



Electrification of households

A diagnostic study of on-grid electrification in Ethiopia

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Disclaimer

This updated version builds upon a draft final report originally released in June 2024. Major enhancements include the addition of newly available data on the number of household connections for 2023 as well as revisions and updates to the same data from prior years. The changes are made to provide a clearer picture of the progress achieved in recent years.

Credits

Cover photo by Mikael Togeby.

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Foreword

Ensuring universal access to reliable and affordable electricity is fundamental to our nation's growth and development agenda. The Government of Ethiopia, has launched the National Electrification Program (NEP), setting an ambitious target of connecting 96% of households to the grid by 2030 with important milestones to be achieved along the way. As Energy Development State Minister of the Ministry of Water and Energy, I am pleased to present this study report on the multifaceted aspects of household electrification in Ethiopia.

This report, a collaborative effort between the Ministry of Water and Energy (MoWE), the Ethiopian Electric Utility (EEU), the Danish Energy Agency, and the Royal Embassy of Denmark, provides an assessment of our progress towards set targets and the obstacles encountered along the way. I extend my deepest appreciation to the individuals and institutions that contributed to this study. Adisalem Mebrahtu, Alemayehu Tadesse, and Mesfin Dabi from MoWE, Tilahun Legesse and Wondimu Ajema from EEU, Dereje Abegaz and Marie Thomsen from the Danish Energy Agency, and Mikael Togeby from the Royal Danish Embassy in Addis Ababa have all played pivotal roles in shaping the direction and findings of this study.

The findings of this study reveal important achievements in household electrification, including notable expansions in the energy infrastructure, access to electricity, and connections to the grid. Despite this commendable progress, much work remains to be done to bridge the gap between targets and achievements. The study identifies a set of inter-related challenges that need to be addressed to accelerate the expansion of access and connections. These include cross-cutting challenges, such as shortages of foreign currency and conflicts, which require coordinated national efforts to overcome. In addition, sector-specific challenges, including financial gaps, shortages of essential equipment, and suboptimal organizational structures, necessitate tailored strategies to speed-up program implementation.

In light of the above findings, the study proposes a set of reflections to inform the formulation of comprehensive, tailored strategies to address identified challenges. These reflections emphasize the importance of additional financing, targeted and transparent subsidy schemes, promotion of domestic manufacturing capacity, enhancement of institutional capacities, stimulation of electricity demand, and improvement of power supply reliability.

Since the completion of this study, the Government of Ethiopia has introduced two pivotal reforms that address some of the barriers identified in this study. Firstly, the government implemented a new foreign exchange regime that establishes a competitive, market-based system for determining the exchange rate. The reform is expected to help mitigate the shortage of foreign currency in country. In addition, electricity tariffs have been revised, with gradual increases designed to achieve cost recovery and enhance investments and overall sector development. These reforms reflect significant progress toward overcoming the challenges identified in this study.

As we move forward, it is imperative that we collaborate closely with all stakeholders, mobilize sufficient resources effectively, and implement targeted interventions to accelerate electrification efforts. I believe that the insights and reflections outlined in this report will serve as essential basis for stakeholders working towards the common goal of expanding electricity access and connections in Ethiopia. I am confident that with our collective efforts and commitment, we can overcome existing challenges and

achieve our shared goal of universal electricity access for all citizens.

Let us work together to illuminate Ethiopia!

Dr. Ing. Sultan Welle Ahmed, State Minister
Ministry of Water and Energy
Addis Ababa, Ethiopia

Executive summary

Ensuring reliable, affordable, and widespread access to electricity is essential for the realisation of Ethiopia's growth and development agenda. Leading this endeavour is the National Electrification Program (NEP), launched in 2017 and updated in 2019 (NEP 2.0), which aims for universal electricity access by 2025 with a target of connecting 68% of households to the grid. Within this program, the Ethiopian Electric Utility (EEU) is tasked with overseeing network planning, design, and implementation of grid components while the Ethiopian Electric Power (EEP) is mandated for the upstream functions of generation and transmission. Acknowledging the inadequacy of progress toward set targets, the Ministry of Water and Energy (MoWE), which is responsible for program coordination and monitoring, has highlighted the need to assess the progress so far and identify barriers, thereby paving the way for targeted measures to expedite program implementation. Consequently, a team comprising MoWE, EEU, the Danish Energy Agency, and the Royal Embassy of Denmark has been organised to conduct this study. The study focuses on the on-grid household electrification and covers the period since the implementation of NEP 2.0.

The analysis in this study draws on a review of relevant documents and administrative data and interviews with a number of stakeholders including households with grid connection, public institutions such as EEP, EEU, MoWE, the Ethiopian Petroleum and Energy Agency (PEA) and the Ministry of Finance (MoF), international financial institutions such as the World Bank, and local manufacturers and suppliers.

Findings in this study indicate that Ethiopia has made progress in household electrification registering a notable increase in the number of households connected to the grid. Between 2019 and 2023, 1.7 million new households were connected to the grid thereby increasing the total number of household connections from 3.5 million to 4.8 million, equivalent to 21% households nationwide. The average annual addition of about 380,000 new connections since 2020 constitutes only one-third of the targets set for the period. Despite the increasing targets over time, the decline or slow increment in the number of added connections post-2020 has widened the gap between targets and actual achievements. The limited progress and widening gap between goals and achievements point at the need for tailored strategies to accelerate progress.

The analysis in the study provides further insights into household electrification in Ethiopia. Firstly, it shows substantial regional variation in household electrification rates, with 79-93% of households in Addis Ababa and Harari having grid connection while the electrification rate in Afar and Somali regions is below 12%. Secondly, shared connections, where multiple households share a single metered connection, are still prevalent, raising concerns regarding connection security. Thirdly, the World Bank's Ethiopia Electrification Program (ELEAP) has played a pivotal role in facilitating a significant share of the achieved connections. The limited achievement outside ELEAP is a major concern. In addition, the concentration of 71% of the newly established connections in urban areas shows the marked rural-urban disparity in electrification efforts. The fact that 42% (respectively 65%) of the population reside within 2.5km (respectively 5km) radius from existing EEU stations reveals a significant opportunity for expanding access and connections.

The period under study witnessed significant improvements in the country's energy infrastructure

contributing to the increased electrification rate, expanding access to previously unserved areas, and laying the foundation to meet the growing demand nationwide. The length of transmission lines expanded from 18,881 km in 2019 to 20,634 km in 2022 while installed generation capacity rose from 4,173 MW in 2019 to 5,257 in 2022, predominantly driven by hydropower, notably the Grand Ethiopian Renaissance Dam (GERD). Other noteworthy achievements include expanded distribution network, increased number of low-, medium-, and high-voltage substations, rehabilitation, upgrading and modernisation of the existing grid.

Despite commendable achievements noted above, a number of cross-cutting challenges have hindered the progress of household electrification. Two of such challenges, namely the shortage of foreign currency and prevalence of war and conflicts, are considered particularly challenging as they require a concerted national effort beyond the institutions in the sector. Given the high demand for imported materials for expanding the grid and last mile connection, the shortage of foreign currency, which is a general macro-economic issue, has been a critical barrier. War, conflict, and the lack of security in various areas have resulted in destruction of energy infrastructure, delayed implementation of projects, hindered investments in the sector, and affected the collection of revenues.

The focus in this study has been on other challenges that are more specific to the energy sector and related to factors that can be addressed by key actors in the sector. These challenges include:

- Financial gap caused by limited government budget and donor contribution and inflation-driven increase in material costs.
- Shortage of essential equipment and materials, which is caused by limited domestic manufacturing capacity and the shortage of foreign currency for importing these materials.
- Certain tendering criteria and requirements such as those pertaining to prior experience have inhibited the competitiveness of domestic manufacturers, further weakening the local supply chain.
- Competing public priorities has led to a reduced proportion of government budget and foreign currency allocated to electrification
- Fragmented organizational structures, limited capacity within relevant institutions, and inadequate collaboration among key stakeholders have reduced potential achievements
- Recurring unreliability of power supply, caused by inadequate grid upgrading, maintenance, and rehabilitation works, remained a serious concern.
- The upfront fee paid by households for connecting to the grid has been a significant barrier, as has the low electricity demand which affected the financial sustainability of power generation, transmission, and distribution activities.

The following reflections are proposed to support the formulation of comprehensive, tailored strategies to address identified challenges:

- There is a need for additional financing through increased governmental funding, donor contribution, and alternative financing schemes including public-private partnerships and carbon credit trading in order to help diversify funding sources and reduce reliance on a few funding streams.
- Targeted and transparent subsidies can be used to address the burden of connection fees. Suitable selection criteria based on distance from the grid and socio-economic conditions can be used for

subsidy allocation. This can be complemented with a suitable credit scheme which can ease the burden of the upfront fee.

