Green Mini Grid Market Development Programme

SEforALL Africa Hub

African Development Bank

Mini Grid Market Opportunity Assessment: Ethiopia

April 2017

Prepared by


BANQUE AFRICAINE DE DEVELOPPEMENT
AFRICAN DEVELOPMENT BANK


SUSTAINABLE
ENERGY FOR ALL
AFRICA HUB


SUSTAINABLE
ENERGY
FUND FOR
AFRICA


CARBON
TRUST


UNEP


ECREEE
TOWARDS SUSTAINABLE ENERGY

List of Acronyms

AETDPD	Alternative Energy Technology Development and Promotion Directorate
AfDB	African Development Bank
AFD	Agence Française de Développement (French development agency)
CiDEV	Carbon Initiative for Development
CRGE	Ethiopia has therefore initiated the Climate-Resilient Green Economy
CSA	Central Statistical Agency
DBE	Development Bank of Ethiopia
DfID	UK's Department for International Development
DRC	Democratic Republic of Congo
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EEU	Ethiopian Electric Utility
EEP	Ethiopian Electric Power
EEA	Ethiopian Energy Authority
EnDev	Energising Development
ESD	Energy Study & Development Follow-Up Directorate
ESMAP	World Bank's Energy Sector Management Assistance Program
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Development Agency)
GMG	Green mini-grid
GTP	Growth and Transformation Plan
IEA	International Energy Agency
IPP	Independent Power Producer
MDP	Market Development Programme
MoWIE	Ministry of Water, Irrigation and Electricity
MoFEC	Ministry of Finance and Economic Coordination
NRECA	National Rural Electric Cooperative Association
PASDEP	Accelerated and Sustained Development to End Poverty
PPA	Power Purchase Agreement
REF	Rural Electrification Fund
RMC	Regional member country
SEforALL	Sustainable Energy for All
SHS	Solar Homes Systems
SREP	Scaling-Up Renewable Energy Program
SEFA	Sustainable Energy Fund for Africa
SDPRP	Sustainable Development and Poverty Reduction Program
UEAP	Universal Electricity Access Project
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development

Contents

EXECUTIVE SUMMARY 7

1. INTRODUCTION TO THE GREEN MINI GRID MARKET DEVELOPMENT PROGRAMME 10

2. COUNTRY OVERVIEW 12

3. POTENTIAL OF GREEN MINI GRIDS 14
3.1. Introduction 14
3.2. Assessment background 14
3.3. Mini grids potential assessment 14
3.4. Renewable energy potential for mini grids 18

4. OVERVIEW OF THE ENERGY SECTOR 26
4.1. Overview of responsibilities and current context 26
4.2. Support for renewable energy 26
4.3. Support for increased access to energy 27
4.4. Challenges to increase renewable energy uptake and access to energy 28
4.5. Power network and infrastructure 28
4.6. Off grid developments 30

5. REGULATORY FRAMEWORK FOR MINI GRIDS 32
5.1. Regulatory and policy environment. Main takeaways 32
5.2. The mini grid policy and regulatory environment 33
5.3. Energy sector policies 37
5.4. Investment incentive policies 40
5.5. Policy Recommendations 40

6. MAIN STAKEHOLDERS 42
6.1. Government and agencies 42
6.2. Mini grid practitioners or product developers 45
6.3. Bilateral and multilateral donor organisations 46
6.4 Other relevant organisations and initatives 49

7. ANNEX. OBJECTIVES, SCOPE AND METHODOLOGY OF THE MARKET ASSESSMENT 52
7.1. Objectives of the market assessment 52
7.2. Scope of the market assessment 52
7.3. Methodology 52


Vestas
Cabeolica
Cabeolica
Cabeolica

EXECUTIVE SUMMARY

This country report is one of five pilot country reports in the first phase of the Market Intelligence business line of the African Development Bank's Green Mini-Grid Market Development Programme (MDP). The other country reports cover Mozambique, Cameroon, Burkina Faso and the Democratic Republic of Congo (DRC). The MDP programme has the ultimate objective of fostering access to electricity across Africa, by promoting the development of Green Mini-Grids (GMGs) where they are technically and economically a better option than the extension of the main grid. The Market Intelligence business line targets the provision of comparable, actionable data on the potential for GMGs between countries in Sub-Saharan Africa. This report provides an analysis for Ethiopia.

This report's methodology combines a high-level opportunity assessment with practical knowledge and information targeted at mini-grid practitioners. Information provided covers key stakeholders, raw data on physical and non-physical factors and a policy and regulatory analysis. The potential for mini-grids is a challenging analysis, requiring plenty of data and assumptions. A thorough assessment must include a number of criteria that are driven by the particular business model and approach of the implementing agency for each case. This report therefore, aims to capture available data and highlight general assessments that would be relevant to most mini-grid stakeholders. Raw data is provided with this report so stakeholders may further conduct their own specific analyses.

Energy access in Ethiopia stands at 25% as of 2014 and at only 10% in rural areas. The Universal Energy Access Program (UEAP) is the national vehicle for electrification and has improved access from 17% in 2006. However, grid intensification is needed as the program has focused on village, rather than household connections. Approximately 30% of the population remains below the basic needs poverty line. This is despite impressive economic growth and a focus on poverty reduction over the last decade. Per capita energy consumption and income, at less than 100kWh and US$739 per year, are well below the Sub-Saharan African average. Approximately 70% of Ethiopians rely on traditional biomass for household cooking and the vast majority (85%) are engaged in small-scale agriculture. About 16.4 million improved cook stoves are estimated to have been disseminated, resulting in 25% of the population now having access to cleaner cooking solutions.

The grid extends into most regions of Ethiopia, with the main gap being in the south and south-eastern parts of the country in the Somali and Oromia provinces. The core of the transmission grid extends radially from the central capital of Addis Ababa, with the least coverage in border areas and the Somali region. Domestic energy consumption is heavily subsidised, with a national flat tariff of less than US$ 3c/kWh against a long run marginal cost-to-grid supply of US$ 7c/kWh. This is a significant barrier to network reinforcement, connection of Independent Power Producers (IPPs) and mini-grids, as well as to sustainable operations of the national Ethiopian Electric Utility. A review of this tariff rate is currently underway. There are 11.2GW of generation capacity installed or commissioned as of 2015, with an additional 18.9GW planned for operation by 2020. The current installed and commissioned capacity is made up of 10GW of large hydro, 854MW of wind, 112MW of diesel, and 77MW of geothermal. Ethiopia is a major exporter of power, currently selling to Djibouti (350GWh), Kenya (14,000GWh) and Sudan (7GWh). By 2037, the planned export capacity will total 47GW, including 2,600GWh to Tanzania by 2018.

The responsibilities and mandates of key institutions have changed significantly within the past year, including the transfer of the Universal Energy Access Program to the Ethiopian Electric Utility. The responsible ministry is the Ministry of Water, Irrigation and Electricity (MoWIE), under which there are three main implementing institutions: Ethiopian Electric Power (EEP), Ethiopian Electric Utility (EEU) and the Ethiopian Energy Authority (EEA). EEP is responsible for generation and transmission (132kV and above), EEU is responsible for distribution and the Universal Electricity Access Project (UEAP), and EEA is the regulatory agency. The Ministry of Finance and Economic Coordination (MoFEC) is also involved in the sector, principally for projects including Power Purchase Agreements (PPAs). There are two relevant directorates under MoWIE: the Energy Study and Development Follow-Up Directorate (ESD); and the Alternative Energy

Technology Development and Promotion Directorate (AETDPD). The ESD is responsible for strategy and coordination within the energy sector. AETDPD was originally an implementing agent, coordinating the Rural Energy Fund, but is now being developed into a strategy and dissemination institution along with the ESD.

Substantial legislative changes are being implemented to promote private sector on- and off-grid solutions under the second Growth and Transformation Plan (GTP II). This includes the development of a new energy policy, national grid code, national electrification strategy, off-grid master plan and a review of the national tariff. Most of these are due to be finalised and ratified between now and end 2017. The issue of insufficient coordination across these institutions may be addressed through the relevant directorate for coordination, the Energy Study and Development Follow-Up Directorate. However, agents such as the World Bank have suggested a new coordinating agent, a prospective "Directorate for Electrification." This is reflected in the country's National Electrification Strategy, which is due to be released in 2017.

Barriers remain towards the development of the energy sector, including limited capacity and experience on off-grid planning and implementation. The overlap of mandates and uncertainty over roles between government institutions during this transition period was mentioned previously. Other barriers include a lack of experience in delivering IPP-based generation, the short-term planning timeframes of the institutions involved in electrification, limited geospatial planning capability and the heavily subsidised national tariff.

Ethiopia has an abundance of natural resources, being dubbed 'the powerhouse of Africa' due to its substantial hydropower resources. Ethiopia has an estimated 45GW of exploitable hydropower, focused in the western half of Ethiopia, of which approximately 3GW is small-scale hydropower. Ethiopia has significant biomass energy potential also from agro-processing waste, including sugar cane bagasse, cotton stalk, coffee hull and oil seed shells. Ethiopia's solar irradiation averages over 2,000 kWh/m2, which is comparable with South Africa and the State of California, and is well distributed across the country. The Somali region is a priority region for wind projects, with 1,060GW of the 1,350GW of Ethiopia's wind potential and localised wind speeds reaching over 10m/s.

Our analysis estimates that 16.2 million of the 99.8 million citizens of Ethiopia (16.2%) would be best served by mini-grids, with an estimated market size of US$ 639 million. This analysis is revised to 13.0 million citizens with an estimated market size of US$ 513 million when including the planned market extensions up to 2020. This market size is based on the average per capita annual expenditure on energy of US$ 39.5 in 2010. The highest current potential is found in Oromia (6.2 million, 17.8%) followed by the Southern Nations (4.7 million, 23.9%) and Amhara (3.1 million, 12.4%) regions. Significant current potential is found in the Tigray and Somali regions, with 954,000 and 906,000 people best served by mini-grids, respectively. The lowest potential is in Addis Ababa and the Harari region. Other regions with low mini-grid potential are the chartered city of Dire Dawa and Benshangul-Gumaz. Off-grid electrification is now a key element of the second GTP (2016-2020), with mini-grids prioritised over standalone systems. GTP II identifies villages to be electrified via off-grid solutions.

1. INTRODUCTION TO THE GREEN MINI-GRID MARKET DEVELOPMENT PROGRAMME

This country report is one of five pilot country reports in the first phase of the Market Intelligence business line of the MDP, providing an analysis of the potential for GMGs per country. Successive phases of the MDP will include additional countries. The ultimate aim is to provide comparable, actionable data on GMG potential throughout Sub-Saharan African countries.

Mini-grids are not a new phenomenon in Africa. Almost all national utilities own and operate diesel-powered generating facilities not connected to the main grid, which supply electricity to secondary towns and larger villages. This solution to rural electrification inevitably results in significant financial losses for the utility, as it is required to sell power at prices much below the cost of production and delivery. Moreover, it leaves the most remote towns and villages unelectrified. The latest Sustainable Energy for All (SEforALL) Global Tracking Framework estimates that the urban-rural divide in access to electricity in Africa is as high as 450%, with 69% urban compared to 15% rural access.

There are three principal options for providing new connections to currently unserved populations in Africa. These include: i) extension of the national grid, ii) installation of separate "mini" grids to operate independently from the main grid, and iii) stand-alone generating systems that supply individual consumers. The most cost-effective approach for powering mini-grids is to use renewable energy sources, which are widely available across Africa. However, the development of GMGs is not without challenges. Barriers to the growth of private sector mini-grids in Africa include gaps in the policy and regulatory framework, the lack of proven business models, the lack of market data and linkages, the lack of capacity of key stakeholders, and limited access to finance.

In response to these challenges, the SEforALL Africa Hub at the African Development Bank (AfDB)[1] designed and launched Phase 1 of the GMG MDP in 2015, with grant funding from the AfDB's Sustainable Energy Fund for Africa (SEFA). The GMG MDP is a pan-African platform that addresses the technical, policy, financial and market barriers confronting the emerging GMG sector. It is part of the larger funded GMG Africa Programme by the UK's Department for International Development (DfID), which also includes GMG initiatives in Kenya, Tanzania, Mozambique and DRC; country-specific GMG policy development through SEFA; and an action learning and exchange component implemented by the World Bank's Energy Sector Management Assistance Program (ESMAP).

The International Energy Agency (IEA) has predicted that by 2040, 70% of new rural electricity supply in Africa will come from stand-alone systems and mini-grids.[2] The GMG MDP, SEforALL, SEFA, ESMAP and similar programmes, which are contributing to falling costs, technological advancements and increased efficiencies in GMG development, will help ensure that up to two thirds of this supply will be powered by renewables.

The goals of the green mini-grids programme are central to AfDB's mission of fostering sustainable economic development, social progress and poverty reduction in its regional member countries (RMCs). Indeed, off-grid and mini-grid solutions are a key component of the AfDB's New Deal on Energy for Africa, launched by the Bank's president in January 2016. The New Deal is a transformative, partnership-driven effort with an aspirational goal of achieving universal access to energy in Africa by 2025.

1 The SEforAll Africa Hub partnership includes the African Union Commission, the New Partnership for Africa's Development, the United Nations Development Programme, and the Regional Economic Communities, which are represented on a rotating basis. http://www.se4all-africa.org

2 Africa Energy Outlook 2014

This report was prepared by Carbon Trust, the United Nations Environment Programme (UNEP) and the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) at the request of the AfDB. It was jointly written by Marcos Sampablo and Luke Walley of Carbon Trust and Meseret Zemedkun and Eugene Ochieng of UNEP. Carbon Trust is a mission-driven organization helping businesses, governments and the public sector to accelerate the move to a low carbon economy. UNEP is a leading global environmental authority. The content of this report was reviewed by Jeff Felten of the AfDB's GMG team and cleared by Dr. Daniel-Alexander Schroth, SEforALL Africa Hub Coordinator at the AfDB. The report was edited by Kimberlee Brown.

2. COUNTRY OVERVIEW

The Federal Democratic Republic of Ethiopia occupies a total area of 1,100,000 square kilometres (420,000 sq. mi).[3] It is bordered by Eritrea to the north, Djibouti and Somalia to the east, Kenya to the south and Sudan and South Sudan to the west.

Administratively, Ethiopia includes nine regions (Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali and Southern Nations, Nationalities and Peoples') and two chartered cities (Addis Ababa and Dire Dawa). Tigray, Afar and Amhara occupy the north of the country, Somali the East, Oromia and Southern Nations the south and Gambela, Oromia and Benishangul-Gumuz the west. The capital Addis Ababa is located in the centre of the country, and has a population of over 3million.[4] Ethiopia has a diverse population, with over 80 ethnic groups. Oromo is the majority group, comprising 34.6% of the population, followed by the Amhara ethnic group making up 27.1%.[5]

Ethiopia has a varied geography, with tropical eastern lowlands, cool highlands in many other parts of the country and a section of the Great Rift Valley running across the country from north-east to south-west. Rainfall is correspondingly varied, with higher rainfall towards the west and much lower rainfall in the north-east lowlands. The eastern Somali region is particularly dry, possessing the majority of Ethiopia's wind resource. The Blue Nile is Ethiopia's main river, originating in Lake Tana, and is one of many rivers that flow from the highlands. Others include the Omo, Baro and Awash rivers.

