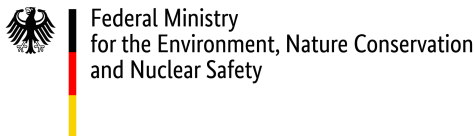

Investment Opportunities In The Climate And Energy Business In Ethiopia

Mapping Of Existing Actors In The Energy Sector

July 2017

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Methodology

- To map existing actors and investment opportunities in Ethiopia's energy sector, the following steps ensued
 - a) To contextualize the mapping:** Provide an overview of key relevant facts about Ethiopia and present relevant stakeholders in the energy sector.
 - b) To show the country's untapped potential** (hydro, wind, solar, geothermal, biomass): Give an overview of high renewable energy potential and highlight what has been developed versus what is available.
 - c) To justify the immediate need for the development of these energy sources:** Present an energy demand forecast for upcoming decades - Ethiopia has a highly increasing demand, and a high energy generation potential.
- Separating on-grid and off-grid sub-sectors is necessary as they require different strategies:
 - Approx. 90% of installed generation capacity is from hydropower; the remaining 8% and 1% are respectively from wind and thermal sources. The hydro-dominated system has been severely affected by drought; the Government of Ethiopia is now diversifying the generation mix with other sources such as solar, wind, geothermal and biomass, which will result in a more climate-resilient power system. A snapshot of each sub-sector is presented.
 - Even though the geographical grid access has reached around 55%, household connectivity still remains under 30%. With a population of over 100 million, it is important that Ethiopia's off-grid potential is assessed.
- An evaluation matrix is developed using detailed criteria to determine recommendations for private investments for both on-grid and off-grid opportunities.

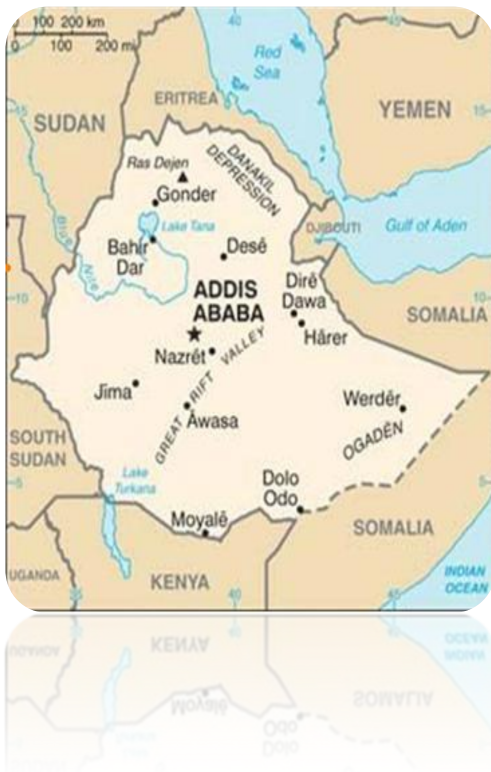
Mapping Overview

Quick Facts about Ethiopia

- Total Area: 1.13M km²
- Total population: around 100 million
- Average Annual GDP Growth: 10%
- Geographic Access to Electricity (% of population): around 56%
- Household connectivity: 25%
- Per capita Energy Consumption: 100 kWh/a
- Energy Consumption: 0.12 Quadrillion Btu
- Major Energy Sources: Hydro and Wind Energy, with big potential in geothermal and Solar

Stakeholders of the Energy Sector in Ethiopia

- Ministry of Water, Irrigation and Electricity (MoWIE)
- Ministry of Environment, Forest and Climate Change (MoEFCC)
- Ministry of Health (MoH)
- Ethiopia Energy Authority (EEA)
- Ethiopian Electric Utility (EEU)
- Ethiopian Electric Power (EEP)
- Ethiopia Standard Agency
- Rural Electrification Fund (REF)