- Establishing a transparent system ensures subsidies reach deserving households, maximizing their impact on electrification progress and financial viability.
- Promoting domestic manufacturing capacity is essential, and this can be achieved by tailoring tender criteria and requirements within the capacities of domestic manufacturers and facilitating joint-ventures between local and international manufacturers for experience sharing.
- There is a need to enhance the capacities within and the cooperation among key institutions through targeted capacity enhancement programs and a clear strategy for partnership and continuous communication along well-defined lines.
- There is a need for stimulating the demand for electricity, e.g., by facilitating loan schemes for purchase of appliances, providing targeted subsidies to ease the burden of electricity bills; organising awareness campaigns and demonstration projects, and offering financial tax breaks or incentives for manufacturing.
- It is essential to address the unreliability of power supply, which can be achieved by ensuring the safety of shared connections and by enhancing the organizational capacity and preparedness of the EEU.

1 Introduction

Access to electricity stands as a cornerstone of economic development, playing a pivotal role in elevating living standards, fostering education, improving healthcare, and facilitating information access. Cognizant of the transformative impact of electricity on economic and societal progress, the Government of Ethiopia (GoE) has launched programs aimed at ensuring universal electrification access nationwide by 2025. The vision for universal electrification not only signifies a commitment to meeting immediate energy needs but it also aligns with Ethiopia's broader developmental objectives. Towards achieving universal electrification access, ambitious targets are set aiming to connect 65% of households to the grid by 2025 and 96% by 2030, with remaining households to be served by off-grid solutions. The road map for achievement of electrification targets is outlined in the National Electrification Program (NEP). While the responsibility of coordination, strategic oversight, and monitoring of program implementation progress rests on the Ministry of Water and Energy (MoWE), the Ethiopian Electric Utility (EEU) was tasked with the responsibility and accountability for network planning, design and implementation of the grid component with the Ethiopian Electric Power (EEP) being responsible for the upstream functions of generation and transmission.

MoWE, EEU and EEP with the assistance of the Embassy of Denmark in Ethiopia and the Danish Energy Agency (DEA) have undertaken the current study to assess the progress achieved thus far and to identify barriers that have hindered the realization of targets. The study is focused on the progress and challenges related to on-grid household electrification since the launch of NEP 2.0. While emphasizing the significance of a concurrent assessment of off-grid solutions, a separate and subsequent study would be needed to address aspects specific to off-grid initiatives. The separate assessment of on-grid and off-grid solutions ensures a detailed examination of each electrification solution, paving the way for nuanced insights. The study is designed to produce valuable insights and draw lessons that can not only enhance ongoing electrification initiatives but also serve as a foundation for the strategic design of future electrification programs.

This diagnostic analysis delves into the multifaceted landscape of on-grid household electrification in Ethiopia, aiming to unravel the complexities that shape this journey. The analysis conducted in this study draws on a review of relevant documents and administrative data from EEU. Additionally, insights have been gained through interviews with a diverse array of stakeholders. The analysis indicates that during the last four years, Ethiopia has connected 380,000 households annually – giving these households newfound possibilities. The achievement, while commendable, only represents progress towards one-third of the electrification targets set by the government. Moreover, the challenges in the electrification landscape have grown more pronounced, evident in the declining number of new households being connected to the grid in recent years. This trend prompts a careful examination of the factors influencing this trajectory. In 2023, the achievement in on-grid household electrification fell short of the planned targets, with only 4.8 million households successfully connected out of the planned 11.8 million. This achievement represents 21% of the total 22.4 million households nationwide. The limited progress points at the prevalence of significant barriers hindering the implementation of electrification efforts. The scale of the challenges becomes apparent when compared with the ambitious target of connecting 96% of the households by 2030, demanding that an average annual connection of 2.9 million new households is made from 2024-2030. This is in stark contrast to the current progress

of around 380,000 new customers annually, inducing a critical assessment to the existing landscape. If the recent trajectory of total household connections continues, only 27% of all households will be connected by 2030, which is far below the 96% targeted.

It is important to note that the electrification rate exhibits substantial variation across regions, with a high rate exceeding 93% in Addis Ababa. In smaller regions/cities such as Harari and Dire Dawa, the rate of electrification ranges between 50-79%, while most other regions achieved lower rates, fluctuating between 6-20%. This diversity underscores the need for a nuanced approach, tailored to the distinctive challenges and progress of each region, to effectively address the varying levels of electrification across the country. The study identifies regional variations and specific obstacles, fostering an understanding of the impediments that hinder successful electrification efforts.

Ultimately, the study concludes with reflections of actionable lessons derived from both the achieved progress and challenges. This will form the basis for a further discussion of how challenges can be addressed, enriching the discourse on sustainable and effective electrification strategies.

Embracing a holistic perspective, this study spans diverse Ethiopian regions encompassing both urban and rural landscapes. Its temporal scope extends across recent years, ensuring a comprehensive understanding of evolving dynamics. Concentrating on progress and challenges, the study aspires to give insights, guiding the trajectory of current electrification endeavours and laying a robust foundation for the planning of future electrification programs in Ethiopia.

2 Progress so far

2.1 Progress in household grid connections

This section outlines the progress in terms of household connections since the roll-out of NEP 2.0. The quantitative data underling our analysis is obtained from both primary and secondary sources. The data source and assumptions embedded in the quantitative analysis are detailed in Annex D of this report. Unless specified otherwise, the term “*household grid connections*” refers to households directly connected to the grid with their own authorised meters. Consequently, grid connection rates in this report do not include households with shared connections. However, it is worth noting that irregular, shared connections are highly prevalent, and efforts are underway to regularize them.

Table 1: Targeted and achieved household grid connections

Year	Added connections (millions)		Cumulative connections (millions)		Share of household grid connection	
	Targeted	Achieved	Targeted	Achieved	Targeted	Achieved*
2019	0.5	0.17	7.4	3.50	36%	17%
2020	0.7	0.39	8.1	3.89	38%	18%
2021	0.9	0.37	9.0	4.30	42%	20%
2022	1.3	0.35	10.3	4.35	47%	20%
2023	1.5	0.43	11.8	4.77	53%	21%

*Using the projections for total household used in NEP 2.0.

Findings in this study, summarized in Table 1 and illustrated in Figure 1 to Figure 3, reveal a significant variations in the number of additional grid connections over time. The number of added connections per year varies from 170,000 households in 2019 to 430,000 in 2023, with an average of about 340,000 households per year during the period. However, it is notable that the number of additional household connections has stagnated post-2020, in stark contrast to the rising targets set for the same period. The achievement in terms of added connections constitutes only 35% of the targeted 4.9 million additional connections during the period under consideration. The limited progress and the growing gap between targeted and achieved connections underscore the importance of identifying barriers hindering progress and the necessity for immediate actions to ensure progress toward achieving targets.

Ethiopia has seen an overall increase in household grid connections, with 1.7 million new connections added between 2019 and 2023. This brings the total number of connections to 4.8 million, representing 21% households in the country. While this progress is commendable, it falls short of the target of 53% set for the end of 2023.

