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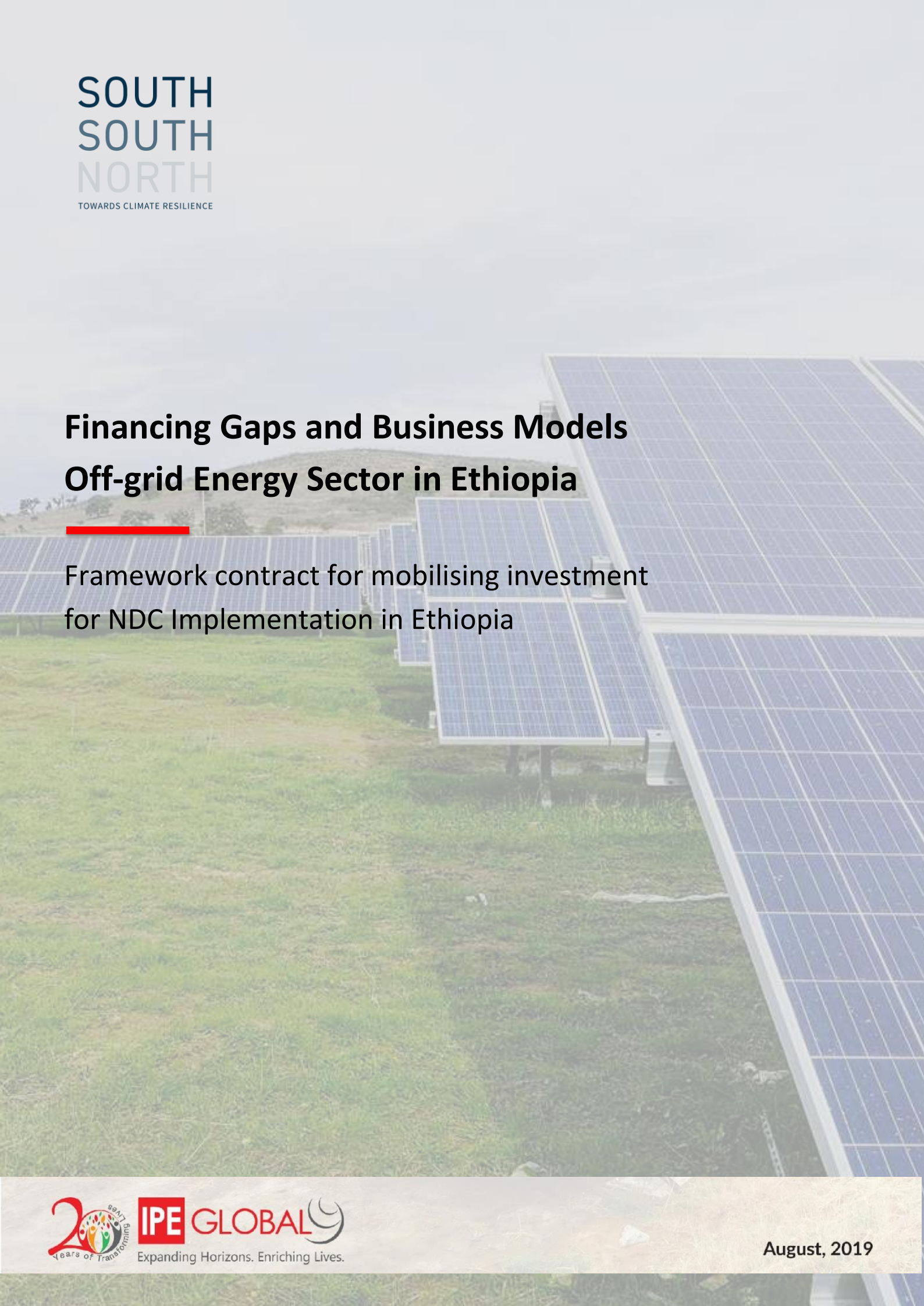

Financing Gaps and Business Models Off-grid Energy Sector in Ethiopia

Framework contract for mobilising investment for NDC Implementation in Ethiopia

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Framework contract for mobilising investment for NDC Implementation in Ethiopia

Submitted by:

IPE GLOBAL LIMITED
IPE Global House,
B - 84, Defence Colony,
New Delhi - 110 024, India
www.ipeglobal.com

Ethiopia Office
2nd Floor, Adika Building, Bole Sub City,
Addis Ababa, Ethiopia
Phone + 251 903183358 / +251 11 667 0453
Email sunilverma@ipeglobal.com

International offices:

Bangladesh, Ethiopia, Kenya, Myanmar, Nepal, Philippines, United Kingdom

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Throughout the development of this report, a consultative approach was taken with both government and non-government stakeholders. The report was researched and written in close cooperation with the Ethiopian Ministry of Water, Irrigation and Energy. To complement this consultative approach and for the purposes of data collection, the team carried out individual stakeholder interviews. Final results from the research were presented to a multi-stakeholder workshop in Addis Ababa in July 2019.

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Reviewed by	Mr. Shewangizaw Kifle, Climate Resilience and Energy Expert
Approved by	Mr. Sunil Verma, Country Head, IPE Global Limited, Ethiopia
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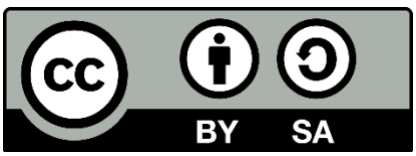

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ABBREVIATIONS AND ACRONYMS

Abbreviation	
BPR	Business Process Reengineering
CBE	Commercial Bank of Ethiopia
CE	Citizen Engagement
CFL	Compact Fluorescent Lamp
CDKN	The Climate Energy Knowledge Network
CO_2	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
IKI	International Climate Initiative
IPE Global	IPE Global Limited
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	Ministry 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
NDC	Nationally Determined Contributions
NEP	National Electrification Program
NES	National Electrification Strategy
NGO	Non-Governmental 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
SSN	SouthSouthNorth
TVET	Technical Vocational Education and Training
UEAP	Universal Electricity Access Program
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
Wp	Watt Peak

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We are grateful for the support and technical guidance provided by SouthSouthNorth during the lifetime of this assignment without which, this report may not have been possible.

[1] Nationally determined contributions (NDCs) embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions that it intends to achieve

EXECUTIVE SUMMARY

Ethiopia's National Electrification Program (NEP 2.0) represents the country's action plan to achieve nationwide access to electricity by the year 2025. Currently, only 44 percent of the population has access to electricity with 33 percent served by grid electrification and 11 percent by off-grid (solar off-grid and mini-grids).[2] To provide energy to the remaining 56 percent of the population over the next six years, the Government of Ethiopia is implementing a fast-paced, ambitious grid connection rollout program, led by the Ethiopian Electric Utility (EEU), and a complementary off-grid access rollout program. The overall cost of the grid (USD 3.5 billion) and off-grid (USD 2.5 billion) programs is about USD 6 billion.

The government has deregulated the off-grid market and introduced legislation to establish a supportive enabling environment, in line with the best practices, as reflected in the prevailing quality standards, custom duties and lifting of testing requirements. Energy Regulations are under revision, and the Ethiopian Energy Authority (EEA) has developed a draft of Tariff Guidelines and Methodology for Off-Grid Systems in consultation with stakeholders to finalize cost-reflective tariffs, and sustainable mini-grid business models in Ethiopia.

The Ethiopian National Electrification Program (NEP) 2.0, recognizes that mini-grid technologies can provide a higher level of service and can support high loads, including for social (e.g. health and school facilities) and productive uses, for energy intensive businesses and even small industries. The adoption of a mini-grid program is part of the Ethiopian Government's 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.[3]

Ethiopia's National Electrification Program 2.0 (NEP 2.0) specifically references the off-grid program and mentions that the program requires full leveraging of all available implementing agents and resources— public, private, as well as public private partnerships and cooperatives. NEP 2.0 calls for a dramatic acceleration in connections and improved quality services with mini-grid solutions to be targeted in areas where the load justifies the investment. NEP 2.0 also supports the establishment of regulatory certainty in the enabling environment by the introduction of a set of policies, regulations, and incentives supportive of the whole off-grid ecosystem across the value chain, including mini-grid developers. Foreign private sector participation is encouraged and productive use in the agriculture sector is proposed as a way to increase local value generation and job creation.[4]

In spite of policy support from NEP 2.0, mini-grid interventions are currently limited in scope and capacity in the country[5] due to reasons that are common throughout the NDC landscape in sub Saharan Africa. In an attempt to address this gap, the government and development partners are testing scalable business models, mainly with a view to stimulating private investment to achieve universal countrywide electrification by year 2025. This is an ambitious target that requires collaboration between government, the private sector and development partners to achieve success.

The preferred choice for mini-grid business and operational model depends on the national,

[2] National Electrification Program (NEP) 2.0

[3] National Electrification Program (NEP) 2.0

[4] National Electrification Program (NEP) 2.0

[5] (Please refer Table 5: Summary of ongoing mini-grid initiatives in the country in Ethiopian Regulatory Environment and Capacity Constraints in Off-Grid Energy Sector Report)

social and political circumstances as well as on the size and structure of the mini-grids. Not only in Ethiopia, but throughout Africa mini-grid business models are largely unproven, although progress has been observed in certain African countries such as Kenya, Tanzania and Nigeria. This report describes the various business and operating models including the Utility Operator Model, the Private Sector Operated Models and the Community Operated Model as well a Hybrid Model, which draws elements from multiple models.

The Utility Operator Model is known and understood in Ethiopia. The Ethiopian Electric Utility (EEU) operates around 31 isolated diesel generated distribution mini-grid systems. Recently, the Ministry of Water, Irrigation, and Energy (MoWIE) and EEU has identified over 250 villages throughout the country that require connection via mini-grid technologies (solar, hydro or hybrid). Prior to scaling up these mini-grid projects, MoWIE and EEU have launched 12 pilot projects in all the nine regions of the country to determine the appropriate technical, financial and operational feasibility of mini-grids. Selected private organizations will design, develop and commission these mini-grid systems within a six months -contract period and will hand them over to the EEU, which will further develop and commission the 12 mini-grid distribution systems (EEU-EPC[6] led).

During the initial stages of mini-grid growth in Ethiopia, the government funded and operated model supports the fulfillment of national electrification objectives and enables learning, is easier from a regulatory perspective, and government subsidization of tariffs ensures affordability for households. Aligned with the social objectives of the Government of Ethiopia (GoE), EEU charges the same tariff – amongst the lowest in sub Saharan Africa - for the 31 mini-grids as paid by customers for grid energy in Ethiopia. However, this model is not scalable or financially sustainable in the medium term. In addition, skilled human resources with appropriate technical capabilities are limited and capacity scale-up will add additional cost. In addition utilities may face political interference and delays in procurement due to competing interests within government.

Experience in Ethiopia and elsewhere show that national utilities rarely go beyond operating a few mini-grids because these tend to be too small and scattered to be managed efficiently by state-owned entities. This context creates the opportunity for private-sector operated sites. However underdeveloped markets like Ethiopia provide challenges for even the most capable project development companies. To attract this new breed of private off-grid utilities, the Ethiopian Government needs to address the enabling environment by removing barriers to private sector investment. For a country like Ethiopia with an underdeveloped private sector, opening up a market that has traditionally been the domain of the state takes political commitment and clear-sighted leadership.

The key ingredients for successful private-sector led investment in this sector are the following: (i) an enabling policy and regulatory environment; (ii) the ability for operators to charge cost-reflective tariffs; (iii) flexible and investor-friendly licensing procedures; (iv) availability of affordable debt-financing; (v) established rules to mitigate conflicts with customers; (vi) and a trusted regulatory mechanism in the event that an existing mini-grid, is 'absorbed' by the main grid. Regulatory mechanisms to address this risk are described later in this report.

In Ethiopia, the EEA has confirmed that the ABC model - Anchor, Businesses and Consumers - is the preferred business model for private sector mini-grids. This model has the potential to

[6] Engineering Procurement and Construction

address both the private sector's requirement for cost reflective tariffs as well as the government's requirements for household tariffs that are aligned with the national tariff through a tiered tariff model. Currently, however, there are no examples of commercially successful private-sector owned and operated mini-grids in Ethiopia. Various pilot and demonstration sites have been implemented with financial and technical support of donors in the country. For example, Power Africa has been supporting private organizations like Ethio-Resource Group PLC and Rensys Engineering and Trading PLC for wind power micro-grids and solar mini-grid systems, respectively, in the Amhara region. The 'ABC' model has potential particularly where the anchor tenant is a farming cluster and the electricity is used to increase productivity through irrigation, cold storage and agri-processing. In theory the anchor customer consumes a consistent proportion of the supply and provides a regular revenue stream with additional small businesses and households contributing to the business case. Renewable energy and hybrid solutions can play an important role in the Ethiopian mini-grid sector by replacing diesel generators reducing emissions and lowering the levelized cost of electricity (LCOE) for farming communities. A *clustering approach* which entails non-interconnected mini-grids supplying electricity to villages located close to each other and bundled together as part of one operational unit can also help to achieve financial viability by reducing costs and driving economies of scale.

A few community operated pilot sites have been implemented in Ethiopia. The investment capital for community mini-grids generally comes from grants, supplemented by contribution from the community (in cash or in-kind). GIZ & EnDev[7] are testing the Cooperative Model for hydro mini-grids under projects/initiatives like 'Engrin, Abaye, Timbil, Idris, Waro, Naso, Gibe, Ameka and Fuamo in Amhara, Oromia and SNNP regions of the country. Whilst community models are generally not scalable, they do contribute to the learning environment and self-managed public infrastructure has been shown to reduce conflict between potential customers and government. However, insufficient local technical and managerial capacities, unclear ownership structures and lack of finances can limit this type of arrangement. The model requires grant funding to cover all capital costs, and the associated low tariffs are often insufficient to cover operations & maintenance and reinvestment costs.

The Ethiopian Government is interested to trial public-private partnerships (PPPs) in the energy sector for mini-grids. PPPs, which are a type of hybrid model where different entities may be involved in investment, ownership and operation, require a well-constructed regulatory framework that includes protection of property rights. Other examples of hybrid models include renewable energy service companies, and the use of concessions.

In this evolving space, the Desco (Distributed Energy Service Company) is a business model that has attracted attention. It requires a PPP and often utilizes a build own operate (BOO) approach. The features of DESCOs include long relationships with customers and the provision of energy services with a 'pay per use' model. Increasingly there are examples of off-grid Descos that can operate without necessarily requiring any external subsidy support and can provide a reasonable return on investment and the government has an expectation that the success of Descos in Asia can be repeated in Ethiopia. It must be noted that recent research conducted in India, Tanzania, Senegal, Uganda reported that at the time of writing, none of the 20 Desco's

[7] The Energising Development (EnDev), programme is a multi-donor initiative delivered by Germany's GIZ and the Netherlands' Enterprise Agency (RVO). EnDev Ethiopia promotes household electrification through pico hydro power and micro hydro power plants, by providing technical assistance and introducing appropriate low-cost designs for hydro power

evaluated had reached profitability[8].

The government is also considering the scale-up of an EEU-led EPC approach, where the private sector or cooperatives install generation assets and operate and maintain the system under contract with the EEU who would own the distribution assets, with the medium-term goal to connect the infrastructure to the main grid. This approach may provide quick wins and assist early learning but is not scalable in Ethiopia in the long run due to financial constraints.

From a tariff perspective, EEA is willing to pilot different tariff regimes with varying levels of subsidy. Stakeholders agree that energy-based tariffs, fee-for service tariffs and flat-rate tariffs all have a role to play in the country. However whichever tariff model is chosen or implemented, attracting private sector investors requires a risk-equivalent return. In consultation with stakeholders, EEA has recently developed a draft of Tariff Guidelines and Methodology for Off-Grid Systems. At the time of writing, this set of guidelines is under revision, but there expectations that this will provide some clarity around future tariffs for the mini-grid ecosystem in Ethiopia.

Sources of private capital in Ethiopia are limited and investment is likely to come from large regional mini-grid operators who are able to benefit from economies of scale. Under private financing mechanisms, distribution and generation assets are financed either by corporate[9]or project[10] finance mechanisms. In Ethiopia access to both equity and debt finance remain challenging and is likely only possible with cost reflective tariff rates. Raising debt finance in particular, remains a challenge with current commercial long-term lending rates exceeding 15 percent. Development finance may in some instances help to bridge the financing gap.

Mini-grids are a new concept in Ethiopia and the government faces challenges related to the shortage of trained mini-grid engineers and quality assurance skills. The current uncertainty related to tariffs and lack of established scalable business models adds further challenges. However the GoE is taking a pragmatic learning approach to this development challenge. They have expressed the desire to pilot various approaches with the private sector by harnessing the expertise and capacity of the EEU in the off-grid space. However at the time of writing this report, this has yet to be realized. It is expected that implementation progress and lessons learned from the first EEU-EPC pilot of 12 solar mini-grids will provide some guidance in terms of the way forward.

