	None	None
All unconnected			**76.0%**	**30.0%**			**67.5%**	**27.5%**
Grid extension	*Addis Ababa*	< 1 km	0.0%	0.0%	*Benishangul-Gumuz*	< 1 km	None	13.2%
	Addis Ababa	1–2.5 km	0.0%	0.0%	*Benishangul-Gumuz*	1–2.5 km	7.2%	5.9%
Pre-electrification	*Addis Ababa*	2.5–5 km	0.0%	0.0%	*Benishangul-Gumuz*	2.5–5 km	11.7%	16.2%
	Addis Ababa	5–10 km	0.0%	0.0%	*Benishangul-Gumuz*	5–10 km	8.6%	None
	Addis Ababa	10–25 km	3.0%	5.5%	*Benishangul-Gumuz*	10–25 km	19.3%	5.9%
Long-term off-grid	*Addis Ababa*	25–50 km	None	None	*Benishangul-Gumuz*	25–50 km	7.2%	5.9%
	Addis Ababa	50–100 km	None	None	*Benishangul-Gumuz*	50–100 km	0.5%	None
	Addis Ababa	100–200 km	None	None	*Benishangul-Gumuz*	100–200 km	None	None
	Addis Ababa	> 200 km	None	None	*Benishangul-Gumuz*	> 200 km	None	None
All unconnected			**3.0%**	**5.5%**			**54.5%**	**47.1%**
Grid extension	*Amhara*	< 1 km	15.5%	18.9%	*Dire Dawa*	< 1 km	None	0.0%
	Amhara	1–2.5 km	13.7%	3.0%	*Dire Dawa*	1–2.5 km	0.0%	0.0%
Pre-electrification	*Amhara*	2.5–5 km	23.1%	2.3%	*Dire Dawa*	2.5–5 km	1.8%	4.8%
	Amhara	5–10 km	19.7%	1.6%	*Dire Dawa*	5–10 km	13.3%	4.8%
	Amhara	10–25 km	9.8%	0.7%	*Dire Dawa*	10–25 km	8.0%	None
Long-term off-grid	*Amhara*	25–50 km	1.1%	0.9%	*Dire Dawa*	25–50 km	None	None
	Amhara	50–100 km	None	None	*Dire Dawa*	50–100 km	None	None
	Amhara	100–200 km	None	None	*Dire Dawa*	100–200 km	None	None
	Amhara	> 200 km	None	None	*Dire Dawa*	> 200 km	None	None
All unconnected			**83.0%**	**27.5%**			**23.0%**	**9.5%**

Table A12.1 Continued

	Region	Distance	Primary	Secondary	Region	Distance	Primary	Secondary
Grid extension	*Gambella*	< 1 km	None	66.0%	*SNNP*	< 1 km	None	5.4%
	Gambella	1–2.5 km	9.4%	None	*SNNP*	1–2.5 km	16.0%	12.6%
Pre-electrification	*Gambella*	2.5–5 km	9.4%	None	*SNNP*	2.5–5 km	15.9%	9.9%
	Gambella	5–10 km	9.8%	None	*SNNP*	5–10 km	10.4%	7.1%
	Gambella	10–25 km	16.7%	None	*SNNP*	10–25 km	6.0%	4.3%
Long-term off-grid	*Gambella*	25–50 km	15.3%	11.3%	*SNNP*	25–50 km	3.1%	2.8%
	Gambella	50–100 km	1.7%	None	*SNNP*	50–100 km	0.2%	None
	Gambella	100–200 km	None	None	*SNNP*	100–200 km	None	None
	Gambella	> 200 km	None	None	*SNNP*	> 200 km	None	None
All unconnected			**62.4%**	**77.4%**			**51.6%**	**42.1%**
Grid extension	*Harari*	< 1 km	None	0.0%	*Somali*	< 1 km	None	0.0%
	Harari	1–2.5 km	9.2%	None	*Somali*	1–2.5 km	0.0%	0.0%
Pre-electrification	*Harari*	2.5–5 km	None	None	*Somali*	2.5–5 km	0.0%	None
	Harari	5–10 km	None	None	*Somali*	5–10 km	0.0%	None
	Harari	10–25 km	None	None	*Somali*	10–25 km	6.5%	0.0%
Long-term off-grid	*Harari*	25–50 km	None	None	*Somali*	25–50 km	9.3%	None
	Harari	50–100 km	None	None	*Somali*	50–100 km	12.9%	23.4%
	Harari	100–200 km	None	None	*Somali*	100–200 km	18.5%	8.9%
	Harari	> 200 km	None	None	*Somali*	> 200 km	34.9%	31.5%
All unconnected			**9.2%**	**0.0%**			**82.1%**	**63.7%**
Grid extension	*Oromia*	< 1 km	None	5.9%	*Tigray*	< 1 km	None	0.0%
	Oromia	1–2.5 km	13.7%	3.5%	*Tigray*	1–2.5 km	14.7%	0.0%
Pre-electrification	*Oromia*	2.5–5 km	21.8%	4.9%	*Tigray*	2.5–5 km	21.3%	0.0%
	Oromia	5–10 km	18.6%	5.9%	*Tigray*	5–10 km	11.2%	0.0%
	Oromia	10–25 km	11.3%	4.6%	*Tigray*	10–25 km	5.5%	0.0%
Long-term off-grid	*Oromia*	25–50 km	2.2%	1.1%	*Tigray*	25–50 km	0.5%	0.5%
	Oromia	50–100 km	0.8%	None	*Tigray*	50–100 km	None	None
	Oromia	100–200 km	0.0%	None	*Tigray*	100–200 km	None	None
	Oromia	> 200 km	None	None	*Tigray*	> 200 km	None	None
All unconnected			**68.5%**	**25.9%**			**53.3%**	**0.5%**