The country is Sub-Saharan Africa's second most populous country, with over 99 million people, but also one of the poorest. Approximately 44% of the population were living below the basic needs poverty line in 1999/00.[6] The government has focused heavily on poverty reduction over the last two decades, implementing initiatives such as the Sustainable Development and Poverty Reduction Program (SDPRP) of 2002 and the 2006 Plan for Accelerated and Sustained Development to End Poverty (PASDEP). These have delivered improvements across multiple sectors. Primary school enrolment has quadrupled, child mortality has halved, and the rate of access to clean water has more than doubled. [7]

Ethiopia has shown impressive economic growth recently but substantial needs remain for rural energy access and poverty alleviation. Ethiopia registered an average annual growth of 10.8% over the last decade (2005-2015) with the World Bank forecasting a 7% growth rate over the next three years.[8] The country's five-year economic strategy, GTP II, seeks to achieve the millennium development goals and middle-income status by 2025. A carbon-neutral transition is targeted, relying on Ethiopia's abundant hydropower resources. GTP II targets reducing the percentage of its population that falls below the poverty line to 16.7% by 2019/20, compared to 30% today. National energy access stands at 25%, but is only 10% in rural areas.[9] More than 80% of the population live in rural areas.[10] Approximately half of Ethiopians live in close proximity to the grid.[11] Per capita energy consumption remains low, at less than 100kWh/annum, well below the Sub-Saharan African average of 540 kWh/year in 2010. (Ethiopia had 77kWh/year in 2013.)[12] The average rural and

3 UN World Statistics Pocketbook. Ethiopia Country Profile. 2014.

4 http://www.citypopulation.de/Ethiopia.html

5 http://www.theodora.com/wfbcurrent/ethiopia/ethiopia_people.html

6 Central Statistics Agency, National Survey, 1999/00

7 UN World Statistics Pocketbook. Ethiopia Country Profile. 2014.

8 Power Africa, 2016, Investment Brief for the Energy Sector in Ethiopia

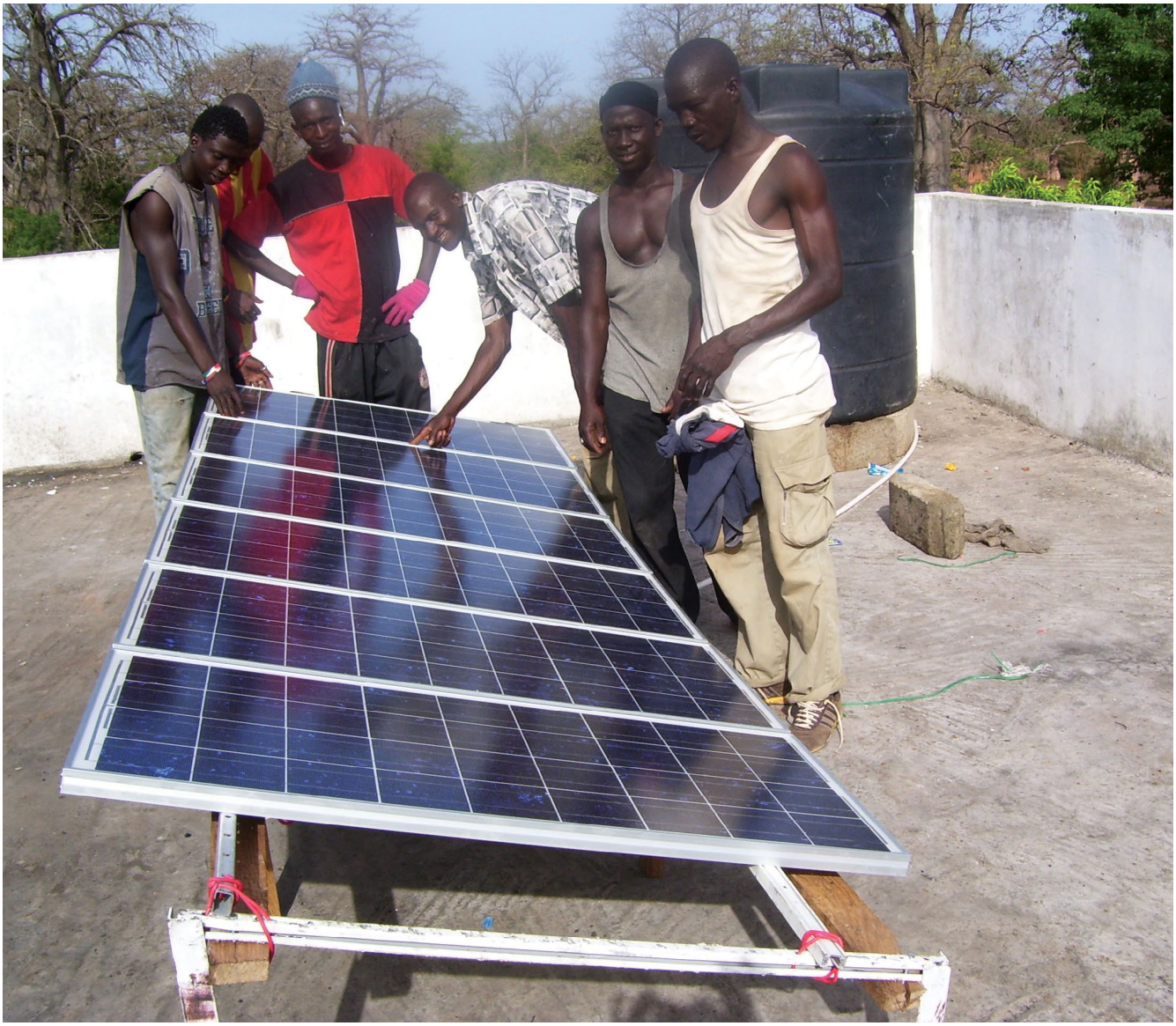
9 World Energy Outlook 2015. Electricity Access Database

10 Ministry of Water and Energy, Scaling-Up Renewable Energy Program Investment Plan, 2012

11 Ministry of Water and Energy, Scaling-Up Renewable Energy Program Investment Plan, 2012

12 Ministry of Water and Energy Presentation. Ethiopia's Renewable Energy Power Potential and Development Opportunities. 2013. Dereje Derbew.

urban household size is 5 and 4.6 persons, respectively.[13] The country's per capita income of US$ 739[14] remains well below the regional average.[15] Approximately 70% of Ethiopians rely on traditional biomass for household cooking, and the vast majority (85%) are engaged in small-scale agriculture.[16] Agriculture accounts for 45.9% of gross domestic product. Agricultural products such as primary export commodities account for up to 86% of total foreign exchange earnings.[17] Petroleum fuels and electricity are more common in urban areas, and biomass fuel use has reduced dramatically in some areas of the country. An estimated 16.4 million improved cook stoves have been disseminated, leaving just over 25% of the population without access to cleaner cooking solutions.[18]



13 MWH Ethiopia National Action Plan, 2014

14 IMF WEO database

15 UN World Statistics Pocketbook. Ethiopia Country Profile. 2014.

16 The Second Growth and Transformation Plan 2015/16-2019/20, National Planning Commission, 2015.

17 Ethiopian Government Portal, Economy Overview

18 Ministry of Water and Energy Presentation. Ethiopia's Renewable Energy Power Potential and Development Opportunities. 2013. Dereje Derbew.

3. POTENTIAL OF GREEN MINI-GRIDS

3.1 INTRODUCTION

Ethiopia has been dubbed 'the powerhouse of Africa' due to its substantial hydropower resources. Ethiopia has an estimated 45GW of exploitable hydropower, mostly located in the western half of the country. Ethiopia has significant biomass energy potential from agro-processing industries' waste, including sugar cane bagasse, cotton stalk, coffee hull and oil seed shells. Ethiopia's solar irradiation is well distributed across the country and averages over 2,000 kWh/m2, which is comparable with South Africa and the State of California. The Somali region is the priority region for wind projects, with 1,060GW of the 1,350GW of Ethiopia's wind potential and localised wind speeds reaching over 10m/s.[19]

Ethiopia's government has incorporated off-grid solutions as a means of achieving universal access within the last five years. The Universal Energy Access Program, in line with the country's Growth and Transformation Plans, is the implementation program through which the electrification of rural areas is prioritised, selected and delivered. GTP I, running from 2010-2015, did not consider off-grid solutions, and hence villages that were too remote from the grid were deprioritised. However off-grid is an integral part of GTP II, which runs until 2020. IPPs are seen as the driver of new on and off-grid generation under GTP II, with institutional and policy changes being implemented to facilitate the move to this model. Mini-grids are prioritised over standalone solar home systems (SHS) within this framework due to their greater rural development potential.

3.2 ASSESSMENT BACKGROUND

Estimating the potential for mini-grids is a challenging task involving a plethora of data and assumptions. Some physical factors such as resource availability and geographic features can be collected remotely through satellite data, but other factors require the availability of local datasets and surveys. Some non-physical factors such as consumption patterns and demand will require precise settlement-level data to be collected. In developing countries this data is often not available, is out of date or is highly resource intensive to obtain. An opportunity assessment requires a number of assumptions that are driven by the particular business model and approach of the implementing agency for each case. For example, a private developer may consider purely financial metrics, whereas a community scheme could focus more on the level of service provided. Therefore a detailed assessment in this report could not address the needs of all of the different stakeholders for which it is intended. This report therefore aims to capture available data and highlight general assessments that would be relevant to most mini-grid stakeholders. Raw data is provided with this report to allow stakeholders to conduct their own, more specific, analyses.

On- and off-grid development plans for the next five years are outlined in the GTP II and will be supported by the World Bank-funded National Electrification Strategy and the forthcoming Off-Grid Master Plan being developed by USAID PowerAfrica. The target is for 90% village access by 2020 through the GTP II. The villages requiring electrification to reach this target are specified in this plan.

3.3 MINI-GRID POTENTIAL ASSESSMENT

Our analysis considers the potential for mini-grids by segmenting countries into three areas: (i) grid, (ii) mini-grid, and (iii) standalone areas, based on distance from the power network and population density. We have used the current power network and geospatial data, which is referenced in Annex 1. Regions suitable for mini-grids are defined based on a distance of greater than 15km from the grid, as well as a household density greater than 50 households/km2. Grid regions are defined as within 15km of the grid, and standalone systems make up the remaining area.

Depending upon the type of off-grid solution, particular developers may wish to also consider regions within areas already serviced by the grid.

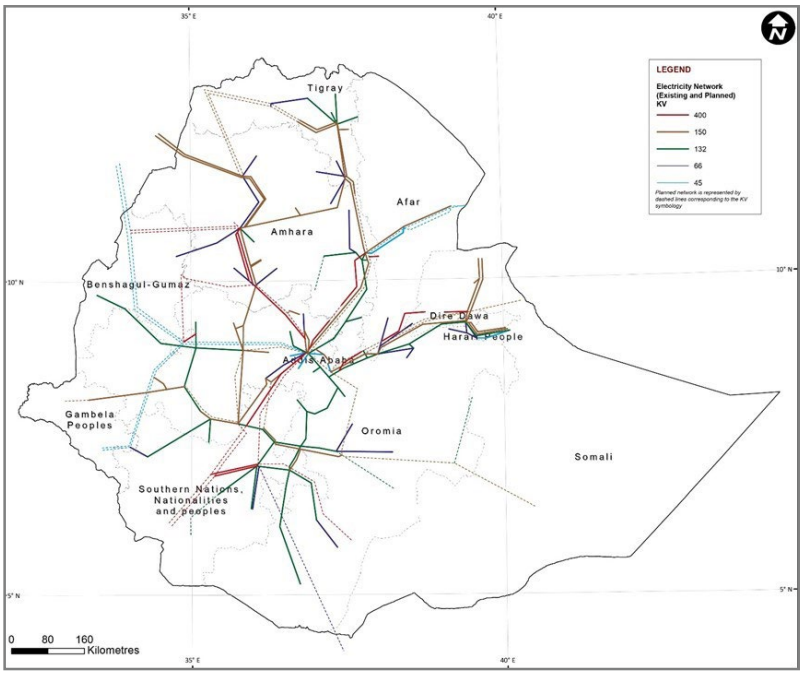
19 REN21 – REEGLE Clean Energy Info Portal. Country Profile

Urban electricity access stands at 85% as of 2013. High connection costs, regular power outages and unreliability associated with the aging grid network have created additional market potential in urban areas as well. This is not considered in our analysis however, due to its high dependence on the existing business model and local demographics.

Energy access stood at 25% in 2016,[20] with only 10% in rural areas.[21] Access was 17% nationally and 2% in rural areas in 2006, at the start of the GTP I program.[22] The government's tracking indicator for energy access (used in GTP, the Climate-Resilient Green Economy (CRGE), and UEAP, see Section 3.2) defines connectivity as the "availability or proximity of a town/community to electricity supply with hospitals, clinics, key administrative and social services, streets benefiting from electricity services." Under this definition the access rate in 2012 was 54%, and the UEAP target for access will be 90% by the end of GTP II in 2020. This definition has led to low connectivity of households in settlements electrified under the UEAP. This problem is being addressed through grid intensification programmes by organisations such as the World Bank and the AfDB (see Section 6.3).

The grid extends into most regions of Ethiopia, with the main gap being in the south and south-eastern parts of the country in the Somali and Oromia provinces, as well as the northern Afar region. The core of the transmission grid extends radially from the central capital of Addis Ababa, as shown in Figure 1. There are many areas remaining unserved by the grid under GTP II, especially further from the capital and in border zones. The largest areas of mini-grid potential are found in the central and northern parts of Ethiopia, such as the Oromia and Amhara regions. Shown in Figure 2 is the population density of Ethiopia together with the transmission network. Results of our analysis on which areas would be best served by mini-grids are shown in Figure 3.

Figure 1. Existing and planned grid up to 2020 (dotted) electricity transmission grid.



Our analysis estimates that 16.2 million people (out of a population of 99.8 million) would currently be best served by mini-grids. This number is 13 million people when including the planned network extensions up to 2020. The highest potential is found in Oromia (6.2 million, 5.5 million by 2020) followed by the Southern Nations (4.7 million, 2.7 million by 2020) and Amhara (3.1 million, 2.8 million by 2020) regions. This correlates with the regions of higher density as seen in Figure 2. Significant potential is found in the Tigray and Somali regions, with 954,000 and 906,000 people best served by mini-grids currently (930,000 and 831,000 by 2020, respectively). Standalone systems are found to be the best

20 Conversation with EEU's CEO, Ato Gosaye Mengistie, 2016

21 World Energy Outlook 2015. Electricity Access Database

22 REN21 – REEGLE Clean Energy Info Portal. Country Profile

current option for 75.5% of the Somali population in our analysis. The lowest potential is in Addis Ababa and Harari region, where all of the population is within 15km of the existing grid. The other regions with low mini-grid potential include the chartered city of Dire Dawa and the Benshangul-Gumaz region. The results of this analysis are detailed in Table 2.

Our analysis estimates a current market size of US$ 639 million,[23] based on an estimated average per capita annual expenditure on energy of US$ 39.5 in 2010.[24] The figure drops to US$ 513 million when including the planned network extensions up to 2020. The results of this analysis are detailed fully in Table 2. The market size includes people already connected to the grid. In total, as shown in Figures 3 and 4, mini-grid areas are found in all regions apart from Addis Ababa and Harari. The largest areas covered by mini-grids are found in the Oromia, Amhara and Southern Nations' regions due to their higher population density.

Standalone systems are found to be the best current option for 33% of the population, including 11.5 million and 8.9 million in the Oromia and Amhara regions, respectively. This is reduced to 27% when including the planned network extensions up to 2020. The health and other development benefits to standalone systems are still significant, if lower than for mini-grids, especially in the replacement of kerosene lighting. Table 1 shows the main source of lighting in Ethiopian households in 2011 and 2014, based on surveys by the World Bank. Over 39% of households' main lighting source was kerosene lamps in 2014 (down from 51% in 2011), posing significant health risks. This rate is decreasing due to the distribution of solar home systems by the Rural Electrification Fund and private sector organisations such as the Stiflung Solar Energy Foundation.

Table 1. – Distribution of main household lighting sources in Ethiopia, 2011 and 2014.

Main source of Lighting	2011 - Percentage (%)	2014 - Percentage (%)
Electricity meter- private	7.64	7.90
Electricity meter- shared	9.65	12.35
Electricity from generator	0.45	0.50
Solar energy	0.13	3.05
Electric battery	0.29	0.50
Light from dry cell with switch	17.29	25.64
Kerosene light lamp (imported)	9.75	5.78
Kerosene light lamp (local kuraz)	41.23	33.54
Candle/wax	0.24	0.08
Firewood	12.99	9.68
Other Sources	0.32	0.98

Source: *Multidimensional Measure of Household Energy Poverty and its Determinants in Ethiopia. M. Bersisa. East Africa Research Papers in Economics and Finance. No. 2016:15*

23 The total market size is estimated from the household energy market size. This assumes that 60% of household energy spend is on electricity, and that household spending comprises 60% of the total revenue of a mini-grid (when including revenue from businesses, public sector buildings and industrial users).

24 Uses the Annual Household Energy Consumption in Ethiopia in 2010 (USD, World Bank Global Consumption Database).

Table 2. – Estimated market size split by grid extension, mini-grid and standalone.