Based on consultations with the government, development partners and private stakeholders, this study makes the following recommendations to stimulate the growth of the sector:

i. Mini grid pilot programmes should trial different business models to evaluate what works in the Ethiopian context

ii. Private Sector Operated for-profit business models using an ABC model can address both the private sector's requirement for cost-reflective tariffs and Government requirements for households to benefit from the low national tariff.

iii. Demonstration mini grids for agriculture commercialization clusters should be supported by government, to prove the 'productive use' thesis. This model has the potential to

[8] How a New Breed of Distributed Energy Services Companies can reach 500mm energy---poor customers within a decade- A commercial solution to the energy access challenge
Pepukaye Bardouille & Dirk Muench (June 2014)

[9] Corporate finance is based on the balance sheet of the entity receiving the financing. Lenders have recourse to all assets of the entity, but they do not have a security interest in any assets

[10] Project finance refers to the financing of a project based on the projected cash flows of the project and the value of the asset

significantly benefit the rural economy through improved agricultural productivity and enhanced food security and is aligned with the CRGE and other climate change policy.

iv. Private-sector developers should be encouraged and incentivized to secure grant funding to improve equity returns and reduce project risks, particular during the early stages of the development f the sector.

v. A project preparation facility will assist private developers to build a pipeline of mini-grid projects.

vi. Legislation to enforce a minimum percentage of local equity will have benefits in the medium term by supporting the development of Ethiopian project developers.

vii. The risk of grid arrival needs a set of clear guidelines communicated to private developers and investors that helps to address their concerns.

viii. The licensing process for private sector project developers needs to be addressed. Delays in this area will result in developers choosing other geographies to invest.

ix. Development partners should support capacity building of government and local private developers.

x. Affordable financial instruments, such as guarantee products, to hedge against foreign exchange fluctuations will help to address a significant barrier to investment.

CHAPTER 1: MINI-GRID BUSINESS MODELS

Electricity access in rural areas can be provided in three ways - by extending the national grid, by stand-alone systems and by mini-grids. Rural electrification experts usually recommend using grid extension only where the cost per connection is reasonable, and rather deploying stand-alone systems (e.g. Solar Home Systems and pico-PV systems) in scarcely populated areas with weak demand potential. Mini-grids may be suitable for rural settlements and agricultural clusters where the cost of grid extension is too high.[11]

*Image SEQ Figure * ARABIC 1 (Courtesy Nazret.com)*

Mini-grids can be a game-changer for rapid, cost-effective, and high-quality electrification in rural Africa. The International Energy Agency (IEA) anticipates that more than 50 percent of the world's rural population, currently without energy access could be best supplied with electricity via mini-grids. Under the right conditions, mini-grids can complement national grid electrification strategies. This in turn can modernize standards of living and enable small rural businesses.[12]

Mini-grids

Mini-grids in Ethiopia are described as local power networks which utilize distributed or embedded generation resources and manage electricity supply and demand. With a typical isolated mini-grid system, the mini grid utility could operate both as the power producer and distributor to off-grid consumers in the local community (EEA).

National Electrification Program (NEP) 2.0

While still in a nascent phase 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 Ethiopian National Electrification Program (NEP) 2.0, recognizes that mini-grid technologies can provide a higher level of service and can support high loads, including for social (e.g. health and school facilities) and productive uses, for energy intensive businesses and even small industries. The adoption of a mini-grid program is part of the Ethiopian Government's 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.[13]

Access to electricity in Ethiopia

Ethiopia has achieved good progress 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. By 2025, at least 65 percent (over 15 million people) are targeted to be connected through grid solutions. The remaining 6 million households in rural and deep rural areas (equivalent to about 35 percent of the population in 2025) are targeted to be connected through off-grid, including mini-grids.

Ethiopia's National Electrification Program 2.0 (NEP 2.0) specifically references the off-grid program and mentions that the program requires full leveraging of all available implementing agents and resources— public, private, as well as public private partnerships and cooperatives.

[11] Mini-grid Policy Toolkit- Policy and Business Frameworks for Successful Mini-grid Roll outs.

[12] Ibid.

[13] National Electrification Program (NEP) 2.0

NEP 2.0 calls for a dramatic acceleration in connections and improved quality services with mini-grid solutions to be targeted in areas where the load justifies the investment. NEP 2.0 supports the establishment of regulatory certainty in the enabling environment by the introduction of a set of policies, regulations, and incentives supportive of the whole off-grid ecosystem across the value chain, including mini-grid developers. Foreign private sector participation, which will lead to foreign direct investment, is encouraged and productive use in the agriculture sector is proposed as a way to increase local value generation and job creation.[14]

In spite of policy support from NEP 2.0, mini-grid interventions are currently limited in scope and capacity in the country[15]. The government and development partners are testing scalable business models, mainly with a view to stimulating private investment to achieve universal countrywide electrification by year 2025.

Generally, the preferred choice of a mini-grid business/operation model depends on national, social and political circumstances as well as on the size and structure of the mini-grids. When using mini-grids as part of a rural electrification portfolio, policy-makers worldwide need to tailor policy and regulatory frameworks to one or more suitable models. Mini-grids can be operated by utilities, dedicated private companies, community-based organisations or a combination of these. Mini-grid business models describe the organizational structure of mini-grid implementation and operation. The four main mini-grid models are the following:[16]:

- Utility Operator Model
- Private Sector Operated Model
- Community Operated Model; and
- Hybrid Model

These models differ based on who owns the power generation and distribution assets, and who operates and maintains the system. They are further defined according to the relationships with customers. At present, there is no 'best practice' or ´one-size-fits-all´ business model for mini-grids. Successful deployment of each model depends on its unique context, including the natural environment (e.g. geography, energy resources and climate/weather conditions), the local socio-economic context and the policy and regulatory environment. The policy and regulatory framework determines which mini-grid operating models can flourish in a country.[17]

[14] National Electrification Program (NEP) 2.0

[15] (Please refer Table 5: Summary of ongoing mini-grid initiatives in the country in Ethiopian Regulatory Environment and Capacity Constraints in Off-Grid Energy Sector Report)

[16] Rolland, Glania, ARE/USAID (2011). Hybrid Mini-Grids for Rural Electrification: Lessons Learned

[17] Ibid.

Mini-grids can have two operational entities viz. a small power producer (SPP) and a small power distributor (SPD).[18] Operators can also fulfill both roles (generation and distribution) and can produce and sell power either to public power distributors or directly to end-users. The size of the mini-grids and the available energy sources also shape the organizational structure. In all these configurations, management and operations[19] can be contracted to a third party. The four models are explained below:

> *"Who owns a mini-grid, what is the size of a mini-grid and who are the customers of the mini-grid energy, determine the suitability of a mini-grid business model in any country. There is currently no proven business model for mini-grid development in Africa."*
>
> ***Representative of a Development Partner***

Utility Operator Models - The basic concept behind this model is that the national or regional electricity utility owns and operates the mini-grid. It is responsible for the installation, repair and maintenance, and operation of the mini-grid. Tariff collection is also the responsibility of the utility staff. To meet social objectives, the government may require the utility to charge prices at similar levels to those paid by customers connected to the national grid. If so, tariffs paid by larger consumers linked to the national grid may be used to cross-subsidize mini-grid consumers (*Franz et al., 2014*). Initial financing is likely to be provided by the utility and subsidized by the actors such as the government or donors (*IED, 2013*).[20] Presently, where grid power is not yet available, the Ethiopian Electric Utility (EEU) operates several isolated diesel generation distribution systems in the country.

Private Sector Operated Model - In this model, the private sector is responsible for building, managing, and operating mini-grids. Potential sponsors are likely to generate funding from various sources, including equity and commercial debt. Subsidized funding for such mini-grid operations may also provided by the public sector (governments) and donors through grants, subsidies, or loan guarantees. Currently, in Africa there are a limited number of examples of such models in which the entire

Critical factors related to each model

Utility Operator Models *can be scaled-up quickly, but only if public funding is available. While tariffs can be cross-subsidized with ease, this model is prone to political interference and procurement problems (International example - Tsumkwe mini-grid in Namibia, a PV-hybrid mini-grid with a capacity of 202 kW supplying power to 3,000 residents as well as 35 commercial and public-service customers).*

Private Operator Models *have a high potential for scaleup, for attracting private investments and for mobilising the know-how of the private sector. However, they require a supportive enabling environment (International example - Powerhive in Kisii and Nyamira, Kenya operates four PV mini-grids and supply electricity to over 1,500 customers in Kenya).*

Community Operated Models *are well suited to ensure local ownership and sustainability but are exposed to management risks and usually require high grant components (International example - Four hydropower mini-grids in Kenya at Thima, Kathamba, Tungu Kabiri and Kipin).*

Hybrid Models *combine different aspects of these three models and may present a good compromise and initial starting point for mini-grid scale-up (International example PPP model - In Senegal, the Government owns the mini-grid and a private company is awarded a 15-year concession to operate and maintain it. This approach has been followed by 18 mini-grids powered by solar PV and diesel generators in Senegal).*

[18] More information on SPDs and especially on SPPs can be found in Tenenbaum et al. (2014)

[19] China Village Power Project Development Guidebook; Getting Power to the People Who Need it Most; A Practical Guidebook for the Development of Renewable Energy Systems for Village Power Projects, Doe et al., SET/UNDP/GEF (2005), chapter 5.2

[20] Business models for mini-grids by Tayyab Safdar-Smart Villages, new thinking for off-grid communities worldwide

funding comes from private sources. In Ethiopia so far, no such mini-grid exists.

Improvements in technology, innovations in finance and development of customer-management platforms as well as dedicated support from donors and national governments have contributed to an increasing focus on Private Sector Operated mini-grids (*IRENA, 2016*). Yadoo (2012) observes that entrepreneurs working to establish mini-grid operations in the private sector are likely to require substantial subsides as well as an anchor customer. In Ethiopia, private organizations like Ethio-Resource Group PLC and Rensys Engineering and Trading PLC are using these models to operate mini-grids in the Amhara region with support from Power Africa.

Developing sustainable business models for private mini-grid developers remains a challenge worldwide. However, evidence suggests that there are innovations that can help operators achieve scale. The following business models have evolved keeping in mind the challenge of low revenue generation from end users while bearing operations and management costs (*Franz et al., 2014*)[21]:

Commercially viable mini-grids

Capital or operating subsidies can help mini-grids to become commercially viable for private investors.

Mini-grids that charge higher tariffs to households than the tariff charged by the national utility can support commercial viability. This model is being implemented in countries like Cambodia, Mali and Senegal but is not currently not envisaged for Ethiopia.

If mini-grid operators are able to charge higher tariff rates to commercial and industrial enterprises within the village, this can support commercial viability. This is a form of cross-subsidization.

Mini-grid operators that support increased demand through productive uses and increase the number of connected households with the ability are able to improve financial viability.

The franchise approach: Management costs are borne by the franchiser with minimum cost to the franchisee. If the franchiser has many franchisees, the marginal cost of managing an additional franchisee is reduced due to economies of scale. Dade et al. (2014) observed that franchising has the potential to improve market efficiencies and help achieve scale. This approach has been implemented in India where Husk Power Systems (HPS) has piloted the franchise model (*Palit and Sarangi, 2014*). As part of these models, HPS motivates and trains a local entrepreneur to own and operate the mini-grid. To help develop and adapt the franchise model, HPS has received support from the Shell Foundation. This business model had helped HPS expand and the company is now looking to develop technologies and tweak their business [22]model to expand their operations further in India and Africa.

Anchor, businesses and consumers - ***"ABC" model***: In this model, the operator aims to develop sites with certain characteristics. There is an anchor customer at the site that requires a consistent and stable load eg. telecom masts, agro-processing factories or gas stations, that generate a stable cash flow for the operator. Access to stable revenue can have a positive impact on the sustainability of mini-grids and help improve their bankability (*SE4All, 2016*). Local businesses can also be supplied by the mini-grid and household consumers are an additional source of revenue to augment revenues from the first two sources. A study by GIZ highlights the potential for this model to be implemented in Sub-Saharan Africa. There are more than 150,000 telecom towers in the continent and many of these are in rural areas, with little or no electricity

[21] Business models for mini-grids by Tayyab Safdar-Smart Villages, new thinking for off-grid communities worldwide.

[22] Desjardins et al., 2014 on mini-grids business models.

supply. With the increase in mobile phone coverage in Africa, this number is bound to increase further. This presents an opportunity for mini-grid operators to tap into a growing revenue stream and expand coverage in rural areas. Long-term contracts that ensure a stable revenue stream are also likely to improve access to capital. Mining and agro-processing facilities present further opportunities for the successful deployment of the ABC model. GIZ has installed such a mini-grid model in Kabunyata village in Uganda. Electricity is supplied to the mobile tower in the village using a solar-diesel hybrid mini-grid system. This has translated into 40 percent cost savings for the telecom operator on cost of fuel. Local businesses have also gained from access to electricity and have been able to save on fuel costs as they were reliant primarily on diesel (*GIZ, 2014*). Corporates can be incentivized to become anchor customers by providing tax cuts or by offering other benefits. However, a problem of the ABC model is that households receive the residual power available after consumption by the anchor load customer (*Gollwitzer et al., 2015*) which may not meet the requirements of the local community, reducing the impact that comes with access to electricity for rural communities. Also, not all sites can have anchor customers, as a study by the International Finance Corporation in Kenya shows. This would mean that potential investors are likely to ignore those areas.[23] The GoE considers the ABC model appropriate to attract private investors.

*Image SEQ Figure * ARABIC 2 (Courtesy Power Africa)*

***Clustering approach**:* When non-interconnected mini-grids supply electricity to villages located close to each other, these mini-grids are bundled together as part of one operational unit to reduce on overhead costs. Lower Bondo (80 kW) and Upper Bondo (56 kW), a cluster of micro-hydro schemes implemented by Practical Action and operated by MEGA (social enterprise) in Mulanje, Malawi are using this approach.

The cluster managers play an important role as conduits between the operating plants and the senior management of the company. There is evidence that clustering has also been implemented in mini-grids installed and operated by the government. In the State of Chhattisgarh in India, the local Renewable Energy Development Authority i.e. Chhattisgarh State Renewable Energy Development Agency (CREDA), which is operating mini-grids in remote areas of the state, has taken a cluster-based approach to reduce transaction costs (*Palit and Sarangi, 2014*). In the CREDA model, each cluster is comprised of 10–15 villages. A team in each cluster is comprised of one technician, an assistant technician and an operator as well as a village energy committee. Cluster teams are expected to meet customer requirements such as replacing lamps and implementing maintenance, supervised by management who receive regular reports (*GNESD, 2014*). The clustering approach can also help lower the cost of capital for mini-grid operators. Development financial institutions in this space encourage operators with proven track records to bundle multiple mini-grids into larger transactions to reduce transaction costs. As mini-grid operators establish track records, this model is likely to accelerate and help operators achieve scale (*Franz et al., 2014*). A recent report by ENEA, a consulting company in Zambia, shows that a cluster approach is likely to support mini-grid development. They use the

[23] Business models for mini-grids by Tayyab Safdar-Smart Villages, new thinking for off-grid communities worldwide

example of a cluster of small-scale, hydro-powered mini-grids operated by a social enterprise (MEGA) in Mulanje, Malawi. The business model is based on managing a cluster of nine mini-grids that are located near the same river. The proximity of these mini-grids contributes towards reducing MEGAs operating costs (*ENEA, 2015*). While clusters might drive economies of scale for operating costs, management of clustered mini-grids requires high levels of technical and management skills. This will be especially true as load factors increase. The lack of trained personnel in sub-Saharan Africa may pose challenges for this model which also requires government regulatory support such as concessions or in the case of mini-hydro, exclusive access to certain basins or rivers.