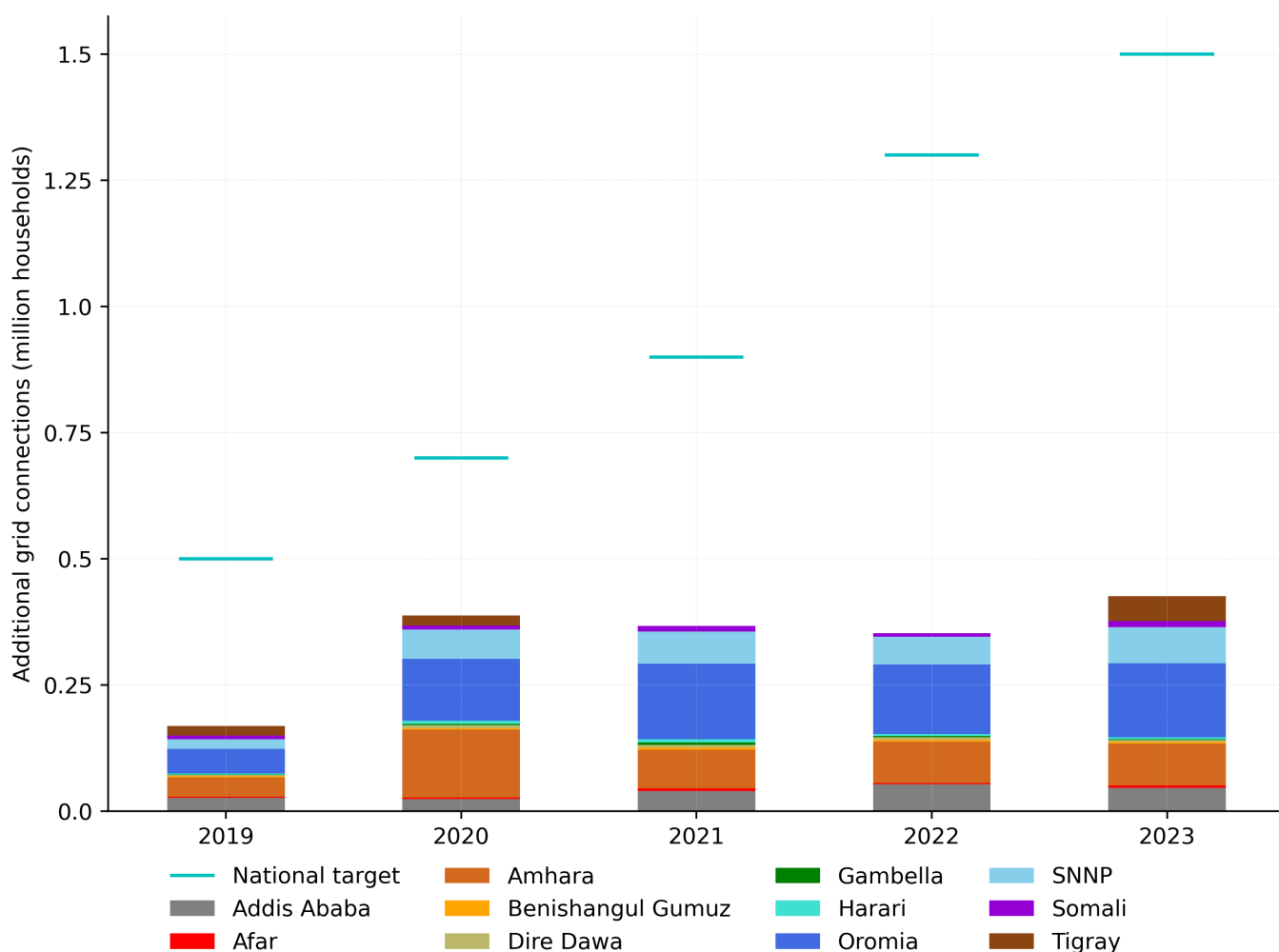


Figure 1: Targeted and achieved new household grid connections

Our analysis shows significant regional disparities in household electrification rates. Notably, 79-93% of households in Addis Ababa and Harari are connected to the grid while at least 88% of households

in Afar and Somali regions remain unconnected. This observed gap in electrification rates appears to align with the level of urbanization and overall regional development, emphasizing the need for targeted strategies to address regional variations.

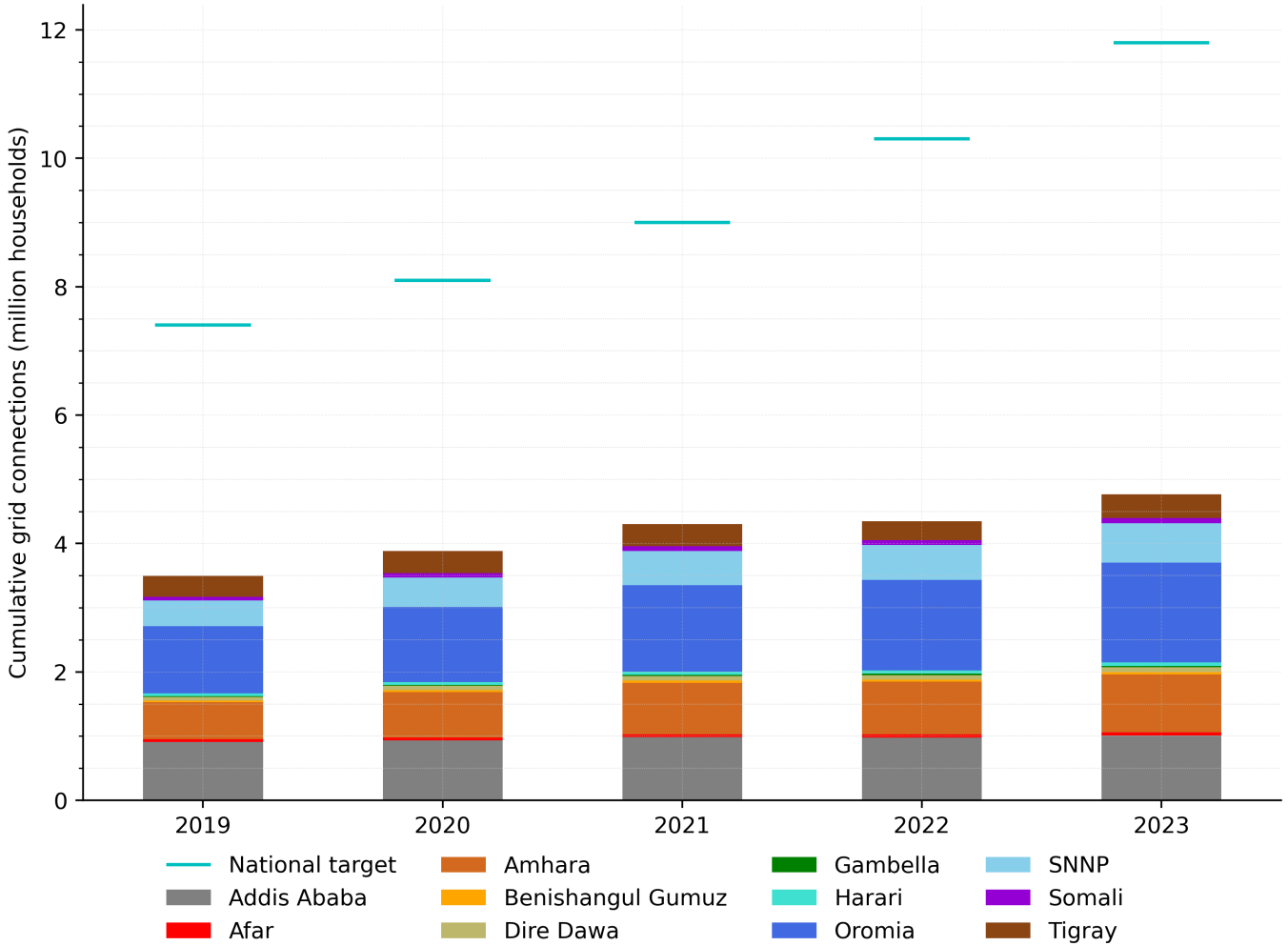


Figure 2: Targeted and achieved household grid connections (in million)

Most household connections achieved thus far have been funded by the World Bank’s Ethiopia Electrification Program (ELEAP).¹ The limited achievement outside ELEAP is a major concern. It is worth noting that most (71%) of the newly established connections were concentrated in urban areas. The limited progress towards electrifying rural areas suggests that proximity to the existing grid might be a major factor influencing where new connections are made.

2.2 Progress in generation, distribution, and transmission capacity

During the study period, Ethiopia embarked on a significant expansion of its energy infrastructure. This expansion not only provided access to electricity in previously unserved areas but also paved the way to meet the growing demand from existing and potential users nationwide. The observed

¹ELEAP follows performance-driven approach to project financing, with funds dispersed upon the verification of achieved connections. The first phase of ELEAP, with a budget of 375 million USD, connected 1,080,000 households, and a second phase with 250 million USD has commenced.

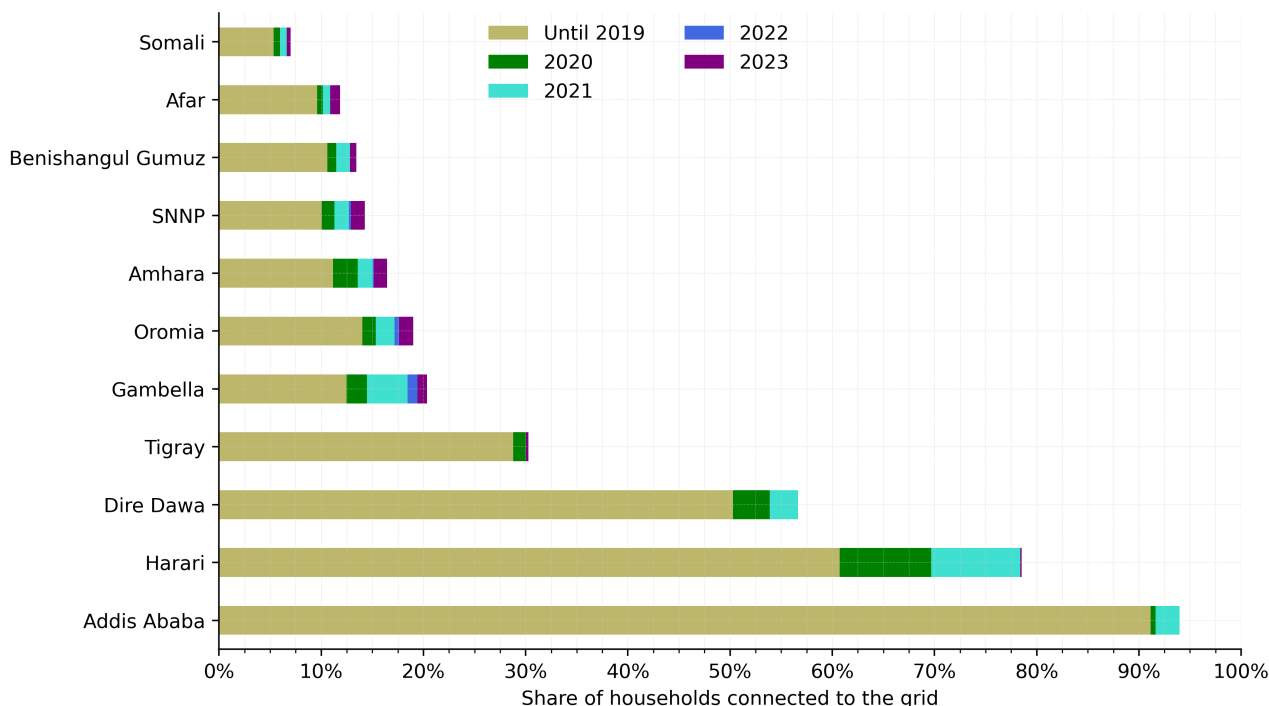


Figure 3: Regional variations in the share of households connected to the grid

increase in household grid connections is a direct result of strategic investments made in several areas, including in increasing the country’s generation capacity, installing new substations and transformers, and expanding and upgrading the transmission and distribution network. Furthermore, efforts were made to rehabilitate and modernize the existing grid to ensure its ability to meet the rising demand for electricity and address the persistent challenge of supply unreliability, which remains a critical concern. This chapter delves deeper into the encouraging progress achieved in both increasing generation capacity and expanding the power grid. These crucial developments are paving the way for achieving the goal of universal access to electrification.