Source: Ministry of Health (MoH) and the Ethiopian Public Health Institute's (EPHI) Service Availability and Readiness Assessment (SARA 2018); MoH, EPHI and ICF International's Ethiopia Service Provision Assessment Plus; USAID; geo-referenced information available.

Table A12.2 Share of all hospitals and health centers that do not have access to electricity, by distance from the MV grid

	Region	Distance	Health Centers	Hospitals
Grid extension	Nationwide	< 1 km	36.1%	14.5%
	Nationwide	1–2.5 km	2.8%	2.0%
Pre-electrification	Nationwide	2.5–5 km	6.4%	3.6%
	Nationwide	5–10 km	14.6%	3.6%
	Nationwide	10–25 km	9.4%	5.9%
Long-term off-grid	Nationwide	25–50 km	1.9%	0.0%
	Nationwide	50–100 km	0.8%	0.0%
	Nationwide	100–200 km	0.1%	0.0%
	Nationwide	> 200 km	0.0%	0.0%
All unconnected			**72.0%**	**29.7%**

Source: Ministry of Health (MoH) and the Ethiopian Public Health Institute's (EPHI) Service Availability and Readiness Assessment (SARA 2018); MoH, EPHI and ICF International's Ethiopia Service Provision Assessment Plus; USAID; geo-referenced information available.

ANNEX 13

Productive Uses of Photovoltaics

Productive uses of electricity are applications of electrical power to the production of goods or the provision of services in any sector, whether agriculture, industry, or tertiary, typically through the use of one or more appliances or machines. These can be differentiated from 'consumptive use' (i.e., the use of energy services such as household lighting, cooking, and private entertainment), and the use of energy for 'community services' (such as health and education). The energy for productive uses can either be sourced from the grid, from off-grid, or from mini-grid power generation. A major prerequisite for productive activities to rely on grid power is the reliability and the quality of available power, as frequent outages disrupt business activities, while unstable voltages deteriorate appliances. In the case of off-grid and mini-grid generation, availability of sufficient power to keep the appliances running during business hours can also represent a constraint, as storage or availability of fuel are often biting constraints in the remote, rural areas where these power sources are prevalent.

The NEP off-grid program aims to enable a wide variety of productive use applications of energy using solar PV, both in stand-alone systems and where greater power is required, but the extension of the grid is still not viable, using solar mini-grids. Several stand-alone solar PV systems certified under Lighting Global and approved for import finance and importation under the Market Development Credit Line in the NEP program have a peak power in excess of 40 W, up to 100 W, and are thus capable of powering a variety of small-scale productive use applications, including freezers, small-scale egg incubators, and shallow pumping applications. Solar-powered pumps for irrigation are already imported tariff free into Ethiopia and are gaining popularity.

Solar PV systems typically generate direct current (DC) and can store it in batteries. This is in contrast with grid power which is generally in alternating current (AC). There are scale and efficiency advantages in generating and transmitting AC over the grid which have made AC the delivery model of choice for grid systems worldwide and preferred over DC. It is easy to step up AC to high voltages which reduces losses in long distance transmission, allowing for large distant power plants to power a distributed system of customers, where voltages are stepped down to useable levels.