Community Operated Model: The mini-grid is operated and managed by the local community, organized in a cooperative that is governed by government regulations. Evidence suggests that community participation contributes to the success of mini-grids. Financing for these enterprises is primarily grant based and the local community provides contributions in-kind (*Smart Villages, 2015*). Examples of in-kind contributions include, providing land and labor as sweat equity. In some circumstances, community-managed and operated mini-grids may be able to provide cheaper electricity to rural communities (*Yadoo, 2012*). They create co-benefit opportunities for the local population such as empowerment through local management; payment for feedstock; or, if grid-connected at a later stage, income from feed-in tariffs and the potential to connect to a more resilient electricity network (*Yadoo and Cruickshank, 2012*). There is usually a lack of technical expertise within the community, therefore planning, design and implementation is done by third parties. To ensure the sustainability of such models, it is important that tariffs cover the main operations, maintenance and depreciation costs. Decision making is likely to be localized in such models. However, this depends on the scale of operation. Furthermore, it is important to ensure that the requisite skills to operate and maintain mini-grids are available in the local area. In the absence of adequately trained human capital such mini-grids are likely to be unsustainable. It will provide opportunities for what Tenenbaum et al. (2014: 25) refers to as "boutique electrification", which implies that it does not lead to sustained and significant electrification. Currently, in Ethiopia, the European Union is financing five hydro mini-grids implemented by GIZ, testing a model for distributed renewable energy generation that is based on cooperatives (Governed by Proclamation no. 985 Cooperative Societies Law of Ethiopia). This initiative is aimed at scaling up the market for private or public agencies.

Hybrid Model: These models combine different aspects of the models identified above. Different entities may be involved in investment, ownership, and operations. There is a division of labor between the responsibilities of various actors through joint ventures or other contractual arrangements. The generation and distribution of electricity can be divided between government companies, private firms or local communities in the form of small power producers (SPPs) and small power distributors (SPDs). The success of these models depend on the regulatory framework and clarity of property rights. Below are some examples of contractual arrangements that are a part of hybrid models: -

- *Public-private partnerships*: Public sector could build, operate and manage the mini-grid with the private firm responsible for maintaining the system. The Government of Ethiopia is keen on Distribution Energy Service Company (Desco) arrangements which are also viewed as a form of Public-Private Partnership (PPP) under a Build Own Operate (BOO) model.
- *Renewable energy service companies (RESCOs):* Assets are owned by the government and the machinery is operated and maintained by RESCOs who are also responsible for tariff collection.

- *Concessions*: Beneficial terms are given to the concessionaire to provide electricity to rural areas. These terms could be in the form of geographic monopolies or preferential tariffs.
- *Power purchase agreements*[24]: Distribution and generation assets are owned and controlled by different entities and a power purchase agreement is signed for providing electricity (*Franz et al., 2014*).[25]

A summary of these mini-grid business models is given in Table 1.

Table 1: Summary of Mini-Grid Business Models

Owners of power generation and distribution assets	Type of Models				
	Utility	Hybrid Model (Private/ Utility/ Community)	Private (Unregulated)	Private (Regulated)	Community
Brief description	Government or parastatal utility manages all aspects of mini-grid	Private actors generate and utility distributes the electricity, or the reverse; or private entity commercializes electricity generated by and distributed through public assets	Private company manages all aspects, in the absence of government regulations	Private company manages all aspects, in a regulated environment	Community members organize to manage generation and distribution in a regulated environment, with support and/or coordination from an NGO or private company
Advantages	Can absorb funds easily; Less regulation needed; Connection of mini-grid to main- grid can be easier; Cross subsidization of tariffs, thus affordability easily ensured; Aims to fulfill national electrification aims	Different actors contribute their strengths, technical and management know-how; Scalable, profit-able; Less conflict potential with customers in case of distribution by utility with cross-subsidized tariffs	Commercial sustainability creates incentives for long-term operation; Ability to act fast without government interference; Profitability ideally allows for scaling up of operations	Scalability through private capital; Technical know-how, high reliability; Profitability ideally allows for scaling up operation; Legal security of regulated market attracts private finance	Self-managed public infrastructure; Less conflict potential with customers and officials; Creating assets and local ownership; Enabling self-determination and economic development

[24] The agreement that governs the sale and purchase of power is known as a PPA or power purchase agreement. A PPA is a contract between two parties, one who produces or generates power for sale (the seller/producer/project company) and one who seeks to purchase power (the buyer/off taker).

[25] Business models for mini-grids by Tayyab Safdar-Smart Villages, new thinking for off-grid communities worldwide.

Disadvantages	Not the core business; Unsuitable company structure for smaller projects; Strain on fiscus; Political interference; Possibly corruption in procurement	Complex management, feasibility of models depends on regional/ local context/ structures; Non-fulfillment of contracts due to conflicts between business partners; Insolvency of one partner (either SPD or SPP) puts full operator model at risk	No financial support from public obtainable; Grid interconnection challenging/ impossible; Changes in regulation and fixed tariffs can reduce profitability; Conflicts with customers due to monopoly; Insufficient quality and safety risks of service can occur if it is not supervised, which can contribute to a bad image of mini-grids	Reliable regulation needed, dependency on lengthy approval procedures; Debt-financing needed for scaling up; Vulnerable to changes in regulation, fixed tariffs, conflict with customers; High transaction costs; Potential risk: grid interconnections	Insufficient local human (technical and management) capacity; Often unclear ownership structure; Usually high grants needed; Tariffs not covering operation and maintenance (O&M) and reinvestment costs; Corruption risk due to overlapping of management and social and family connections

All the business models have advantages and disadvantages. The various models need to be tested, taking into consideration requirements of ownership, size of mini-grids and availability of customers. Different strategies are required to make each model a success, including demand management, promotion of productive end use, quality of electricity service, tariff design, revenue collection and end user finance[26] as discussed later in this report.

Since utilities have experience in electricity generation, distribution as well as carrying out administrative processes and understand a country's legal system comprehensively, the Utility Model is often the starting point. In Ethiopia, the EEU operates around 31 isolated diesel generated distribution mini-grid systems using this model. Recently, the Ministry of Water, Irrigation and Energy (MoWIE) and EEU have identified over 250 villages throughout the country that are suitable for mini-grid electrification (solar, hydro or hybrid).

Prior to developing these sites, MoWIE and EEU launched 12 pilot projects in nine regions of the country to determine the appropriate technical, financial and operational feasibility. Private organizations, selected through a competitive tendering process, have been selected to design, develop and commission mini-grid systems at these sites within a six months-contract period and, once complete, will hand them over to EEU for commissioning.

The contracts were awarded to four international private companies, including three Chinese firms and one Spanish firm. Norinco International Cooperation Ltd. will design, develop and commission private power generation system in Oromia (Beltu and Bahima villages). Guodian Nanjing Automation Co. Ltd has been selected to develop the projects in the SNNP region (Tum

[26] https://greenminigrid.se4all-africa.org/how-it-works/help-desk-developers-and-operators/mini-grid-business-models.

and Omorata villages), and CET and R Consortium have been selected to develop projects in three regions - Somali (Qorie village), Gambella (Ungoge village) and Benishangul (Albasa village). A Spanish private company Trama TecnoAmbiental S.L. will develop projects in Amhara (Banbaho and Wasel Villages), Tigray (Arae village) and Afar (Kusrewad village). A decision on tariffs for these 12 pilot mini-grids will be taken by EEU at a later stage, based on the experience of the four private firms. These sites are geographically, demographically and socio-culturally diverse and this is likely to result in varying capital and operational costs across the sites. EEU will manage these mini-grid distribution systems and in the process will learn valuable lessons that will assist in the scaling up.

According to government sources, the Community Model in Ethiopia may improve operations and maintenance by increasing a sense of ownership in the community. However communities generally lack the technical and business skills required for running mini-grids which at times leads to higher costs from outsourcing these services. According to some private stakeholders, the Build Operate Transfer (BOT) model may be a good option for the Ethiopian context under a Community Model. Though, this requires strengthened capacities of local community to operate the mini-grid systems sustainably; which is not often the case, as observed by GIZ's experience of operating five micro hydropower mini-grids using this model. It has been noted that despite intense capacity building efforts, the community lacks the skills to successfully operate the mini-grids. From a private business perspective, it would be best if the private company builds, owns, operates and transfers the system to the community (i.e. essentially sells its assets to the community), and then the community contracts the private company to continue to operate the system on a contract basis.

The Government of Ethiopia is willing to promote private investment in mini-grids if it ensures efficiency and private companies have the capacity to offer better operation and management services. But for this model to flourish, enabling policy must be implemented. This includes the ability to charge cost-reflective tariffs, flexible and investor-friendly licensing procedures, affordable debt financing, established rules to mitigate conflicts with customers along with regulatory actions and options which are available, in the event that an existing isolated mini-grid is 'enveloped' or 'absorbed' by the main grid. The GoE has proposed three options for private investors in the case where grid extension arrives at a site where a mini-grid developer has invested. The options are (i) Desco Mini Grid Model, (ii) Grid Connected Small Power Producer and (iii) Sale of Mini Grid Assets to the National Grid Licensee. These options need to be communicated to private developers and become part of contractual agreements between the government and private developers.

Over the past few 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 empowering environment, in line with the best practices as reflected in the prevailing quality standards, custom duties and lifting of testing. Lighting Global (LG) standards are now mandatory for products up to 15 Watt Peak (Wp). This is combined with the International Electrotechnical Commission (IEC) standards that have been adopted for systems up to 350 Wp by the Ethiopian Standards Agency. For pico-PV products, the Government of Ethiopia 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. The Ethiopian Revenues and Customs Authority (ERCA), now Ministry of Revenue, 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), now Ministry of Finance on renewable energy. Larger home solar systems with quality certificates are also benefiting from this exemption (but 15 percent VAT and 3 percent withholding tax is still applicable). 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 removed the procedure of taking samples from every shipment, related testing fees, and a previous 0.5 percent deposit based on the shipment value.

Moreover, recently the developed draft of Tariff Guidelines and Methodology for Off-Grid Systems drafted by EEA in consultation with stakeholders, and presently under revision, will strengthen the mini-grid ecosystem in Ethiopia.

Image 3 (Courtesy Green Mini Grids - SEforALL Africa Hub)

CHAPTER 2: BUSINESS MODELS SUITABLE IN ETHIOPIAN CONTEXT

The government's electrification targets aim to serve at least six million households with off-grid energy by 2025 in Ethiopia, mainly in rural and deep rural areas. The Ethiopian Government aims to adopt business models that ensure a return on investment for private sector companies, ensure the availability of convenient payment options, affordability of off-grid services, and adequate quality of after sale services.

Image 4 (Courtesy Ethio-Resource Group PLC)

Presently, the GoE, with the support of development partners and private stakeholders is testing various mini-grids business models to learn what works best for the country. Mini-grids are being operated by:

- EEU adopting a Utility Operator Model;
- Private companies, with financial and technical support from donors;
- Cooperatives like in Community Operated Model

Table 2 below provides examples of these varying operating models in practice in Ethiopia.

Table 2: Mini-Grid Business Models in Ethiopia

Model Type	Interventions	Observations
Utility Operator Model	The EEU operates around 31 isolated diesel generation distribution mini-grid systems in Ethiopia. Recently, MoWIE and EEU have identified over 250 villages throughout the country that need to be connected via mini-grid technologies using solar, hydro or hybrid configurations. Prior to scaling up solar mini-grid projects, MoWIE and EEU have launched pilot projects in different regions of the country to determine the appropriate business model and technical, financial and operational feasibility. EEU has identified 12 pilot villages that need to be electrified using solar and ESS power systems with backup diesel generators. The EEU has awarded contracts to four international organizations. These private companies[27] will design, install, commission and operate the mini-grid system and deliver to the EEU after a six month-contract period. Thereafter, EEU will be responsible for managing the mini-grid distribution systems. Tariff rates will also be decided by EEU based on region specific experience.	EEU has been responsible for the installation, repair, maintenance and operation of these 31 mini-grids. Tariff collection is also the responsibility of the utility staff. To meet social objectives of the GoE, EEU charges the same tariff rates for these mini-grids as paid by customers who are connected to the main grid. This model requires fewer regulations and to connect these EEU operated mini-grids to the main grid is less complicated from an institutional perspective. Indeed, five out of the total 31 mini-grids are already connected to the main grid. In the initial stages of the growth of the sector in Ethiopia, this model helps to establish standard practices, provide learning-by-doing and informs policy related the sector in Ethiopia. However scaling up this model is challenging: it puts pressure on government funds and it is affected by political interference. This model, will likely only be adopted in limited areas and is not a scalable solution for large scale implementation in the country.
Private Sector Model	As of now, no mini-grid is being owned and managed, exclusively by the private sector in Ethiopia. However, the private model is being tested with financial and technical support of donors in the country. For example, Power Africa has been supporting private organizations like Ethio-Resource Group PLC and Rensys Engineering and Trading PLC for wind power micro-grids and solar mini-grid systems, respectively, in	In the Ethiopian context, a regulated private sector model may prove the correct formula to encourage the growth of mini-grids if agreement can be reached around tariffs. Private companies can manage all aspects of mini-grids under the overall policy and regulatory framework of the government, including tariff regulations. Commercially sustainable tariffs will create incentives for long-term operation. This model is flexible, with less/limited political interference like any other private-owned businesses. This model is easily scalable using private stakeholders' funds and technical know-how. Also,

[27] In June 2019, MOWIE has awarded contract to four international private companies, out of which three are Chinese firms namely Norinco International Cooperation Ltd. which will design, develop and commission private power generation system in Oromia (Beltu and Bahima villages), Guodian Nanjing Automation Co. Ltd that will work in SNNP region (Tum and Omorata villages), and CET and R Consortium which will establish mini-grids in three regions of Somali (Qorie village), Gambella (Ungoge village) and Benishangul (Albasa village). A Spanish private company Trama TecnoAmbiental S.L. will set-up mini-grids in Amhara (Banbaho and Wasel Villages), Tigray (Arae village) and Afar (Kusrewad village)- For more details please refer 'Ethiopian Regulatory Environment and Capacity Constraints in Off-Grid Energy Sector' report

	Amhara region. Ethio-Resources Group have been engaging with the EEA for more than 18 months to have operating licenses issued. As of July 2019 licences have still not been issued due to disagreements about tariffs and the treatment of grant funding in the capital structure of the operating company.	legal security of regulated market will attract private finance. However, for this model to work in Ethiopia, the GoE must establish pro-investor regulations, including investor-friendly licensing procedures, financing opportunities (through DBE, REF etc.), increased local manufacturing of mini-grids equipments, capacity building of human resources, policies to mitigate conflict with customers, clear and suitable regulations specifying options for private investors when grid envelopes the mini-grid etc., along with cost-reflective tariffs
Community Operated Model	GIZ/EnDev is testing cooperative model for hydro mini-grids under projects/initiatives like 'Engrin, Abaye, Timbil, Idris, Waro, Naso, Gibe, Ameka and Fuamo in Amhara, Oromia and SNNP regions of Ethiopia.	This model may be suitable in the Ethiopian context, but is not scalable from a financing perspective as it relies on grant finance for capital expenditure. Community members can manage generation and distribution in a regulated environment, with support from NGOs or private companies, provided they have the required technical and managerial capacities. With clear ownership structures and tariffs that can cover operation costs, this model can generate employment and lead to economic development at grassroots levels in Ethiopia.
Hybrid Model	As of now, Ethiopia does not have a Hybrid Model. EEU submitted an 'Off-grid Electrification Project-I (SHS & Mini-grid)' to MoFEC to be considered under a PPP model but this project was not shortlisted. The GoE is working to have an off-grid PPP project in the future.	This model could be a frontrunner for the private sector model in Ethiopia, wherein both GoE and private investors can combine strengths to contribute funds, technical and managerial skills to intensify growth of mini-grids. Since the management of this model is complex, clear operating modalities are required between the partners mainly around roles, contractual obligations, exigencies like insolvency, etc.

The EEU has recently established a mini-grid unit 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 responding to questions and complaints. The mini-grid unit is expected to play a central role for the rollout of the mini-grids programme. Within the unit, technical maintenance of mini-grids will be organized to ensure minimum downtime in case of technical failures.