Province	Grid Extension (population)	Mini-Grid (population)	Stand Alone Systems (population)	Percentage Mini-Grid	Mini-Grid Market Size (US$m)
Existing grid network					
Addis Ababa	4,369,630	-	-	0.0	
Afar	402,971	174,528	1,325,370	9.2	6,892,790
Amhara	13,239,500	3,133,480	8,890,920	12.4	123,753,313
Benshangul-Gumaz	226,172	62,753	712,003	6.3	2,478,360
Dire Dawa	542,421	2,257	11,539	0.4	89,138
Gambela Peoples	104,335	17,355	302,834	4.1	685,416
Harari	274,031	-	-	0	
Oromia	17,227,200	6,216,750	11,571,000	17.8	245,523,637
Somali	464,601	905,641	4,224,780	16.2	35,767,286
Southern	10,914,300	4,703,000	4,030,370	23.9	185,739,762
Tigray	2,830,680	953,526	2,007,060	16.5	37,658,450
TOTAL	**50,595,841**	**16,169,290**	**33,075,876**	**16.2**	**638,588,151**
Planned grid network up to 2020					
Addis Ababa	4,369,500	-	-	0.0	
Afar	516,582	124,260	1,261,840	6.5	4,907,511
Amhara	15,023,600	2,821,770	7,256,390	11.2	111,442,672
Benshangul-Gumaz	431,945	52,563	516,442	5.3	2,075,917
Dire Dawa	551,335	1,880	3,035	0.3	74,249
Gambela Peoples	188,624	10,259	225,850	2.4	405,168
Harari People	273,988	-	-	0.0	
Oromia	19,983,600	5,514,400	9,406,650	5.8	217,785,104
Somali	739,235	831,344	4,024,200	14.9	32,833,008
Southern	13,857,200	2,695,680	2,876,140	13.9	106,462,888
Tigray	3,188,600	930,080	1,644,300	16.1	36,732,477
TOTAL	**59,124,209**	**12,982,236**	**27,214,847**	**13.1**	**512,718,993**

Source: *Carbon Trust analysis using an annual household energy consumption of US$ 39.5 in 2010 for the existing network and the planned network up to 2020.*[25]

25 Uses the Annual Household Energy Consumption in Ethiopia in 2010 (USD, World Bank Global Consumption Database).

3.4 RENEWABLE ENERGY POTENTIAL FOR MINI GRIDS

HYDRO

Ethiopia has an estimated 45GW of exploitable hydropower, of which less than 5% is currently utilised. The country possesses about 20% of the total technically feasible potential in Africa and is thus often called the 'powerhouse of Africa.' Hydro supplies over 95% of Ethiopia's power (roughly 2.1GW),[26] concentrated in the western half of Ethiopia. An estimated 7% of this (3GW) is small-scale hydropower, with approximately 1.5GW of this in proximity to the grid.[27] In total, Ethiopia has nine major river basins. The only operating mini-grids are five community-owned mini-hydro schemes, implemented by German development agency, GIZ, under its Energising Development (EnDev) program (Sections 4.6 and 6.3). Hydropower is the main component of the planned generation under GTP II, which details 11GW of new capacity. Most of these hydro generation projects are intended for IPP/PPP (Private Public Partnership) modality, including the Upper Menbdaya and Beko Abo (2,635MW) project, TAMS (1.7GW) project, KARADOBI (1.6GW) project, Garo I & II and Genji (859MW) projects.

GTP II identifies 105 off-grid villages to be electrified through micro-hydro schemes. Pilot design studies have been completed for five of these sites. The Enterprise Canada Network estimates the Ethiopian micro and pico hydropower (<500kW) market at US$ 200 million, and the mini and small hydropower (> 500kW) market at US$ 2 billion.[28] It is hoped that identifying off-grid settlements under GTP II will provide the clarity needed to engage off-grid IPPs to this market. To further facilitate this engagement, pilot design studies have been completed for five of these sites by the Rural Electrification Fund (REF) and the Alternative Energy Technology Development and Promotion Directorate (AETDPD): Aleltu (300kW), Bello (192kW), Bote (160kW), Dilla (480kW), and Sonkole (260kW).[29] A number of key challenges remain including a lack of legislation for compensating grid stranded assets, the absence locally of modern metric horsepower technologies and limited local technical skills. The GIZ EnDev program, detailed in Section 6.3 is attempting to address these last two barriers.

BIOMASS

Ethiopia has significant biomass resources, however demand for traditional biomass for cooking is reducing supply. Ethiopia had 1,149 million tons of woody biomass stock in 2000 with 50 million tons harvested annually, according to the Woody Biomass Inventory and Strategic Planning Project. EEP estimates that half of its 1,120 million tons of resources are currently being exploited.[30] Certain regions such as the Eastern Escarpment of the Amhara region have the greatest deficit of biomass resources, while the northern highlands and eastern lowlands also have low woody biomass cover. The government's GTP II paper estimates that 70% of Ethiopian's rely on traditional biomass, and states the national forest coverage as 15.5% as of 2014/15.[31] The estimated wood demand growth rate is 2.8% in the Ministry of Water and Energy's 2012 Scaling-Up Renewable Energy Program (SREP): Ethiopia Investment Plan, in line with anticipated population growth. The same report raised the issue of "insufficient assessment of biomass energy resources and technologies."

Ethiopia has considerable potential for energy generation from agro-processing industries, including processing sugar cane bagasse, cotton stalk, coffee hull and oil seed shells. This is reflected in the GTP II target of 420MW of biomass generation capacity by 2020.[32] Although no biomass-based power is used in the grid, several sugar factories have been using sugar cane bagasse for internal power since the 1950s, and an estimated 30MW of capacity surplus

26 Ministry of Water and Energy Presentation. Ethiopia's Renewable Energy Power Potential and Development Opportunities. 2013. Dereje Derbew.

27 Power Sector Market Report – Ethiopia, Enterprise Canada Network, 2013.

28 Power Sector Market Report – Ethiopia, Enterprise Canada Network, 2013.

29 Ethiopia Electric Power Presentation, Azeb Asnake, CEO, UK-Ethiopia Trade & Investment Forum, 2015

30 Ethiopia Electric Power Presentation, Ethiopian Bulk Power Development & Regional Interconnection, 2014

31 The Second Growth and Transformation Plan 2015/16-2019/20, National Planning Commission, 2015.

32 Ethiopia Electric Power Presentation, Azeb Asnake, CEO, UK-Ethiopia Trade & Investment Forum, 2015

Figure 2. Population density map of Ethiopia. Dotted lines are planned grid extensions up to 2020.

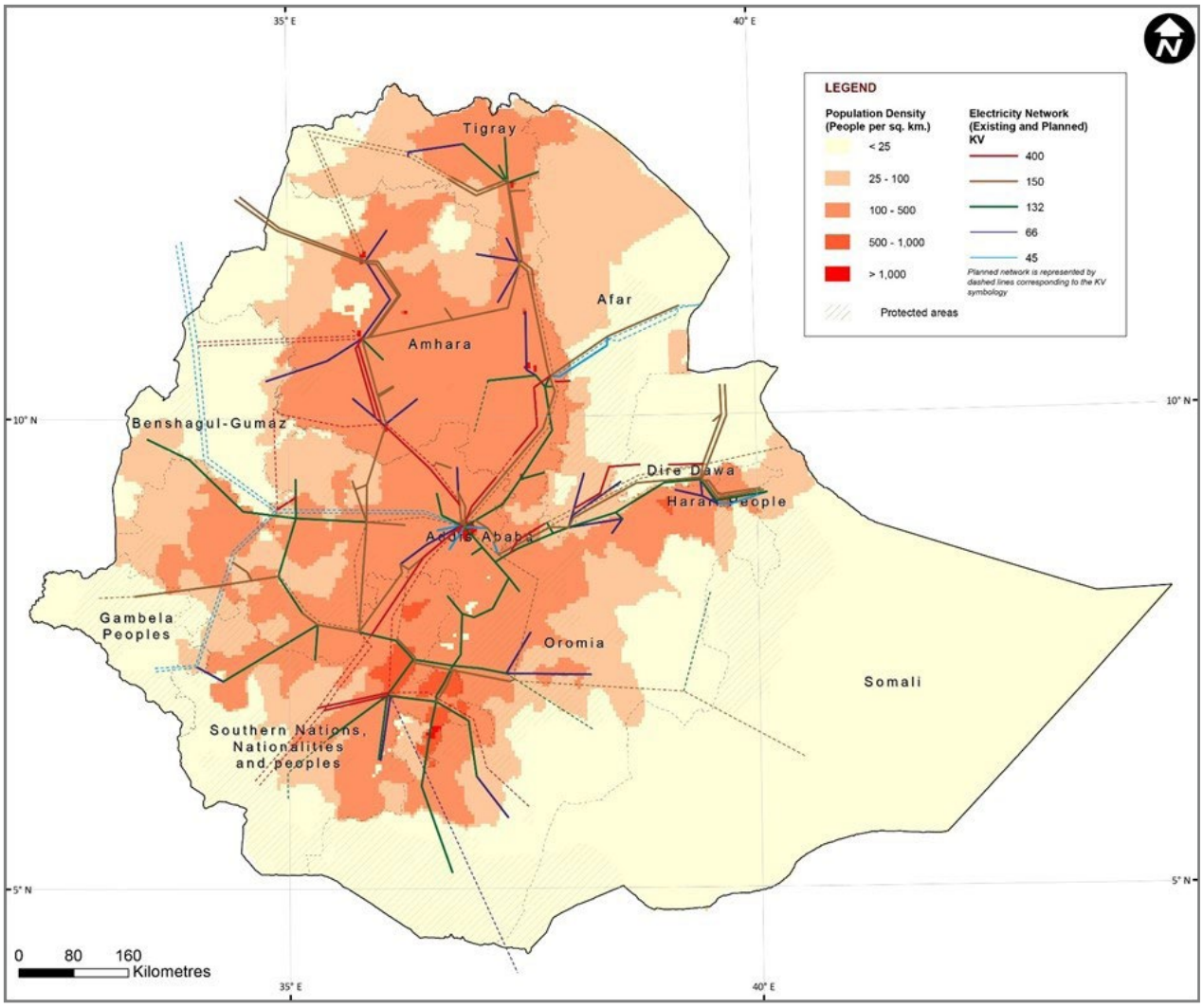
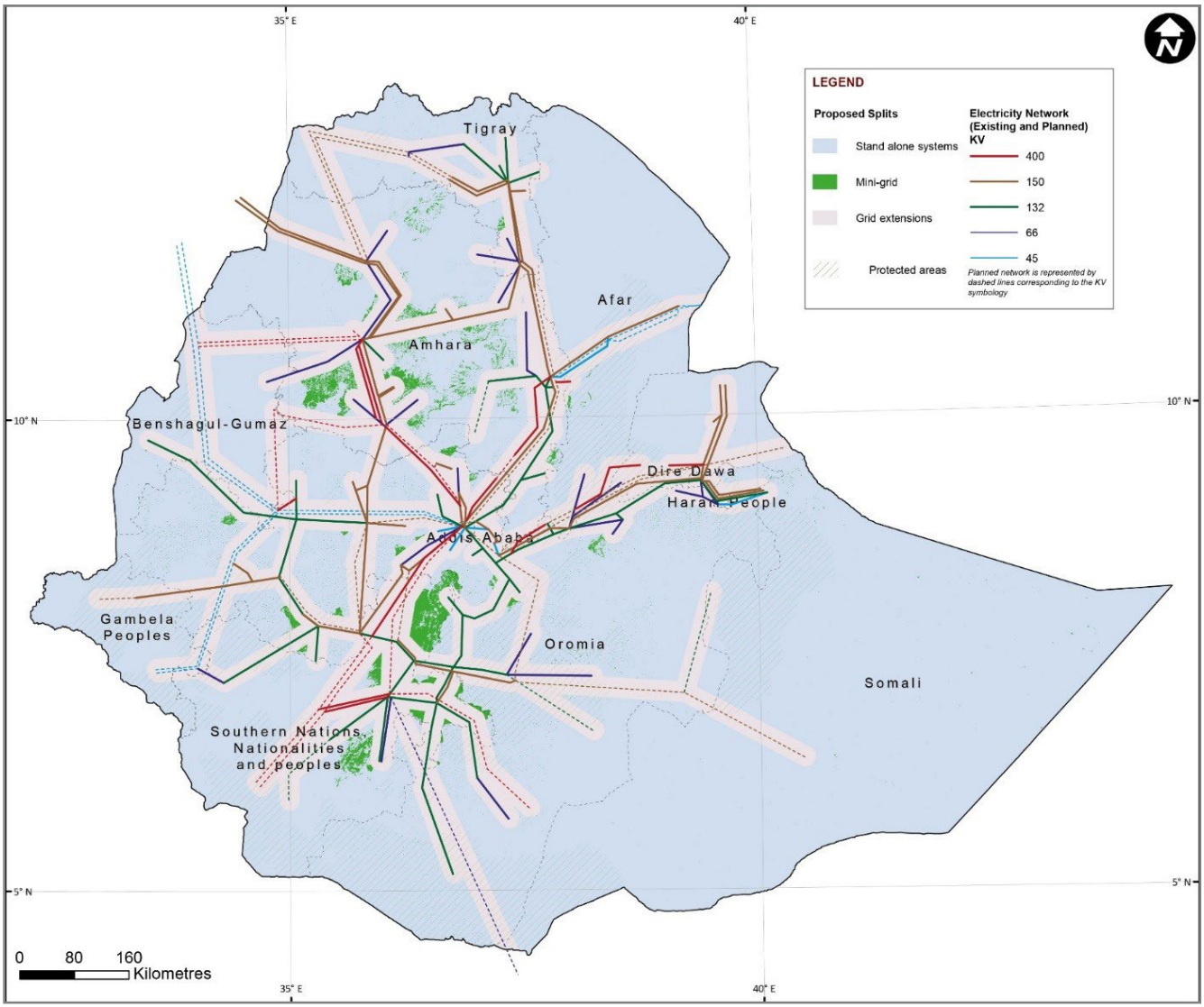
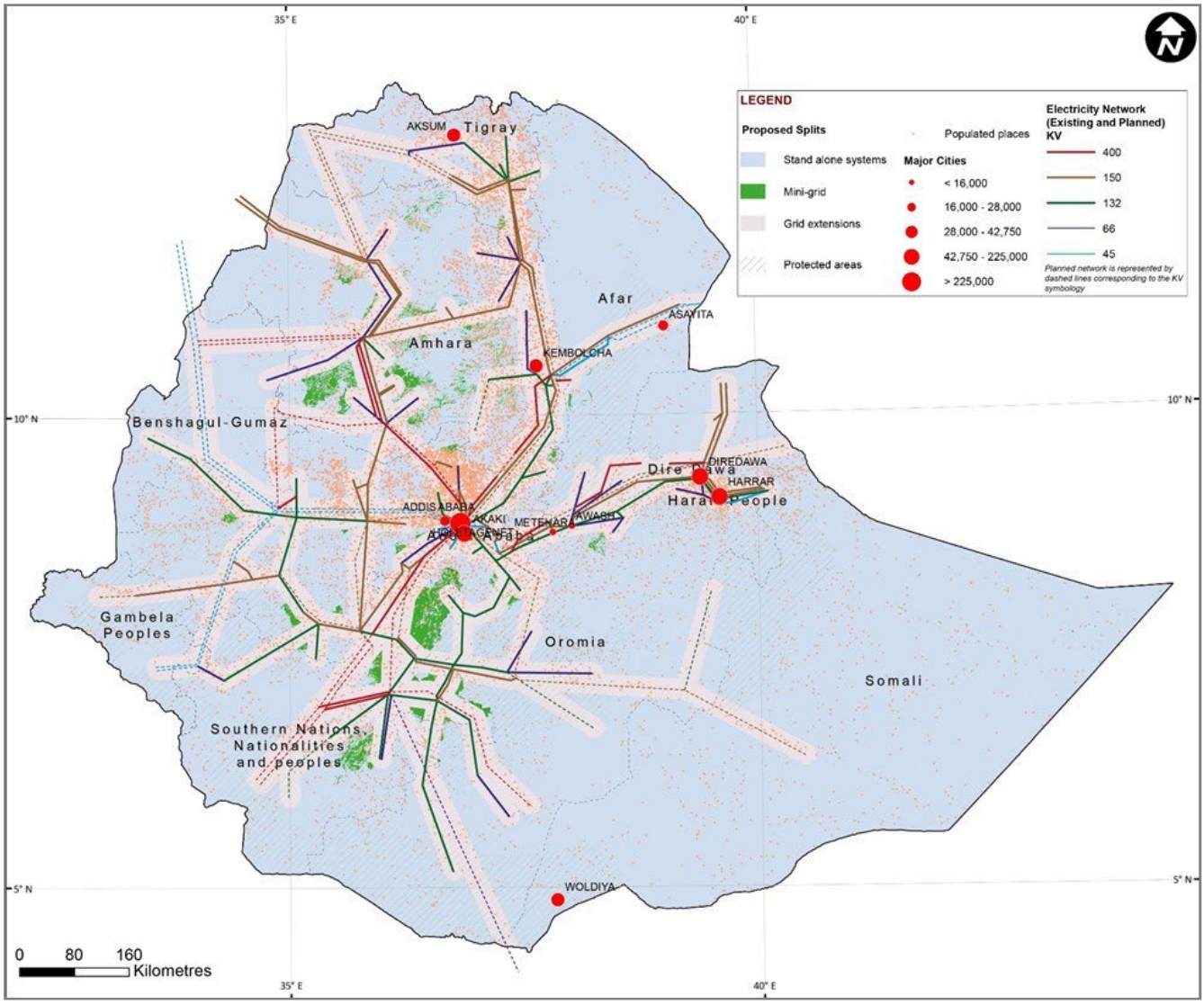


Figure 3. Split of grid extension, mini-grid and standalone systems. Dotted lines are planned grid extensions up to 2020.



Source: *Carbon Trust analysis*

Figure 4. – Split of grid extension, mini-grid and standalone systems, shown with major and minor population centres. Dotted lines are planned grid extensions up to 2020.