Grid expansion and upgrade

Recognizing the pivotal role of grid expansion for achieving universal household electrification, the GoE has made significant investments in transmission and distribution networks, as well as in the installation of substations and transformers. As a result, the length of transmission lines in the country grew from 18,881 km in 2019 to 20,634 km in 2022, marking a 3% annual growth rate. In tandem with the transmission network, the number of medium- and high-voltage substations has increased by 5% per year, rising from 167 in 2019 to 192 in 2022. The expansion of medium- and high-voltage lines particularly required high investments but was essential to extend access to areas located farther away from the existing grid. Similar upward trends are observed in the length of the distribution network and the number of transformers and low-capacity substations, reflecting significant progress made in expanding the energy infrastructure across the nation. These components are essential in connecting all households in areas that are within short distance from the existing grid.

The expansion of the grid network has paved the way to improved access and connections. The

progress is illustrated in [Figure 4](#). In the Somali region, for instance, grid expansion has provided access and connection to an area that was previously unserved by the grid. In addition, the proportion of the population nationwide residing within a 5-kilometre radius from transformer stations has grown significantly since 2019. According to the 2023 report on tracking the progress of SDG 7, the access rate in Ethiopia grew by more than 3 percentage points per year between 2019 and 2021.² This improved proximity to the grid positions an increasing number of households to gain access to electricity in the near future.

[Figure 4](#) shows that the grid has larger coverage. The share of population within 1, 2.5, 5, 10, and 25 km from an EEU transformer station is respectively 24%, 42%, 65%, 82%, and 94% (see [Table 2](#)). Having 65% of households within 5 km underline that the current challenge for increasing connection is not the remote areas. The rate of electrification can be more than tripled by connecting households within 5 km from existing transformers.

Table 2: Access to electricity before and after the roll-out of NEP 2.0

	2019 (NEP 2.0)	2023*
Population/households within 1.0 km from a transformer station		24%
Population/households within 2.5 km from a transformer station		42%
Population/households within 5.0 km from a transformer station	75-80%	65%
Population/households within 10 km from a transformer station	90%	82%
Population/households within 25 km from a transformer station	95-96%	94%

*Source: Computation based on EEU data

Despite the significant expansion in the grid network during the study period, Ethiopia is one of the countries with the largest number of people without access to electricity.³ Parts of the distribution grid have not undergone necessary rehabilitation, maintenance, or upgrades which resulted in situations where the aging components are more prone to faults, leading to frequent power outages. The significance of this issue is further elaborated in the barriers section.

In Addis Ababa, EEU has undertaken substantial grid rehabilitation to enhance the reliability of electricity supply. The work carried out include infrastructure upgrade, the replacement of wooden poles with concrete structures, and a gradual transition to underground cables. Despite these efforts, the broader aim remains the comprehensive rehabilitation of all medium voltage lines in the coming years. Similarly, an extensive grid rehabilitation work in Hawassa has improved the reliability of electricity supply in the region. However, despite these commendable efforts, persistent unreliability problems in all regions continue to hinder the nationwide progress of electrification.

Increased generation capacity

Achieving connection targets requires a commensurate increase in generation capacity as demand for electricity increases with the addition of more households to the grid and economic growth. One of the pivotal achievements in Ethiopia's electrification journey is the significant boost in generation capacity. The installed generation capacity rose from 4,173 MW in 2019 to 5,257 in 2022, marking an impressive

²Tracking SDG 7: The Energy Progress Report (2023). IEA, IRENA, UNSD, World Bank, and WHO.

³Tracking SDG 7: The Energy Progress Report (2023). IEA, IRENA, UNSD, World Bank, and WHO.

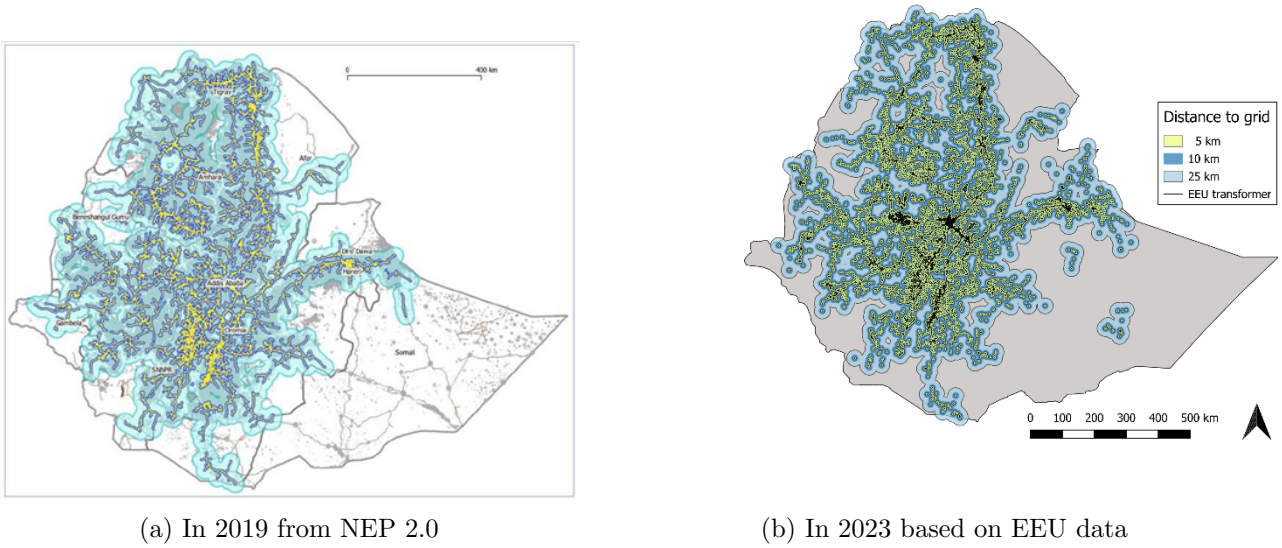


Figure 4: Share of population/households within different radii from distribution substations

compound annual growth rate of 8% during the period. A significant share of this increased generation capacity is attributed to hydropower, notably the Grand Ethiopian Renaissance Dam (GERD). A significant increase in generation capacity is expected upon the completion of the GERD construction, paving the way towards the achievement of universal electrification access and meeting the growing demand for electricity. GERD holds the promise of supplying generation for local demand as well as export. However, navigating the intricacies of this mega-project involves addressing capacity issues and managing concerns related to debt payment.

Table 3: Changes in various components of Ethiopia’s energy infrastructure

	2019	2022
Installed generation capacity (MW)	4,173	5,257
Number of substations with a capacity 132 kV or higher	167	192
Number of substations with a capacity up to 66 kV	-	40,000
Length of transmission network (km)	18,881	20,634

The investment portfolio on generation has been dominated by large hydro projects and the GoE as the main and often only capital provider. While private sector involvement remains very limited, encouraging developments are emerging particularly in the wind and solar energy sources. The dominance of electricity supply from hydro sources calls for strategies to mitigate lower capacity during dry years and/or seasons.

3 Challenges faced

Stakeholder interviews have been conducted to gather insights on lessons learned and challenges encountered in connecting households to the grid. A diverse range of stakeholders were engaged in

these interviews, including households, EEP, EEU offices at federal, regional, district and customer service centre levels, material manufacturers and suppliers, as well as representatives from MoWE and other governmental institutions. A list of the interviewed stakeholders and the interview guide utilized are provided in Annex B and Annex C. The following sections provide a summary of insights gleaned from these interviews. The subsequent sections offer a summary of insights derived from these interviews, including distinct challenge areas outlined in the following section.