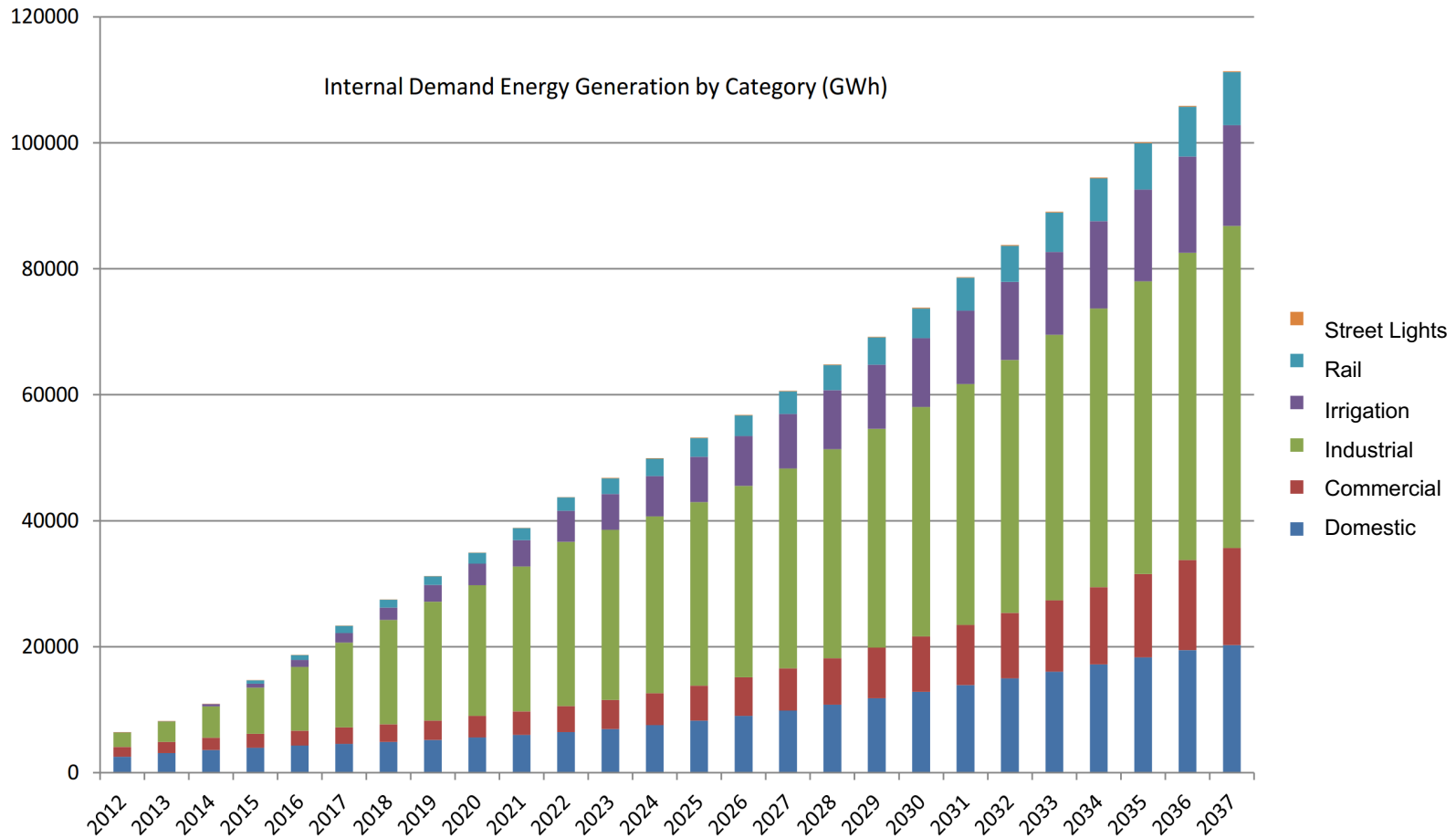


Renewable Energy Potential - Ethiopia

Resource	Unit	Available resource	Developed	Developed vs Available
Hydropower	MW	More than 45,000	3,808	<10%
Wind	MW	More than 1,350,000	324	<0.1%
Geothermal	MW	More than 10,000	7.3	<0.1%
Solar	million TWH/annum	2.199	-	0%
Agricultural Waste	million tonnes/year	15-20	6	30%

Source: Ethiopian Electric Power Corporation (Feb 2017)

Projected Energy Demand Growth - Ethiopia



Source: Ethiopian Electric Power Corporation (Power System Expansion Plan)

On-Grid Sub-Sectors

Introduction

- The Government of Ethiopia (GoE) is on a drive to propel Ethiopia to being the power house of sub-Saharan Africa by embarking on landmark power sector developments which are sufficient not only to power Ethiopia's rapid industrialisation and urbanisation, but also to power other countries in the region through interconnectors as part of the East African Power Pool.
- Ethiopia's current installed capacity is over 4200 MW, its energy penetration rate is 55% and its energy demand is increasing at 25% per year.
- Hydropower dominates Ethiopia's installed capacity, at 90% of the total installed capacity, with an increasing number of project in wind, solar and geothermal to secure energy mix.

Policy Landscape

Key Agencies and Organizations

Growth and Transformation Plan (GTP) II

- Set overall vision and development strategy for the country

Ministry of Water, Irrigation and Electricity (MoWIE)

- Regulatory policy and decision making, energy operations, implementation and supervising other governmental enterprises

Ministry of Environment, Forest and Climate Change (MoEFCC)

- Regulatory policy and decision making, environmental, climate related operations and implementing ICS and climate change Mitigation

Ethiopia Energy Authority (EEA)

- Regulate the electricity sector
- Regulate energy efficiency and conservation
- Issue technical codes standards and directives, commission programs and projects on Energy Efficiency
- Issue investment permits and generation licenses
- Approve the tariff of the national grid

Policy Landscape

Key Agencies and Organizations (cont.)

Ethiopian Electric Utility (EEU)

- Engage in the construction and maintenance of electricity distribution networks
- Purchase of bulk electric power, selling electrical energy to customers

Ethiopian Electric Power (EEP)

- Undertake feasibility studies, design and survey of electric generation, transmission and substation construction and upgrading
- Handle electricity generation and transmission operational and maintenance activities
- Lease electricity transmission lines
- Sell bulk electric power and undertake universal electric access works

Rural Electrification Fund (REF)

- Provide loan and technical assistance to eligible rural electrification Project Promoters

Policy Landscape

Expected Regulatory Reform

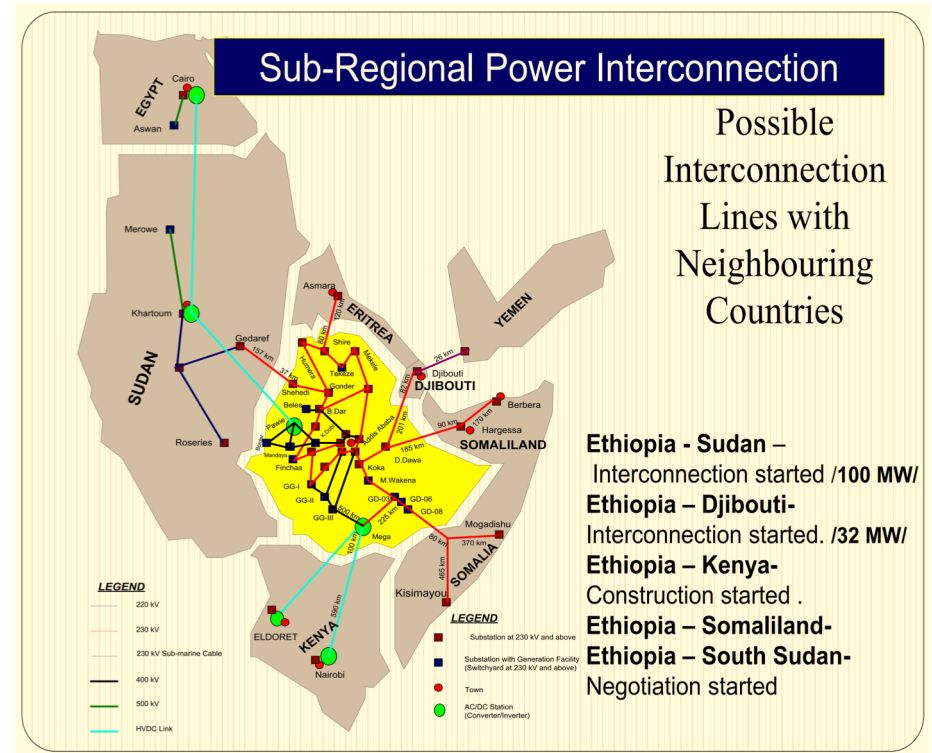
- Traditionally, all operational power projects in Ethiopia to date have been developed by the GoE on an engineering, procurement and construction (EPC) basis.
 - At present, the GOE has opened the energy sector for private sector participation, specifically to generate significant financial resources and stimulate investment in power generation and power transmission. Ethiopia is in the process of drafting its feed-in tariff bill, which should offer independent power producers the option to sell renewable energy power to the national grid at specified rates. As of May 2015, the GOE is in negotiations for its first Independent Power Production Agreement with Reykjavik Geothermal to develop two 500 MW geo-thermal sites in Ethiopia.
 - Independent Power Producers (IPPs) are encouraged to enter the market through the Electricity Operations Regulations (49/1999), the letter of power sector policy (2003) and the Investment proclamation (280/2004).
 - *Power Africa* is assisting the GOE on developing and passing a Renewable Energy Proclamation/Regulation covering solar, wind, hydro, biomass, and off-grid generation Independent Power Production (IPP) projects that will be submitted to Parliament in June 2017 along with the Geothermal Proclamation and the Geothermal Regulation. The Renewable Energy Proclamation is to establish a regulatory process for implementing the IPPs with a legal process for project financing and risk management based on power purchase agreement tariff rates and purchase requirements.
 - The GoE has made it clear to the private sector that there is no limit on the amount of generation that may be developed by the private sector in future.
-