However, an AC grid also has a number of disadvantages, particularly in terms of equipment costs. Inverters are required to convert AC power back to DC for DC-powered appliances. An AC grid must be synchronized, i.e., "alternate" the current according to the same technical parameters. Systems to maintain grid synchronization are costly, as are transformers used to step up and step down voltage. Many popular pieces of electronic equipment, including LED lighting and entertainment and media, like phones and TVs, run on DC and use an AC adapter when connected to the grid.

Especially for solar-based isolated grids or stand-alone systems, a DC system has some advantages. Due to the high concentration of these sorts of customers, these advantages can outweigh the advantages of AC in lowering transmission losses and enabling scaled and remote generation. In comparing AC and DC systems, Lasch and Groh identified some key advantages of DC.[167] On a DC grid no frequency synchronization is necessary, which results in greater reliability and flexibility. Low loads are not a problem for DC systems, which can even operate at very low loads, e.g., a single light, for several hours without

significant losses, whereas AC systems see relatively high losses in generators and inverters under low load conditions. A DC system has no inductive or capacitive losses or costs of conversion between DC and AC. DC distribution is simpler to manage and design, and generally safer, which are two significant advantages in developing country contexts.

Solar-PV compatible productive uses and appliances

DC appliances can combine high efficiency with a robust and simple design, which makes them easier to maintain and repair. Drawing extensively on a GIZ publication,[168] Tables A13.1 and A13.2 present a few examples demonstrating costs and feature a raft of different appliances suitable or specifically designed for operating on a (appropriately sized) DC mini-grid or stand-alone system. This serves to illustrate the variety of different productive uses that the NEP aims to promote in the off-grid space.

Table A13.1 Examples of productive uses

Productive activity	Specific Appliance
Lifestock breeding	Poultry incubators, milking machines
Food production	Water pumping
Food processing	Grain mills, husker, polisher
Food storage	Cooling
Food for sale	Kettles, buttermaker, coffeemaker
Tailoring	Sewing machines, weaving loom
Workshop tools	Cordless power tools
Media and entertainment	IT, secretarial services, cinema, etc.
Energy services	Charging mobile phones and battery, DC/DC converter, DC-kWh meter, etc.
Haircutting and other services	Haircutter, hairdryer, washing machines

Source: GIZ. 2015. Photovoltaics for Productive Use Applications.

Table A13.2 Examples of PV appliances

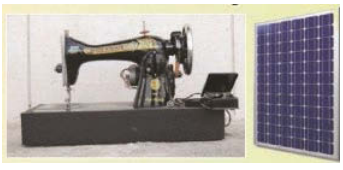
Product Name	Product Image	Product Type	Load (W)	Solar Panel Capacity (W)	Price (US$)
Egg incubator WQ-42 Engokho		Egg incubator	80	120	280
Solar Milking Machine Lifeway Solar		Milking machine	250	N/A	1,060

Table A13.2 Continued

Product Name	Product Image	Product Type	Load (W)	Solar Panel Capacity (W)	Price (US$)
Adjustable Solar Electric Fence Controller Thunderbold		Solar fence	1.3	N/A	70
Submersible Irrigation Systems ONergy		Pump	0.45–22	0.9–64	N/A
Grain Mill 750W Project Support Services PNG		Milling machine	750	500–1000	3,230
Rice Huller RHT-1 AC, 250W		Hulling/shelling machines	250	240	840–2,450
Oil Press BOSS Kit Pro Press		Oil presses	1,500	2,400	N/A

(continues)

Table A13.2 Continued

Product Name	Product Image	Product Type	Load (W)	Solar Panel Capacity (W)	Price (US$)
Refrigerator Steca PF 166/240		Refrigerator	40–100	70	1,000–1,600
Kettle RoadPro 12-Volt 20 oz. Hot Pot		Food processing for sale	85	N/A	20
Sewing Machine CERAD		Tailoring	40	70–100	190
Rotary Hammer—Bosch RHS181		Workshop tools	N/A	N/A	330
PC Asus EEE Box EB1007P		Computers	27	N/A	N/A

Product Name	Product Image	Product Type	Load (W)	Solar Panel Capacity (W)	Price (US$)
Fan ONergy Pedestal Fan		Fans	15	20	N/A
Laser printer: Sharp AL-1035		Printers	660	N/A	300
TV fosera DC 15.6'' 12 V		TVs	5.5	20	150
Charging ECOBOXX Qube 50/90/160		Charging stations	(1–2 USB ports)	5–20	110–220

Source: GIZ, Photovoltaics for Productive Use Applications. A Catalogue of DC-Appliances, 2015.

Notes

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