3.1 Financial gap

Insights from stakeholder interviews underscore the significant gap between the required and secured financing as a critical barrier hindering further progress in connection and access rates. The following key factors were identified as contributors to the financial gap:

Limited finance for electrification compared to the investment needed to achieve set targets

Despite the increasing number of targeted household connections and anticipated rises in the unit cost of achieving these connections, the annual government grant to EEU for rural electrification remained the same between 2019 and 2022.⁴ The stagnation in funding allocation, coupled with high and rising inflation rates, has led to a widening financial gap, significantly impeding progress in household electrification, particularly in extending access to new settlements and villages.

The financing plan to achieve the 2025 electrification targets involves securing 50% financing from development partners through concessional loans and grants. However, progress in securing this external support has been very limited. The lack of external financing, coupled with limited national contributions, has led to a significant financial gap, which impeded progress in household connections. It shall be noted that the targeted 50% financing from development partners specifically excludes fund already secured from the first phase of the ELEAP project.

Despite the need for extending electricity access in newly developed residential areas within cities that have already achieved high access and overall connection rates, these areas often face a critical financing gap for grid expansion. Since government funding prioritizes rural electrification efforts, extending the grid to new urban neighborhoods becomes the responsibility of residents and the city administration. While some residents obtained grid connection through self-financing or city subsidies, the lack of dedicated funding has limited the overall number of household connections in these areas.

Limited revenue collection has constrained the sector's ability to invest on expanding access and connections. Available resources have been restricted by a high rate of uncollected revenue, which is caused by lack of security in various areas and manual billing systems. The low electricity tariffs (see details in Annex E), while beneficial for affordability, has limited potential investments. However, the prospect of higher tariffs also raises concerns for hindering household electrification, especially for low-income households. Frequent power outages further restrict potential revenue and resources for expansion. Finally, limited ability to pay for connections, particularly in rural areas, resulted in fewer new customers contributing to overall investment costs. These interconnected challenges highlight the

⁴In each year during the study period, EEU received ETB 1 billion (about USD 17 million) in grant from the GoE.

need for a comprehensive solution that considers both affordability and the financial viability of the distribution, transmission, and generation operators to achieve universal electrification.

Rising cost of connection caused by inflation

Inflation-driven increases in the cost of cables, cement, steel, and essential other materials used in electrification projects has limited the progress in access and household connections achieved with the available financing. The impact of material cost increases on EEU is further pronounced by delays in providing connection after collecting connection fees from customers. In Addis Ababa, for instance, delays in providing connection to a number of large housing associations who have already paid connection fees have posed a considerable financial challenge due to the added burden of rising costs.

Whether stemming from limited government budgets or donor support, inflation-driven material cost increases, uncollected revenues, or lower tariffs, there is a need to rethink the financing strategy to address the financial gap and accelerate the progress of household electrification.

3.2 Shortage of material supply

One of the main barriers to progress in household electrification was the shortage of essential materials such as cables, meters, and transformers. While these materials are crucial for network expansion, rehabilitation, and last-mile connections, they are in short supply in the local market. Consequently, an increasing number of households in areas already with electricity access are experiencing prolonged waiting periods to gain connections. In addition, ongoing and planned network expansion projects have been delayed due to material shortages. The shortage of essential materials is caused by a combination of factors, including inadequate domestic manufacturing capacity and a scarcity of foreign currency.

Local manufacturers have limited capacity to meet the current level of material demand. Even when operating at full capacity, local manufacturers may not be able to meet 50% of the overall material demand. The limited local production capacity is related to the underdeveloped manufacturing sector, which is characterized by the lack of complementary inputs and industries in the upper and lower streams of the value chain. Interviewed local manufacturers or suppliers point at certain qualification and evaluation criteria in internationally competitive bids have rendered them unable to compete with international bidders. Some of the said criteria include requirement for prior experience in supplying large quantities or to multiple customers. The fact that a local manufacturer or supplier has never won an international tender was noted as a testimony to such requirements. Another barrier identified by local manufacturers is the cumbersome and lengthy customs process when importing raw materials. The lifting of previously available tax incentives is also noted as a factor that weakened the local manufacturing capacity.

The overarching challenge of foreign currency shortage has had a twofold impact. Firstly, it has impeded the import of equipment and materials required for network infrastructure and last mile connections, thereby directly impeding the expansion of access and household connections. In the last five years, EEU has been granted only 25% of the foreign currency it requested from the Ministry of Finance. The impact of limited import is exacerbated by the weak local value chain and inadequate

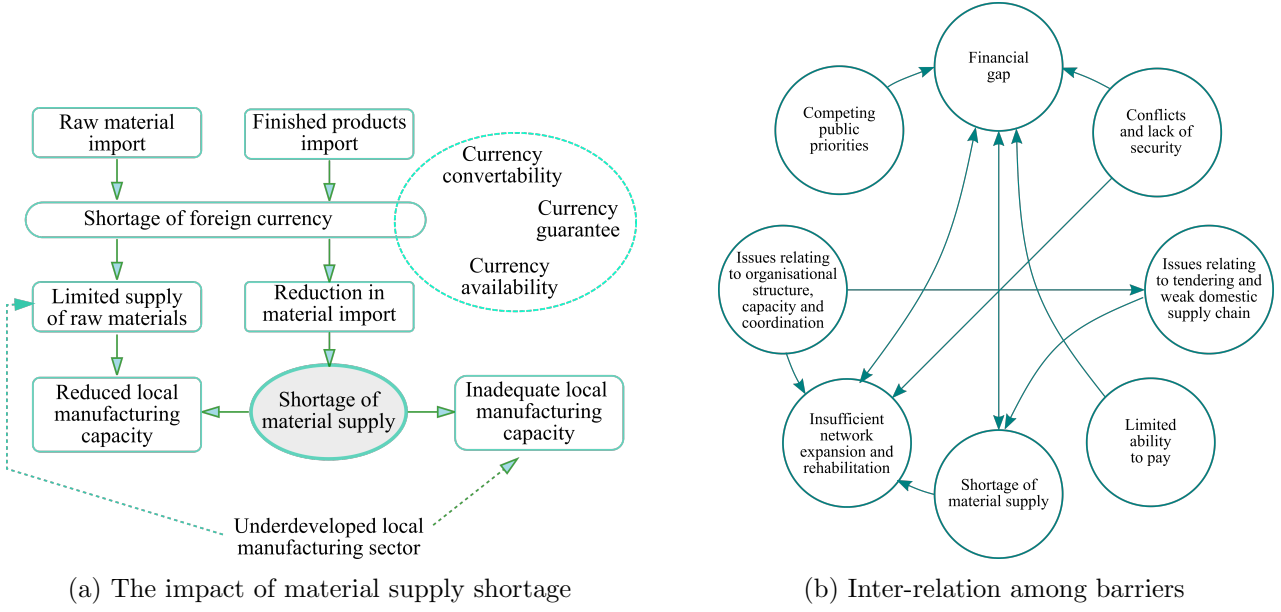


Figure 5: Mapping the shortage of material supply and the interconnection among various barriers

local manufacturing capacity. Secondly, the shortage of foreign currency has restricted the import of material inputs necessary for local production of critical materials. This, in turn, has placed a strain on the already limited local manufacturing capacity, with domestic producers operating far below their full potential due to the scarcity of essential imported inputs. The foreign currency shortage has had especially vital consequences pertaining to raw materials that are not locally produced. This has limited the progress in electrifying households and led to operational delays resulting in time and cost overruns, efficiency losses, and loss of potential revenue.

The shortage of foreign currency has also raised concerns regarding currency convertibility and guarantees, thereby deterring foreign investment particularly in power generation.

3.3 Tendering requirements hindering the development of domestic supply chain

EEU procures equipment purchases exceeding ETB 50 million through an internationally competitive bid (ICB) process. While the adoption of an ICB is aimed at ensuring transparency and competitiveness, it entails challenges that limit local manufacturer's ability to prepare competitive bids within this framework. A major challenge in this regard is meeting specific criteria related to prior experience, particularly in delivering large volumes to multiple clients. Findings in this study indicate that most, if not all, domestic manufacturers face difficulties satisfying these criteria. These difficulties emanate from their lack of prior experience with clients beyond EEU and their inherent constraints in terms of production capacity. Despite the 15% price margin provided to small local manufacturers, their lack of success in ICBs underscores other challenges inhibiting their capacity to submit competitive bids. Addressing this challenge may require customising the current evaluation and qualification criteria, which are drawn from bidding documents suggested under the ELEAP project and/or the Standard Bidding Documents of Ethiopian Public Procurement and Property Authority (FPPPA).

Furthermore, in cases such as meters, requirements for type testing and the absence of local testing

facilities necessitates the use of facilities outside of Ethiopia. This reliance on external facilities not only introduces delays in the procurement process but also results in additional costs for local manufacturers. In addition to the above, slow and cumbersome procedures associated with importing raw material and spare parts further impede the efficiency and capability of local manufacturers in meeting contractual obligations. These procedural bottlenecks pose challenges in adhering to project timelines and may have implications for the overall success in the procurement process.