Potential As a Regional Power Hub

- Ethiopia plans to become a regional power exporter (mainly from renewable energy), and transmission offers attractive opportunities for investment.
- GTP II indicates that the government plans a 90% domestic requirement coverage by 2020 from the current 60% level. Accordingly, the GOE plans to construct additional 9000 km distribution lines throughout the country.

Planned Transmission Projects

- 500 KV = 1,229 km
- 400 KV = 2,137 km
- 230 KV = 3,343 km
- 132 KV = 3,041 km
- < 132 KV = < 250 km
- Total = < 10,000 km



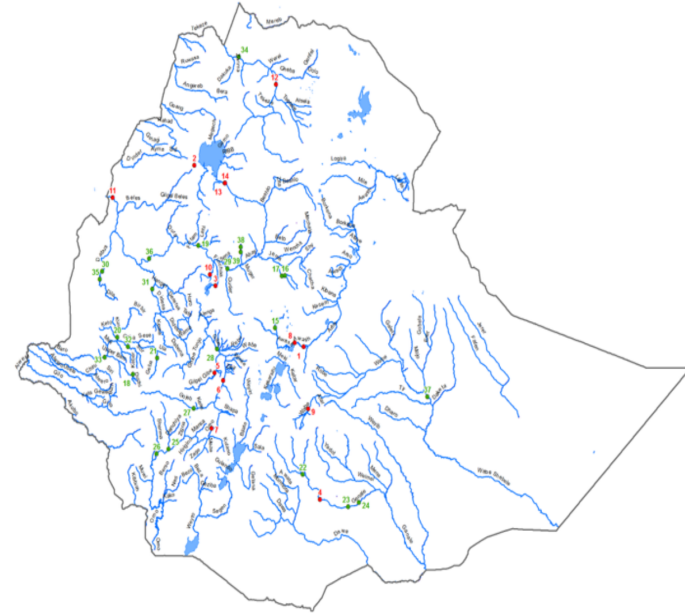
Source: Ethiopian Electric Power Corporation (Transmission Expansion Plan)

Planned Substation Construction

- 115 New
- 63 Rehabilitation/Upgrading

Hydropower Snapshot

- Ethiopia's hydro potential (45,000 MW) constitutes 20% of the total technically feasible potential in Africa. With this potential, Ethiopia is usually referred as the power house of Africa.
- However, Ethiopia has utilized less than 5 % of its potential so far; which is represented by 13 Hydropower plants installed, with a total capacity of 3,807 MW.
- Out of the 13 Plants, 12 plants are currently running and producing 9,500 GWh.
- Ethiopia is building *The Great Renaissance Dam* HPP (<60% completion):
 - Two power stations with 16 Francis turbines generate 375 MW power with a total installed power of 6,000 MW and an estimated production of 15,200 GWh per year
 - At the end of the works, this dam will be the **largest in Africa**: 1,800 m long, 145 m high, with a total volume of 74,000 million m³.



Source: Ethiopian Ministry Of Water, Irrigation and Energy

Hydropower

Opportunities and Challenges

Planned Projects (2017-2025)

- 14 additional Hydro power plants are scheduled to be built by 2025, with a total installed capacity of 11,105 MW and a generation capacity of 50,208 GWh per year.

Financial Requirements

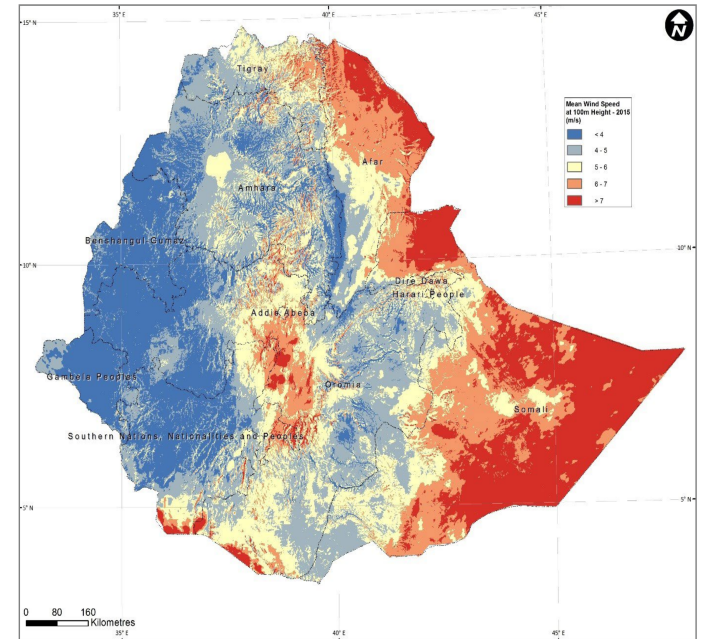
- The total cost requirement to meet this target is budgeted at USD \$20.1 billion, which brings to USD \$1.81 million budgeted for 1 MW installed hydropower capacity.

Current Investments / Opportunities / Barriers

- Two British firms (Contingent Technology and Globeleq), have jointly bid on the 257 MW *Genale Dawa VI plant*, the fourth hydroelectric project in the Genale Dawa River basin (with two projects focused on irrigation).
- The \$850 million bid is backed by the UK's CDC Group and Norway's Norfund. It would be the first privately-managed hydroelectric plant in the country. Under the terms of the bid, the firms would operate the plant under private ownership or in a PPP for up to 25 years.
- Hydro-mega projects still remain high cost and high risk investments, which are also not backed by adequate institutional framework by the GoE.

Wind Power Snapshot

- Ethiopia inaugurated one of the continent's largest wind farms in 2013: the USD \$290 million, 120 megawatt (MW) *Ashedoga plant*. This was followed by the larger 153 MW *Adama II* facility in 2015.
- However, wind accounts for less than 8% of Ethiopia's total installed capacity. Three Wind Farms are installed, with total capacity of 324 MW.
- These three powerplants are currently running and producing 779 GWh.



Source: DTU/IRENA.