Source: *Carbon Trust analysis*

from these systems could be fed easily into the grid.[33] Biofuels are also of interest as a replacement for petroleum. The Ethiopian Biofuel Development and Utilization Strategy targets the supply of local jatropha, caster bean, palm oil and sugar cane for fuel. Several local and international private and non-private biofuel developers have registered in Ethiopia and over 1.3 million hectares have been allocated to investors across the Benshangul, Amahara, Oromia and Southern Nations regions.[34] There are also a number of MoWIE projects to support biomass and biogas projects in rural areas such as the National Biogas Program and Improved Cook Stoves Program. The first phase of the National Biogas Program successfully installed 8,161 biogas plants between 2009 and 2013, with the ongoing second phase focusing more on private sector entrepreneurship development.[35]

SOLAR

Ethiopia's exploitable solar resource is estimated at 5.5 kWh/m2/day, or just over 2,000 kWh/m2 annually, compared to 2,015 kWh/m2 in South Africa and California.[36] The country's annual average global horizontal irradiation is shown in Figure 5. This corresponds to a total solar energy reserve of 2.199 million TWh/annum,[37] and is found across the country. The higher potential is mainly found in the central and northern parts of Ethiopia (Tigray, Oromia and Amhara regions) and the Somali region, where irradiation can exceed 2,450 kWh/m2. However, even in potential lower regions there are sufficient resources to develop grid and off-grid solar projects, including the mini-grid areas identified in Figures 3 and 4. An example is the Awassa area south-west of Addis Ababa, which averages between 2,350 and 2,450 kWh/m2, compared to Mozambique, which averages 1,927 kWh/m2.

Despite the potential, solar has not been a focus of government policy and no solar projects are operational or under construction. GTP II, which focuses mainly on hydro, wind and geothermal, does however identify 5.2GW of solar power within its 18.9GW of additional generation. 300MW is planned from identified sites by 2017,[38] with a further 4.9GW from as of yet unidentified sites by 2020. All 5.2GW are anticipated to be delivered through private financing, under an IPP/PPP modality. There has been greater activity to date in the solar lanterns and SHSs market. The Solar Energy Foundation estimates that in addition to the 40,000 SHS installed by REF, some 60,000 were distributed by NGOs and close to one million solar lanterns sold.[39]

33 Energypedia, Ethiopia Energy Situation

34 Biofuel Energy for Mitigation of Climate Change in Ethiopia, A. Berta, B. Zerga, Journal of Energy and Natural Resources. Volume 4, Issue 6, December 2015, Pages: 62-72.

35 http://www.snv.org/project/national-biogas-programme-ethiopia

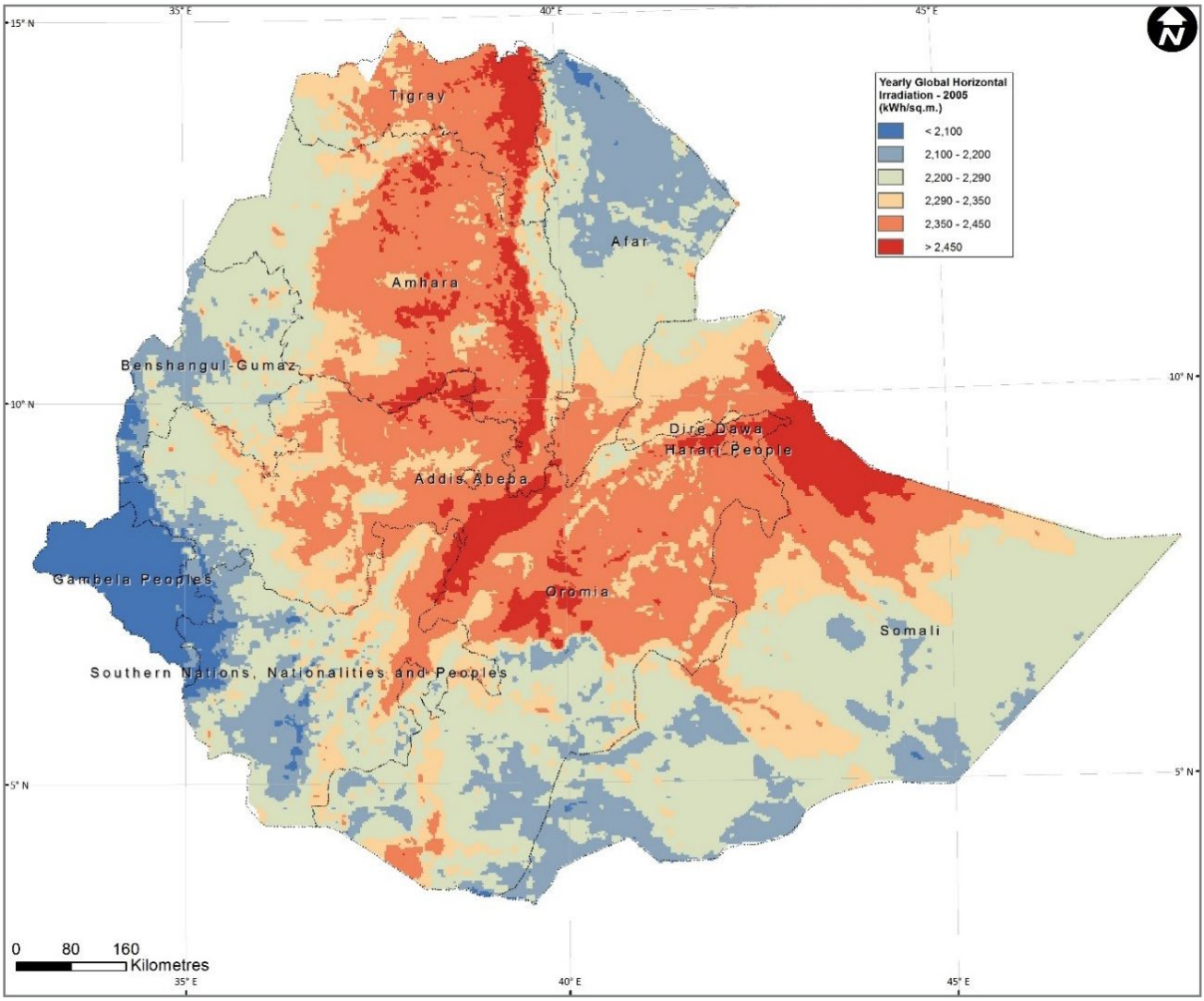
36 1990-2004. Soda, Mines Paristech and Gesto Energia.

37 Ethiopia's Renewable Energy Power Potential and Development Opportunities. MoWE, D. Derbew. 2013

38 Ethiopia Electric Power Presentation, Azeb Asnake, CEO, UK-Ethiopia Trade & Investment Forum, 2015

39 Highlights of the Ethiopian Energy Sector presentation, Solar Energy Foundation, 2016

Figure 5: Solar annual average global horizontal irradiation (kWh/m2/year) 2005.



Source: *DTU/IRENA.*

WIND

Ethiopia has significant wind energy potential, estimated at 1,350 GW. Resources are concentrated in the Somali region, with over 1,000GW of potential, mean wind speeds of over 7m/s and pockets of areas with greater than 10m/s.[40] he wind speed at 100m is shown in Figure 6. Afar, Oromia and the Southern Nations also have average wind speeds greater than 6.5m/s, which is the minimum level required for wind power projects.[41] Western regions such as Gambela and Benshangul-Gumaz average less than 4m/s. Only 324MW have been developed by 2016. Nevertheless, wind power is one of the key resources, along with geothermal, that are being considered to diversify the country's generation mix. This is partially due to the seasonality of wind and hydro, with rainy seasons having higher hydro potential and lower wind speeds and vice versa. Having both within the national generation mix therefore would enable better balancing of supply. A number

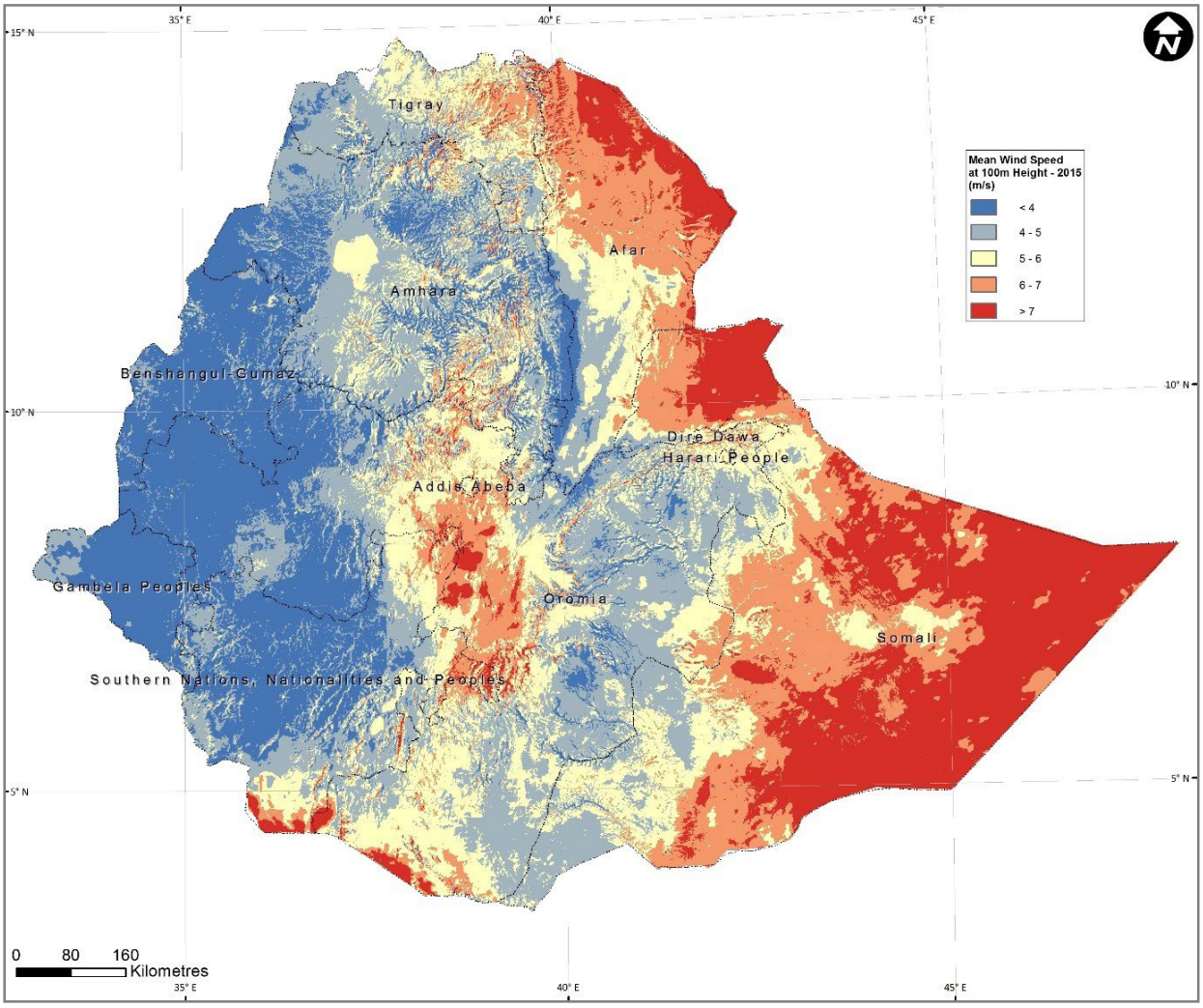
40 REN21 – REEGLE Clean Energy Info Portal. Country Profile

41 Ethiopia's Renewable Energy Power Potential and Development Opportunities. MoWE, D. Derbew. 2013

of projects are currently under construction such as the 300MW Ayesha wind farm. A total of 5GW is currently planned under GTP II.[42] Wind resource mapping was also conducted by the Energy Sector Management Assistance Program (ESMAP) from January 2015. The modelling report and associated GIS (Geographic Information System) files are freely available on the ESMAP website (http://www.esmap.org/re_mapping_ethiopia).

There are prospects for wind-based off-grid projects, especially in Somali region. Hybrid systems are recommended to better deal with the seasonal variation in wind speeds. One major barrier for the use of wind as the primary generation source of mini-grids in Ethiopia is its seasonal and daily variation. Maximum wind speeds in high potential locations can be three to four times greater than its minimum.[43] In highland areas, the peak seasons are March to May and September to November, while in the lowlands the peak is between May and August. Therefore for non-grid connected projects it may be more cost effective to use a hybrid generation mix of wind with solar.

Figure 6: Mean wind speed at 100m. 2015.



Source: *DTU/IRENA.*

42 Ethiopia Electric Power Presentation, Ethiopian Bulk Power Development & Regional Interconnection, 2014

43 Eastern Africa Resource Base: GTZ Online Regional Energy Resource Base: Regional and Country Specific Energy Resource Database: II - Energy Resource. 2007.

OTHER RESOURCES

Ethiopia has geothermal potential along the Ethiopian Rift Valley system, with 16 resource areas at various stages of development. Ethiopia's first Purchase Power Agreement (PPA) was singed for a 500MW geothermal plant at Corbetti,[44] and there are 270MW of other geothermal generation initiatives planned under GTP II. Apart from Corbetti, only one of the remaining 15 sites (Aluto Landano) is currently being developed towards commercial operation.[45] EEP estimates Ethiopia's exploitable reserve at 7GW,[46] with a target of 1GW of generation by 2030.[47] The Japan International Cooperation Agency (JICA) completed a geothermal master plan for Ethiopia in 2015, which set out a master plan for geothermal development based on a number of surface studies. This plan proposed the utilisation of significant geothermal resources in Ethiopia's energy mix, as a reliable baseload to increase energy security. The current position of geothermal within the government's energy strategy is however unclear.

44 ClimateScope 2016 Ethiopia Country Profile

45 The Project for Formulating Master Plan Development of Geothermal Energy in Ethiopia, JICA, 2015.

46 Ethiopia Electric Power Presentation, Azeb Asnake, CEO, UK-Ethiopia Trade & Investment Forum, 2015

47 Ministry of Water and Energy, Scaling-Up Renewable Energy Program Investment Plan, 2012

4. OVERVIEW OF THE ENERGY SECTOR

4.1 OVERVIEW OF RESPONSIBILITIES AND CURRENT CONTEXT

Off-grid solutions are gaining presence in recent national electrification strategies. This has led to an ongoing transition period over the last one to two years driven in part, by sustained support from multi-lateral funders, primarily the World Bank, USAID PowerAfrica, DFID and the EU. These stakeholders have been involved from an early stage in identifying and addressing institutional and legislative barriers faced by both public and private-led development of Ethiopia's energy sector.

The responsibilities and mandates of key institutions have changed significantly within the last year. The responsible ministry is the Ministry of Water, Irrigation and Electricity (MoWIE). Within MoWIE there are three main implementing institutions: Ethiopian Electric Power (EEP), Ethiopian Electric Utility (EEU) and the Ethiopian Energy Authority (EEA). EEP is responsible for generation and transmission (132kV and above), EEU is responsible for distribution and the Universal Electricity Access Project (UEAP), and EEA is the regulatory agent. The Ministry of Finance and Economic Coordination (MoFEC) is also involved in the sector, principally for projects including PPAs. There are two relevant directorates under MoWIE: the Energy Study and Development Follow-Up Directorate (ESD); and the Alternative Energy Technology Development and Promotion Directorate (AETDPD). The ESD is a directorate for strategy and coordination within the energy sector. AETDPD was originally an implementing agent, coordinating the Rural Energy Fund, but is now being developed into a strategy and dissemination institution along with the ESD. These institutions are detailed further in Section 6.1.

Substantial legislative changes are being implemented to realise the government's aims of having private sector delivered on and off-grid solutions under GTP II. This includes the development of a new energy policy, national grid code, national electrification strategy, off-grid master plan and a review of the national tariff. Most of these are due to be finalised and ratified between now and end 2017. The additional issue of lack of strong coordination across these institutions may be addressed through the relevant directorate for coordination, the Energy Study and Development Follow-Up Directorate (ESD). Agencies such as the World Bank have suggested a new coordinating agent, which would potentially be called the Directorate for Electrification.

Barriers remain to the development of the energy sector, including limited capacity and experience in off-grid planning and implementation. The overlap of mandates and uncertainty over roles between government institutions during this transition period was mentioned previously. Other barriers include limited experience in delivering IPP-based generation projects, the small planning timeframes of the institutions involved in electrification planning, a lack of geospatial planning capability and the heavily subsidised national tariff rate. These are detailed further in Section 4.4.

4.2 SUPPORT FOR RENEWABLE ENERGY

Economic growth in recent years has been partially enabled and driven by its renewable energy generation, with a doubling of Ethiopia's renewable generation capacity to 2.36GW from 2008 to 2015 and up to 10GW including projects currently under commission.[48] Eighty-six percent of Ethiopia's current generation is from hydropower, with approximately 8% of its sources from other renewables (wind and geothermal). This capacity, nevertheless, represents only a fraction of potential renewable capacity, as an estimated 45GW of hydropower and 60GW of renewable power is available.[49] The space for further development is reflected in the country's GTP II, where renewables make up 18.5GW of

48 Power Africa, 2016, Investment Brief for the Energy Sector in Ethiopia

49 Gartner, H. J., & Stamps, A. M. J. P. (2014). Ethiopian power grid: electrical power engineering & environment. Eindhoven: Technische Universiteit Eindhoven.

the 18.9GW of new generation. Under this plan, Ethiopia's oil and gas reserves are used primarily for exports. The long-term generation plan illustrates the scaling up of generation to 21.1GW by 2037, of which only 3.76GW is gas and 420MW is diesel backup.