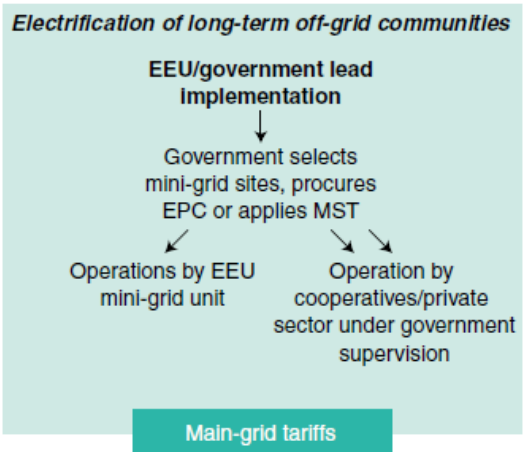


Image 5 (Courtesy NEP 2.0)

As per the mini-grid program, 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 companies that decide 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 cross-subsidy through a partially fixed payment and a per Kilowatt/hour (kWh) charge. 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.[28]

The government states that even though mini-grids and other off-grid systems may be technically well-designed, this alone will not be enough to ensure the long-term financial sustainability of projects. The reason for the failure of many off-grid projects can be attributed to the adoption of inappropriate business models. It is also important to recognize that mini-grid tariffs will depend on the type of business model adopted.[29]. EEA states that the ABC model could be the basis for successful mini-grid projects in the country. The ability to identify and sign a PPA with a bankable ANCHOR (A), and service other BUSINESS (B) customers will make it possible to supply the COMMUNITY (C) customers with electricity at lower costs, while the operator also benefits from increased sales and enhanced scale of operations. This model is not applicable everywhere as it depends on A and B customers. Outside of ABC model projects, government may have to consider options of providing incentives and subsidies to make mini-grid tariffs attractive for private investors. In Ethiopia, off-grid business models, from tariff outlook are broadly categorized as follows: -

For-Profit Model - With the For-Profit business model, the approved tariff should allow the developer to fully recover the Operations and Maintenance (O&M) and capital costs, including return on investment. To successfully implement this model, the developer must first identify an "anchor customer" which could be a commercial load, with whom it can sign a long-term contract and define important issues such as price, service quality, plant availability and reliability. Even though the developer may benefit from some concessional or grant financing, the financial viability is basically achieved through the tariff and hence, the revenue stream from the tariff collection. Since the For-profit business model seeks to optimize revenue collection, developers tend to use pre-payment meters or special revenue collection mechanisms. Developers also may establish customer service centers in the community to respond to customer service queries with technicians available to undertake site visits to solve technical problems.

Distribution Energy Services Company (Desco)

"The Government prefers for-profit off-grid business models, such as the Desco Model suitable in Ethiopian context. Of course, we have to consider general economic and social development aspect of the specified area."
An EEA Officer

The Distributed Energy Service Company or Desco is a commercial business model where the private company installs energy generating assets and installs and owns the local grid infrastructure. In contrast to typical utilities, (national or private) the DESCO does not focus on delivering "free-flow kWhs" but rather charges the customer by supplying energy services eg lighting, cellphone charging; the ability to use a fan, TV, radio, computer; or power for a retail business.

[28] National Electrification Program (NEP) 2.0

[29] Tariff Guidelines and Methodology for Off-Grid Systems zero draft developed by EEA

The Government of Ethiopia is keen on implementing mini-grids using a DESCO type of arrangement under a Public-Private Partnerships (PPP). This business model requires the main distribution licensee to build good customer relationship by connecting off-grid customers and collecting the electricity tariffs from the consumers. The main distribution licensee can provide each market segment with the agreed services. For instance, the licensee can decide to provide enough electricity for basic services such as lighting, mobile phone charging, television, computer usage, small businesses etc. To successfully operationalize the Desco Model and make it affordable, the licensee can either eliminate upfront connection fees or spread the upfront costs over a period. The distribution licensee can adopt Pay-Per-Use Model, Rental Model or Lease Finance Model to ensure cost recovery and financial sustainability.

The pay-per-use model requires the licensee to charge consumer tariffs based on the services used or consumed (i.e. based on kWh), or per hours of supply of certain services. Under this approach, the consumer buys the right to certain amount of supply of electricity for certain period of time, with no further commitments. Under the rental model, the consumer is required to make fixed periodic payments or pay fixed fee per week or per month, even if he/she does not use the appliances. As per this approach, a consumer has access to certain hours of supply of electricity or a certain amount of electricity consumed and the consumer pays regular and periodic fees on a weekly or monthly basis. A lease finance model is used if the distribution licensee also installs stand-alone solar systems as a way of enhancing accessibility. With this approach, the licensee may decide to sell its assets to consumers after they have made certain payments over a period of time. Under this approach, consumer has access to certain hours of supply of electricity or certain amount of electricity consumption and after the end of the contractual period, the assets are owned by the consumers.

To ensure a high level of revenue collection and to achieve financial sustainability, the government suggests companies use specific revenue collection methods, including use of an Agent (The licensee can appoint an agent from the off-grid community to manually collect the fees from consumers - this method is known to reduce the risk of delinquency); use of scratch cards (this approach requires consumers to buy scratch cards from vendors, similar to mobile phone top-up cards, to either activate access to the system or top-up usage credit for a given level of service or period of time); and use of mobile money (this involves the use of mobile phone for virtual payment where the system activates or tops-up usage credit. This method is similar to what is commonly used for mobile money transfer).

Partly-Subsidized Model – The partly-subsidized off-grid business model is based on approved tariffs which enable the developer to recover only the O&M costs, while capital costs, including return on investment are subsidized from external sources or from the government. The partly-subsidized model usually relies on grants or concessional finance from the government, multilateral or bilateral agencies, to cover the capital and in some cases the O&M expenses. This implies that a large portion or all the capital costs are subsidized but the O&M costs are usually recovered through the tariff.

Thus, this model focuses on grid reliability to ensure a steady flow of revenue to cover all O&M expenses. Unlike the For-Profit Model which is developed around an “anchor customer”, the partly-subsidized model does not focus on customer selection or the customer’s ability to pay. The aim is to strike a balance between supplying profitable consumers, as well as the entire off-grid community or village, irrespective of the ability to pay. Customers for this model are often poor rural dwellers and for successful implementation of this model, it is important that the

developer achieves service reliability to maintain customer loyalty. Under this business model, developers must strike a balance between factors that enhance O&M cost recovery, with efforts which will incentivize community involvement and cooperation. The GoE is keen on establishing this model in rural villages where there are no opportunities for anchor customers and has proposed using subsidies from the government reserves or from development partners, to cover capital costs with tariffs enabling the developer to recover the O&M costs.

Wholly-Subsidized Model - Under the wholly-subsidized model, the focus of the off-grid developer is not on cost recovery, but rather on preventive and corrective maintenance usually using contractors in the short term. This is usually complemented by in-kind local community labor for non-technical maintenance. The wholly-subsidized model also relies on grant and concessional financing to meet its expenses. The aim of using contractors is for the expert to work with the local community technicians and build their capacities through hands-on training so that they can manage, operate and maintain the off-grid systems in the medium to long-term.

Cost recovery and minimizing the impact of high cost of generation from the off-grid systems is expected to be achieved through the tariffs by utilizing the 'Bulk Generation Charge tariff Methodology', to calculate the system generation tariff. This approach also seeks to achieve implicit generation cost cross-subsidization by using low-cost generation to cross-subsidize high cost generation for off-grid systems. Whatever model is adopted, it should be complemented with building the capacities of off-grid local village or community, through hands-on training so that they will be able to operate and maintain the off-grid system to help reduce operating costs.

For developing mini-grids in areas within 25 km of the existing network, the Government of Ethiopia intends to harness the expertise and capacity of the EEU, 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, implementing progress and lessons learned like from the first EEU - EPC pilot of 12 solar mini-grids. The government is considering the scale-up of two business model options-

(i) Ethiopian Electric Utility (EEU) - led with Engineering, Procurement and Construction (EPC) .

(ii) Private sector or cooperatives to install generation assets, 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.

EEU-led with EPC projects are similar to turnkey projects where private companies will provide required human and material resources for the development and construction of mini-grids. The private companies will coordinate with different actors involved in the process of establishing mini-grids and will be responsible for conducting all design, engineering, procurement, construction, commissioning and testing activities. These private companies (EPC contractor) will undertake the entire risk of mini-grid establishment, in lieu of a fixed contract price established by EEU with mutual consensus. Besides, EEU and private company will agree on a fixed completion date for the overall contract, and activities will be linked to specific milestones to facilitate accountability of payments. As part of the EPC contract, the EEU will manage issues related to monetary security, supplier's warranty, defect liability as done in general EPC contracts.

The GoE considers this model economical as one company coordinates all the work unlike in

traditional option, which consists of contracting the development and execution of mini-grid projects separately, commissioning different agents. Under the EPC program, private companies will deliver completely functioning mini-grid facility to EEU by carrying out the design, engineering, procurement and construction until a set date, in return for a predetermined price. It is important to note that EPC contracts do not constitute private sector investment – the EPC Company is paid to develop a fully functioning mini-grid and this does not facilitate medium of long-term investment.

Under the second model, private stakeholders or cooperatives will install, operate and maintain mini-grids along with recovering tariffs as per the agreed rates, but ownership of the distribution assets will lie with the EEU.

Even though Ethiopia has to date, no fully privately owned mini-grids, the government is keen on supporting both public and private actors, public-private partnerships (PPP) as well as cooperative models. Lessons learnt by the testing of ongoing utility, community and donor supported private business models in the country will inform changes that need to be made to advance the enabling environment. Moreover, international best practices in other Asian and African countries will also guiding the government's off-grid development agenda. .

In this current early stage of mini-grid development in Ethiopia, Utility and Cooperative led business models are relevant to test the concept. However, providing off-grid/mini-grids energy to millions households by 2025, will require a rapid ramp up through involving the private sector. Private companies will invest their money in the Ethiopian mini-grid space only if they can achieve the necessary returns on their investment and cost reflective tariffs are clearly a precondition for this. In its Tariff Guidelines and Methodology for Off-Grid Systems (draft), EEA has reflected this understanding along with the options available for private mini-grid operators when the grid arrives. EEA is hopeful of finalizing this set of guidelines by July 2019.

CHAPTER 3: BUSINESS MODELS - BEST PRACTICES

Mini-grid models vary according to (i) the ownership and management of the distribution and generation assets of the mini-grid as discussed in the previous chapter; (ii) size (varying from a few kilowatts to up to 10 megawatts); (iii) and customers (which may include households, small businesses, large anchor clients or a mixture of all three). While some business models as starting to gain traction, there are arguable as yet no proven mini-grid business models in Africa.

In the section below, we outline experience from various developing countries:

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 systems. 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.[30] 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 the income brackets. Commercially viable and non-viable areas were identified based on geo-spatial mapping, MTF (Multi-Tier Framework) survey, a willingness to pay survey, analysis of existing market trends and consultations with companies. With support from the World Bank, Kenya undertook a geo-spatial mapping exercise and a multi-tier framework survey. Geo-spatial mapping enabled the government to determine the most appropriate 'least-cost' solution for meeting the current levels of demand around the country, while the multi-tier 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.

Solar mini-grid in western Kenya

Image 6 (Courtesy http://cleanleap.com)

In Ethiopia also, a Multi-Tier framework (MTF) global energy access survey was conducted in 2017, which provided a more accurate baseline assessment of the access outlook in the country. MTF[31] survey was conducted in both rural and urban areas for the development of a baseline to track progress toward the achievement of universal access, and the results now constitute the

[30] National Electrification Program 2.0

[31] 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.

baseline for access in the country. Through the tiers approach, the survey supplemented and complemented EEU customer accounts, gathered further 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. Besides, the GoE also conducted a geo-spatial analysis and mapping, reflecting the digitized location of the existing medium voltage (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 comprising solar systems and mini-grids.

The mini-grid system in Kenya has traditionally been managed by the national utility. Over the last few years, there has been a change in the policy framework and, like most countries in sub-Saharan Africa, the government has set-up a rural electrification agency. There is now a move to convert diesel-based plants generating electricity in these mini-grid systems to hybrid systems. At least nine of the 21 operational mini-grids had been hybridized (solar/wind) by 2014 in Kenya (ECA, 2014). The Government of Kenya through the Privatization Commission has also developed a public-private partnership model for the hybrid mini-grids. The government has been establishing mini-grids under public-private partnership (PPP) model, jointly implemented by Rural Electrification Authority (REA) and the national utility, the Kenya Power and Lighting Company Limited (KPLC). Private companies build generation and distribution network and operate and maintain those assets over seven to ten years. The mini grid customers are being charged a regulated tariff, paid to KPLC. The private companies receive monthly payments from KPLC for services provided under the Power Purchasing Agreement (PPA). Involving private sector has supported the scalability of mini-grids using private capital. The private investors have technical skills and trained manpower to manage the infrastructure, which is stimulating the growth of the sector in Kenya.

China represents one of the most successful instances of state-directed electrification by utilizing mini-grids. Off-grid systems in the country were primarily based on small-hydro power generation systems. In 2001, the Chinese central government launched the Township Electrification Program with a target of supplying electricity to 1,000 townships, which is equivalent to almost 1 million people. Within a span of 3 years, 377 villages were electrified using small hydropower (264 MW) and 688 villages with PV and PV-wind hybrid mini-grids (20 MW) (*Zhang and Kumar, 2011*). Local communities also have some agency in the system as tariffs are decided by the village committees (*Bhattacharya and Ohiare, 2012*). Furthermore, there was a major focus by central planners on developing the local capacity for designing, operating and maintaining systems. This supported the decentralization of off-grid energy systems in the country, as capacities were available at grass root levels.

China pursued the development of small mini-grids where the plants first operated in standalone mode and were then connected to the national grid as it expanded into the rural areas. The Chinese program remains one of the biggest decentralized generation programs. It also shows that there is no inherent in-built inefficiency in government sponsored and operated mini-grids.

The **Nigerian** Federal Government is piloting a program to provide electricity to rural areas in different zones of the country. Communities in most of these areas are remotely inaccessible,

therefore traditional grid extension projects are prohibitively expensive. As part of this initiative, a solar-based mini-grid project has been installed in one such community. In this example of a hybrid operation model, the local community provided land and is also supposed to provide ongoing security for the site with the rest of the funding coming from the Federal Government of Nigeria. Through the project, 120 households have been provided with electricity. In Ethiopia also, the government is considering persuading communities to provide land and manpower to private companies under overall regulations as per the national laws. This model requires financial and technical cooperation from private investors, government and communities.

Image 7 (Courtesy Simi Vijay Photography/for the World Bank)

In some countries, the deployment of mini-grids in rural areas has been quite successful based on public-private partnerships. **Mali** presents an example of such a case. In 2015, there were around more than 160 standalone mini-grids in operation being supervised by the Malian Agency for the Development of Domestic Energy and Rural Electrification (AMADER). Each mini-grid on an average provides around 500 connections. The development of the market for private mini-grids was supported by the government through AMADER with support from the World Bank and the German Development Bank (KfW). While the mini-grids are operated by the private sector, AMADER plays an important role as it provides potential investors in smaller mini-grids with a substantial percentage of initial capital costs of up to 80 percent of the project value. Grants are released based on potential investors reaching certain milestones. To ensure that the investor(s) has a stake in the business, they are supposed to cover the remaining amount within 60 days of the start of construction. Recently, AMADER has also started providing capital cost support for hybridization of the diesel-based mini-grids. Potential investors are granted revenue certainty as they are provided monopoly rights to sell electricity for 15 years in the area. Private operators are also allowed to set their own tariffs. However, final approval is provided by AMADER (*Rai et al., 2015*).[32]

In **Tanzania**, there are a number of private sector-operated mini-grids. Private companies have been involved in establishing solar-diesel hybrid mini-grid systems to provide electricity to rural communities. E.On off Grid Solutions (EOGS), using their brand name Rafiki Power, developed and installed a containerized hybrid system which is comprised of a 6 kWp PV array and battery storage with a capacity of 20kWh. The system installed in Itaswi village with a population of 1,000 people also includes a kiosk with various services such as a refrigerator and a battery charging station. The mini-grid system is connected to 130 households in the village and includes smart meters. In other areas, such as Terrat in Northern Tanzania, the mini-grid is community-owned and managed. Electricity is generated by a 380 kW Jatropha seed-based biodiesel plant. The plant provides electricity through a mini-grid system to 224 households in the village along with several small and medium-sized enterprises. Households and businesses are metered and are charged at higher rates than the national grid. There are plans to augment biofuel-based generation with a biogas plant (*SVI, 2015*). The government is also piloting hybrid operational models through public-private partnerships.

[32] Ibid.

India has witnessed some success in the deployment of private renewable energy based mini grids. The dominant technology in the Indian scenario seems to be solar, followed by biomass and hydro-based grids. Public policy has played an important role in the dominance of solar models. Biomass based mini-grids have also played an important part in increasing decentralized energy access to communities in rural areas of India. Husk Power Systems (HPS) and DESI Power[33] are two companies that are working in this area and have established biomass based mini-grids. Both companies began their operations by installing plants that utilize rice husk as the basic fuel and have now diversified to other biomass sources, including wheat husks, elephant grass, mustard stems, corn cobs etc. (*GNESD, 2014*). A typical plant of HPS supplies electricity to 300-400 households in a cluster of two to four villages within a radius of 1.5 km (*Bhattacharya, 2013; GNESD, 2014*). Husk Power Systems has been funded by several social venture capital investors such as Acumen Fund and Bamboo Finance, corporate foundations like the Shell Foundation, multilateral institutions such as the International Finance Corporation and Ministry of New and Renewable Energy (MNRE), Government of India (*Husk Power Systems, nd*.).