Wind Power

Opportunities and Challenges

Planned Projects (2017-2025)

- Nine (9) additional wind farms are scheduled to be built by 2025, with a total installed capacity of 1520 MW and a generation capacity of 4955 GWh per year.

Financial Requirements

- The total cost requirement to meet this target is budgeted at USD \$3.14 billion (although other estimates place it over USD \$6 billion) which brings to USD \$2.06 million budgeted for 1 MW installed wind power capacity.

Current Investments / Opportunities / Barriers

- Three factors are driving Ethiopia's shift to wind: 1) the devastating droughts that have diminished the value of hydropower energy, 2) the falling cost of wind power technology, and 3) growing evidence that Ethiopia is blessed with ideal sites for harvesting wind.
- Under the “*Accelerating Wind Power Generation in Ethiopia*” Programme (AWPGE) between Denmark and Ethiopia, the Danish Energy Agency is exchanging experiences on how to support large scale wind power investment through clear and effective political and regulatory frameworks.

Wind Power

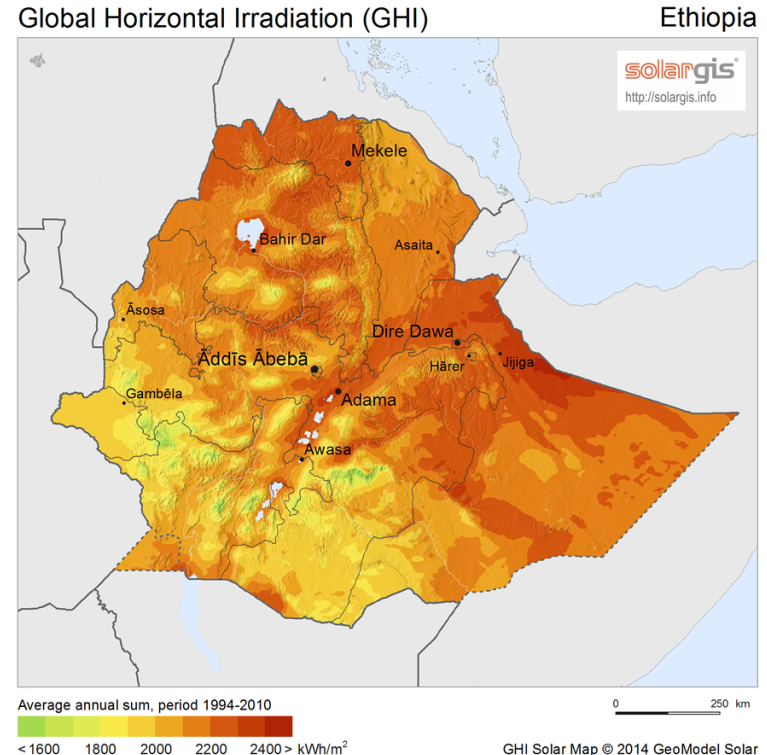
Opportunities and Challenges (cont.)

Current Investments / Opportunities / Barriers

- The Danish Energy Agency (DEA) is assisting the Ethiopian authorities to develop an independent power producer roadmap for onshore wind projects and to shape new procedures and framework conditions.
- During this Implementation Partner Arrangement signed in February 2017 between the MOWIE and the DEA, a number of activities have been arranged in order to ensure successful IPP wind tenders in Ethiopia.
- In addition, a one-stop-model for wind projects inspired by Danish examples will be developed by the Ethiopian authorities securing that IPPs only have to deal with one public authority regarding project approvals and licenses.
- A workshop took place in Addis Ababa in May 2017, during which wind power companies and experts shared experiences on wind project development in Africa and internationally with the Ethiopian government and its relevant authorities.
- Mega-wind projects still remain high cost and high risk investments, which are also not backed by adequate institutional framework by the GoE.

Solar Power Snapshot

- To date, there are no solar farms built or contributing to Ethiopia's national grid.
- The 100 MW solar farm project in Metahara is currently at a bid evaluation process.
- The process started with an expression of interest that invited companies to come as investors and Independent Power Producers (IPP).
- The idea is for investors to get their investment back by selling the electricity produced to the government at an agreed-upon tariff.



Source: solargis.info

Solar Power

Opportunities and Challenges

Planned Projects (2017-2025)

- Three (3) new solar power plants are scheduled to be built by 2025, with a total installed capacity of 300 MW and a generation capacity of 525 GWh per year.

Financial Requirements

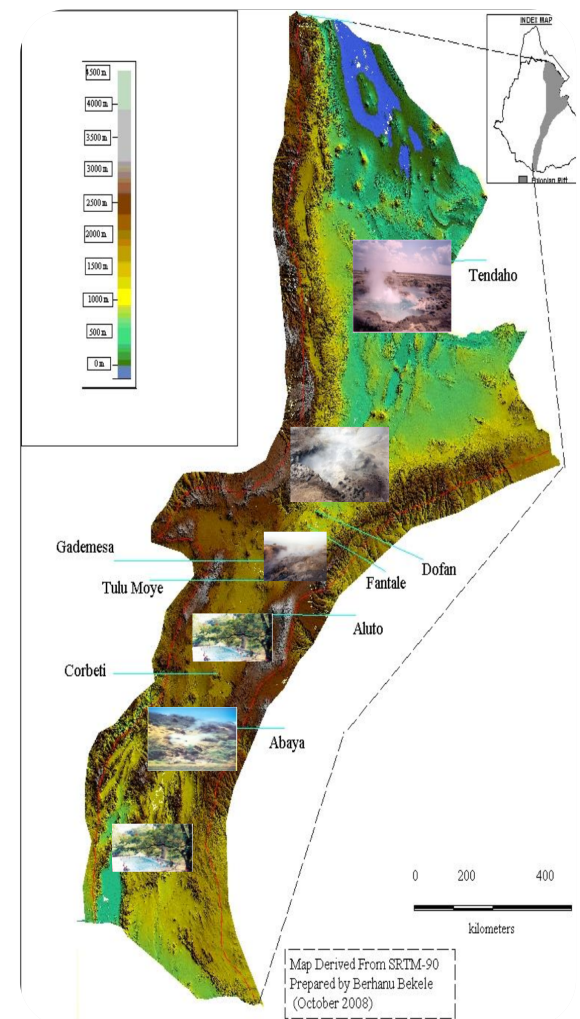
- The total cost requirement to meet this target is budgeted at USD \$610 million, which brings to USD \$2.03 million budgeted for 1 MW installed solar power capacity.