Instances have been documented where local manufacturers, despite outbidding others in price, faced difficulties in demonstrating obligations associated with contract delivery. This raises a fundamental dilemma: How can local industries be promoted without compromising on quality and cost-effectiveness? The consideration for reducing bid sizes emerges as a potential solution, though the feasibility and implications of such an adjustment warrant careful evaluation. Striking a good balance between promoting local industries and ensuring the delivery of high-quality products within the stipulated budgets remains a complex issue that demands innovative solutions.

3.4 Competing public priorities

In the allocation of government financial resources, electrification has received relatively lower priority compared to other sectors, notably agriculture and healthcare, which have consistently received significant shares of the resources due to their fundamental importance to the country's economy and population well-being, respectively. Despite the growing targeted number of connections, the annual budget allocation for rural electrification has remained the same throughout the study period. It has in fact declined in real terms due to the high inflation in the country. In addition, only 25% of the foreign currency requested by EEU has been granted by the Ministry of Finance, partly attributed to the overall foreign currency shortage in the country. With limited budget support, finances for electrification have fallen short of the investment needed to meet set targets. Additionally, considering the shortage of essential equipment in the local market, access to foreign currency for importing these items is crucial. The limited foreign currency allocated to electrification has consequently impeded progress in household electrification efforts.

Competing priorities arise during the tariff review and adjustment process, as the government navigates the challenge of balancing the financial sustainability of electricity generation, transmission, and distribution operators against ensuring other public objective through lower tariffs. This complex task entails setting tariffs that accurately reflect costs while also considering the importance of lowering tariffs to promote fairness, stimulate investment, and facilitate job creation. However, due to the prevalence of non-cost-reflective tariffs, the transmission and generation system operator is experiencing significant losses.

3.5 Issues relating to organizational structure, capacity, and coordination

Progress in household electrification has been hindered by fragmented organizational structures, limited capacity within relevant organizations, and insufficient collaboration among key stakeholders.

Inadequate coordination among the key institutions and a lack of centralized planning have resulted in inefficient resource allocation. While anticipated demand growth spurred significant investments in network expansion, slow connection growth and lower than expected demand have resulted in excess

capacity in some areas. Stakeholder insights reveal that feasibility studies, which inform network expansion planning, often point at the need for additional capacity without adequately exploring possibilities for optimising the use of existing infrastructure. This has led to underutilized substations in some areas and overloaded substations in others. In fact, most EEP substations have been operating below 50% capacity. These findings highlight a critical need for improved collaboration between EEP and EEU, which is responsible for demand forecasting and feasibility studies.

While MoWE is tasked with providing strategic oversight and monitoring electrification progress, the implementing institutions EEP and EEU report respectively to the Ministry Finance and the Ethiopian Investment Holdings. This fragmented structure and the lack of direct reporting lines has contributed to the lack of adequate collaboration. Misunderstandings or lack of clarity on the division of certain roles and responsibilities between EEP and EEU has further exacerbated the collaboration problem, leading to implementation delays.

While connecting households with large demand near an existing grid with surplus capacity may present a viable business case, electrifying a vast majority of the population involves substantial investments that only slowly yield benefits such as improved health, education, productivity, and growth. With utility finances being squeezed by the low household demand for electricity and the sizeable cost of providing connections, EEU has focused largely on connecting households using existing lines rather than investing to expand the network. While this is done to ensure financial viability, it demonstrates the need for devising mechanisms to align EEU's financial orientation with the policy-mandated duty of electrifying all households.

Lack of adequate capacity within key institutions has also hindered progress in electrification. Notably, users have been experiencing prolonged power interruptions due to delays caused by the inadequacy of technicians and service vehicles. The lack of digitized systems means that significant potential revenue, which could be used to expand access and connections, remains uncollected due to untimely and manual collection and faulty meter readings. Stakeholder insights point to the need for staff training to enhancement individual capacities. They also point to the presence of unethical staff behaviour and malpractice whereby customers are asked to make unlawful payments to obtain a connection.

3.6 Limited ability to pay

The high cost of connecting to the grid, particularly for low-income households, has been a significant barrier hindering the progress of electrification. Households faced a substantial upfront fee of ETB 12,000 (around USD 200) for a connection requiring two wooden poles, with fees increasing for those located farther away from the grid. This is a significant outlay for the average household and have deterred connections in already electrified areas. This affordability challenge is expected to worsen as electrification expands to deeper rural areas, where a larger proportion of low-income households reside. In addition, despite certain households demonstrating willingness and capacity to pay the connection fee, they have not been promptly connected due to delays caused by material shortages and capacity limitations.

The limited ability to pay has also resulted in low electricity demand, with many households predominantly using electricity for lighting purposes. The higher energy demand for cooking is primarily met using biomass (firewood, crop residues, and dung), which has serious environmental and health

risks. The limited electricity consumption for cooking can be attributed to the unaffordability of electrical appliances since electricity is cost-competitive on account of the low tariffs. Hence, there is a pressing need to devise strategies to incentivize demand. Since the current electricity tariffs are not cost-reflective, there is an inherent need to revise them to ensure alignment with the cost of electricity provision. This involves a delicate balance between ensuring affordability for households and establishing a tariff structure that supports the sustainable generation of electricity and expansion and maintenance of the power grid.

3.7 Inadequate network expansion, rehabilitation, and upgrades

Despite notable improvements in the country's energy infrastructure, the progress in grid expansion, rehabilitation, and upgrading has fallen short of the extent needed to achieve national electrification goals. Due to insufficient grid extension, particularly in rural areas, fewer households than targeted have obtained connections and access. Despite substantial efforts to upgrade, rehabilitate, and modernize the grid, including by replacing wooden poles with concrete and transitioning to underground cables, unreliability of supply remains a major challenge. This challenge persists even in urban centres like Hawassa, where extensive network rehabilitation has recently been conducted, and a dedicated team stands ready to address any reliability issues. This demonstrates the extent of the prevailing issue and the scale of work needed to address it. With increasing demand on the network and an aging grid, the problem of unreliability is expected to worsen without sufficient investments in grid rehabilitation, upgrading, and modernization.

Several factors contribute to the inadequate pace of grid expansion, upgrade, and rehabilitation. The limited budget allocation and significant uncollected revenues means that limited fund was available to finance the necessary large-scale grid expansion and upgrading works. The shortage of imported essential materials, caused by the scarcity of foreign currency, has resulted in significant delays in planned and ongoing network expansion and rehabilitation works. Notably, the lion's share of planned and ongoing transmission projects has been delayed due to foreign currency shortage. This has significantly affected the expansion and upgrade of the transmission network and contributed to the challenges in on-grid electrification.

4 Reflections on the way forward

This study has identified a multitude of factors for the insufficient progress in household electrification. Below are key reflections intended to provide a basis for discussions with stakeholders about how to improve electrification efforts in the future.

Rethinking the support towards reducing the high cost of connection

While electrifying all households may not be a good, short-term business case, the need for supporting relevant institutions to achieve this goal is imperative given the significant, long-term social and wider economic importance of electrification. A targeted and transparent subsidy program is proposed to address the significant connection fees. Existing and planned subsidies from the GoE and other sources could be customised to accelerate household electrification by ensuring that subsidies are targeted to connecting those that would otherwise not be a good business case.

To ensure efficient use of financial support, it is imperative to reconsider the criteria for selection of households who receive a subsidized connection. Verifiable criteria can be developed based on the distance of households from the grid and their socio-economic conditions to determine households in need of subsidies and the level of subsidy thereof. By categorizing households into full subsidy, partial subsidy, and no subsidy groups, it becomes possible to allocate funds strategically to address customers' unaffordability and balance the overall project funding and progress. Flexible financing options, such as low-interest loans and extended payment plans, can be introduced for households that may not qualify for the full subsidy but still need financial assistance. This can help ensure a more inclusive approach to electrification.

Furthermore, accountability in the allocation of subsidies is paramount. Establishing a transparent system that accounts for all types of subsidies and directs funds only to deserving households ensures that projects relying solely on end-user payments and demonstrating financial viability do not receive subsidies. This two-step change can significantly contribute to maximizing the impact of subsidies, ensuring that they target households with the need for support.

Empowering local manufacturers for a sustainable supply chain

There is a need to strengthen the local manufacturing capacity to ensure adequate supply of essential components such as meters, cables, and poles that are foundational for achieving electrification goals. Achieving this requires attracting investments to enhance local manufacturing capacity and addressing barriers to allow optimal utilization of existing capacities and participation in international tenders.

In tendering, considerations shall be given to align tender volumes with the capacity of local manufacturers. This may entail breaking down large tenders into smaller, more manageable volumes, allowing a wider range of local manufacturers to participate. Establishing local testing facilities can enhance local manufacturers' competitiveness in the tendering process since these facilities would reduce the time required for conducting tests and eliminate the need for foreign currency required for conducting tests abroad. Establishing national quality standards and accreditation of testing facilities would streamline the national quality assurance processes.

Facilitating joint ventures between local and international manufacturers can help strengthen local manufacturers in Ethiopia. Such arrangements can address procurement challenges faced by local manufacturers, who can also gain access to global best practices, advanced technologies, and expertise. As such, joint-ventures can enhance the efficiency, competitiveness, and the ability of local manufacturers to meet international standards. In addition, initiatives focused on enhancing the capabilities of local manufacturers can be instrumental. Training programs in adherence to international quality standards, project management, and documentation practices can empower local manufacturers to meet the stringent requirements of international tenders. There is also a need to ease up the cumbersome and lengthy procedures local manufacturers face when importing essential raw materials.