Nepal uses the community model. There are more than 200 community-based organizations (CBOs) operating in the country under the ambit of the government supported, National Association of Community Electricity Users Nepal (NACEUN). Local community members are trained to operate and maintain the infrastructure. Electricity is sold at rates that are fixed by the National Electricity Authority. CBOs also provide their members with small loans to buy equipment to set up productive enterprises so that they can take advantage of access to electricity.

Image 8 (Courtesy Wind Power Nepal)

Community-based mini-grids are also being operated quite successfully in other countries in South Asia such as **Pakistan**. Similar small-scale systems are also working in **South America**. In northern **Peru**, Practical Action installed a small 40 kW hydro-based mini-grid to serve 160 households in Tamborapa Pueblo. The project was part of an initiative by the Inter-American Development Bank to promote mini-hydro based power systems. Capital was provided by local and state agencies while the community contributed in kind through unpaid labor. Electricity is available 24 hours a day and has been used for many productive and household activities. Similar examples can also be found in **Sri Lanka** where the private sector and other stakeholders like non-governmental organizations have played an important role in organizing communities to deploy mini-grids. Local communities have been organized into "Electricity Consumer Societies" and the model has been highly successful (*Ariyabandu, 2005*).

The installation of mini-grids is driven by several objectives, including political, economic and even partner-state programs. Private and community built mini-grids are also seen, however, these are usually driven by economic motives. A variety of operator models have been used to install mini-grids around the world – ranging from concession to anchor-client or NGO-driven to utility operated. Still, adequate policy frameworks for mini-grid projects are yet to be developed in most countries. A few case studies[34] are demonstrated in Table 3.

[33] Decentralised Energy Systems (India) Pvt. Ltd

[34] Mini-grid Policy Toolkit- Policy and Business Frameworks for Successful Mini-grid Roll outs

Table 3: Case Studies on Mini-Grid Models

Location	Mini-grid Technology and Operator Model	Remarks
Cape Verde	AC-coupled wind-PV-diesel hybrid mini-grid Community Model (donor led, grant-based).	Solar/wind diesel hybrid applied in a remote island for rural electrification. Relatively expensive.
India	Biomass PV mini-grids regulated private sector PPP model (Subsidized private sector model with reducing subsidies and semi-commercial roll-out).	Indian experience in hundreds of off-grid communities has special relevance to Africa.
Kenya	Diesel gen-set with solar additions Model: national utility led model.	Diesel mini-grids as examples of the most prevalent type of mini-grids in Africa. The case study explores how the addition of PV to a diesel system can improve performance (on-going KPLC projects).
Namibia	AC-coupled hybrid inverter technology Hybrid (utility and community aspects, and system design optimization)	Hybrid diesel-PV mini-grid as an example of the importance of project design, whereby, ideological considerations are proven to be not very practical.
Rwanda	Mini-grids that are subsequently connected to the main grid model: regulated private sector-led installations (incorporated into the national grid)	Privately created micro hydro plants and mini-grids showing that local organizations can be strong enough to develop, finance and operate micro hydro plants; the initial systematic assistance pays off as these project developers are now technically and financially capable of replicating their experiences. The regulatory framework is crucial, which in this case prevented the mini-grids from being built.
Senegal	AC-coupled hybrid inverter technology Hybrid (concession model).	Mini-grids as a representative case study for the West African experience of government-subsidized PV/diesel hybrid mini-grids to fill in areas not serviced by the national grid.
Somalia	Unregulated private sector led.	No alternatives planned so the private sector stepped in.
Tanzania	Gas-fired generator mini-grid (bio waste, biogas, etc.) regulated private sector led (anchor client led model incorporates into national grid).	Tanzania experience of Tanzania Wattle and their biomass based mini-grid is relevant to Africa.

International best practices related to growth of mini-grids clarify that private sector involvement is mandatory for scaling up mini-grids across the length and breadth of a country, and Ethiopia is no exception. The success of mini-grid business models depends on geographic, political and social context besides ownership, size, management and clientele. Hence, it is necessary to test business models before cascading them. In Ethiopia, currently the government is playing a larger role in establishing and managing mini-grids. However, soon country specific, pro-private investor models are expected to emerge.

CHAPTER 4: MINI-GRID ECONOMICS AND FINANCING MECHANISMS

Mini-grid operators need to cover their costs and a risk-equivalent return through revenues to be attracted to invest. The costs of mini-grids accrue through project development and investment (also reinvestment), cost of generation and distribution assets, running cost from operations, maintenance and management. Revenues for mini-grids originate from connection fees, electricity sales and grants or subsidies. Connection fees, electricity sales and sometimes subsidies depend on the number of customers, their willingness to pay for electricity which has a direct bearing on mini-grid economics along with customers' electricity demand.

To estimate profitability, mini-grids need precise predictions of electricity demand. Investors must assess power demand for the near future in rural areas where people do not have personal experience with electricity, and then accurately estimate demand growth over time. The daily and seasonal demand for electricity depends on various factors, including income patterns of consumers and therefore, available cash for consumer applications of electricity, seasons and their influence on lighting, cooling loads and other loads, operation of small industries, businesses, farms etc., crop cycles for farming-related productive loads (e.g. irrigation, milling), efficiency of appliances and machines, and occasional events like festivals and weddings causing ad hoc increase in demand.[35]

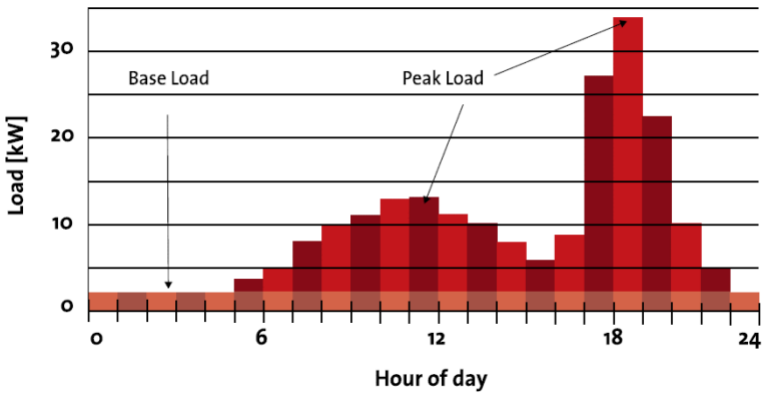


Image 9: Typical load curve of a large mini-grid

Thus, the mini-grid must be sufficiently flexible, technically and in its operator model and tariff model to meet the demands of customers as matching customers' electricity demand with the electricity supply is critical from both an economic and technical perspective.

From a technical perspective, like in all electricity grids, electricity supply must meet electricity demand. Yet, as mini-grids have fewer customers and less varied consumer types than national grids, the concurrency of demand is higher and load profiles are more volatile. A typical mini-grid load curve with mainly residential customers can be seen in image 9, with some productive use during the day, a peak from lighting and television (TV) during the evening hours, and little demand at night. The technical solutions for meeting demand have costs. Moreover, a basic economic perspective is that the more electricity produced in a system can be sold, the lower the tariffs for the customers can be. Consequently, mini-grid economics mainly depend on electricity demand, electricity supply, fixed and variable costs, and the potential revenues. Electricity demand, electricity tariff plus connection fees, and electricity supply are interdependent. For example, the lower the electricity tariff the higher the overall electricity demand but low margin on electricity supply costs. Investment and running costs in mini-grids can be split into fixed and variable costs (Please refer Table 4).

[35] Ibid.

Table 4: Fixed and Variable Costs

Fixed costs	Variable costs
Typical fixed costs are generation and distribution infrastructure costs. These include the depreciation of assets, interest on debt and fixed taxes and fees (e.g. on infrastructure and land). Further, fixed costs include overhead and transaction costs, local management, and local operations such as local power plant operation, money collection, maintenance, guards, customer relationship management, fixed technical losses (self-consumption of inverters, batteries, iron losses of transformers, etc.) and cleaning of equipment and buildings.	Variable costs increase with demand in mini-grids. They are for example fuel costs, lubrication oil, maintenance costs that depend on runtime/energy throughput, load-dependent technical losses (conversion losses of inverters, copper losses of transformers, battery storage losses), battery depreciation and revenue- or energy-related taxes. In biomass systems, the variable fuel and maintenance costs are increased. In hydro power stations, fixed asset depreciation is higher.

Fixed costs are independent of variations in the number of kWh produced, show marginal or no short-term dependency on the number of customers connected, and depend only marginally on the number of sites serviced. Variable costs, on the other hand, increase with electricity generated. Besides costs, revenue and tariffs are also important factors that impact economic viability of mini-grids in a country.

Revenues can be acquired through connection fees, subsidies and tariffs. In general, monthly electricity bills of more than 7.60 EUR are not affordable for a large share of the rural population. Thus, spreading connection fees, obtaining subsidies, and offering different tariff or service levels for customer groups usually improves the affordability for customers (Banerjee et al., 2008; World Bank, 2008).

In addition, the amount of subsidy available also influences the average tariff, the affordability and the scalability of mini-grids. Higher subsidies result in lower tariffs and more people can afford the tariffs.

Grants and subsidies must be high enough to allow affordability for customers (increasing electricity access), and hence, increasing electricity demand and improving the economics, which in turn can attract private investors. At the same time, grants and subsidies should be as low as possible to allow scaling up beyond a few pilot projects and upgrading of existing mini-grids. In fact, more than grants and subsidies, private companies are attracted to invest in mini-grids due to attractive tariffs.

Pay-As-You-Go and mini-grids

Pay-as-you-go means that electricity customers pre-pay and consume electricity based on the availability of cash. This means that electricity consumption can vary considerably with time. This is not well suited to off-grid electricity systems with high fixed costs such as PV and battery based mini-grids. In such systems, the operator must try to sell all the electricity produced before it gets lost, which occurs when the battery is full. The lower the amount of available/produced electricity that is sold, the lower the revenues and the higher is the tariff per kWh. Thus, a daily electricity demand that uses all the electricity produced would be favorable for the system's economics and the affordability of electricity for all mini-grid customers. To provide the flexibility required for pay-as-you-go payment and related varying load curves, a more flexible power source is required. This power source should have a low investment cost and can have higher operational costs. A diesel generator would be such a power source. For PV-based mini-grids, flat-rate or take-or-pay contracts are thus more suitable than pay-as-you-go.

Tariffs for mini-grids could either be pure flat rate/basic prices (which are fixed regardless of electricity consumption), pure energy prices (which are tariffs-based, solely on the consumed amount of energy) or a combination of both. Electricity customers usually prefer higher energy tariff components over higher fixed basic tariff components since this provides them with

more financial flexibility. As customers usually oppose high basic prices that reflect the fixed costs, the calculated margin can only be realized by selling a certain amount of electricity (kWh) per year. Any kWh sold beyond the planned electricity sales volume will generate an extra margin.[36]

From a mini-grid point of view, the risk would be lowest if the tariff would have a combination of both prices, where revenues from the fixed basic tariff exactly covered the fixed costs and energy prices are slightly higher than variable costs. Unfortunately, high fixed tariff components do not incentivize customers to use electricity efficiently.[37]

This efficient use of energy is, however, necessary in a mini-grid system with limited power generation and distribution capacity. Flat rate tariffs are nonetheless used in nano-grids and mini-grids, although their appropriateness is questioned. A tariff consisting of the energy tariff component only, like in a pay-as-you-go scenario, results in the highest possible risk for the mini-grid operator[38]. Table 5 explains different tariff structures in mini-grids and the schematic diagram[39] in image 10 below, shows how electricity prices can be derived from electricity generation, distribution and sales costs.

Table 5: Tariff Structure in Mini-Grids

1	Energy-based tariffs **depend on the actual electricity consumed and are thus, based on measured kWh. For example, one PV diesel hybrid mini-grid in Bangladesh has a connection fee of c. 47 EUR and an operational tariff of c. 0.28 EUR/kWh (Philipp, 2014).**
2	**Power-based tariffs** are based on the expected power consumption, which in turn, determines the maximum power available for the consumers. These tariffs are calculated on a Watt basis. A basic tariff would limit consumer consumption to, for e.g., 60W and charge each consumer 5.54 EUR each month (ESMAP, 2000). It might also be linked to the number of light bulbs and appliances that the consumer proposes to use.
3	**Fee-for service tariffs** charge for services provided and not per unit of energy. The tariff is based on kg, hour, liters or other units of service, for e.g., TV service: 0.68 EUR per hour per.
4	**Customer class tariff regime** sets diverse tariffs according to consumer group, for e.g., residents, institutions and businesses. It is mostly used to cross-subsidies residents.
5	**Stepped tariff regime** includes different tariffs depending on consumption level of the consumers.
6	**Progressive tariffs** consumers pay low tariffs for the first kilowatt-hours (or Watts) and higher tariffs for further consumption (cross-subsidization). It may also include a lifeline tariff, which basically is a subsidized tariff providing basic electricity needs.
7	**Regressive tariffs** larger consumers pay a lower unit price.
8	**Flat-rate tariffs** fixed tariffs that do not depend on electricity consumption, and only need a load limiter as a metering technology.
9	**Time-based tariffs** variable tariffs based on the time of day. They are mostly applied for commercial and industrial consumers and are also used for load scheduling (Demand Side Management).
10	**Flexible tariff structure** includes tariffs that change according to electricity demand or power demand, providing incentives for electricity usage when surplus energy is available. Here, advanced

[36] Ibid.

[37] SBI (2013). Scaling up Successful Micro-Utilities for Rural Electrification; Private Sector Perspectives on Operational Approaches, Financing Instruments and Stakeholder Interaction

[38] Development and Rural Electrification" TOOL: MGPT Financial Model for Mini-grids (minigridpolicytoolkit.euei-pdf.org/tools)

[39] The Y axis shows the cost/price, and the X axis shows the amount of electricity sold per year

	metering systems are needed.

GoE and private investors consider that energy-based tariffs, fee-for service tariffs and flat-rate tariffs are appropriate in the Ethiopian context.

A suitable mini-grid model needs to consider that private mini-grid operators in Africa expect a project Internal Rate of Return (IRR) of at least 12 percent and an equity IRR above 16 percent. These IRRs are adequate for social entrepreneurs and impact funds but purely profit-oriented companies and investors will likely require higher returns. Private stakeholders in Ethiopia appreciate that acceptable/viable return on equity will depend on the size of the investment, geographic location etc.

The return on equity on mini-grids should be at least equal to or exceed return on equity on bank shares (20-40 percent).

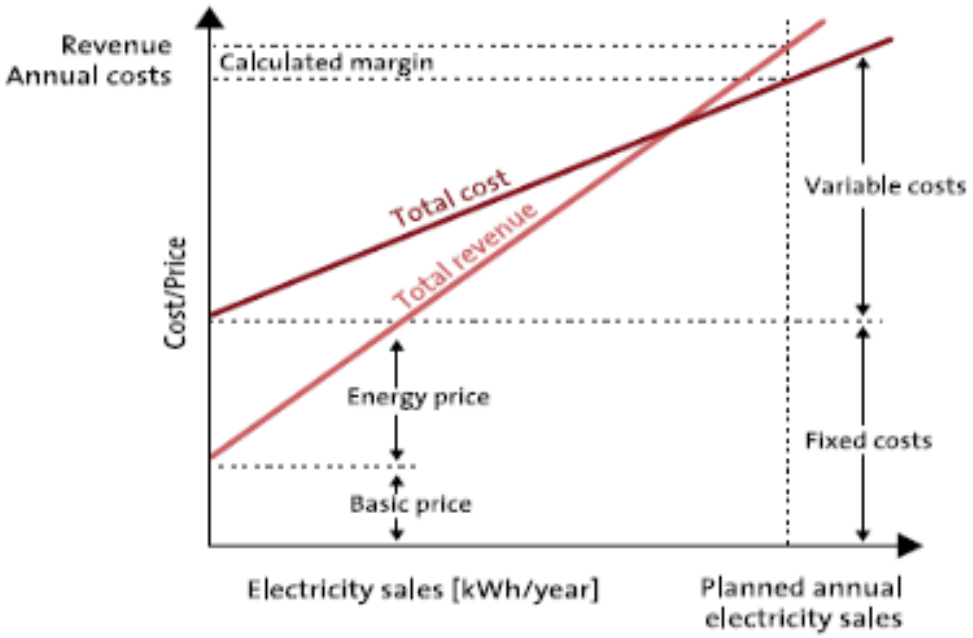


Image 10 Schematic mini-grid electricity costs, prices and profit margin (Müller, 2001)

Table 6 shows simulation results of a PV diesel-battery mini-grid system based on data adapted from a real-life example in Bangladesh, including the technical design, capital structure, cost summaries, financial indicators and tariff design. This is considered as an exemplary mini-grid model for developing countries.