Current Investments / Opportunities / Barriers

- The first Independent Power Produced solar farm in Metahara with a capacity of 100 MW has been put out for Request For Proposal, which targeted over 35 shortlisted companies (from over 80 companies who submitted an Expression of Interest). Five companies have submitted their proposal by February 2017 and EEP is finalizing its evaluation.
- *Power Africa* and the World Bank are giving support on both regulatory framework and tender preparation to back the project.
- Mega solar project still remain high cost and high risk investments, which are also not backed by adequate institutional framework by the GoE. Private Investors are patiently waiting for the outcome of the Metahara Project.

Geothermal Snapshot

- There is currently one geothermal plant in Ethiopia, with a generation capacity of 7.3 MW.
- However, it has stopped energy production due to dilapidated infrastructure.
- A USD \$2 billion, 1000MW geothermal project (to be phased and built in two stages of 500MW) is being developed by Reykjavik Geothermal in Corbetti. It is the first independent power project (IPP) in Ethiopia's history.



Geothermal

Opportunities and Challenges

Planned Projects (2017-2025)

- Four (4) additional geothermal power plants are scheduled to be built by 2025, with a total installed capacity of 570 MW and a generation capacity of 4,494 GWh per year:
 - *Aluto Langano*, geothermal expansion – 70 MW (2018)
 - GoE, GoJ, WB, SREP, ICEIDA
 - *Tendaho Alalobeda*, 1st phase – 25 MW (2017)
 - GoE, WB, ICEIDA
 - *Tendaho Dubti*, shallow reservoir – 12 MW (2018)
 - GoE, AFD, EU ITF
 - *Corbetti Geothermal Power*, 1st phase – 500 MW (2018)
 - HoTPPA signed with Reykjavik Geothermal
 - Detailed PPA negotiations are ongoing
 - Candidate under *Power Africa initiative* (USA)

Financial Requirements

- The total cost requirement to meet this target is budgeted at USD \$2.66 billion, which brings to USD \$ 4.67 million budgeted for 1 MW installed geothermal power capacity.

Geothermal

Opportunities and Challenges (cont.)

Current Investments / Opportunities / Barriers

- **Challenges and weaknesses**
 - Large financial requirement
 - Resource and other risks
 - Long gestation period
 - Lack of institutional capacity
 - Shortage of professional skills (scientific, technical, commercial, legal)
 - Sub-optimal legal and regulatory framework (upstream mineral – downstream energy/power)
- **Opportunities and strengths**
 - Large resource (considerable detailed investigations and test drillings done/ongoing)
 - Strong policy commitment (cost competitive, base load, renewable, heat as well as electricity, indigenous, energy security and climate resilience).
 - Open for private sector development.
- The highest investment cost is registered in mega geothermal projects, for which the risk of investment is not well backed by adequate institutional framework by the GoE.

Biomass Snapshot

- The first Waste-to-Energy plant in Africa - *Reppi Waste-to-Energy Plant* - is in its final stage of construction.
- It has a total production capacity of 50 MW.
- No Biomass energy projects currently operational in Ethiopia.



Biomass

Opportunities and Challenges

Planned Projects (2017-2025)

- Even though the exact number of planned biomass sites have not been determined, a total installed capacity is planned to reach 420 MW by 2025, with a total generation capacity of 2940 GWh per year.

Financial Requirements

- The total cost requirement to meet this target is budgeted at USD \$966 million, which brings to USD \$2.30 million USD budgeted for 1 MW installed biomass power capacity.

Current Investments / Opportunities / Barriers

- The *Reppi Project* is first of its kind in Africa. The development, design and construction of the project is conducted by Cambridge Industries Ltd (CIL) and its partner China National Electric Engineering Co (CNEEC).
- The hulking waste-to-energy power plant is taking shape at the edge of Addis Ababa, Ethiopia's capital, and symbolises the ambitions to convert the agrarian Horn of Africa country into an eco-friendly industrial powerhouse.
- Such projects remain very new to Ethiopia and even Africa.

Sub-Sector Selection Criteria

1. **Technology Cost:** Initial investment cost required for setting up
2. **Sectoral Integration:** Applicability towards achieving the GoE's sectoral development objectives (Industrialisation, Agriculture productivity etc.)
3. **Legal framework :** The availability of sub-sector specific and enabling policy frameworks for investment in the areas
4. **Impact on GHG:** Estimated aggregate impact on the reduction of green house gas emissions
5. **Private Sector Experience:** The level of experience by private companies in this subsector
6. **Attractiveness for the private sector:** The cumulative rough assessment of the above five criteria

Scale Qualification

Evaluation Criteria	Low	Medium	High
Technology Cost	The technology cost is too high, thereby affecting the sub-sector's ROI or RoR	The tech. cost is tolerably high in the short term, could be manageably reduced by combination of for ex.: tax or tariff incentives, enabling frameworks	The tech. cost is low or favourable and is within reasonable ranges for private investments
Sectorial Integration	No integration with other economic sectors or with those that could serve as uptakes for power production	Some sectoral integration exists. Linkages with potential uptakes is limited but promising	Multiple and present sectoral integrations exist as well as tangible uptakes, forming the demand for power production
Legal Framework	No legal frameworks. No intended framework design in the near future	Some legal frameworks exist, but no clear directives and implementation	There are clear and enabling legal frameworks in place with experience in implementation
Impact on GHG	Sub-sector has directly or indirectly negative impact on GHG; it has the potential to contribute towards some GHG emissions	Some limited components within the sub-sector have the potential to indirectly contribute towards GHG emissions	Sub-sector does not have any direct or indirect contribution towards GHG emission. It even supports reduction of GHG emission
Private Sector experience	No private sector actively working in the sub-sector in the country. None have even registered to enter the sector	There are some private companies with some experience in the sector in the country	The are many private sector projects and companies working in the sub-sector in the country
Attractiveness for Private Sector	The aggregate value of the above 5 criteria is in general negative	The aggregate value of the above 5 criteria is in general normal and medium	The aggregate value of the above 5 criteria is in general positive, enabling and strong

Evaluation Matrix

Energy subsectors	Technology Cost	Sectorial Integration	Legal Framework	Impact on GHG	Private Sector experience	Attractiveness for Private Sector
Mega Hydro	Medium	High	Medium	Medium	Medium	Medium
Mega Wind	Medium	High	Medium	High	Medium	Medium
Mega Solar	Medium	High	Medium	High	Medium	Medium
Mega Geothermal	Low	High	Medium	High	Medium	Medium
Mega Biomass	Medium	High	Medium	High	Medium	Medium