There are numerous support schemes for renewable energy and other green technologies, including the World Bank-funded Development Bank of Ethiopia credit line, which provides concessional financing to renewable projects. The World Bank has accredited emissions savings produced by projects funded by this credit line with the Carbon Initiative for Development (Ci-DEV) program, as detailed in Section 4.6. Other initiatives include a number of MoWIE projects supporting renewable and rural energy, including the National Biogas program and the Improved Cook Stoves Program.

4.3 SUPPORT FOR INCREASED ACCESS TO ENERGY

The government implementation vehicle for access to energy is the Universal Energy Access Program (UEAP), which involves on- and off-grid electrification. This was established in 2005 under the former utility Ethiopian Electric Power Corporation (EEPCo). The program implements access to electricity for rural towns and villages, commercial agricultural production and irrigation pumping. This was initially only done through grid extension, with a target of 50% village electrification which was achieved by 2011.[50] The UEAP was moved in 2016 from EEU to EEP, as the most relevant party for distribution-scale development, and now includes on and off-grid aspects. Currently 200,000 customers are being connected to the grid annually, which is short of the estimated one million customers per year needed to achieve the aims set out under GTP II.[51] The inclusion of off-grid solutions in GTP II reflects the recognition that the target of 90% electrification is not feasible through on-grid solutions alone. Within off-grid, UEAP is looking beyond SHSs to mini-grids, to capture the development opportunities for rural communities. There are also EEU initiatives, including a potential collaboration with South Korea to run an off-grid pilot project and initial discussions with Poland to get soft loans towards implementing Polish hybrid off-grid technologies.

The National Electrification Strategy outlines the plan for electrifying the villages identified under GTP II. This strategy will integrate the Off-Grid Master Plan being developed by Power Africa. This strategy was developed by National Rural Electric Cooperative Association (NRECA), with funding from the World Bank, and is currently under internal review with the government of Ethiopia. Therefore strategy is not yet publically available at the time of writing. The strategy attempts to address a number of the key challenges highlighted in Section 4.4, including short electrification planning timeframes and the need for better planning coordination. The strategy aims to establish a Directorate of Energy within MoWIE to deliver this coordination. Other key objectives include the development of a geospatial master-planning framework, the establishment of an electrification fund using a levy on power sales and the development of a 'realistic tariff regime.' The strategy also outlines an off-grid strategic program, aiming to deliver electrification for 100,000 businesses and households per year by its second year. This strategy is built around two streams: larger, government-owned mini-grids (contracted to a third party service provider) and concessionary areas issued under licence.

A number of multi-lateral donors have off-grid programs in Ethiopia. GIZ, with funding from the EU, has established five community-owned mini-hydro off-grid schemes through the Energising Development (EnDev) program. The EU is running a number of projects including those involving disseminating solar kiosks, providing energy and sustainable cooking to refugee camps and bio-digesters with SNV Netherlands Development Organisation. A World Bank-funded credit line through the Development Bank of Ethiopia is discussed in Section 4.6. Multi-lateral donors and projects are detailed in Section 6.

50 Conversation with EEU's CEO, Ato Gosaye Mengistie, 2016

51 Conversation with EEU's CEO, Ato Gosaye Mengistie, 2016

4.4 CHALLENGES TO INCREASE RENEWABLE ENERGY UPTAKE AND ACCESS TO ENERGY

A number of challenges are faced in delivering the targets set out under GTP II, including limited experience in IPP-based generation and overlapping mandates of key institutions. Government institutions, such as the EEU with its responsibility for the UEAP, have yet to fully adjust to their new roles. IPPs, will in the future, also be handled by EEU, especially those related to off-grid projects. However, this is currently still being handled by EEP. The overlap of EEU's new operational mandate and that of the Alternative Energy Technology Development and Promotion Directorate is outlined in Section 6. Geospatial planning capability is being developed by both the World Bank and USAID PowerAfrica, including a World Bank energy access tool for the whole of Africa which will build upon the recently published United Nations Department of Economic and Social Affairs (UNDESA) Universal Electrification Tool.[52]

The need for longer-term electrification planning is highlighted as a critical barrier under GTP II. Current planning timeframes consist of one to two year implementation periods, while a minimum of five to ten years is needed to enable private sector engagement. The process for prioritising villages for electrification starts with the provincial authorities, who suggest a priority list of villages within their province. Prioritization is not purely economic, and will include political and social motivations as well. Provincial lists are then compiled by the Ministry of Water, Irrigation and Electricity (MoWIE) and a balanced list to be integrated into the national electrification plan is produced. This consideration is based on achieving social balance across provinces rather than least-cost solutions. The national electrification strategy seeks to improve this process, recommending a stronger central planning mandate and increased capacity of provincial authorities.

Further generation capacity and grid strengthening will be critical to Ethiopia's unrestrained development over the next few decades. Ethiopia was ranked 62nd out of 64 countries in the IEA's 2011 Energy Development Index, only ahead of the DRC and Mozambique. The index ranks household and community level access to electricity and clean cooking facilities. Despite this relatively low state of development, Ethiopia's fast growing population, and associated 10-14% predicted power demand growth[53] will lead to an even greater future strain on its grid network. The current transmission and distribution networks are already struggling with growing demand. However, the government of Ethiopia has already begun to tackle this challenge through its GTP I and II. GTP II targets 17GW of capacity by 2020 and 35GW by 2037, as well as a number of line and substation reinforcements.

The heavily subsidised national flat-rate tariff, at less than US$ 3c/kWh is also a significant barrier to development, and is addressed in Section 4.5 below.

4.5 POWER NETWORK AND INFRASTRUCTURE

The main gap in grid coverage is in the south and south-eastern parts of the country, in the Somali and Oromia provinces. The current village access level is 56% nationally, with 16,018 km of transmission lines and 166,967 km of distribution lines as of 2014/15.[54] Of this, the majority of transmission is 132kV (over 5,000km), followed by 3,900km of 230kV lines, as well as 400, 66 and 45kV lines. The core of the transmission grid extends radially from the central capital of Addis Ababa, with the least coverage in border areas and the Somali region.

Domestic energy consumption is heavily subsidised, with a national flat tariff of less than 3c$/kWh against a long run marginal cost to grid supply of 7cUS$/kWh.[55] This 60-70% subsidisation also applies to industries and commercial users. This is a significant barrier to network reinforcement, IPP connections, as well as operating sustainability of the national utility EEU. This makes Ethiopia's power export revenue critical for the funding of future power projects. EEU

52 UNDESA Website - http://un-desa-modelling.github.io/Electrification_Paths/index.html

53 Ethiopia Electric Power Presentation, Ethiopian Bulk Power Development & Regional Interconnection, 2014

54 The Second Growth and Transformation Plan 2015/16-2019/20, National Planning Commission, 2015.

55 Conversation with EEU's CEO, Ato Gosaye Mengistie, 2016

and EEP have conducted an internal joint report on the tariff, reviewed by PowerAfrica as a third-party consultant, which recommends an average rate of 8c$/kWh. This rate would also be differentiated for industrial and domestic consumers. This has already been supported in principle by the Council of Ministers.

11.2GW of power has been installed or commissioned by 2015, with an additional 18.9GW of capacity planned for operation by the end of GTP II in 2020.[56] The current installed and commissioned capacity is made up of 10GW of large hydro, 854MW of wind, 112MW of diesel, and 77MW of geothermal. This includes major projects commissioned in 2015 such as the 6GW Ethiopian Grand Renaissance Dam (entirely domestically funded), the 70MW Aluto Lang II geothermal extension and 4 wind farms totalling 551MW. By the end of GTP II, with a mixture of government and private funding, a further 18.9GW of capacity is planned to be operational: 7.6GW of hydro; 500MW of geothermal; 5.2GW of wind; 5.2GW of solar; and just 420MW of standby thermal plants. This will address the growing electricity demand in Ethiopia, which is expected to grow from 4.9TWh in 2012 to over 97TWh in 2037.[57] The major demand sectors are identified by EEP as being railway, large-scale irrigation and industrial developments, with a total forecasted growth for these sectors, from approximately 3TWh in 2015 to 65TWh by 2037.

Ethiopia is a major exporter of power, currently selling to Djibouti (350GWh), Kenya (14,000GWh) and Sudan (7GWh). Further planned exports include Tanzania (2,600GWh) by 2018 and a total export capacity of 47GW by 2037.[58] This includes a 3.2GyW interconnector between Ethiopia, Sudan and Egypt starting from year 2018, which has passed the feasibility studies conducted by the Eastern Nile Power Trade Study Project and East Africa Power Pool Master Plan Study. With Kenya paying US$ 7c/kWh and Tanzania set to pay around US$ 8c/kWh, Ethiopia should be able to pay for its own energy projects from the revenues from these major export schemes.

Ageing transmission and distribution assets is a major constraint to economic development, with network losses in Ethiopia at 21% in 2011/12.[59] In order to tackle this, various reinforcement and upgrade programs are planned or underway under GTP II. For example, EEU is planning the complete overhaul of eight settlement distribution networks, including Addis Ababa. EEP's long-term plan up to 2037 includes 78 new substations, 41 substation reinforcements and 9,257km of new 400kV to 132kV transmission lines.[60] Support for extending and reinforcing the transmission network is given by multi-lateral funders such as the AfDB and World Bank. The AfDB is supporting the Mekele-Dallol and Semera-Afdera Power Transmission Supply through the Industrial Development and Access Scale-up Project, which will extend access to industries in the Tigray and Afar regions through a US$ 105 million loan. A further issue is the reliability of supply to residential and small business customers. EEU has a mandate to prioritise industries that drive economic development (i.e. exports), and these large customers are usually given dedicated power access. Any supply issues from unreliability and/or generation deficits are passed on to domestic and other customers. Low priority is given also due to the subsidised tariff rate charged to such customers.

Lack of domestic demand for installed generation capacity may be another constraint in the future, as connections look set to trail behind installed generation. Historically, there were significant constraints on customer connections due to generation deficits. Ethiopia had to postpone a large part of the World Bank-financed Second Electricity Access Rural Expansion Project (2007) because it didn't have the generating capacity to meet projected demand. However, this trend looks set to reverse, partially due to the UEAPs focus on village rather than household connection (see Section 3.3). Per capita electricity consumption was just 77 kWh/year in 2013,[61] and has been forecasted to rise by 30% per year. This is

56 Ethiopia Electric Power Presentation, Ethiopian Bulk Power Development & Regional Interconnection, 2014

57 Ethiopia Electric Power Presentation, Ethiopian Bulk Power Development & Regional Interconnection, 2014

58 Ethiopia Electric Power Presentation, Ethiopian Bulk Power Development & Regional Interconnection, 2014

59 EEPCO, 2011/12.

60 Ethiopia Electric Power Presentation, Ethiopian Bulk Power Development & Regional Interconnection, 2014

61 Ministry of Water and Energy Presentation. Ethiopia's Renewable Energy Power Potential and Development Opportunities. 2013. Dereje Derbew.

partly due to expected reductions in dependence on traditional biomass as the primary source of fuel. However if slow development leads to Ethiopia falling short of this consumption target, then the demand issue will be even more acute. High export levels and the anticipated growth of key sectors (i.e. irrigation, railway and industrial) may mitigate this concern.

4.6 OFF-GRID DEVELOPMENTS

The Universal Energy Access Program (UEAP) is replacing the Rural Electrification Fund (REF) as the vehicle for implementing public-sector off-grid programmes. The REF is run by the Alternative Energy Technologies Development and Promotion Directorate (AETDPD), which sits under the Ministry of Water, Irrigation and Electricity (MoWIE). The AETDPD originally had the mandate to implement off-grid schemes, but this has now been transferred to EEU under the UEAP program (see Section 6.1). Before this occurred, the AETDPD received various funds, including from the World Bank, to disseminate SHSs in rural areas. Some 45,000 SHSs have been disseminated by AETDPD to date, and the total number of solar energy technologies in Ethiopia has reached 614,399. However, this is only 52% of the targeted total of 1,184,480.[62] A further 3.6 million solar lanterns and 400,000 SHSs are planned to be disseminated by 2020 under GTP II.[63]

AETDPD have conducted five pilot design studies for off-grid mini-hydro schemes identified under GTP II. These design studies will be provided to private developers to help encourage IPP applications for GTP II projects. AETDPD is looking to access funding to deliver a design study for the remaining 100 mini-hydro schemes under GTP II. A number of other MoWIE projects exist to support renewable and rural energy, listed in Section 4.3.

A key driver of current off-grid development is the credit line financed by the World Bank. This credit line is administered by the Development Bank of Ethiopia and supports investment in renewable energy (RE) and energy efficiency (EE) through two products: a credit line to support working capital for developers and a credit line to micro-finance institutions (MFIs) to lend to small households for spend on RE and EE products. Concessional loans are offered to diesel (loan of 85% of capital at an interest rate of 7.5%) and renewable energy projects (loan of 95% of capital at zero interest rate). However, equal collateral is required on all money lent under the Development Bank of Ethiopia (DBE) credit line, so a business must already own physical assets to access the loans. Approximately 500,000 solar lanterns and SHSs have been delivered under an initial US$ 40 million phase of funding, providing about 3 to 4 million customers with access to electricity. This credit line will form an integral part of the World Bank's future engagement in Ethiopia, alongside two other credit lines tackling women's entrepreneurship and SME development. The credit line has also been registered with the CiDEV program to ratify the carbon savings from the activities under the program, with the DBE being the auditing body. As the coordinator and manager of the program, DBE is authorised by the government to collect reduction certificates and sell these on the market. Further risk mitigation is provided by the World Bank, who has contracted to buy all of the estimated certificates off the DBE at the start of the program. The World Bank therefore assumes the trading risk, as well as the risk of the number of certificates generated.

The GIZ EnDev program has established five operational community-owned mini-hydro schemes, four in Sidama and one in Oromia Gima, with the next stage of EU financing being finalised at the time of writing. Detailed in Section 6.3, these mini-hydro schemes are centred on operational or derelict flow-mills as these ensure existing social structures, a critical base load industry and existing infrastructure. These schemes produce only 10 to 20kW. However, the low per capita consumption of communities in these remote regions means many still have excess capacity. As a result, there is the potential for further investigation into productive use opportunities for these schemes. GIZ has worked with 13 universities to develop mini-hydro skills and manufacturing capacity in Ethiopia.

62 Growth and Transformation Plan Annual Progress Report 2012/13. MoFED, 2014

63 Highlights of the Ethiopian Energy Sector presentation, Solar Energy Foundation, 2016

Ethio Resource Group is establishing six wind-powered micro-grids in Menz-Gera in Amhara region.[64] These schemes, at less than 5kW, are past the feasibility study phase. No households in the area have electricity access, so the scheme will replace kerosene lighting. Ethio Resource Group will manage and own the micro-grids as a distributed energy service company, one of the first of its kind in Ethiopia. There are also a number of (10 - 100kW) small power producers that operate without a licence. A large number of these are used for medium- to large-scale irrigation. Replacing these diesel-powered systems is a key focus area for the government and the USAID Beyond the Grid project. The five GIZ-run mini-grids are also not regulated by EEA, as these are governed by the Cooperatives Law.

Local solar off-grid manufacturing is spearheaded by the Solar Energy Development Association-Ethiopia and its founder, the Stiflung Solar Energy Foundation. This foundation has driven the solar off-grid market in Ethiopia for the last ten years (see Section 6.2) through training of technicians and support for local manufacturing. One result of its efforts is the 20MW/annum Solar PV manufacturing plant, completed in January 2013, which produces solar power system components (i.e. transformers, meters) built by Sky Energy International and Metals and Engineering Corporation of Ethiopia. A 100MW/annum Solar PV mini-grid plant at Woldia University that has also been reportedly built in partnership with Global Trade and Development Corporation (GTDC) and AIB Stimaken. Three major barriers for the SHS market were also identified by the Foundation: the mass-availability of imported poor quality products; the lack of off-grid friendly legislation (including compensation for grid-connected systems); and the capacity deficit of the Conformity Assessment Enterprise which is responsible for testing and approving imported products against national standards.

64 US Power Africa: Off-Grid Energy Projects Investment Summary, 2015

5. REGULATORY FRAMEWORK FOR MINI-GRIDS

Ethiopia is transitioning from a public sector focused model to one that includes significant contributions from IPPs. This shift started approximately a decade ago, with funders such as the World Bank and USAID PowerAfrica encouraging a regulatory model that encouraged and utilised private sector involvement. The government has released a substantial number of proclamations and national strategies relating to environmental protection, economic development and poverty alleviation. This section gives a high level overview of policy and regulatory aspects affecting mini-grid development.