Table 6: Exemplary Mini-Grid Model Results of Bangladesh

Technical System Design	
Solar PV	100 kWp
Diesel generator size Battery size	100 kVA 560 kWh C 10
Battery inverter size	60 kW
System type	Mixed AC/DC coupled
Mini-grid length	Approx. 3.5 km
Mini-grid efficiency	96 percent
Capital	
Equity	20 percent
Debt	30 percent

Grant	50 percent
Total investment	520,000 €
Renewable Fraction	
Renewable fraction	47 percent
O&M&M Cost Summary 1	
Diesel price on site	0.70 €/L
Overheads	15,000 €/year
Financial Indicators	
Project IRR	10 percent
Equity IRR Project lifetime (in simu).	15 percent 20 years
Debt Terms	
Tenure	10 years
Grace period	2 years
Interest rate	6 percent
Type	Constant principal amount
Tariff	
Electricity sales price Purely energy based No fixed basic tariff comp.	0.43 €/kWh This is a deviation of the simulation from the actual setup
Electricity sales	
Average electricity sales	420 kWh/day
O&M&M Cost Summary II	
O&M on site	10,000 €/year
Battery/inverter replacement	After 7 years/5 years

A cost-reflective tariff is a major precondition for increased private investment in mini-grids, globally. The tariff-setting process can be used by project developers and regulators. Usually, there is a national regulatory authority that must approve tariffs with the objective of guaranteeing fair tariffs for the customers. In Ethiopia, EEA is mandated to promote investment in off-grid electrification under Energy Proclamation No. 810/2013. The Proclamation empowered the regulatory agency to perform its role regarding regulation of both grid-related and off-grid tariffs. EEA is yet to approve off-grid (including mini-grid) tariffs in the country. However, the tariffs are expected to be at a level to attract private investors which is important for the development of the sector.

Along with understanding the economics of mini-grids, availability of financing options and sources of investment is a key ingredient for the growth of the sector. As discussed earlier in this report, mini-grids are financed both by public and private finance mechanisms, including project and corporate finance (Please refer Table 7).

Table 7: Understanding Project Finance and Corporate Finance

Project Finance	Corporate Finance
Project finance refers to the financing of a project based on the projected cash flows of the project and the value of the asset. A project's financing is typically non-recourse, the lenders have recourse to the assets of the project itself, but they have no recourse to the owners of the project. The lenders are repaid by project cash flows or, in a worst-case scenario, by foreclosing on the project and acquiring the project assets. In a typical project financing, a special purpose entity is created to own the assets of the project and enter into the financing documents and the project documents, including Power Purchasing Agreement (PPA).	Corporate finance, by contrast, is based on the balance sheet of the entity receiving the financing. Lenders have recourse to all assets of the entity, but they do not have a security interest in any assets. There are typically no (or very few) restrictions on cash flow. Documentation is relatively light. Raising funds through corporate finance may be cheaper than through project finance. However, corporate finance is only available to fairly credit -worthy borrowers, and where the financing providers are confident in a relatively deep secondary market. Capital markets are unlikely to take construction risk.

The nascent state of the mini-grid sector, as well as the political pressure to limit tariffs, are the main reasons to justify the need for grant funding (Public financing) (*Tenenbaum et al., 2014*). Capital subsidies are a common method of reducing project costs. They can offset the high costs of grid infrastructure and user connections and be disbursed in intervals to ensure performance. Capital subsidies may be calculated based on the number of connections, total capital costs, or project Internal Rate of Return (IRR). Grants typically support projects to achieve equity IRRs in the range of 15-20 percent[40], which may not be an adequate return to compensate for the risks encountered in developing country projects. Besides capital costs, grant funding may be used to provide technical assistance (TA) for feasibility work to make projects investible, or to balance development risk by providing grants to match equity commitments[41]. While the structure and volume of subsidies are important, attracting private capital requires an efficient disbursement process. Subsidy programs that are not responsive, generate high transaction costs and delivered by inefficient government agencies, will fail to deliver the sector stimulus they aim to achieve[42].

Under the private financing mechanism, the capital required to start a business or to build an infrastructure project is usually obtained by raising either corporate or project finance. Mini-grid distribution and generation assets can be financed using both approaches. A private company that builds these assets could raise funds at the corporate level or establish a Special Purpose Vehicle (SPV) for which it could arrange project financing.

[40] This IRR is typical for projects realised in industrialised countries, which comprise lower risks than projects in developing countries

[41] Mostert, KfW (2005). Financing Renewable Energy; Instruments, Strategies, Practice Approaches. Justice, UNEP (2009). Private Financing of Renewable Energy - A Guide for Policymakers

[42] Mini-grid Policy Toolkit- Policy and Business Frameworks for Successful Mini-grid Roll outs

Communities generally do not have a balance sheet/track record to raise corporate finance. Instead, community mini-grids are developed and implemented by a third-party project developer that structures a project entity, into which financing would be raised, and in which the community would have some ownership based on their contribution in terms of land, labor, materials, etc.

"We don't prefer corporate financing of mini-grid projects. Our policies and proclamations recommend project financing. Private companies intending to work in mini-grids in Ethiopia should establish a Special Purpose Vehicle (SPV) for which they could arrange project financing. We don't go for corporate financing because any such debt will be transmitted to the country's balance sheets, which we don't want to see this. Since, Ethiopia's debt burden is already very high. So, the PPP policy doesn't allow corporate financing. Also, we don't allow mother companies to invest as a PPP without establishing the project company (in the country)."-

PPP Project Development and Monitoring Directorate Officer

As mentioned earlier, project finance is considered to be more appropriate for mini-grids, as they are highly capital intensive. However, project finance is a challenging solution in the near term. Even bundled mini-grid projects are relatively small, and project finance is difficult to justify below 20 million EUR[43]. Project finance equity investors accept lower internal rates of return (IRR) due to predictability of cash flows, which mini-grids do not necessarily provide. Since project finance for mini-grids is hard to come by, most mini-grid development companies are raising corporate finance from equity investors to build demonstration projects and develop their business models. Through corporate finance, a developer may be financed in multiple transactions as it deploys systems, in contrast to an infrastructure project that requires a large financial commitment at "financial close" prior to the start of construction.

Ethiopia encourages project finance

In the Ethiopian context, both private investors and government stakeholders consider project financing as a more viable option for financing of mini-grids. The GoE's Public Private Partnership Proclamation (PPP Proclamation) No. 1076/2018 and Public-Private Partnership Policy (PPP Policy) 2017 advise to follow project financing for infrastructure projects, including energy. Article 44 of PPP Proclamation states that the PPP Directorate General shall require that a successful private bidder establish a Project Company incorporated under the laws of the Federal Democratic Republic of Ethiopia whose sole purpose shall be to execute and implement the Public Private Partnership Agreement and other Project Agreements, if any.

It is also necessary to understand the profile and requirements of potential equity investors. Very early stage (seed) equity may be sourced from angel investors[44], slightly later-stage funding may be provided by venture capital funds[45] and expansion capital by private equity funds and public capital markets. Investment decisions are based on the operator model, the market opportunity, the management team track record and the perceived scalability of the company. An increasing number of Africa-focused investors identify themselves as impact investors[46] with a mandate to achieve social and environmental impact in addition to financial returns and which are

[43] Development and Rural Electrification" TOOL: MGPT Financial Model for Mini-grids

[44] An angel investor (also known as a business angel, informal investor, angel funder, private investor, or seed investor) is an affluent individual who provides capital for a business start-up, usually in exchange for convertible debt or ownership equity. Angel investors usually give support to start-ups at the initial moments (where risks of the start-ups failing are relatively high) and when most investors are not prepared to back them (Dr.Tom McKaskill, p.2 p.3 An Introduction to Angel Investing: A guide to investing in early stage entrepreneurial ventures (PDF)

[45] Venture capital (VC) is a type of private equity, a form of financing that is provided by firms or funds to small, early-stage, emerging firms that are deemed to have high growth potential, or which have demonstrated high growth (in terms of number of employees, annual revenue, or both) (Private Company Knowledge Bank)

[46] Impact investing refers to investments "made into companies, organizations, and funds with the intention to generate a measurable, beneficial social or environmental impact alongside a financial return" (2017 Annual Impact Investor Survey)

measured by job creation, by new/improved energy access, or by carbon avoidance. While some accept lower than risk-adjusted returns, many investors target relatively high returns (e.g. 20 percent + equity IRRs). The numerous challenges associated with mini-grids provide insufficient risk-adjusted returns for investors seeking high-growth and scalable ventures, with higher potential returns.

In addition to private investors, multilateral development banks and development finance institutions (collectively "DFIs") design, finance, and operate facilities that provide equity. These actors typically prioritize development impact as well as financial viability and provide growth equity to established companies or capital for larger projects. While mini-grids present several challenges to these financiers, there is an increasing interest in pursuing mini-]s as viable opportunities. Successful pilot projects and large-scale rollouts will help these natural investors participate, who are bringing their experience in energy project development.

The risk/return profile mismatch limits the number of potential equity investors, thus, access to appropriate debt finance is highly challenging for mini-grid developers (*cKinetics, 2013*). Debt is theoretically available from local and international banks, DFIs, funds and crowdfunding[47] platforms. Guarantees from DFIs are viable through mechanisms similar to solar home system financing and guarantee systems set up by the World Bank. At >15 percent interest rate for loans from Ethiopian banks, further complicated by a lack of understanding of the risks and business models, it is challenging for mini-grid private investors in Ethiopia. However, as mini-grids are largely an unproven model, thus far, commercial lenders are hesitant to lend. In Ethiopia, private investors prefer financing from local banks and development partners. Grants are available for pilots but in the long term and for larger projects these are not enough.. International investors are willing to provide equity and debt but current regulations for international investment are time consuming and onerous.

Projects will struggle to raise commercial debt until some of the technical, regulatory, and operational challenges are addressed and risks mitigated. Local financial institutions are natural debt providers due to their ability to understand market dynamics and perform due diligence. However, these institutions have limited experience in cash flow analysis and rely on a collateral for corporate lending. Local banks typically offer short tenure, high cost loans that are not viable for mini-grids. Interest rates may range from 16-24 percent, while the few precedents for project finance have resulted in interest rates around 10 percent. In Ethiopia, the current commercial long-term lending rates are >15 percent with variable rates from Commercial Bank of Ethiopia, Awash National Bank, Dashen Bank, Hibret Bank, etc. and some micro financial institutions (MFIs).

Mezzanine[48] finance is closer to equity than debt on the risk/return spectrum, in so far as mezzanine investors have a lower degree of preference than lenders and they are paid after lenders in the event of bankruptcy/ liquidation. Therefore, mezzanine instruments typically command a higher return to compensate for this additional risk relative to debt. However, mezzanine finance is typically paid before equity, and thus, it does not command as much financial return (interest rate) as straight equity.

Development finance institutions (DFIs) attempt to fill the gap left by local banks, though the

[47] Crowdfunding is the practice of funding a project or venture by raising small amounts of money from a large number of people, typically via the Internet. Crowdfunding is a form of crowdsourcing and alternative finance. In 2015, over US$34 billion was raised worldwide by crowdfunding (Definition of Crowdfunding *www.merriam-webster.com*. Retrieved October 23, 2017)

[48] Mezzanine finance is a hybrid of debt and equity financing that gives the lender the right to convert to an equity interest in the company in case of default, generally, after venture capital companies and other senior lenders are paid

limited scale of mini-grids leads to prohibitively high transaction costs. In some cases, developers bundle mini-grids into sufficiently large transactions, a trend likely to accelerate, as developers establish track records.[49] DFIs may also provide credit lines or guarantees to encourage lending. Impact funds and crowd funding platforms also provide debt, although the limited amount of capital available is unlikely to finance at scale. Nevertheless, they may lend to pilot projects to demonstrate project viability and carry lower interest rates and higher risk tolerance than many banks. In these initial stages of mini-grid sector development, several countries are using both public and private financing options to support mini-grid investment. Through favourable laws and policies like Public Private Partnership (PPP) and financing mechanisms, nations endeavor to increase financial resources available for the development and delivery of mini-grid energy through leveraging private sector investment and management.

In Ethiopia, since 7 June 2018, grid and off-grid energy interventions are being financed by a loan of USD 375 Million (Loan No: IDA-6157 & IDA-6158) till 7 July 2023 under the Ethiopian Electric Utility Universal Electricity Access Program. Also, a credit line at the Development Bank of Ethiopia (DBE) has already undergone two phases of implementation, with an overall funding of USD 40 million. Phase I was between 2012 – 2016 (USD 20 million). Phase II started in 2017 with the same funding – 32 percent has been disbursed whilst 68 percent was still available as of 31 March, 2019, although as of the date of this report, no private mini-grid projects have applied or been financed. The DBE through its External Fund and Credit Management Directorate provides 2 years working capital loan and 5 years project loan. Many applicants who were originally interested in accessing DBE credit line to establish mini-grids were skeptical that a mini-grid project might not generate enough revenues to repay the loan within 5 years. Besides, private investors are waiting for clearer directives regarding distribution and sales licensing and mini-grid tariffs.

[49] Lindlein, Mostert, KfW (2005). Financing Renewable Energy; Instruments, Strategies, Practice Approaches. Justice, UNEP (2009). Private Financing of Renewable Energy - A Guide for Policymakers

CHAPTER 5: PUBLIC-PRIVATE-PARTNERSHIP (PPP) MODELS IN ETHIOPIA

To sustain the present growth momentum and achieve the targets of the Growth and Transformation Plan II (GTP II), the Government of Ethiopia is mobilizing resources from different sources other than the traditional government financing to meet the growing demand for public services. Public Private Partnerships (PPP) are one of the tools available to improve infrastructure services and mobilise private finance and have provided some success in the agriculture sector in the country.

The Ministry of Finance (MoF) has designed a Public Private Partnership (PPP) program to realize government's partnership with the private sector and support the preparation of a legal framework for PPPs.

PPPs for infrastructure provisions are new for Ethiopia and will focus on a few carefully chosen infrastructure projects, to test the PPP model, with energy being one of the priority sectors. The first PPP project in Ethiopia was related to grid electricity (production) and the government is keen to test the financing of distribution (transmission lines) under a PPP model, once the legal framework is developed.

All PPP projects, including in the energy sector, undertaken by a 'Contracting Authorities' that meet the general definition of PPP must be evaluated to ensure that a PPP delivery approach is appropriate for the proposed project. This is particularly true during the early years of PPP program development, when capacity within the government to deliver PPP projects is limited. As a result, both on-grid and off-grid energy projects proposed using a PPP approach will need to be studied in detail to evaluate whether they meet certain criteria.

An overview of key evaluation criteria is provided below[50]: -

Value for Money - Private sector participation in the delivery of infrastructure services can deliver value beyond public sector service delivery. However, the involvement of the private sector alone does not guarantee that such value will be generated, or that this value is adequate to justify the associated costs to the government. Private sector involvement is expected to generate benefits sufficient to justify their implementation as PPPs are deemed to deliver Value for Money ("VfM") and demonstration of this expectation is a requirement. VfM is generally derived by comparing the expected cost to the government for the implementation of the project under a PPP delivery approach to the expected cost for delivering the same project under a traditional public procurement approach. A wide variety of estimated benefits and costs may be considered in determining VfM and further guidance on how to evaluate VfM will be laid out in the PPP Framework.

[50] Ethiopian Public Private Partnership Policy

However, it is important to recognize that the costs to government associated with individual projects may include both financial and economic costs and related benefits. Also, the importance of the impact of a project's risk allocation on VfM cannot be overlooked. To maximize VfM, risks should be allocated to the party best able to manage them. This reduces the overall cost to the government associated with the delivery of the project. To calculate VfM, therefore, risks associated with a project's implementation must be considered. These include both the risks the government has transferred, for example, the value of avoiding responsibility for a particular cost overrun, as well as the risks the government has fully or partially assumed, for example, providing a payment guarantee which may or may not be called. Given the expected costs of PPP project development, contract values of greater than USD 50 million are generally expected to be most appropriate. However, projects below this threshold may also be suitable for PPP delivery, if they exhibit sufficient potential to deliver VfM.

> *"There is no operational PPP model for off-grid energy in Ethiopia, so far. We have received a PPP proposal from EEU for off-grid electrification projects-I (SHS& Mini grid) but we could not shortlist that project as it did not match PPP Policy selection criteria. Off-grid electrification, by nature, is fragmented and small, which is a problem. In PPP selection criteria, size of the project is a major determinant. Any off-grid PPP project has to be large enough to justify transaction costs. Otherwise, we find it difficult to consider off-grid PPP projects."-*
>
> ***A MoF Officer***

Affordability- PPP agreements frequently represent a long-term commitment of government resources or the resources of end-users who pay for the service, or a combination of the two. Regardless of the source of revenue to the private party, such revenue stream must be evaluated to ensure that it is within the means of the government and end-users to meet any payment obligation. As a result, studies investigating the delivery of projects through a PPP approach should include appropriate projections of expected tariff and/or expected government budget allocation. These projects should be compared against the existing constraints such as end-user ability and willingness to pay and the expected availability of government funds. If end-user ability or willingness to pay is insufficient, the government budget may be used to reduce end-user tariffs, where appropriate.