High

Medium

Low

Recommendations On Grid Sub-sector

- **Hydro:** The well-developed hydropower sector represents a clear and proven opportunity for private sector investment:
 - Well-known sector with an important amount of expertise within Ethiopia
 - The GoE is competitively tendering-out new hydro projects internationally and searching for Independent Power Producing (IPP) partners
 - Over 14 identified high potential sites (scheduled completion in the next 8 years)
 - **Wind:** The growing interest and efforts demonstrated by international actors in the wind sector and the conducive environment provided by the GoE make it ripe for additional investment.
 - **Geothermal:** Years of efforts and a multi-billion dollar investment at Corbetti demonstrates the GoE's commitment and investor's commitment to geothermal. However, the high investment requirements and the non-finalized regulatory framework leads us to not recommend this sector in the near term until results from current efforts are observed.
 - **Mega-Solar:** There are no current investments in large solar projects although the first project expected to produce 100 MW is under tender process. Just like the geothermal sector, immediate engagement in the solar sub-sector is not recommended until further review of the aforementioned project.
 - **Biomass:** Ethiopia is home to Africa's first waste-to-energy facility, which will be operational soon. As this project is still one of a kind, we recommend waiting to see and learn from it before embarking on another biomass project.
-

Recommendations

On Grid Sub-sector (cont.)

Conclusion

- The GTP II (2016-2020) targets and the diminished value of hydropower energy (most dominant utilized energy source) reflects the GoE focus in diversifying and utilizing alternative renewable resources.
- The GoE is showing signs to minimize concessional loans in the energy sector which is leading towards opening doors for private investment.
- With the help of organizations such as the World Bank and *Power Africa*, there is a lot of works being conducted in the regulatory and legal side to cater for the new projects stated above. It is expected that this would open many doors for the private sector in all major renewable energy projects.
- In addition to power generation from renewable energy sources, existing old power plants, substations and transmission lines require substantial maintenance and overhaul to increase the overall efficiency. These **maintenance works are priority business opportunities** for investors.

Off-Grid Sub-sectors

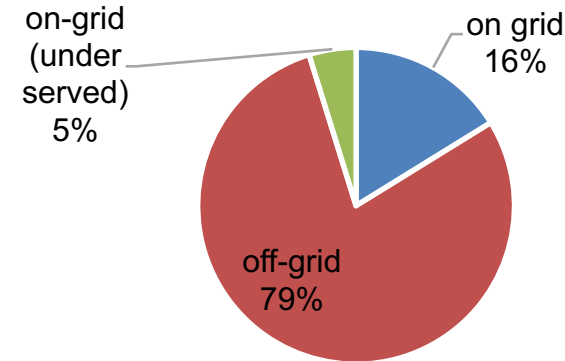
Overview

A Large Underserved Population

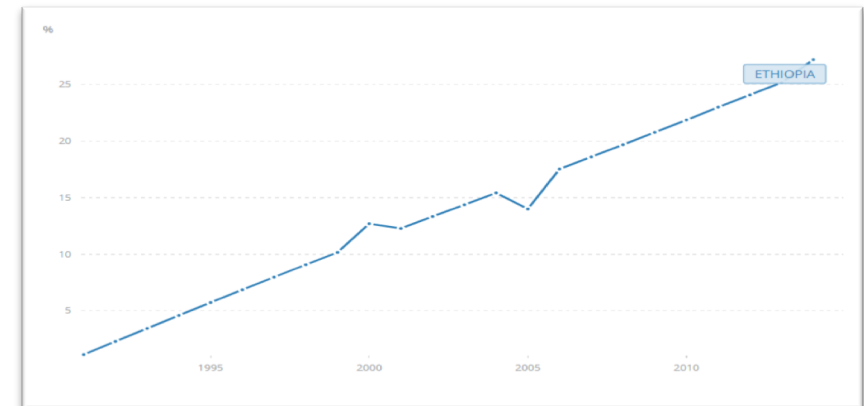
Ethiopia Rural Household Population, by region ⁽¹⁾

SN	Region	Population	Woreda	Average HH 5.5
1	Addis Ababa	3352000	10	609,454.5
2	Afar	1769002	30	321,636.7
3	Amhara	20296876	137	3,690,341.1
4	Benshangul	1033999	20	187,999.8
5	Dire dawa	453000	1	82,363.6
6	Gambela	422002	13	76,727.6
7	Harari	240000	1	43,636.4
8	Oromia	33906981	274	6,164,905.6
9	SNNP	18414673	143	3,348,122.4
10	Somali	5659640	55	1,029,025.5
11	Tigray	5099563	46	927,193.3
		90,647,736.00	730.00	16,481,406.55

Off-grid Business Market size (2)



Access to electricity (% of population) = 27.2%



1. Ministry of Water, Irrigation and Energy Ethiopia, Rural Electrification Fund, Off-Grid Investment Plan for Ethiopia. Investment Plan Report, Final draft, August 2015
2. OBIN Off-Grid Business Indicator 2014, pp 25. Copyright © 2014 by Stiftung Solarenergie - Solar Energy Foundation
3. World Bank Access to Electricity as percentage of population _2014

Overview

Existing Challenges

- Despite potential and attractiveness, remain tangible challenges and risks in the off-grid energy sub-sector, at least in the short to medium term:
 - No Feed-in Tariff currently in place.
 - Import Tax exemption on solar systems and units in place but not efficiently implemented.
 - Administration capacity development is highly sought for Import Tax management on renewable items; mainly in terms of training of customs and tax authorities as well as other enforcement units.
 - Large scale marketing and policy development work is required for solar lanterns and solar household systems both in on-grid and off-grid areas in order to further solidify demand for the products.

Off Grid Policy Framework

- The 2nd Growth and Transformation Plan (GTP-II) and the Universal Electricity Access Programme UEAP.
- NAMA: Off-grid Rural electrification in Ethiopia, 2016
- Off-grid Investment plan in Ethiopia, 2015
- National Biogas Programme of Ethiopia (NBPE I and II)
- A draft proclamation has been submitted by the EEA to the Ministry of Water Irrigation and Energy / MoWEI for a small-scale feed-in-tariff accompanied by a standardized PPA (Power Purchasing Agreement) for renewable projects equal to or less than 10MW in an aggregate amount of up to 300MW
- Independent Power Producer IPP proclamation
- Energy Proclamation, 2013

Potential Off-Grid Energy Business Sub-Sectors

- Mini-grids
- Solar lanterns, SHS (Solar Home Systems) and Small wind turbines
- Renewable Energy (RE) water pumping
- Biogas digestion
- Cook stoves

Mini-Grids

Justification

Mini-grids are the most attractive and strongly promoted sub-sector at the moment. However, the technology cost may be initially high as it involves combining various power sources.