5.1 REGULATORY AND POLICY ENVIRONMENT: KEY TAKEAWAYS

Table 3. – Enabling and limiting factors for the development of clean energy mini-grids

	Enabling Factors	Limiting Factors
Planning and institutional setting	– The Universal Energy Access Program (UEAP) is the dedicated rural energy programme, including grid and off-grid – Clean energy access and renewable energy targets are set under GTP II: 18.5GW of new renewable generation and 90% electricity service coverage – Off-grid projects and areas identified under GTP II – The National Electrification Strategy addresses key energy sector challenges, including proposing a number of off-grid specific initiatives	– The short-term and poor planning capabilities within the government and regional authorities limit the effectiveness of electrification programs – Reduced public energy sector activities due to recent changes to the institutional structure, responsibilities and mandates of key institutions
Data availability		– Data availability is a constraint to energy sector development. There is a need for greater availability of geospatial data, including the digitising of government data on national grid infrastructure and the production of a renewable energy atlas
Licensing	– Private developers are able to obtain transmission, generation and distribution and sale licences	– All projects except those run by cooperatives require a licence – The National Electrification Strategy identifies the barrier of insufficient clarity for the licencing process of off-grid investments
Tariffs	– A review of the national tariff structure is proposed under the National Electrification Strategy	– Off-grid tariff does not allow full cost recovery – Ethiopia has a highly subsidised national flat-rate tariff of under 3c$/kWh (in place since 2006), against a long run marginal cost to grid supply of 7cUS$/kWh.

	Enabling Factors	Limiting Factors
Subsidies and incentives	– The Rural Electrification Fund Credit Line supports renewable energy and energy efficiency through concessional loans to generate working capital for developers – General investment incentives are available, such as the duty-free import of machinery and equipment	– No off-grid specific incentives or subsidies exist – Issues with the import of solar products due to the lack of capacity of the standards testing authority - the Conformity Assessment Enterprise
PPAs	– Private and independent power producers and distributors can operate in Ethiopia – Grid generation under GTP II is set for delivery through PPAs	– No standard PPAs for mini-grids exist; although a feed-in-tariff law was drafted in 2012 it has not been operationalised, as the government decided to favour an auction or tender based approach
Arrival of the grid	– The National Electrification Plan, in line with ongoing donor support, targets the development of planning capacity, including development of a geospatial planning framework	– Lack of clarity over grid extension plans and timeframes, due to planning capacity issues – Current planning timescales are 1 or 2 years – No protection or compensation legislation for off-grid projects against future grid connection; national utility is not obliged to buy excess power
Technical rules		– All projects that utilise electrical power systems must adhere to national grid codes, this precludes the development of direct current mini-grids
Mobile services	– There are two main mobile money payment services, M-BIRR and helloCash (Belcash Technology Solutions)	– Telecom and financial sectors are tightly controlled; national restrictions around mobile money services exist – Sole national telecom provider, EthioTelecom, which has 85% national coverage, other telecom-based services must operate through EthioTelecom

5.2 THE MINI-GRID POLICY AND REGULATORY ENVIRONMENT

INSTITUTIONS AND PLANNING

The energy sector is the responsibility of the Ministry of Water, Irrigation and Electricity (MoWIE). Under MoWIE are three main implementation bodies: Ethiopian Electric Power (EEP), Ethiopian Electric Utility (EEU) and the Ethiopian Energy Authority (EEA). EEP is responsible for generation and transmission (132kV and above), EEU is responsible for distribution and for the UEAP, and EEA is the regulatory agent. There are two relevant directorates under MoWIE: the Energy Study and Development Follow-Up Directorate (ESD); and the Alternative Energy Technology Development

and Promotion Directorate (AETDPD). The ESD is a directorate for strategy and coordination within the energy sector. AETDPD was originally an implementing agent, coordinating the Rural Energy Fund, but is now being developed into a strategy and dissemination institution along with the ESD. These institutions are detailed further in Section 6.1.

Planning is done centrally by the Ministry of Water, Irrigation and Electricity, in partnership with regional energy agencies. These agencies coordinate energy activities within their regions, suggest priority settlements for electrification to MoWIE, and are responsible for promoting and facilitating regional dissemination of modern energy technologies. The planning process is not done on a purely economic basis, but involves balancing political and social factors. Challenges surrounding timeframes and institutional planning capacity are discussed in Section 4.4.

There is a dedicated rural energy programme sitting under EEU that covers both on- and off-grid solutions, called the Universal Energy Access Program (UEAP). This programme is the implementing vehicle for the implementation of off-grid government programs, although it previously only delivered grid extension programs. The UEAP is detailed fully in Section 4.3. The UEAP is replacing the Rural Electrification Fund, run by the Alternative Energy Technologies Development and Promotion Directorate (AETDPD), as the primary implementation vehicle for off-grid public sector programmes.

The energy access target of 90% electricity service coverage is set out in the GTP II. The target of 'electricity service coverage' is defined as "availability or proximity of a town/community to electricity supply with hospitals, clinics, key administrative and social services, streets benefiting from electricity services". Under this definition the coverage was 54% in 2012. The target is for 90% coverage by 2020. There are no legally binding carbon reduction targets or carbon pricing systems in place, although Ethiopia plans to achieve a 64% GHG reduction by 2030 in its INDC released in June of 2015. GTP II identifies the areas and settlements to be electrified through on- and off-grid solutions in order to achieve this energy access target.

The National Electrification Strategy outlines a number of important changes to the energy sector. The strategy is currently being reviewed by the government of Ethiopia, so is not yet publically available. The changes proposed include a review of the national tariff regime, establishment of a Directorate of Energy to improve planning coordination and the development of a geospatial master-planning framework. With respect to off-grid electrification, the strategy outlines an off-grid strategic program, specifying the villages due to be electrified by off-grid solutions, and highlights the need to clarify the licencing process for off-grid investments. The publication of this strategy is expected in 2017.

DATA AVAILABILITY

The lack of available data constrains development of the energy sector, especially for renewable energy-based and off-grid solutions. No geospatial or digitised data exists for the location of transmission and distribution grid lines. There is no centrally maintained source of datasets that covers renewable resource availability. Production of a renewable energy atlas, such as that produced in Mozambique, would be highly beneficial to prospective developers. An atlas on rural services is produced by the Central Statistical Agency (CSA), covering location of public services, commercial services, infrastructural services and agricultural development centres. However, this was last published in 2013/14, and is updated approximately only every four years. The CSA also collects information such as household expenditure and income. However, data regarding regional economic development is politically sensitive, so this information is made available only as a national average.

LICENCING

Private developers can apply for transmission, generation and distribution and sale licences. The Council of Ministers energy regulations cover the licencing of grid and off-grid generation, transmission and distribution (hereafter referred to as "Energy Regulations," covered in Section 5.3). There is no prioritised access to the grid for renewable energy,

nor specific operational rules for managing renewable energy. A distribution and sales licence gives an exclusive right for distribution and sale of electricity within its licence area, as well as non-exclusive rights outside the licence area. In order to be awarded an exclusive licence, the developer must show that all demand can be addressed.

There remains a lack of clarity over the licencing of off-grid investments. It is not yet clear however how the government will define or allocate off-grid licence areas, or whether an application could be made for an area that had not been pre-allocated by the government. It is expected that allocation of licences will most likely be through competitive tendering, but other options are being considered such as auctions for price. This issue is highlighted in the National Electrification Strategy, and may also be clarified in the Renewable Energy proclamation reportedly in development.[65]

All projects except those run by cooperatives require a licence. The duration, renewal, amendment, replacement, transfer and termination of licences are covered in Article 11 of the Energy Regulations. Transmission licences are limited to 30 years, hydro and geothermal generation licences to 25 years, and all other licences to 20 years. Subsequent renewals of licences are limited to half these initial periods. Article 19 of the Energy Regulations specifies license fees. A Certificate of Competency is required for any electrical work, conditions for which are set out in Article 10. Excepting cooperative projects, which are covered by the Cooperative Law, there are three main stages of project regulation through EEA:

- Initial feasibility and pre-feasibility studies, requiring an investment permit, governed by the investment proclamation (769/2012)
- Investment incentives are covered under regulation (270/2012)
- Following the feasibility study a detailed plan needs to be submitted to EEA in order to obtain an operational licence (15-25 years), which is covered by operational regulation (49/1999). A new operation regulation relating to the already ratified new energy law is under ratification by the Council of Ministers currently, covered in Section 5.3.

TARIFFS

The EEA reviews, recommends and approves tariffs for grid and off-grid projects. Currently the off-grid tariff rate does not allow full cost recovery. The general principles guiding the review of grid-related tariffs and approval of off-grid tariffs are listed in Article 28 of the Energy Regulations. The Energy Regulations detail requirements such as the production of a general tariff study every four years and the need for a uniform system of accounts and annual audited reporting. The pricing procedure for small mini-grids is outlined in the Pricing Procedure for Small and Very Small Self-Contained System (SCS) No. 2/2005. This covers small (100KVA to 500KVA peak demand) and very-small (less than 100KVA peak demand) self-contained systems (SCSs). Price structures for SCSs are submitted every four years, based on marginal and average costs. Price structures are reviewed by the EEA before being submitted to the ministry for approval.

Ethiopia has a highly subsidised national flat-rate tariff of under 3c$/kWh, against a long run marginal cost to grid supply of 7cUS$/kWh.[66] This tariff rate has been in place since 2006 as part of a national strategy to drive consumption, but is currently being reviewed by EEU and EEP. The current tariff schedule extends to some parties who could pay a much higher tariff, such as industrial customers, although export prices are higher (from 7cUS$/kWh). This subsidisation is not extended to off-grid programs or projects.

A review of the national tariff structure is proposed under the National Electrification Strategy, in order to seek full cost recovery to better promote electrification reach and service quality. The Strategy also addresses the issue of clarity of tariff setting principles for off-grid projects, highlighted within the broader issue of limited regulatory powers

65 US Power Africa, Annual Report, 2016

66 Ministry of Water and Energy Presentation. Ethiopia's Renewable Energy Power Potential and Development Opportunities. 2013. Dereje Derbew.

provided to EEA. As cost recovery is not typically achieved by off-grid projects, legislation is needed either to develop a specific (cost-recovering) decentralised tariff (i.e. technology-specific feed-in-tariff), increase the ability to set project tariffs or to provide subsidies for off-grid generators to cover tariff-cost deficits.

SUBSIDIES AND INCENTIVES

A working credit subsidy for low carbon technologies is available through the Rural Electrification Fund Credit Line (detailed in Section 4.6). Administered by the Development Bank of Ethiopia and funded by the World Bank (through an US$ 40 million initial funding round), it provides a credit line to micro-finance institutions to support household spending on renewable energy and energy efficiency products. This credit line will form an integral part of the World Bank's future engagement in Ethiopia, alongside two other credit lines tackling women's entrepreneurship and SME development.

General investment incentives are available, such as the duty-free import of machinery and equipment. An investor is exempted from taxes and duty for machinery and equipment intended for the project and 15% of spare parts. With respect to batteries, they must be imported with solar equipment to be eligible for customs duties exceptions, as batteries could be used for other purposes. There are no VAT exemptions. Challenges arising from the import of solar products currently exist due to the lack of capacity at the Conformity Assessment Enterprise, which is responsible for testing of imported products. Given their speed of testing, many products are stranded in customs for long periods of time, leading to additional substantial storage costs.

POWER PURCHASE AGREEMENTS

Ethiopia law allows for private and independent power producers and distributors, with grid generation under GTP II set for delivery through PPAs with IPPs (using government and private financing). IPPs are eligible for market entry under the Electricity Operations Regulations (2016, 49/1999), the Letter of Power Sector Policy (2003) and the Investment Proclamation (280/2004). Geothermal power projects are well supported under this regulatory framework, with developers able to buy exploration licences and concessions.

Power purchase agreements are currently agreed initially with the off-taker, EEP. Although for off-grid projects this may be agreed through the UEAP in the future. Final approval is given by the EEA, based on economic and technical feasibility and considerations of the community. The Ministry of Finance and Economic Coordination (MoFEC) is also involved in the financial aspects of PPAs. The utility is not obliged to buy or use any excess power and there are no rules defining the sharing of curtailment costs. PPAs are expected to be agreed through competitive tendering in most cases.

ARRIVAL OF THE GRID

Planning capacity issues makes estimating the arrival of the main grid difficult, although the villages to be electrified up to 2020 are listed in GTP II. Agencies such as the World Bank, USAID and its implementing partner NRECA are engaged with the government to develop both its geospatial and long-term planning capabilities. The Ethiopian National Electrification Strategy and accompanying off-grid master plan developed with support from the aforementioned agencies mark the start of this process (see Section 5.3). This will need to be combined with a more coordinated approach to on- and off-grid planning before clarity can be given to practitioners.

There is a need to produce legislation to protect off-grid projects against future grid connection. In the event of arrival of the main grid, as covered by point 81 of the Council of Ministers Energy Regulation, there is no guarantee that the grid-stranded off-grid assets will be integrated into the grid.

TECHNICAL RULES

All projects that utilise electrical power systems must adhere to the national grid codes, listed in Section 5.3, including off-grid projects (which are included non-specifically as power systems). This precludes the development of direct current mini-grids. There are no further specific technical rules or specifications to which mini-grid projects must adhere.

MOBILE SERVICES

The telecom and finance sectors are still tightly controlled, although nascent mobile money services are available to facilitate payments for power services. Ethiopia has one national telecom provider, EthioTelecom, through which all other telecom-based services must operate. EthioTelecom has approximately 85% coverage, with the gaps mainly in the peripheral regions of Afar and Somali.[67] A US$ 16 million Chinese government program has reportedly been approved to expand this coverage. Telecom services coverage has increased from 7.7 million in 2009/10 (6.25 million of these mobile) to 29.63 million in 2013/14 (28.3 million of these mobile). Ninety-six percent of the rural population is now within 5km of telephone services,[68] although just 31.6% had mobile subscriptions as of 2014.[69]

There are two main providers of mobile money payment services: M-BIRR provided by Irish company MOSS ICT and helloCash by Belcash Technology Solutions PLC. The M-BIRR service works through five main micro-finance institutions that have a collective coverage of 95%. M-BIRR is working with Azuri Technologies to provide their pay-as-you-go model for solar home systems in Ethiopia. The company now has 4,000 points of presence (branches and agents), serving 280,000 customers and expanding rapidly. The main constraint is the tight national restrictions on the telecom and finance sectors. This includes requirements from the national bank for agents to have an existing business licence, which is rare in remote settlements. As the mobile money service becomes more established it is expected that these issues will be addressed by the government.

5.3. ENERGY SECTOR POLICIES

Since the Ethiopian Energy Policy (1994) there have been significant developments in the structuring of regulation and operation of Ethiopia's energy sector. Provided below are the policies and policy documents relevant to the energy sector and rural electrification.

A number of documents are available on the EEA website including PPA templates and relevant regulatory laws - http://www.ethioenergyauthority.gov.et/.

THE ELECTRICITY PROCLAMATION, NO. 86-1997

Link – http://www.ethioenergyauthority.gov.et/attachments/article/43/Proclamation%20No.280-2002.pdf

The 1997 Electricity Proclamation established the Ethiopian Electricity Agency (now the Ethiopian Energy Agency) as an autonomous institution, mandated to regulate the operation of the energy sector, including tariffs and standards.

ELECTRICITY OPERATIONS REGULATIONS, NO. 49/1999

Link – http://www.ethioenergyauthority.gov.et/attachments/article/43/Regulation%20no.49-1999.pdf

67 Conversation with M-BIRR. Addis Ababa. 2016

68 The Second Growth and Transformation Plan 2015/16-2019/20, National Planning Commission, 2015

69 UN World Statistics Pocketbook, Ethiopia Country Profile.

The Electricity Operations Regulations provide for the regulation of electricity operations, detailing registration, application, issuance and refusal of licences as well as electricity prices, tariffs and standards of safety, technical and quality of service of electricity services. This will be replaced by the Council of Ministers Energy Regulation, 2016, once it has been ratified by the Council of Ministers.

PRICING PROCEDURE FOR SMALL AND VERY SMALL SELF-CONTAINED SYSTEM (SCS), NO. 2/2005

Link - https://chilot.files.wordpress.com/2011/04/pricing-procedure-for-small-and-very-small-self-contained-systems-scs-no-2-2005.pdf

Pricing Procedure for Small and Very Small Self-Contained System No. 2/2005 details the pricing procedure for systems that are isolated from the national grid. This applies to systems smaller than 500KVA. This document guides licensees in the preparation of pricing submissions to EEA as part of their licence conditions, and guides the EEA its review of pricing submissions and of licensee price performance under license. Support to licensees includes formulas dictating the financial analyses to be conducted; for example, price adjustment with the cost of diesel or the allowed forecast of revenue for subsequent financial years based on previous year revenue.

CLIMATE-RESILIENT GREEN ECONOMY (CRGE) STRATEGY, 2011

Link – http://www.undp.org/content/dam/ethiopia/docs/Ethiopia%20CRGE.pdf

The Climate-Resilient Green Economy Strategy, along with the GTP, outlines the national economic and social development plans. CRGE focuses on green growth as a necessity to mitigate and adapt to the effects of climate change. CRGE is built on a plan targeting Ethiopia to become a middle-income country by 2025, with four key pillars of agriculture, reforestation, power and transportation. Within these priority growth pillars, implementation plans are developed, with the power pillar detailing the generation from renewable sources for domestic and regional markets. CRGE establishes the target of limiting 2030 emissions to 150 Mt CO_2e (level of 2010 emissions), approximately 250 Mt CO_2e less than in the business-as-usual scenario. It also establishes a target to increase generation capacity by 25,000MW by 2030 (hydro 22,000MW, geothermal 1,000MW and wind 2,000MW), as well as establishes biogas and cook stove programmes.