Enhancing the capacities within and the coordination among key institutions

Establishing a clear strategy for ongoing communication and collaboration among key institutions like EEP and EEU is essential. Establishing well-defined communication channels allows for close

cooperation and exchange continuous information exchange. This fosters the alignment of work plans and ensures the optimal utilization of existing and planned grid infrastructure. Regular joint planning sessions further facilitate information sharing, discussions on ongoing and planned projects, and prompt resolution of emerging challenges. Through continuous interaction, any ambiguity regarding roles and responsibilities can be addressed openly and collaboratively, leading to a unified effort that avoids delays and maximizes efficiency in achieving national electrification goals.

Beyond fostering collaboration, additional support is needed to enhance the capacity of key actors. Targeted trainings, strategic staffing, and fostering a culture of learning and experience-sharing will be crucial. Strengthening the regulator's capabilities is crucial in facilitating centralized network planning. There is also a need to strengthen its capacity for creating a more attractive investment environment and enhanced overall sector governance. Lessons learned from international best practices can be a valuable resource for achieving this. Similarly, the utility's capacity to address persistent unreliability issues requires enhancements to conduct routine maintenance and promptly respond to any unreliability issues. In addition, promoting transparent work processes with clear reporting and accountability measures will help address staff malpractices.

Improving the reliability of power supply for connected households

A balanced approach to electrifying new households while simultaneously improving the reliability of power supply for connected households is crucial to fully reap the benefits of established connections. Resorting to biomass, generators and fossil fuels to cope with recurrent power outages does not only diminish the value of connections but it also undermines efforts to mitigate climate change. The reliance on gasoline not only incurs high costs for consumers but also utilizes valuable foreign exchange that could be better directed towards importing materials for expanding the energy infrastructure. However important it is to connect new households to the grid, focus shall also be given in improving the reliability of connected households.

It is proposed that the organizational capacity of the utility shall be enhanced to reduce the frequency of power outages and promptly address them whenever they arise. Tailored capacity enhancement program can be developed to improve organizational preparedness, recruit additional staff, and enhance the capacity of existing individuals. Proposed capacity enhancement activities could be financed through subsidy, additional user payments, revenue generated due to reduced outages, etc.

Since irregular connections may not be safely installed, they pose safety risk and unreliability concerns not only to the relevant households but also to others in the network. To address these risk and concerns, irregular connections can be temporary allowed upon inspection of the safety of the installation. While this is not a long-term option, it can help reduce the unreliability of power supply.

Promoting electricity demand

There is a need to incentivise electricity demand to ensure the financial viability of power generation, transmission, and distribution activities and reduce emissions associated with the use of alternative energy sources. The electricity demand for cooking can be stimulated by introducing suitable loan schemes that offer credit to purchase appliances; targeted subsidies for low-income households to ease the burden of electricity bills; launching public awareness campaigns about the benefits of using

electricity; and organising demonstration projects in rural communities to showcase the use and importance of electricity. From a regulatory perspective, financial tax breaks or incentives can be provided to businesses that manufacture and sell energy-efficient appliances in Ethiopia.

Addressing the financing gap

Additional financing is needed to match the investments required for achieving a faster electrification rate. There is a need for additional financing through increased government funding, which can be achieved by reallocating existing budgets or securing additional funding from national development programs. In addition to governmental support, an enhanced donor engagement is needed to foster partnerships with potential donors to secure additional financial support for electrification projects. Alternative financing schemes such as public-private partnerships and carbon credit trading shall also be explored to help diversify funding sources and reduce reliance on a few funding streams.

Monitoring new connections and enhancing technology integration

Embracing digital solutions can improve revenue collection processes, addressing challenges associated with delayed and uncollected payments. By promoting and implementing digital platforms, such as mobile payment systems and online billing portals, utilities can streamline and automate revenue collection, ensuring timely payments and improving overall financial stability.

Continuous monitoring of added connections is imperative to assess progress in expanding electrification, particularly in rural areas. By tracking new connections, authorities can identify gaps in coverage and allocate resources effectively to reach underserved communities. Additionally, monitoring shared connections enables utilities to identify households in need of regularization, ensuring equitable access to electricity and enhancing service reliability.

Annex

A References

National Electrification Program 2.0. Integral Planning for Universal Access, 2019.
Final Verification report on On-grid Electricity Connections. Central Statistics Agency, 2021.
Ethiopian Electrification Program (ELEAP), 2018-2023. Program Operational Manual, 2018
Ethiopian Electrification Program Additional Financing. World Bank, 2023
Population Projections for Ethiopia from 2007 – 2037, Central Statistical Agency, Ethiopia
The 2021 Labour Force and Migration Survey (2021 LMS), Ethiopian Statistics Service, 2021
Tracking SDG 7: The Energy Progress Report; IEA, IRENA, UNSD, World Bank, and WHO; 2023.
Assessment Report of Grid Transformers' Utilization and switchyard equipment limitation in the Existing System, EEP, May, 2022

B List of interviewed stakeholders

Stakeholder interviews are conducted to gather insights on successes and barriers of electrification initiatives in Ethiopia. The interviews are conducted in person during 02 – 10 October 2023.

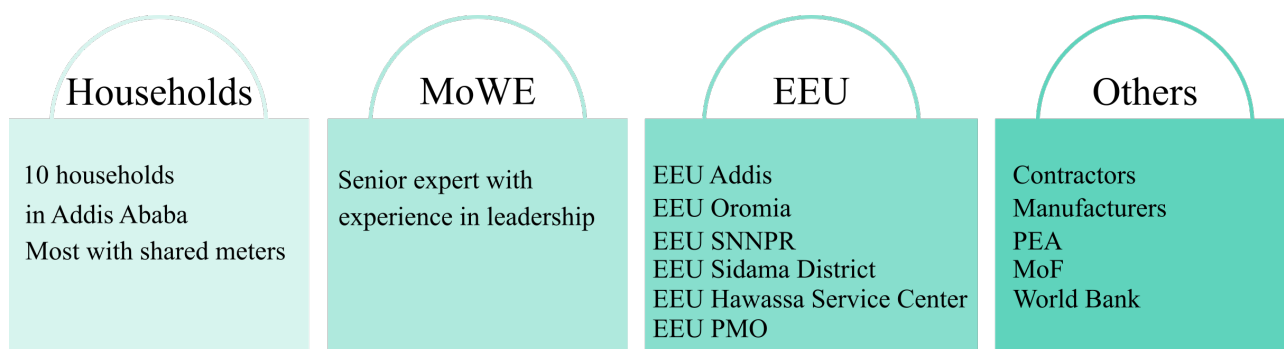


Figure B1: List of interviewed stakeholders

C Interview guide

The following interview guide was used to ensure coverage of main discussion points during individual interviews.

1. Welcome and introduction
 - Provide an overview of the purpose of the interview
 - Introduce national targets for household grid connections
 - The interview is conducted in English unless local language is preferred
 - Assure confidentiality and ask if we can record the interview
2. Overall assessment of household grid connections
 - The interviewees' role within their organization and their tenure at the organization
 - The interviewees' involvement with household grid connections
 - Overall assessment of progress made in household grid connections
3. Successes from initiatives for enhancing household grid connections
 - Notable success stories from initiatives to enhance household grid connections

4. Barriers that limited the number of household grid connections
 - Description of challenges that limited the number of household grid connections
 - How the challenges arose
 - Regional disparities to the challenges
5. Actions
 - What should or could be done to improve household electrification

D Sources of quantitative data and assumptions used in analysis

The quantitative data underling the analysis in this report is collected from both primary and secondary sources. Data on additional and cumulative number of household grid connections at the regional and national levels is obtained from EEU, while secondary data pertaining to national electrification targets and average household size is obtained from reports of studies or surveys conducted by MoWE and ESS.

Table D1: Sources of quantitative data used in the report

Data	Source: Institution	Source: Document
Added and cumulative number of household grid connections	EEU	Internal
National electrification targets	MoWE: National Electrification Program (NEP) 2.0: Integrated Planning for Universal Access, 2019	National Electrification Program (NEP) 2.0: Integrated Planning for Universal Access, 2019
Population projections for Ethiopia	Central Statistical Agency	Population Projections for Ethiopia from 2007 - 2037
The number of individuals in household at the regional level	Ethiopian Statistics Service (ESS)	The 2021 Labour Force and Migration Survey
GIS data	Location of EEU transformers	Supplied by EEU

The following assumptions are made regarding the number of connections, number of households, and definition of calendar years.