- Off-grid areas **demand is growing** to the level whereby a system with additional function than lighting and mobile charging is needed (e.g. small scale business and integration of rural demand) – Note: the GTP II plans to promote 100 mini-grids
 - A hybridized mini-grid is a **stable energy source** (various and complementary energy resource options exist in different parts of Ethiopia)
 - Mini-grids are interesting from private sector investment point of view as it has a **modular implementation and investment scalability**
 - Future **possible grid interconnection** is an added advantage with the advent of the tariff
 - Opportunity for **leveraging investment**, including from foreign sources
 - **Economic viability** (where grid connection is not viable)
 - **Productive** use, **local value addition** and **job creation potential** is high
 - **Improved living conditions** are exerting more demand for such grid system alternatives
 - **Improved social services** (in particular health and education)
 - **Environmental benefits** (micro and macro)
-

Mini-Grids

Snapshot

Minigrid means a small isolated electrical grid supplying a remote village or rural town or several thereof. It is a self contained system composed of a small grid and one or more electricity generation plants of any technology or combination (hybrid).

➤ **Business Potential**

- Micro Hydropower Plants (MHP)
- Small Windpower generations
- Small PV power generators

➤ **Business Potential – MSHP (Micro and Small Hydropower)**

- 232 small scale Hydropower potential nationwide (MoWIE)
- 600 water mills in place but not functional
- MSHP Generation capacity of 26 to 9,840 kW
- Vast Solar irradiation capacity in cash crop producing areas of the country
- Promising potential for wind power generation (velocities of 7-9 m/s and total potential estimation of 10,000 MW nationwide)

Mini-Grids Opportunities

Planned Investment: MoWIE

- 105 sites have been identified for potential mini-grid installation
- The GoE plans to invest USD \$3,875,000 on mini-grid projects

Financial Requirements

- Cost covering tariffs in Minigrids are high: between 20 and 30 USc/kWh, compared to 2 to 3 USc/kWh grid-connected in Ethiopia
- Cost-recovery tariffs for renewable energy-based mini-grids may be higher than main grid tariffs, but are lower than alternatives, such as kerosene lighting, dry cell batteries and diesel generation, and provide better and cleaner services
- Government subsidy planned for off-grid mini-grid investments

Financing Mechanisms

- Power Africa - US Africa Development Foundation (Off-grid Energy Grants of USD \$100,000 financing per project)
- African Development Bank

Current Investments

- There are currently no mini-grid projects in the country.
- Rensys Engineering and Trading is installing a 12 kilowatt solar mini-grid system to electrify a potential of 198 households, small businesses, and institutions.
- Ethio Resource Group PLC is to build six wind-powered micro-grid systems to provide electricity services to rural households in rural North Showa Zone (Amhara Region). It is currently operational since July 2016 and has been providing electricity services to up to 300 rural households.

Solar Lanterns, Solar Home Systems

Justification

Solar Lanterns and SHS (Solar Home Systems) are attractive as they require an easy process of import, manufacturing and installation.

However, import tariff irregularities also affect it strongly.

- The **market has developed** well and **demand are high** as can be seen from current import scales as well as market availability of various types of products
- **Supply chain exists** (requires enhancement)
- **Easy entry** for the private sector as there are not many initial requirements

Solar Lanterns, Solar Home Systems, Small Wind Turbines

Business Potential

- Solar lanterns and Solar Home Systems (SHS) are applicable everywhere in Ethiopia
- Small Wind Turbines (SWT) can be used in areas where mean wind speeds above 7m/s prevail
- As a new technology, installing a SWT incurs a substantial risk

Planned Investment

- In the current GTP-II plan, the following volume of solar and SHS products are planned to be distributed until the year 2020:
 - Lantern : 3,600,000
 - SHS: 400,000
 - Institutional PV (photovoltaic): 3,600
 - Solar Thermal : 500
 - Solar Cooker: 3,600
- With these number of products, a budget of USD \$209,700,000 is planned.

Financial Requirement

- Estimated startup working capital to the tune of USD \$200,000 is required to engage in the importation, trading, distribution of lanterns and SHS.

Financing Mechanisms

- World Bank has availed USD \$40 Million as a source of finance for the GoE to distribute to private sector through tenders for supply of these systems. However, to date, only 1% of this fund has been utilized.

Water Pumping

Justifications

Renewable Energy (RE) Water Pumping has become highly attractive as it involves availing water for agricultural productivity and increasing water supply in off-grid areas.

- The **need to replace diesel operating** water pumps, which are expensive to operate (more than 10,000)
- The **need to tap water** for and from big irrigation schemes under implementation
- It can be one factor for **augmenting agricultural productivity** as a result of availing water

Water Pumping Opportunities

Business Potential

- Provide reliable water supply
- Support agricultural productivity by pumping water for irrigation and drip systems
- 92,000 potable water wells currently identified nationwide
- Combinable with PV, Micro/Pico Hydropower as well as Small Wind Turbines in order to curb seasonality of power sources

Planned Investment

- Within the current GTP-II plan, around 30,000 RE wells are planned to be developed by 2020
- The development of these wells and ensuing water pumping systems are expected to cost USD \$200-300 million by 2020

Financial Requirement

- There are various cost outlays depending on the magnitude of the pumping system and capacity as well as the combination of hybrid power generation systems, the financial requirement various. To be analysed and confirmed

Financing Mechanisms

- The *Global Green Climate Fund* is expected to be one of the finance sources for this sub-sector
- The *Climate Resilient Green Economy* is expected to provide finance and enabling ground for financing on this sub-sector
- *ENERGY + Programme* is now closed. However it served as a source of funding for such engagements
- *Payment By Results* is a financing mechanism for both private sector and public sector entities working on off-grid investment
- *WASH Programmes*: Water and sanitation programme expansion is an additional source of finance as the expansion of the programme strongly demands energy sources in all off-grid areas
- *AfDB* - Through its support on agricultural productivity augmentation as well as energy expansion, it supports various levels and types of financing for energy as a main as well as auxiliary product.

Biogas Digestion

Justifications

Biogas Digestion - as it has strong institutional application - curbs the need for uptake, which translates into direct market availability.

This makes it attractive both for technology providers, as well as power producers.