ELECTRICITY FEED-IN-TARIFF LAW, 2012

The Feed-in-Tariff law targeted a diversification of the national energy mix to increase the robustness of supply against weather and market conditions. This law considers energy projects for up to 10MW of generation capacity. Although diversification is still a key priority in the energy sector, the feed-in-tariff approach is not currently being pursued by the government.

INVESTMENT PROCLAMATION, NO. 769/2012

Link - http://www.mot.gov.et/documents/27281/0/Proc+No.769-2012-investment-proclamation.pdf/190b309b-18dc-47bc-b1ce-6ab2d9219363?version=1.1

The investment proclamation (769/2012) is an amendment to Ethiopia's investment proclamation (280/2004), which provides for the establishment of state and privately run industrial development zones (IDZs). These IDZs are given favourable investment, tax and infrastructure incentives. This amendment increased the minimum capital requirement to US$ 200,000 per project for wholly owned foreign instruments and US$ 150,000 for joint investment with domestic investors. A foreign investor reinvesting profits/dividends may not be required to allocate minimum capital.

Also relevant is the Council of Ministers Regulation on Investment No. 270/ 2012, the Commercial Registration and Business Licensing Proclamation No. 686/2010 and its amending proclamation No. 731/2012.

ENERGY PROCLAMATION, PROCLAMATION 810/2013

Link – https://chilot.files.wordpress.com/2014/09/proclamation-no-810-2013-energy-proclamation.pdf

The Energy Proclamation expands on previous energy sector policies, specifically on the national approach to independent PPAs, fully off-grid systems and on-grid energy efficiency. This law makes the EEA responsible for the negation of off-grid IPPs as well as the national grid, accountable to MoWIE. This includes defining EEA's responsibility for the issue and regulation of the implementation of guidelines for, and final approval of, off-grid tariffs. This is additional to the EEA's responsibilities for setting performance standards, issuing licences and regulating the power sector.

GROWTH AND TRANSFORMATION PLAN II (GTP II), 2015

Link – https://www.africaintelligence.com/c/dc/LOI/1415/GTP-II.pdf (GTP I - www.iea.org/media/pams/ethiopia/Ethiopia_GTP_2010to2915.pdf)

The Growth and Transformation Plan is the government's development plan for 2015-20, including targets and strategies for the power sector. The first GTP ran from 2010 to 2015. GTP I focused on growth through institutional capacity building and on energy generation, transmission and distribution systems. GTP II focuses on delivering the target to become a middle-income country by 2025, building as well on the CRGE Strategy. Private sector development and a climate-resilient green economy is seen as the strategic pillars of GTP II, including further support to MSMEs in all sectors. GTP II targets 90% village access, as well as 18.9GW of additional generation capacity. This includes 7.6GW of hydro, 500MW of geothermal, 5.2GW of wind, 5.2GW of solar and 420MW of backup thermal generation.

ETHIOPIA NATIONAL ELECTRICITY TRANSMISSION AND DISTRIBUTION GRID CODE, 2016

Transmission link - http://www.ethioenergyauthority.gov.et/attachments/article/74/ENTGC%202016%20Preliminary%20Draft%20Feb2016.pdf)

Distribution link - http://www.ethioenergyauthority.gov.et/attachments/article/74/ENDGC%202016%20August%202016.pdf

The National Grid Code is a set of documents that outline the rules and responsibilities for all entities relating to the electrical power system's planning and operation. Its purpose is to "legally establish technical and other requirements for the connection to, and use of, an electrical power system by parties in a manner that will ensure reliable, efficient and safe operation." This includes the specifications needed by off-grid projects to ensure the feasibility of future grid connection. Provided here are the documents relating to transmission and distribution systems.

COUNCIL OF MINISTERS ENERGY REGULATION, 2016

Link - http://www.ethioenergyauthority.gov.et/attachments/article/66/English%20Draft%20Energy%20Regulation%20September%202016.pdf

The draft Energy Regulation, released on 28th September 2016, has yet to be ratified by the Council of Ministers. It builds on the previous 2015 draft Regulation of Energy Operations. This relates to the already ratified New Energy Law (810/2013), and governs EEA's regulation of energy operations. Specifically, this covers procedures for licencing energy operations, the rights and obligations of licensees, tariff regulations, safety and quality of service standards, conflict resolution and regulation of energy efficiency and conservation measures.

Other key national development policies that have impact on the energy sector are the:

- National Electrification Strategy and Off-Grid Master Plan, expected 2017;
- Renewable Energy Proclamation, reportedly in development;
- Rural Development Policy and Strategy;
- Environmental Policy;
- Science and Technology Policy; and the

- Water Resources Management Policy.

5.4. INVESTMENT INCENTIVE POLICIES

This section draws on the Bureau of Economic and Business Affairs Ethiopia Investment Climate Statement 2016, which is a valuable additional reference. Useful information on investment incentives, details and opportunities can be also sought from the Ethiopian Energy Authority.

Ethiopia's rapid economic growth and relatively stable outlook forms a strong foundation for investment, receiving a 'B+' credit rating from Moody's and 'B' from S&P and Fitch in 2014. However, the 2017 *World Bank Doing Business Report* ranked Ethiopia 159th out of 190 economies, highlighting a number of challenges with respect to its investment climate:

- Relatively low levels of investor protection
- Low levels of tax payments
- Poor trade logistics
- Barriers to accessing credit
- Limited ability to resolve insolvencies

The private sector has always been a key engine of growth. Since 2002, with the release of the Industrial Development Strategy, the government has set about liberalising foreign trade, promulgating liberal investment laws and enhancing institutional support. The government of Ethiopia is reportedly reviewing its 1960 Commercial Code in order to help facilitate investment and ease of operations. This will include clarifying regulations for potential investors, modernising trade and registration processes, increasing protection for shareholders and provisions for filing for bankruptcy. Additionally, the revised Investment Code of 1996 and the Investment Proclamation provide incentives for development and removal of many sector-specific investment restrictions.

Many sectors remain state-owned, including telecommunications, power transmission and distribution and postal services. Foreign banking and insurance is still prohibited. Overall, however, the general investment climate is supportive for investment. A few technology-specific subsidies exist:

- Solar lanterns and SHSs – Import duties waived, but VAT (14%) maintained
- Biogas installations – 225 EUR subsidy for an average cost of 600 EUR
- Biofuels – No appliance subsidy, but ethanol is subsidised

5.5. RECOMMENDATIONS

Ethiopia has made progress towards the creation of a policy environment that is supportive to the development of mini-grids. The inclusion of off-grid solutions under the GTP II has been accompanied by a restructuring of the energy sector and the development of a national electrification strategy and off-grid master plan. Private sector participation is an integral component of Ethiopia's electrification strategy. The government has also encouraged the support of international donors in this transition, including in the delivery of off-grid initiatives such as the GIZ EnDev program and the World Bank-funded Development Bank of Ethiopia Credit Line.

Further progress is necessary however, before mini-grid rural energy solutions are viable. National grid extension and long-term electrification plans, for example, must be formalized, while institutional mandates following recent revisions to the energy sector's institutional structure, must be clarified. A number of these recommendations are addressed in the National Electrification Strategy due to be published in 2017. Moving forward, to advance GMG development in Ethiopia, we offer the following high-level policy recommendations, which include:

- Clarifying the current licencing process for off-grid projects, including the procedure for allocating and awarding concessionary agreements and the mandates of government institutions;
- Developing a simple, fast and transparent licensing process for mini-grids, as well as the respective concession terms;
- Addressing market uncertainty through better dissemination of government GIS-based electrification planning, including the regular publication of grid extension plans and schedules. This includes making available the villages which have been identified for off-grid electrification under GTP II, and any underlying resource assessment studies;
- Legislating the proposed increase in national electricity tariff (currently under review);
- Addressing the lack of accessible data on resource availability, potentially through a national renewable energy atlas such as the ones released for DRC and Mozambique;
- Developing capacity through future training and knowledge transference on mini-grids within the private and public-sectors;
- Supporting the further development of alternative financing solutions, investment funds, microfinance and climate finance mechanisms, to reduce the reliance on donor funding; and
- Supporting the development of mobile payment coverage and solutions.

The Green Mini-Grids Market Development Programme could support the mini-grid sector through a number of initiatives. The primary recommendation is to schedule a refresh of this report in one to two years' time, to capture the new developments that are planned, or in development at the time of writing this report. The timing of this report has meant that a number of key considerations affecting mini-grid developers are in development or transition at the time of writing. These considerations include the changing responsibilities of relevant government institutions and the uncertainty over tariff setting structures and policies for mini-grids. Clarification of these considerations is important for practitioners and other stakeholders, so a refresh of this report should be arranged for a time when the development of these considerations is likely to have been completed. Additional recommendations for potential support includes:

- Producing a geospatial map of the electrification options suggested under GTP II, potentially with a focus on the villages to be electrified through off-grid solutions;
- Mapping of national mobile money coverage; and
- Mapping of national hydro and biomass resources, identifying potential locations for hydro and biomass-based mini-grids.

6. MAIN STAKEHOLDERS

6.1. GOVERNMENT AND AGENCIES

Organizations that currently have the greatest impact and influence over prospects for green mini-grids in Ethiopia are those in the public sector. Since the concept of cost-effective non-grid electrification is relatively new to Ethiopia, there is limited private sector involvement outside of SHSs.

Final approval for most aspects of energy sector development comes from the Council of Ministers. The Council of Ministers is the cabinet of the government of Ethiopia, and contains the Prime Minister, Deputy Prime Minister and Heads of Ministry. The Ministry responsible for the energy sector in Ethiopia is the Ministry of Water, Irrigation and Electricity (MoWIE), which was previously called the Ministry of Water and Energy. From this there are three main implementing institutions formed from the former utility Ethiopian Electric Power Corporation (EEPCo); Ethiopian Electric Power (EEP), Ethiopian Electric Utility (EEU) and the Ethiopian Energy Authority (EEA). EEP is responsible for generation and transmission (132kV and above), EEU is responsible for distribution, including the Universal Energy Access Program (UEAP), and EEA is the regulatory agent. The Ministry of Finance and Economic Coordination (MoFEC) is also important, and is involved in financial aspects such as Power Purchase Agreements (PPAs). There are two relevant directorates under MoWIE: the Energy Study and Development Follow-Up Directorate (ESD); and the Alternative Energy Technology Development and Promotion Directorate (AETDPD).

These organisations are detailed separately below.

THE COUNCIL OF MINISTERS

Contact: Dr. Mulatu Teshome, President

Link: http://www.ethiopia.gov.et/en_GB/officials-contact

The Council of Ministers is the cabinet of the government of Ethiopia, and is made up of the Prime Minster, Deputy Prime Minister and the minister of each ministry. It is, among other things, responsible for final approval of various important government decisions such as major legislative changes and government strategy documents. This is defined fully in Article 77 of Proclamation 691/2010. Policies such as the National Electrification Strategy, new Energy Code or the tariff review conducted by EEU and EEP will need to be ratified by the Council.

THE MINISTRY OF WATER, IRRIGATION AND ELECTRICITY

Contact: Alemayehu Tegenu, Minster of Water, Irrigation and Electricity

Link: http://www.mowie.gov.et/en_GB/overview

Responsible for water resources management, medium- to large-scale irrigation and electricity resources. This regulatory body is engaged in planning, developing and managing these resources; developing guidelines strategies, polices, and programs; developing and implementing sectoral laws and regulations; conducting studies and research activities; providing technical support to regional water and energy bureaus; and signing international agreements. The Ministry has two directorates directly relevant to electricity: the Alternative Energy Technology Development and Promotion Directorate and the Energy Study and Development Follow-Up Directorate. These are detailed below.

THE MINISTRY OF FINANCE AND ECONOMIC COOPERATION

Contact: Mr Sufian Ahmed, Minister of Finance and Economic Cooperation

Link: http://www.mofed.gov.et/

Responsible for three strategic pillars: public finance administration and control, resource mobilisation and effective utilisation and economic leadership and management. Its mission is to: "Make real a prosperous Ethiopia by formulating development policies, preparing a development plan and budget, mobilizing and administering external resources, installing modern, efficient, effective and accountable public finance and property administration and controlling systems." In relation to the energy sector, the MoFEC is involved in financial aspects such as PPAs, and currently is setting up a PPA team within EEP to increase coordination in this role.

ETHIOPIAN ELECTRIC UTILITY

Contact: Mr Gosaye Mengistie, Chief Operating Officer, gosayea@gmail.com

Link: www.eeu.gov.et

Responsible for distributing and selling electrical energy, with the current threshold for EEU's responsibilities being 66kV and below. EEU's responsibilities now include the Universal Energy Access Program, which is the primary government-implementing vehicle for both on and off-grid development under GTP II. The EEU was established by Regulation No. 18/1997 after the division of the Ethiopian Electric Power Corporation (EEPCo). EEU can also build and operate distribution networks for IPPs, unless this is done directly by the IPP, with either method needing agreement from the EEA. The EEU and EEP are currently conducting a tariff review, and EEU has other programs including organising a joint off-grid pilot project with the government of South Korea and working with Poland to get soft loans to implement a Polish hybrid technology.

ETHIOPIAN ELECTRIC POWER

Contact: Mr. Azeb Asnake, Chief Executive Officer, azebasnake@gmail.com

Link: http://www.eep.gov.et/

Responsible for transmission (132kV and above) and generation, including managing negotiation and delivery of power exports. EEP is currently the sole provider of bulk electricity to users, mainly to the EEU, and currently has over 10GW of capacity either operational or under construction. This includes new projects such as the Ethiopian Grand Renaissance Dam (6GW large hydro) and four new wind farms totalling 551MW. EEP recently signed an agreement with the Corbetti Geothermal Company for Ethiopia's first PPA (500MW, July 2015). Under GTP II, a large number of projects will be delivered through this new PPA modality. EEP has negotiated Ethiopia's power exports, which currently includes 100MW to Djibouti, 2GW to Kenya and 1.2GW to Sudan. By 2018 this will include a further 400MW to Tanzania and discussions are underway with Egypt for a 3.2GW interconnector, as well as a potential undersea interconnector to Yemen through Djibouti. EEP was previously also the host for the Universal Energy Access Program, although this responsibility has now transferred to the EEU.

ETHIOPIAN ENERGY AUTHORITY

Contact: Mr Getahun Moges Kifle, Executive Director, getahunmoges@gmail.com

Link: http://www.ethioenergyauthority.gov.et

Responsible for regulating the electricity sector and associated objectives for energy efficiency and conservation. Specifically, this involves the powers, duties and responsibilities to "issue technical codes standards and directives, commission programs and projects on energy efficiency, delegate its mandates to state governments to better deliver regulatory services and promote energy efficiency and conservation services in the economy." The EEA was established by Ministry of Councils Regulation No 308/2014 to accomplish duties and responsibilities that are given by the Energy Proclamation No 810/2013. The new Energy Operation Regulation is currently in an advanced stage of preparation, awaiting ratification

of the Council of Ministers. It will state, among other things, EEAs mandate regarding issuing and renewal of investment licenses, issuing professional and business competency certificates, compliance monitoring (inspection) services and complaint handling services.

THE ENERGY STUDY AND DEVELOPMENT FOLLOW-UP DIRECTORATE (ESD)

Contact: Mr Sahele Tamiru Fekede, Director, saheletf@yahoo.com

Link: http://www.mowie.gov.et/en_GB/directorates

This directorate, under the Ministry of Water, Irrigation and Electricity, is responsible for sector and policy-level strategy in the energy sector, as well as for guidance to the implementation of strategic energy projects. This directorate sits with two other directorates under the State Minister for Electricity: the Alternative Energy Technology Development and Promotion Directorate and the Hydro Power Study and Dam Administration Directorate. This is complementary to the original mandate of the AETDPD, which was for the operation of such strategic projects, such as the Rural Electrification Fund. The ESD is directly involved in the planning for electrification, in coordination with the rural energy authorities, and has been working with AETDPD and NRECA (funded by the World Bank) on the National Electrification Strategy and Off-Grid Master Plan. ESD is the source for the provision of energy-related data and information.

THE ALTERNATIVE ENERGY TECHNOLOGY DEVELOPMENT AND PROMOTION DIRECTORATE (AETDPD)

Contact: Mr Asress Giorgis, Director, w.asress@gmail.com

Link: http://www.mowie.gov.et/en_GB/directorates

This directorate, under the Ministry of Water, Irrigation and Electricity, sits with the two other directorates under the State Minister for Electricity: the Energy Study and Development Follow-Up Directorate and the Hydro Power Study and Dam Administration Directorate. The AETDPD is responsible for manufacturing, laboratory and training support for alternative energies, which includes biomass, solar, wind, mini-hydro and other alternative technologies. The AETDPD is also responsible for the Rural Electrification Fund (REF), of which Mr Bacha Alemayehu is the Technical Coordinator. AETDPD has disseminated over 45,000 SHSs through various REF programs, and is now turning its attention towards mini-grids. It has completed design studies for five mini-hydro sites identified under GTP II, and has been working with ESD and NRECA on the National Electrification Strategy and Off-Grid Master Plan.