- To facilitate comparison between targets and achievements, the Sidama and South West Ethiopia regions are considered as part of the SNNP region despite them becoming independent regions during the study period.
- Due to lack of regional-level data, the average household in Tigray is assumed to comprise of 4.4 persons, in line with the national average value.
- The average number of persons per household is assumed to be the same during the study period. This is relevant where information on the total number of households is used.
- The grid access rate at the regional level is calculated as the ratio of total grid connections to the number of households in each region. Given the absence of up-to-date data on household numbers per region over time, estimates were made using projected population figures based on the 2007 census and average household size data from ESS' 2021 Labour Force and Migration Survey. This method initially produced a projected grid access rate for Addis Ababa exceeding

100%, which was considered unrealistic. As a result, the rate was adjusted to 90% of the initial estimate to provide a more realistic estimate.

- Calendar years: Data on the number of achieved grid connections is provided in Ethiopian Calendar (EC) years, while the national electrification targets are stated in Gregorian Calendar (GC) years. To ensure a direct comparison between achievements and targets, we convert all years to GC, considering 2012 in EC as 2019/2020 in GC, which is then regarded as 2019 GC, and so forth.

E Data on all and new EEU customers

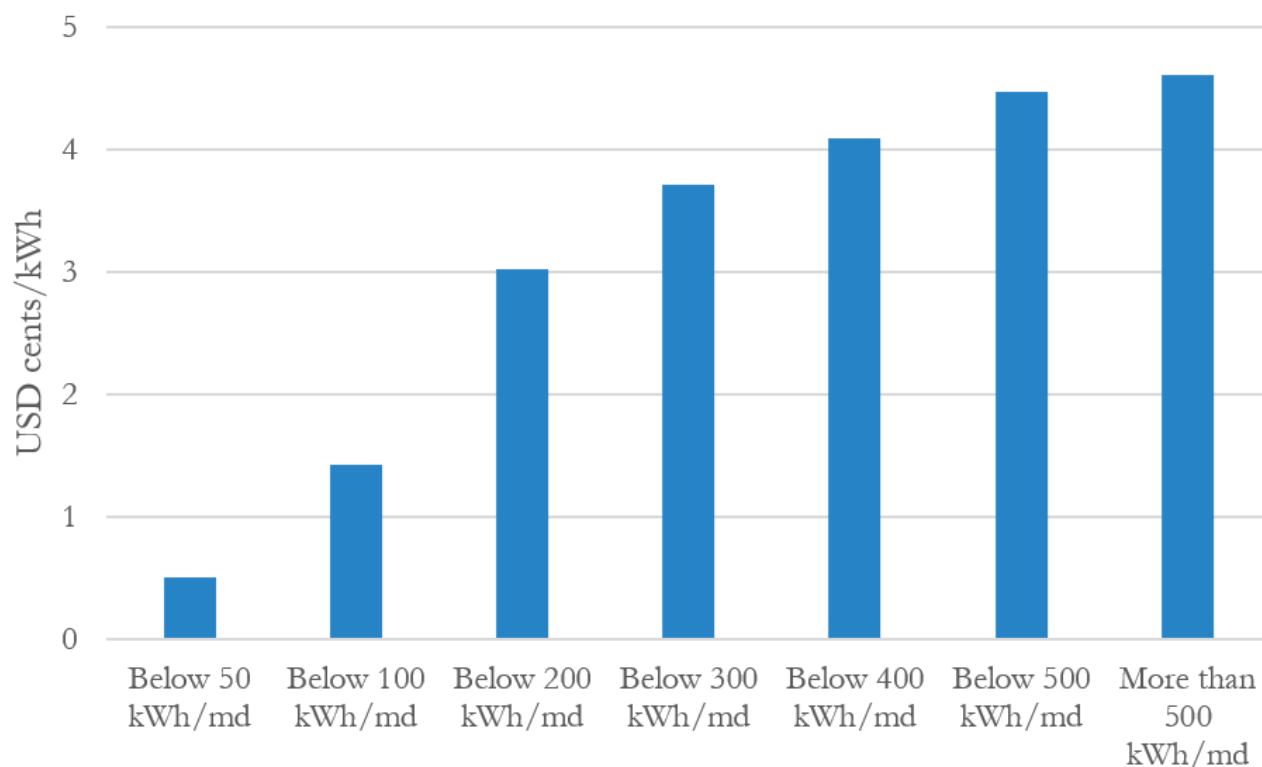


Figure E1: Progressive tariff for households, December 2021. Average tariff is 3.6 USD cents/kWh

Average electricity demand was estimated using EEU data on all customers (approx. 2.7 million) and for a sample of households connected in 2020 (70,000). For new customers, demand is recorded for 2021-2023. The new customers have a significant lower demand (average: 78 kWh/month) than the existing customers (average: 176 kWh/month).

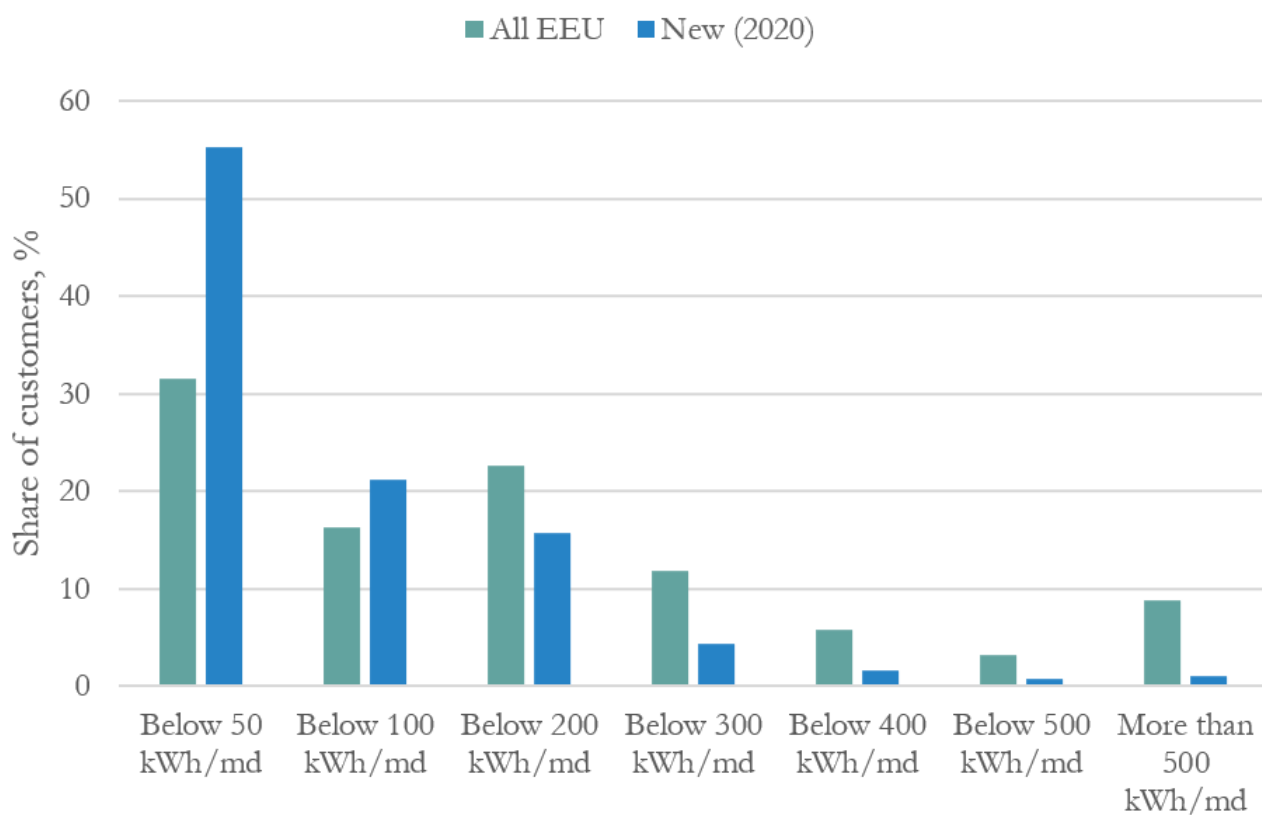


Figure E2: Progressive tariff for households, December 2021. Average tariff is 3.6 USD cents/kWh

F Acronyms and abbreviations

Table F1: Definition of abbreviations

Acronym	Description
DEA	The Danish Energy Agency
DSO	Distribution System Operator
EC	Ethiopian Calendar
EEP	Ethiopian Electric Power
EEU	Ethiopian Electric Utility
ELEAP	Electrification Program
EOD	The Embassy of Denmark in Ethiopia
ETB	Ethiopian Birr
ESS	Ethiopian Statistical Services
FPPPA	Public Procurement and Property Authority
GC	Gregorian Calendar
GERD	Grand Ethiopian Renaissance Dam
GoE	Government of Ethiopia
ICB	Internationally Competitive Bid
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
km	Kilometre
kV	Kilo-volt
kWh	Kilo Watt-hour
MoWE	Ethiopian Ministry of Water and Energy
MW	Mega Watt
NEP	National Electrification Plan
PEA	Ethiopian Petroleum and Energy Agency
SDG	Sustainable Development Goals
UNSD	United Nations Statistics Division
USD	United States Dollars
WHO	World Health Organization