- The **growing off-grid agro-based processing activities needs energy** (to heat, light, electricity)
- The **need to increasing yields** of animal husbandry and agriculture (GTP-II)

Biogas Digestion Opportunities

Business Potential

- 100 million heads of cattle, sheep and goat, which produce large amounts of organic animal waste (1)
- Fuel: Fuel wood replacement
- Lighting: Replacing kerosene lamps
- Soil Treatment: Digestate used as soil conditioner in agricultural

Planned Investment

- Within the National Biogas Programme of Ethiopia (NBPE-II) + the GTP-II, have been identified 31,400 Biogas digesters and 20,000 bio fuel stoves
- The European Union (EU) has pledged USD \$22,000,000 for supporting the NEBP-II implementation

Financial Requirement

- Construction cost for a 6 cubic meter digester is USD \$750

Financing Mechanisms

- The GoE, in partnership with HIVOS and the Netherlands Government, is providing various forms of financing for those seeking to engage in this sub-sector
- The EU has recently launched a new fund for biogas expansion

Examples

- There are a multitude of biogas plants installed nationwide. Notable are the ones in prisons, universities, and a few private institutions (ex: hotels)

(1) Ethiopia Livestock Development Strategy 2015

Cook Stoves

Justifications

Cook Stoves - With the large scale utilization of biomass and vast demand for household and institutions, there is a big gap that needs to be met.

Those providing innovative technology in this area are highly promoted and supported by government and non-governmental actors.

- **Protection** of forest stock
- Innovation to **improve the existing** improved cook stoves
- Existence of **government support** for manufactures
- **Wide scale technical and skills provision** by non-governmental organizations

Cook Stoves

Opportunities

Business Potential

- Fuel wood is the major source of household cooking
- More than 80% of energy supplied in the country is used for cooking at social, commercial and residential levels (1)
- Lack of, or high expense of alternative cooking fuel
- Ethiopia loses 140,00 Ha of natural forest annually (2)
- 62 million tonnes of wood used annually for cooking

Planned Investment

- GTP II stipulates the distribution of 9,000,000 cook stoves nationwide by 2020

Financial Requirement

- To be analysed and confirmed

Financing Mechanisms

- Government of Ethiopia (subsidies)
- German Government - BMU

Expected Investment cost

- It is estimated that the indicated number of cook stoves will require an investment of almost USD \$100,000,000 from the government side.
- Currently, a single household cook stove sells for ETB 250 per unit (approx. USD \$12).

(1) Improved Cook Stoves final Report. Gaia 2012
(2) Food and Agriculture Organization of the United Nation (FAO) Global Forest Resources Assessment 2010- Forestry paper. FAO. Rome, Italy, 2010

Sub-Sector Selection Criteria

1. **Technology Cost:** Initial investment cost required for setting up
2. **Rate of Return:** The annual rate of Return on Investment (ROI) for the investor over a period of time expressed as a proportion of the original investment (5-10 years) to represent short to medium terms of investment
3. **Legal framework:** The availability of sub-sector specific and enabling policy frameworks for investment in the areas
4. **Impact on GHG:** Estimated aggregate impact on the reduction of green house gas emissions
5. **Growth/Expansion potential:** The potential of the business to expand or grow and re-investment
6. **Attractiveness for the private sector:** The cumulative rough assessment of the above five criteria

Scale Qualification

Evaluation Criteria	Low	Medium	High
Technology Cost	The technology cost is too high, thereby affecting the sub-sector's ROI or RoR	The tech. cost is tolerably high in the short term, could be manageably reduced by combination of for ex.: tax or tariff incentives, enabling frameworks	The tech. cost is low or favourable and is within reasonable ranges for private investments
Rate of Return (RoR)	Expected RoR for investing in the selected sub-sector is too low, it will take a very long time to see gains on initial investments	Expected RoR is acceptable given the appropriate regulatory and legal framework adjustments under the pipeline	Expected RoR is high, and makes the sub-sector highly attractive for private investors to engage in the nearest future
Legal Framework	No legal frameworks. There are legal frameworks that are disabling	Some legal frameworks exist, but no clear directives and implementation	There are clear and enabling legal frameworks in place with experience in implementation
Impact on GHG	Sub-sector has directly or indirectly negative impact on GHG; it has the potential to contribute towards some GHG emissions	Some limited components within the sub-sector have the potential to indirectly contribute towards GHG emissions	Sub-sector does not have any direct or indirect contribution towards GHG emission. It even supports reduction of GHG emission
Growth / Expansion potential	Sub-sector and its demand are very limited. May serve a limited area or time period, and has low potential for expansion or growth	Sub-sector has a moderate potential of expansion and growth in terms of time frame and geographic coverage	Sub-sector has vast expansion and high growth potential and high demand in various geographic areas
Attractiveness for Private Sector	The aggregate value of the above 5 criteria is in general negative	The aggregate value of the above 5 criteria is in general normal and medium	The aggregate value of the above 5 criteria is in general positive, enabling and strong

Evaluation Matrix

Energy subsectors	Technology Cost	Rate of Return	Legal Framework	Impact on GHG	Growth / Expansion potential	Attractiveness for Private Sector
Mini-grid	Medium	Medium	Medium	High	High	High
Solar Lanterns and SHS	High	High	High	High	High	High
RE Water Pumping	High	High	High	Medium	High	High
Cook Stoves	High	High	High	Low	Medium	High
Biogas Digestion	Medium	High	High	Medium	High	High

High

Medium

Low

Recommendations

Off-Grid

Based on the above analyses, the following subsectors have been selected for their attractiveness for private sector investment in the off grid sub-sector. However, each has its own pros and cons:

- **Mini-grids** are the most attractive and strongly promoted sub-sector at the moment. However, the technology cost may be initially high as it involves combining various power sources.
- **Solar Lanterns and SHS (Solar Home Systems)** are attractive as they require an easy process of import, manufacturing and installation. However, import tariff irregularities also affect it.
- **Renewable Energy (RE) Water Pumping** - This becomes highly attractive as it involves availing water for agricultural productivity and increasing water supply in off-grid areas.
- **Biogas Digestion** - as this has strong institutional application, it curbs the need for uptake, which thereby translates into direct market availability. This makes it attractive both for technology providers, as well as power producers.
- **Cook Stoves** - With the large scale utilization of biomass and vast demand for household and institutions, there is a big gap that needs to be met. Those providing innovative technology in this area are highly promoted and supported.

Most Attractive Elements

Off-grid sub-sector

➤ **Mini-grids**

- High government support, large applicability, and strong attractiveness for private sector
- Support package prepared by the government's off-grid investment plan to bring in as much private sector as possible

➤ **Solar Lanterns/SHS and Local Economic Development**

- Highly commercial and private sector driven business.
- Government has been expressing strong demand for tangible suppliers
- No-state actors foster strong engagement with private sector for solar systems for productive use in off-grid areas, hence, the local economic development concept

➤ **Cook stoves**

- Largest part of demand for energy goes into cooking and food preparation as well as related activities. They also have the strongest potential to reduce GHG emission by introducing improved technology
- Commercial cook stoves are viable (from the national experience)
- Government and partnering non-state actors are in strong support of this sub-sector as well