Public Interest - Consistent with the government's commitment to ensure protection of the public interest, individual projects should be studied to understand the ways in which issues of public interest may be impacted over the life of the project. This may include an evaluation of the environmental, health and safety impacts of the development or delivery of a particular public service, along with other issues that may have a bearing on the welfare of the general public or end-users of the service. These impacts should be clearly presented so that the government can make an informed determination with respect to the protections that may need to be put into place to ensure the safe and equitable implementation of the project in accordance with the Ethiopian law.

Sustainability - Given the long-term nature of PPP agreements, PPP projects will need to weather many changes in circumstances, both foreseen and unforeseen. To the extent possible, PPP agreements are written to enable flexibility to allow parties to adapt to changing situations. However, the best assurance of sustainability is a project which has the potential to deliver benefits to both parties over its life. When both parties are truly benefitting from the deal, each will strive to fulfil the spirit of the agreement despite future changes. For the government, this means not only considering whether the quality and price of an infrastructure service is

acceptable, but also ensuring that the private party will have an opportunity to earn an appropriate profit given the risk it has assumed. A government's commitment to structuring win-win agreements will also serve to increase private sector interest in the project, thereby, driving a competitive selection process and improving VfM. For both reasons, the assessment of the attractiveness of the project to private sector parties is an important step in determining whether a project can be successfully implemented through a PPP approach.

Institutional Capacity - PPP agreements are both complex and time consuming to prepare and also impose long-term commitments on the government. These commitments fall into two broad categories i.e. fulfilling government obligations under the agreements, which may include among others; providing land, connecting infrastructure, making timely payments, or adjusting tariffs over time; and monitoring the performance of the private sector's obligations under the agreement.

Achieving VfM is dependent on both how well prepared a project is and how well the government meets its ongoing commitments. Therefore, it is important to clearly understand the institutional capacity that will be required during the project preparation stage and throughout the life of the project. A realistic plan demonstrating how these issues will be managed by the Contracting Authority should form an integral part of the government's evaluation of whether a PPP delivery approach is appropriate.

EEU prefers PPP to fulfil its electrification targets

EEU has a plan to electrify 2,034 rural villages per year and 10, 150 villages within 2016-2020 but the current performing capacity per year is around 350 villages. There is a big gap between target and achievement and strategic initiatives are needed to fill the gap. Data indicates that one of the main challenges of rural electrification is shortage of finance/funds. PPP projects can be a solution to the funding gap..

In March 2017, EEU proposed the first ever 'Off-grid Electrification Projects-I (SHS& Mini-grid)' under Build Operate Transfer (BOT) form of a PPP, to be implemented in all regions of Ethiopia over a duration of 5 years. The maximum cost proposed for project design, construction and operation was USD 100,000,000. The project proposed 'Fee/Charges collected from End User', as payment modality.

Through this PPP off-grid project, EEU wanted to demonstrate that it is possible to supply power within limited space and wanted to attain last mile connectivity, quickly, for rural villages (rural electrification) with renewable energy source. According to EEU, the project had tremendous contribution for other infrastructure development in rural villages by supplying power for them like telecom, water etc., and it could have had a significant impact on integrated rural infrastructure development such as water, social sectors (health, school etc.) along with creating job opportunity for the rural youth.

This off-grid project aimed at:-

- Providing rural households with home solar system LED lights and cell phone charging with additional capabilities to include other loads such as fans, radio, refrigerators and cooking;
- Providing and deploying microfinance and mobile payment system that allow villages the ability to use money that was previously being used to pay for kerosene lighting to pay for the new solar home system through a microfinance structure;
- Deploying local business infrastructure to support the local villages with electricity, water, and microfinance and mobile payment with a network of solar kiosk system;
- Implement sustainable roadmap that allows villages from every stage of poverty or access to earn and grow with increased functionality and capability of off-grid technology;
- Design optimum business model of micro grid with renewable energy resources with

least cost of power production scheme;

- Transfer the maintenance and operation knowledge of micro grid system;
- Conduct test and commissioning together with attendees who will be assigned O&M works of micro grid system; and
- Development of Eco-Friendly Energy Town along with installation of independent micro grid system and commissioning together with EEU.

The Ethiopian PPP Policy criteria of VfM, affordability, public interest, sustainability and institutional capacity guided the approach and methodology of the draft proposal. Unfortunately this project could not be shortlisted for PPP model due to gaps against the PPP Policy criteria.

Both EEU and the Ministry of Finance are working towards successful off-grid (mini-grid) PPP projects and are confident of bridging the technical and financial in the near future.

Furthermore, to encourage private investors, the GoE aspires to set attractive tariffs and is considering the scope of aggregation to unlock private investment in off-grid (mini-grid) energy infrastructure.

CHAPTER 6: AGGREGATION OF MINI-GRIDS TO UNLOCK PRIVATE INVESTMENT

An estimated USD $ 48 billion of annual investments are required to provide electricity access to about 1.1 billion people worldwide by 2030 (*IEA and the World Bank, 2015*). In Ethiopia, the overall costing for ongoing grid and off-grid programs is about USD 6 billion. For the grid access component, two main sources of funding are envisaged - 50 percent syndicated from development partners under concessional terms and grants. The other half of the funding is projected to come from customer revenues, and the government's equity contributions. For the off-grid access component, the government contribution is estimated to be about 40 percent-USD 1 billion-and the remaining-USD 1.5 billion-for syndication through development partners and private sector resources.

Aggregation -in context

Energy aggregation *is when a group of companies or local institutions partner together to buy energy from a single developer, or multiple developers, at smaller volumes while retaining the economic advantages of a high-volume purchase. The term is widely used to describe bulk purchases of renewables from wind, solar and hydro-power projects.*

Project aggregation *is creating a portfolio of projects, like the idea of a mutual fund, which blends a diverse range of renewable energy projects together. This method allows buyers to transact with less risk and get access to a higher value product in one transaction, instead of buying into different projects across multiple transactions. Think of project aggregation as investing in an index fund versus a single stock, reducing the overall risk of a renewable energy purchase.*

Buyer aggregation *on the other hand, references when several non-utility buyers combine their efforts and increase their buying power to access more projects. Aggregating smaller buyers together allows them to access a similar range of projects as a larger entity would and at an affordable price.*

Private investment is likely to play a major role in meeting energy targets (*UNCTAD, 2014*) for both the grid and off-grid sectors. However attracting private investment for mini-grids is a challenge due to multiple risks inherent in the sector in Ethiopia[51]. Table 8 below outlines generic risks, most of which are applicable in the Ethiopian context. Off-grid electrification projects (including mini-grids) are often unattractive for the private investors due to unfavorable risk-return profiles and small investment volumes (*Schmidt, 2015*). Studies reveal that both issues can potentially be addressed by aggregating projects into larger, diversified portfolios.

The potential of aggregation to redirect financial flows into small-scale renewable energy is beginning to be recognized internationally[52]. For instance, solar home system developers in East Africa such as BBOXX and M-Kopa have closed aggregation transactions in 2016. Internationally, the Climate Aggregation Platform (CAP) initiative was announced at the COP21 climate talks in Paris (*UNDP; GEF; CBI, 2015*). Structuring pooling facilities can aggregate off-grid (including mini-grid) projects to reduce risks, increase investment volume, and lower transaction costs (*Davidsen et al. 2015, Gershenson et al. 2015 and Orlandi et al., 2016*).

[51] Scaling up finance for off-grid renewable energy: The role of aggregation and spatial diversification in derisking investments in mini-grids for rural electrification in India- Article in Energy Policy · September 2017

[52] Ibid.

Table 8: Risk Categories for Renewable Energy Mini-Grid Projects

Risk Category	Description	Key Stakeholder Group
Power market risk	Risk arising from limitations and uncertainty in the energy market (on and off-grid) regarding market outlook, price, access and competition.	Power market-related policymakers; legislators; regulators.
Permits risk	Risk arising from the public sector's limitations to efficiently and transparently administer mini-grid related licensing and permits.	Permit administrators in a country. EEA in Ethiopian context.
Technology sourcing risk	Risk arising from limitations in the quality and availability of mini-grid hardware, as well as the customs treatment of hardware.	Technology supply chain; technical regulator; customs (excise).
Financing risk	Risks arising from scarcity of domestic investor capital (debt and equity) for renewable energy, and domestic investors' lack of familiarity with renewable energy and appropriate financing structures.	Domestic investors (equity and debt), financial sector regulator.
Currency risk	Risks arising from currency mismatch between hard currency debt/equity and domestic currency revenues.	No specific stakeholder.
Grid extension risk	Risks arising from uncertainty in grid extension plans and technical regulations for integration into the main grid.	Utility, distribution company; utility/grid regulator.
Social acceptance risk	Risks arising from lack of awareness and resistance to renewable energy and mini-grids in communities.	General public; NGOs.
Payment and credit risk	Risk arising from customers' willingness, ability, and methods of payment for electricity/	End users; consumer finance actors (consumer banks, credit data actors, end-consumer finance regulator).
Sovereign risk	Risk arising from a mix of cross-cutting political, economic, institutional and social characteristics in the country which are not specific to mini-grids.	No specific stakeholder.
Labor inputs risk	Risks arising from the lack of skilled and qualified potential employees.	Labor force, educational institutions.
Developer risk	Risks arising from limitations in the developer's capability to efficiently and effectively design, install, operate, maintain and monitor the project.	Mini-grid developer (BOO).

Among all the above-mentioned risks, lack of financing mainly due to unfavorable risk-return profiles, small investment volumes, and absence of appropriate financing sources and structures – continues to be one of the major bottlenecks in scaling up mini-grid deployment. Aggregation of projects can help to meet this challenge (*Gershenson et al. (2015) and Davidsen et al., 2015*) by reducing transaction costs for private investors, increasing access to institutional capital, and lead to diversification of risks. Financial aggregation bundles together energy opportunities to lower transaction costs, risks and the cost of capital. Financial aggregators can bring together enterprises or their assets into portfolios, diversifying risk across many investments and making the sector more attractive for investors[53].

[53] Turning up the volume: financial aggregation for off-grid energy- Clare Shakya, Rebecca Byrnes

The GoE agrees that risk-return profiles for mini-grids can be made more attractive through enabling policies that facilitate aggregation of projects into diversified portfolios, but till now, aggregation is absent in Ethiopia as off-grid (mini-grid) market size is relatively small. Both GoE and private stakeholders understand that bundling together smaller loans and assets from relatively small-scale decentralized renewable energy projects and enterprises can create investment products that meet the larger-scale needs of institutional investors. Once off-grid market size in Ethiopia reaches a medium scale, aggregation will happen. Together with aggregation, attractive tariffs for mini-grids are expected to escalate private investment.

> *"Aggregation will happen only after a large market develops for mini grids in Ethiopia with hundreds (perhaps thousands) of operators. The first thing is therefore to create an attractive environment for small as well as large mini-grid investors (both local and international). There are obvious advantages of aggregation in efficiency, cost, reliability that will come with aggregation, it will help private investors."-*
>
> ***A Private Mini-Grid Stakeholder***

CHAPTER 7: TARIFF GUIDELINES AND METHODOLOGY FOR OFF-GRID SYSTEMS

Ethiopia is presently reviewing its Energy Regulation. The updated Energy Regulation would allow for business models with cost-reflective tariffs to attract private sector participation while decreasing the need for public support for mini-grids scale-up.[54]

A sustainable off-grid (including mini-grid) tariff, must cover the system's efficient and prudently incurred cost comprising the capital expenditure (CapEx) and operating expenditure (OpEx), including fuel costs. The cost of service for a typical mini grid which supplies electricity to off-grid consumers should recover the local generation cost and mini distribution grid, including retail cost, as explained below[55]; also, Table 10 provides information on grid and off-grid tariffs in selected countries: -

Local Generation Cost

The Revenue Requirements for off-grid electricity generation is given as:

$RROG,i = (RABOG,i \times WACC) + O\&Mi + Depi + Taxest$

where:

RROG,i = Revenue requirements for off-grid generator, i,

RABOG = Regulatory Asset Base for off-grid generator i,

WACC = Benchmark Weighted Average Cost of Capital as established by EEA per the attached methodology (Annex ONE),

O&Mi = Operation and Maintenance expenditure for plant i,

Depi = Depreciation for plant i.

Taxest = Taxes payable by developer during period t

The generation tariff would be computed and denominated in KWh, and would be based on a forward-looking tariff philosophy, which takes account of production forecasts over a period at least 4 years.

Mini Distribution System Cost

Since a typical mini grid operator, in addition to operating and managing the grid, also undertakes retail activities, the revenue requirements for the distributions system should recover the following costs:

i. Network assets and equipment.

ii. Retail costs: Customer service, metering, billing and collections.

The total distribution system revenue requirements is therefore expressed as follows:

$DRROG = (WACC \times RAB) + O\&Mi + Depri + Lossesi + CSCit + Taxes$

where:

DRROG = Distribution System revenue requirements for off-grid;

WACC = Benchmark Weighted Average Cost of Capital as determined by EEA or to be determined

[54] Tariff Guidelines and Methodology for Off-Grid Systems (ZERO DRAFT).

[55] Ibid.

based on methodologies annexed to this guideline;

RAB = Regulatory Asset Base;

Lossesi = Losses associated with the off-grid system i;

Depri = Depreciation of mini distribution system assets;

CSCi = Customer Service Costs for off-grid system i,

Taxest = Taxes payable during period t;

The retail off-grid tariff would therefore comprise the following two components:

I. **Off-grid Generation Tariff**

II. **Off-grid Distribution Tariff**

The retail tariff can thus be formulated as:

ORT = OGT + ODT

where:

ORT = Off-grid retail tariff;

OGT = Off-grid generation tariff;

ODT = off-grid distribution tariff;

In determining and approving off-grid tariffs, EEA will undertake revenue requirement analysis, so that the Authority would be able to determine the actual cost of operating the off-grid system. The analysis will further establish the revenue-cost gap, if any, which can arise under both the partly and wholly subsidized off-grid business models (these models are described in Chapter 2 above) as discussed under: -

Partly-Subsidized Model: Full Connection Cost Subsidy - Under a partly-subsidized model where the mini- grid operator receives only connection subsidy but no capital subsidy, and the retail tariff is capped at the national end-user tariff, the off-grid developer would still need to meet its capital cost. The exact level of capital subsidy can therefore be determined from the revenue requirement analysis.

Partly-Subsidized Model: *Partial Capital Cost, Connection Subsidy* - There is also a possibility that a developer operating under a partly-subsidized business model could benefit from partial capital subsidy and full connection subsidy. With this model, if the tariff to the off-grid customer is capped at the national average end-user tariff, the developer may still require external funding support to close the revenue-cost gap. The amount of further subsidy required can only be quantified after a detailed revenue requirement analysis is done.

Partly-Subsidized Model: *Connection, Partial Capital Subsidy but Unconstrained Tariff* - Under the partly-subsidized model, the developer benefits from full connection and partial capital subsidy, but unlike the above scenarios, the off-grid retail tariff is not capped at the national end-user tariff. Under this scenario, the

Recommendations on tariff design and structure

The off-grid tariff should be set by EEA as a consumption-based tariff, denominated in Birr/KWh.

The off-grid retail tariff should be capped at the national average end-user tariff.

In localities, where there are commercial customers which can serve as "anchor loads", these loads could pay a tariff which exceed the national average end-user tariff. This will enable the commercial customers or loads to cross-subsidize the poor and vulnerable residential consumers

off-grid retail tariff may be differentiated as follows:

(a) The regulator could allow the mini-grid operator to charge the large commercial customers or the "anchor loads", a tariff which exceeds the national average end-user tariff.

(b) The poor and low-usage rural households are charged a tariff, not exceeding the national average end-use tariff. With this approach, the tariffs for the "anchor loads" and commercial customers are used to cross-subsidize the rural off-grid poor residential consumers.

The Energy Regulation stipulates that in approving grid and off-grid tariff in relation to generation, transmission, wheeling, distribution and sale of electricity, EEA may include approved tariff adjustments, which requires prior approval by EEA to reflect periodic changes in the cost of fuel, cost of power purchase, rate of inflation/deflation and currency fluctuation.

The Tariff Adjustment Mechanism (TAM) for such systems will be formulated to account for changes in O&M costs, since these are the main ongoing costs which are likely to change during the life of the project. As the capital related costs are assumed to be fixed over the project's life, these costs will not be adjusted. Therefore, for off-grid tariff, the main variable costs which are adjusted and hence "escalated" are the O&M costs. The automatic adjustment formula is thus formulated as follows:

$$OFT_t = \alpha\, OFT_{t-1} + \beta\, OFT_{t-1}\, \frac{CPI_t}{CPI_{t-1}}$$

where:

OFT_t = Off-grid retail tariff applicable in period t (Birr/KWh);

OFT_{t-1} = Off-grid retail tariff in the previous period (Birr/KWh);

CPI = Consumer Price Index for Ethiopia, as published by the Central Statistical Agency;

β = Measures the share of O&M cost in the OFT, and known as O&M coefficient;

α = Determined as $1 - \beta$. Determined as share of percentage of capex in the OFT and known as fixed cost coefficient;

Assuming an off-grid operator incurs fuel cost in the electricity generation process, the above TAM can be modified to accommodate the fuel cost as follows:

$$OFT_t = \alpha\, OFT_{t-1} + \beta\, OFT_{t-1}\, \frac{(CPT_t + FT_t)}{(CPI_{t-1}\, FP_{t-1})}$$

where:

FP_t = Fuel Price in period t;

FP_{t-1} = Fuel Price in previous period;

To establish the benchmark O&M weights (i.e. β) and in the absence of actual costs, EEA could use the following industrial benchmark values in Table 9.

Table 9: Benchmark O&M Costs

Renewable technology	O&M as a percentage of capex
Biomass	1.0 percent - 6.0 percent
Wind	
On – shore	2.5 percent - 4.4 percent
Off – shore	3.5 percent - 5.5 percent
Geothermal	2.0 percent - 3.0 percent

Solar	
Solar PV	1.5 percent - 2.5 percent
Solar Thermal	1.0 percent - 2.5 percent
Small Hydro	3 percent – 4 percent
Sources: World Energy Council, (2004), "Renewable Energy Projects Handbook", U.K; IRENA (2013),"Renewable Power Generation Costs in 2012	

EEA is currently finalizing the draft of Tariff Guidelines and Methodology for Off-Grid Systems which would support development of private sector friendly environment in the off-grid (mini-grid) sector of Ethiopia by establishing attractive tariffs and subsidies scales. If public subsidies are required in the pre-electrification areas, they will likely be provided to the operator per kWh sold to third party household and public customers. The GoE proposes a fully automatic monitoring of electricity sold through information technology as a key requirement for the smooth implementation of the cross-subsidy. Along with establishing guidelines and methodology of tariff, the zero draft has also detailed the regulatory actions and options which are available, in the event that an existing isolated mini-grid, is 'enveloped' or 'absorbed' by the main grid in future. This is to ensure that the necessary regulatory mechanisms are put in place so that the private sector is not disincentivised to invest in isolated mini-grids. EEA is considering allowing the original mini-grid to convert into any one of the following: -

i. *Desco mini grid Model*: This is where an existing isolated mini-grid which is 'enveloped' or 'engulfed' by the main grid, is given the option to convert to a Small Power Producer, while the national distribution licensee operates the distribution mini-grid unit, to supply to the off-grid community.

ii. *Grid connected Small Power Producer*: This is where the previously isolated mini-grid operator which has been 'enveloped', decides to focus on electricity generation and sales, to the main grid licensee and no longer engages in electricity generation and retail to off-grid consumers.

iii. *Sale of mini grid assets to the national grid licensee*: This refers to the situation where an existing mini grid operator decides to sell all its assets (i.e. the distribution network and/or the generating unit), to the main distribution or network licensee.

Table 10: Grid and Off Grid Tariffs in Selected Countries

Country	On-Grid Tariff	Mini-Grid Tariff
India	$ 0.04/kWh[56]	Husk Power Systems-$ 2.41/mo WBREDA (PS)-$ 1.28-$4.32/mo[57]
Burundi	$ 0.04/kWh for first 50 kWh per 2-month billing cycle	Unavailable
Ethiopia	For households approx. $ 0.01/kWh for the first 50kWh plus a service charge of approx. $ 0.10, with tariffs increasing in blocks based on consumption	Not finalized yet but expected to be in the range of 0.30 US$/kWh to 1.20 US$/kWh
Kenya	$ 0.226/kWh for residential customers	Off-grid (including mini-grids) $0.50 - $0.80/kwh
Malawi	$ 0.066/kWh for first 50kWh	Not finalized but a cost-reflective tariff method is currently under development
Rwanda	$ 0.20 /kWh between 15 and 50 kWh	Off-grid licensees are free to set their own

[56] largest power company, NTPC, sells electricity from its coal-based generation units at a princely Rs 3.20 per kWh. https://qz.com/india/984656/solar-power-is-now-cheaper-than-coal-based-electricity-in-india-but-the-math-makes-no-sense/

[57] Comparison of costs to be recovered by Tariffs (Schnitzer et all 2014)

		tariffs under supervision of Regulation authorities
Tanzania	$ 0.04-0.16 p/kWh for residential customers	Off-grid (including mini-grids) tariff ranges between $0.5-$2/kWh
Uganda	$ 0.20 / kWh for residential customers	For Off-grid tariff, developers have to apply for a license, part of which is to obtain tariff approval
Zambia	Residential $ 0.011 /kWh up to 200kWh	Tariff exemption for mini-grids under 100kWp, cost-reflective tariffs for above 100kWp

CHAPTER 8: RECOMMENDATIONS

Based on consultations with the government, development partners and private stakeholders, this report makes the following recommendations to support the growth of mini-grids in Ethiopia:

1. Mini grid pilot programmes should trial different business models to evaluate what works in the Ethiopian context

The Government of Ethiopia supports the development of mini-grid business models with EEU playing a role through public private partnerships. Private Sector business models also have significant potential and pilot programmes should trial different business models.

It is clear that significant private sector investment will be required to address the ambitious targets outlined in the NEP. Regional private developers and investors have the financial and technical capacities required to scale growth of mini-grids towards universal access by 2025, provided a supportive regulatory environment with investor-friendly policies. These include cheaper and quicker licensing process, easy availability of debt financing, availability of hard currency, increased local manufacturing of mini-grid equipments, etc.[58]

Community Operated Business Model may also be suitable for Ethiopia due to its advantages of local ownership, lesser conflicts with customers and self-managed public infrastructure. For this model to work, technical and managerial capacities of communities will need to be developed. Establishment of clear ownership structures and divisions of work are critical to ensure community operated models are self-sustainable.

Public Private Partnership (PPP) Projects are also likely to encourage some foreign companies to invest in the sector. Ethiopia has achieved some early successes attracting private sector investment into agriculture through PPPs with large international agri-business and this experience should be leveraged in the energy sector.

2. A detailed tariff study will help to evaluate tariff levels and subsidies under different business models.

The GoE has proposed three tariff models in its draft of Tariff Guidelines and Methodology for Off-Grid Systems viz for-profit model (not subsidized), partly-subsidized model and wholly-subsidized model. Private stakeholders suggest that GoE must not regulate tariffs if a subsidy is not available for the private investor. Fixed or regulated tariffs may have a cooling effect on investors while high tariffs will reduce affordability and payment. Project developers understand these trade-offs and will need to justify their proposed tariffs during license application.

Under a partly subsidized model, tariff that only allow the recovery of O&M costs provide little or no scope for return on investment. This is not likely incentivize developers to take risks and invest in this market. It is understandable that government may want to regulate tariff for domestic consumers and a certain minimum electricity supply should be reserved for domestic consumers. Once such supply is ensured, developers should be free to supply anchor consumers at a rate that provides a return to the investor. This will allow financial viability of the project and also ensure affordability for domestic consumers.

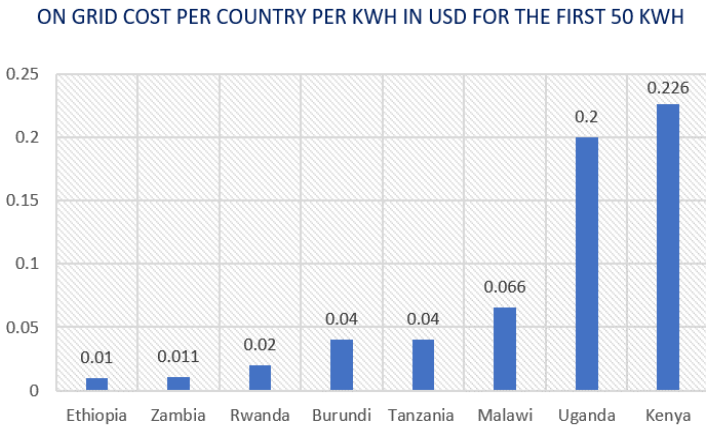
Since, the entire costs are borne either by the government or by development partners, wholly

[58] For details please refer 'Chapter 3- Capacity Challenges for the Private Sector, in Ethiopian Regulatory Environment and Capacity Constraints in Off-Grid Energy Sector Report

subsidized models are not scalable and sustainable but may provide early learning in a nascent market like Ethiopia. It is difficult to motivate private investors to provide infrastructure under this model unless they are responding to an EPC RFP, where they provide their experience and expertise in design, procurement and implementation and hand over the site to government at completion.

3. Mini grids for productive use in agriculture create the opportunity for cost reflective tariffs and should be the starting point for a pilot programme with private sector investment.

The Government of Ethiopia does not want a major price difference between the tariff rates for grid and mini-grid energy to meet its social objectives. Grid tariffs in Ethiopia are very low for households at approx. $ 0.01/kWh for the first 50kWh, when compared to other countries. Cost reflective tariffs are currently expected to be in the range of 0.30 US$/kWh to 1.20 US$/kWh, when evaluating other countries' experiences but will differ from region to region, owing to geographical, demographic and socio-cultural variations among the nine regions. The ABC model creates opportunities for charging different tariff levels where the anchor tenant effectively subsidizes households. The agriculture sector is a good starting point when looking at electricity for productive opportunities. This will enable ground-water irrigation, processing and storage of agricultural products leading to increased productivity and improved livelihoods for rural farming communities affected by climate change and is aligned with the CRGE and other climate change policy. A robust M&E design should be used to test for financial viability and understand data points in the pilot programme.



4. Private-sector developers should be encouraged to secure grant funding to improve equity returns and reduce project risks, particular during the early stages of the development of the sector.

In the early stages of a development of a nascent market, de-risking finance can often play a catalytic role to establish early demonstration projects. Once these projects are up and running and showing financial viability, the need for grant finance is likely to decrease. However to secure grant finance for their projects, companies will need to invest time and resources to develop competitive funding proposals. Companies should be encouraged to secure grant finance by allowing all or part of the grant to be counted as equity in the capital structure.

5. A project preparation facility will assist private developers to build a pipeline of mini-grid projects.

Scaling up private investment to support NDCs will require a strong and transparent pipeline of low-carbon projects that generate an acceptable financial return for private investors. However a common and recurring theme from most stakeholders including project developers, advisory firms, private sector funds and DFIs suggests that early-stage project development support to conduct feasibility studies, address risks and structure transactions, is vital to bring projects from concepts to finance-ready investments. This is even more critical in an underdeveloped market like Ethiopia where capacity gaps coupled with poverty and affordability challenges

make crafting of investment cases challenging. Clearly there is a pressing need for much more early stage risk finance to take developments from ideas to bankable business cases. Lastly, the GoE should support national private companies to access international energy funds like Private Finance Advisory Network (PFAN), Sustainable Energy Fund for Africa, the World Bank financing and others, to ensure availability of foreign currency. Concessional climate finance may also provide a source of lower cost capital for mini grid projects particularly as there compelling mitigation and adaptation benefits for clean energy mini grids.

6. Legislation to enforce a minimum percentage of local equity will have benefits in the medium term by supporting the development of Ethiopian project developers.

This mechanism has been used to varying success in other countries. It is important that targets are realistic and achievable otherwise this will serve as a barrier to investment. It is important that private sector stakeholders are engaged so that this mechanism achieves the necessary balance.

7. The risk of grid arrival needs a set of clear guidelines communicated to private developers and investors that helps to address their concerns.

The GoE has proposed three options for private investors in the case where grid extension arrives at a site where a mini-grid developer has invested. The options are (i) Desco Mini Grid Model, (ii) Grid Connected Small Power Producer and (iii) Sale of Mini Grid Assets to the National Grid Licensee. These options need to be communicated to private developers and become part of contractual agreements between the government and private developers.

8. The licensing process needs improvement

The process of obtaining generation, distribution and sale licenses should be simpler, cheaper and quicker. Indeed, some argue that very small mini-grids up to 50 kW should be exempted from any license regulations. Private developers view delays in licensing and inconsistent licensing processes as significant project risks and may encourage developers to look elsewhere for projects. The entire licensing process needs to be reevaluated in order to remove bottlenecks and reduce regulatory risks. For example project developers need clarity on tariff levels and licensing terms before being required to invest in infrastructure.

9. Development Partners should support capacity building of government and private investors

Mini-grids are a new concept in Ethiopia for both the government and private investors. Government counterparts are constrained on setting streamlined licensing process, design standards for installation of mini-grids, establishing procedures for tariff setting, quality testing, power quality measurement, etc. International energy partners may support the GoE by disseminating best practices in these areas. Knowledge exchange visits, will be beneficial to expedite finalizing procedures and regulations related to mini-grid tariffs and related aspects.

10. Reduce the foreign exchange risk

Generally international debt and equity finance to developing countries is denominated in foreign currency which creates a foreign exchange risk for project developers who receive project cash flows in local currencies. Experienced project finance advisors can implement risk mitigation measures including hedging and currency swaps however these instruments add to the costs of projects and will impact the investment case.

The Ethiopian government has identified measures that support increased access to forex in the market, as well as decrease the need to access for supply chain components. The GoE is

promoting increased foreign private sector participation in the Ethiopian supply chain to reduce costs through the development of local manufacturing capacity.

CONCLUSION

As the population continues to grow worldwide, so will the demand for affordable energy; and the climate change risks will continue with increasing use of fossil fuels. Investing in clean renewable power, improving energy productivity, and ensuring energy for all is vital, if we are to achieve Sustainable Development Goal 7 of 'Affordable and Clean Energy' by 2030. Developed and developing countries are working towards expanding infrastructure and upgrading technology to provide clean and more efficient energy to attain sustainable development, and Ethiopia is one of the frontrunners in the African continent in this context.

Ethiopia has abundant renewable energy resources and has the potential to generate over 60,000 megawatts (MW) of electric power from hydroelectric, wind, solar and geothermal sources. As a result of Ethiopia's rapid GDP growth witnessed over the previous decade, demand for electricity has been steadily increasing. Despite the country's huge energy potential, it is experiencing energy shortages as it struggles to serve a population of over 100 million people and meet the growing electricity demand which is expected to grow by approximately 30 percent per year.[59]

Ethiopia launched its first National Electrification Program (NEP) in 2017. Since then the country has achieved significant milestones in connecting 33 percent of its population with on-grid electrification and 11 percent with off-grid pre-electrification. 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, with 100 percent rural and urban electricity access. The updated version of the National Electrification Program (NEP 2.0) initiated in 2019, 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, and mini-grids are expected to play a pivotal role in this.

However, this sector is challenged by technical capacities, regulatory and financial issues, along with socio-economic considerations that need to be well-thought-out to augment the nascent mini-grid sector. (Please refer report on Ethiopian Regulatory Environment and Capacity Constraints in Off-Grid Energy Sector for details on mini-grid background and challenges in Ethiopia). Lack of proven business models and mini-grid tariffs are the major bottlenecks the sector currently faces. Presently, Ethiopia is testing various models include with support of development partners. The government is keen on scale-up of models like EEU-led with EPC, and Private sector or cooperatives to install generation assets, 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.

In addition, the GoE has established Public Private Partnerships for the transformation of energy project financing and implementation, projects are ongoing in grid energy and efforts are underway to have Public Private Partnership projects in off-grid, including mini-grids in Ethiopia.

As the market size grows, the Ethiopian Government will also explore possibilities of aggregation of mini-grids to unlock private investment. The government is working to establish workable tariffs and the EEA has developed a draft of tariff guidelines and methodology for off-grid systems. Cost reflective tariffs are currently expected to be in the range of 0.30 US$/kWh to

[59] https://www.export.gov/article?id=Ethiopia-Energy

1.20 US$/kWh, according to other countries' experiences, but need to be validated based on implementation experiences in different regions to ensure sustainability of the off-grid sector and stimulate private sector investment.

Lastly in order to secure private investment in high-risk infrastructure projects in rural and deep rural areas, private developers need to believe that the market will flourish and that the state will work with them in a supportive manner. On the other hand, governments need to be confident that the private sector will do business responsibly particularly when delivering a service, which has long been the developmental mandate of government.