The AETDPD is being refocused as a strategy and dissemination institution, along with the ESD, with EEU taking responsibility for implementing off-grid projects. This is due to its lack of capacity for handling large funds or implementing large schemes. The future housing of the REF is unclear at this point, but remains with the AETDPD under current plans. The new implementing mandate of EEU does not explicitly reference the invalidation of AETDPDs mandate. As a result, there is currently disagreement over the responsibility of implementation of government off-grid projects.

CENTRAL STATISTICS AGENCY (CSA)

Contact: Sahelu Tilahun, Population Statistics Directorate, sahelutilahun@yahoo.com, 011-111-51-31

Link: http://www.csa.gov.et/

The Central Statistics Agency is the government agency responsible for collecting, analysing and disseminating statistical data in Ethiopia. This is primarily done through censuses, sample surveys, administrative records and registrations. There is an atlas on rural services on their website, covering location of public services, commercial services, infrastructural services and agricultural development centres, last published in 2013/14. There are a number of directorates, predominantly under the three deputy directors for Statistics Surveys and Census; Population and Vital Statistics; and National Statistics System Coordination and Operation.

6.2. MINI-GRID PRACTITIONERS AND PRODUCT DEVELOPERS

There are few mini-grid practitioners in Ethiopia to date, primarily solar PV and solar home systems providers. A non-exhaustive list is provided below:

STIFTUNG SOLAR ENERGY FOUNDATION

Contact: Mr Samson Tsegaye, Country Director, samson@solar-energy-foundation.org

Link: www.solar-energy-foundation.org/

A German foundation working also in Kenya and the Philippines. This foundation has driven the solar off-grid market in Ethiopia for ten years through training of technicians and support for local manufacturing. The Foundation also provides a credit facility to rural households to purchase the technology. The Country Director, Samson Tsegaye, is also a founder of the Solar Energy Development Association-Ethiopia. The Foundation has spawned two commercial entities: Solar Technologies Manufacturing (an investment company) and SunTransfer as its corporate arm. This second business phase aims to increase access and service impact. As part of this service impact, SunTransfer now also installs mini-grid systems. Yonas Workeye is the Managing Director for SunTransfer (yonas@suntransfer.com, www.suntransfer.com).

BESHAH INTERNATIONAL SOLAR & INFORMATION TECHNOLOGY (BISIT)

Contact: Tameru Beshah, General Manager, temeru.beshah@bisitgroup.com, +492273595962

Link: www.bisit-group.com

A private German company supplying solar energy applications across Ethiopia and Africa. Main solutions include SHSs and solar refrigeration, pumping and lighting systems.

GREEN LIGHT PLANET

Contact: Selamekristos Belay, Brand Manager selame@greenlightplanet.com

Link: www.greenlightplanet.com/

An Indian-based for-profit, social business solar home systems and solar lamp kits developer, manufacturer and supplier. The products go by the name of SunKing. Green Light Planet is a member of the Global Off-Grid Lighting Association.

LYDETCO PLC

Contact: Dereje Walelign, Owner/Managing Director, dwalelign@lydetco.com.et, + 251 114 660 267

Link: http://www.lydetco.com/

A solar home systems manufacturer linked with the distributers Phaesun, Newlong and Linuo Ritter.

NIWA SOLAR

Contact: Ti el Attar, Founder and Executive Director, sales@niwasolar.com

Link: www.niwasolar.com

A developer, manufacturer and distributer of solar home systems and highly efficient appliances.

SOLARTECH

Contact: Yohannes Shiferaw, Expert, yohannesshi@gmail.com

Link: www.solartech.org.uk

A solar technology distributer also offering installation, support and consultancy services.

AZURI TECHNOLOGIES

Contact: Simon Bransfield-Garth, Chief Executive Officer, sbg@azuri-technologies.com

Link: http://www.azuri-technologies.com/

Azuri is a commercial provider of pay-as-you-go solar systems for rural off-grid communities. The business model is built around mobile payment, and Azuri has partnered with M-BIRR to provide this service in Ethiopia.

ETHIO RESOURCE GROUP

Contact: Hilawe Lakew, Director of Projects, hilawe_l@yahoo.com

Link: http://ergethio.com/

Ethio Resource Group is a private energy and environment research and consulting organisation based in Addis Ababa. The services provided includes policy and strategy consultancy; project development and evaluation; research design, installation and supervision of projects; and capacity development. ERG is establishing six wind-powered micro-grids in Menz-Gera as detailed in Section 4.6.

6.3. BILATERAL AND MULTILATERAL DONOR ORGANISATIONS

WORLD BANK

Contact: Rahul Kitchlu, Senior Energy Specialist, rkitchlu@worldbank.org

Link: http://www.worldbank.org/en/country/ethiopia

The World Bank's engagement in Ethiopia is through its lower income branch, the International Development Association (IDA). The World Bank has been engaged with the government of Ethiopia to support its medium- to long-term development agenda through policy support, capacity building, financing and implementation initiatives. Previous focuses of support have been access and infrastructure expansion, connection intensification, geothermal power and interconnectors. The World Bank is currently engaged with the government on the restructuring of the energy sector's institutional framework, as well as the National Electrification Strategy and Off-Grid Master Plan.

The current US$ 250 million phase of funding is primarily focused on grid intensification. However, approximately US$ 40 million of this funding phase was allocated to the Development Bank of Ethiopia Credit Line, which provides concessional financing for low carbon technologies. This facilitates both the supply (entrepreneurs) and demand side (customers through microfinance), and is detailed further in Section 4.6. The previous World Bank credit program went through the Alternative Energy Technology Development and Promotion Directorate, which had insufficient capability to handle large finances.

Another project stream in Ethiopia is geospatial analysis and planning. The World Bank is developing a GIS-based planning tool, targeting operation by the end of 2016, which builds upon the UNDESA Universal Electrification Access Tool (un-desa-modelling.github.io/Electrification_Paths/index.html). This tool will incorporate an opportunity assessment methodology for practitioners, allowing them to adjust various criteria according to their criteria and business model. This analysis aspect of the tool will be completed at some point in 2017, in addition to other data collection activities that the World Bank will run to populate the model.

USAID POWERAFRICA

Contact: Mr Gene Lin, Senior Energy Advisor, glin@usaid.gov

Link: https://www.usaid.gov/powerafrica/ethiopia

PowerAfrica has been strongly engaged with the government of Ethiopia on a number of policy and institutional issues, as well as prioritising geospatial analysis and planning. PowerAfrica has also been leading informal coordination of donors in Ethiopia. PowerAfrica has supported the development of the national electrification master plan, the legal and regulatory framework for geothermal generation and current development of government geospatial management capabilities. They have also been a consultant to the government on its short- to long-term energy strategies, which includes mini-grid developments targeting diesel powered irrigation and agricultural processing systems. PowerAfrica is also looking into the issue of foreign currency liability in the energy sector.

PowerAfrica has employed the National Renewable Electricity Cooperative Association (NRECA) to deliver a number of projects including USAID's Beyond the Grid, which centres on establishing business models for off-grid generation in Ethiopia. This examines four sets of projects: 1) full feasibility studies of the five hydro sites for which the AETDPD did design studies; 2) the 37 diesel mini-grids operating legally in Ethiopia; 3) some of the 150 village areas identified for mini-grids under GTP II; and 4) medium to large irrigation sites that currently use diesel-generation. NRECA is also looking into the tariff structure for off-grid projects.

AFDB

Contact: Mr Girma Mekuria Abiyehoy, Senior Energy Officer, g.abiyehoy@afdb.org

Link: http://www.afdb.org/en/countries/southern-africa/ethiopia

The AfDB has historically been engaged mainly in large infrastructure projects in Ethiopia, and is currently working on the Kenya interconnector with the World Bank and French Development Agency, AFD. The Ethiopia office is also working on two AfDB-funded projects, involving the electrification of 335 towns and a planned 170,000 connections. Funding under the AfDB is available through two windows: the African Development Fund (public sector with sovereign guarantee) and the African Development Bank Window (commercial). Through these windows, Ethiopia has received a commercial loan for local water supply development in four towns, and recently also for transmission and sub-stations for a mining company.

The Sustainable Energy for All Africa Hub, hosted by the AfDB, is currently implementing a green mini-grid market development programme (GMG MDP) to facilitate greater investment into GMGs across the continent. To achieve the SEforALL objectives, Africa will require substantial investments into national power grids, off-grid solar home systems, and isolated mini-grids. AfDB's programme will provide business development services to green mini-grid developers, assisting them on a wide range of issues, from business planning, market development and grid design to project finance, grid operation and maintenance.

The first phase of the Green Mini-Grid Market Development Programme was launched in late 2015. The Programme consists of five business lines:

- Market intelligence relative to GMG development at the African country level;
- Business development services;
- Policy and enabling environment development;
- Access to financing for GMG project developers; and
- Technical standardisation and quality control of mini-grids, which will be operationalised in a second phase of the MDP.

This Programme works in close collaboration with other partners and was also referenced in the G20 Action Plan on Energy Access in Sub-Saharan Africa adopted in October 2015.

GIZ

Contact: Rainer Hakala, Programme Director, Rainer.Hakala@giz.de

Link: https://www.giz.de/en/worldwide/336.html

The Energising Development, or EnDev, programme is a multi-donor initiative delivered by Germany's GIZ and the Netherlands' Enterprise Agency (RVO). It is funded by the governments of the Netherlands, Germany, Norway, Australia, the United Kingdom, Switzerland and Sweden. 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.

The program has established five operational community-owned mini-hydro schemes: four in Sidama and one in Oromia Gima, with the next stage of EU financing being finalised at the time of writing. These schemes are centred on operational or derelict flow-mills, as these ensure existing social structures, a critical base load industry and existing infrastructure. This program trains local scouts to promote hydro power and assist municipalities in identifying and developing suitable sites. EnDev provides financial resources to cover parts of the investment costs, and the local community contributes with civil works. EnDev selects the personnel to do the installation of the machinery, the supervision of the civil works and the wiring. Partners from local institutions were sent to Indonesia to be trained in turbine manufacturing.

EU DELEGATION

Contact: Mr. Jean-Baptiste Fauvel, Jean-Baptiste.Fauvel@eeas.europa.eu

Link: http://eeas.europa.eu/delegations/ethiopia/index_en.html

The EU's role in Ethiopia is in grant funding through the government, targeting physical projects on energy and infrastructure. A EUR 60 million funding pot is available until 2020, and allocation will be driven primarily by government demand. The EU's aim is to use this funding as seed money for larger projects, such as the EUR 10 million given to the GIZ EnDev Project. The two main focal points for the EU with respect to its energy strategy are energy efficiency and renewable energy. As renewable development is comparatively stronger in Ethiopia, the EU's energy priorities to date have been in energy efficiency. This includes supporting the EEA in developing an energy efficiency master plan. Future projects include: community mini-hydro under the GIZ EnDev project and a biogas digester project with SNV that are under final approval. Others include the Regional Development and Protection Project that provides electricity and sustainable cooking to refugee camps and their host communities and a solar kiosk program for African, Caribbean and Pacific states, which is under development.

UNDP

Contact: Ms. Kidanua Abera, Programme Analyst - Energy and Low Carbon Development, kidanua.abera@undp.org

Link: http://www.et.undp.org/

UNDP is predominantly focused around supporting delivery of the country's priorities under its GTP II, which also align with the Sustainable Development Goals. Support programmes fall into three strategic pillars: growth and poverty reduction, climate change and environment vulnerability, and governance. The first pillar focuses mostly around agriculture. The UNDP has therefore supported the design of Ethiopia's multi-donor funded national Agriculture Growth Programme (AGP). Governance focuses around capacity building and leadership at senior level, including training and twinning with institutions such as think tanks. Finally, the climate, risk and resilience programme focuses on support for the implementation of Ethiopia's 2011 Climate Resilient Green Economy document (CRGE).

KOREA INTERNATIONAL COOPERATION AGENCY (KOICA)

Contact: Doh Young Ah, Country Director, yadoh@koica.go.kr

Link: www.koica.go.kr

The Korea International Cooperation Agency was established in 1991 as the government organisation responsible for official development assistance, and is tasked with implementing the government's grant aid and technical cooperation programs. Its focus sectors are education, health, public administration, rural development, energy technology and industry (water, energy, transportation and science, technology and innovation) and the cross-cutting issues of climate change, gender, human rights and ICT. In Africa, within which Ethiopia is KOICA's biggest recipient, KOICA is focused on health, education and rural development. In Ethiopia, this includes a joint off-grid pilot program under development in partnership with EEU.

EUROPEAN INVESTMENT BANK (EIB)

Contact: Eva Romer, Head of Secretariat of AITF, E.Romer@eib.org

Link: www.eu-africa-infrastructure-tf.net/

The EU-Africa Infrastructure Trust Fund (EU-AITF) was established in 2007 and aims to increase investment in infrastructure in Sub-Saharan Africa by blending long-term loans from participating financiers with Infrastructure Trust Fund grant resources. Private and public sector co-financing is encouraged, and projects must be financed by at least one member of the EU-AITF Project Financiers Group. The grant funding is composed of two envelopes, the regional envelope, which focuses on regional infrastructure projects, and the SEforALL envelopes, which supports regional, national and local energy projects targeting SEforALL objectives. No funds are targeted at private sector developers.

EIB - ENERGY ACCESS VENTURES FUND

Contact: Thomas Andre, Schneider Electric, thomas.andre@schneider-electric.com

Link: http://www2.schneider-electric.com/documents/press-releases/en/shared/2015/03/20150302_PRF_AfricaEnergyAccessFund_EN.pdf

Technical and financial assistance targeting small energy access businesses. The Fund will be managed by Aster Capital (Energy Access Venture jointly backed by Schneider Electric and the CDC Group), the UK's Department for International Development (DFID), European Investment Bank, FISEA (PROPARCO, OFID, and AFD) and FFEM. The Fund has secured commitments of EUR 54.5 million to invest in Africa.

6.4. OTHER RELEVANT ORGANISATIONS AND INITIATIVES

Other local organisations and initiatives that can provide useful background information regarding prospects for GMGs in Ethiopia include:

THE SCALING-UP OF RENEWABLE ENERGY IN LOW INCOME COUNTRIES PROGRAM (SREP)

Contact: Dessalegne Mesfin Fanta, Deputy Executive Director, Environmental Protection Authority, epa_ddg@ethionet.et

Link: https://www-cif.climateinvestmentfunds.org/country/ethiopia

The Climate Investment Funds (CIF) is made up of the key development banks (the African Development Bank, the Asian Development Bank, the European Bank for Reconstruction and Development, the Inter-American Development Bank and the World Bank Group). The SREP is a US$ 839 million financing window of the CIF, working across 28 countries to scale-up the deployment of renewable energy solutions to increase energy access and economic opportunities. US$ 50 million has been allocated to Ethiopia to date, and has included the US$ 25 million Geothermal Sector Development Project and US$ 1.6 million Lighting Ethiopia project. The SREP investment plan details the full investment strategy for this project.[70]

70 Ministry of Water and Energy, Scaling-Up Renewable Energy Program Investment Plan, 2012

EAST AFRICAN POWER POOL (EAPP)

Contact: Mr. Lebbi Changullah, Secretary General, lchangullah@eappool.org

Link: http://www.eappool.org/

The EAPP has ten member countries: Burundi, DRC, Egypt, Ethiopia, Kenya, Libya, Rwanda, Sudan, Tanzania and Uganda. The EAPP was formed under an Inter-governmental Memorandum of Understanding (IGMoU) between the countries' energy ministers, and an inter-utility MoU between the countries' power utilities. This organisation seeks to facilitate the further regional integration of its member countries and to thereby realise sustainable growth and development. The primary document of the EAPP is the EAPP Regional Power System Master Plan, which outlines the plan for the expansion of the East African electricity transmission system. This details a number of scenarios for the least-cost investment in generation and transmission for the entire system. An interconnection code compliance program is an integral part of enabling this regional integration.

PLAN INTERNATIONAL SPAIN

Contact: Carlos Sordo Olive, RE and EE Department Manager, carlos.sordo@plan-international.org, (+34) 915241222 Extension 106, Skype: Carlos.sordo.plan

Link: http://plan-espana.org/

Plan International is an international aid and development organisation focused on safeguarding the rights of children. Plan International provides finances, local knowledge and logistical assistance to increase the impact of several Plan International programmes through the use of energy resources. It aims to provide energy access to rural communities in Ethiopia.

SCHNEIDER ELECTRIC

Contact: Thomas André, Strategy & Performance - Access to Energy program, +33141393163, thomas.andre@schneider-electric.com

Link: http://energy-access.schneider-electric.com/

Schneider Electric is a French multinational corporation specialising in electrical distribution, industrial control and automation products, systems and services. Schneider Electric's Access to Energy Program delivers technical and financial assistance on clean off-grid solutions, including product development, commercialisation and investment assistance.

STATERA CAPITAL

Contact: David L. Ross, Managing Director, david@stateracapital.com

Link: www.stateracapital.com

Statera Capital is an impact investment banking and transaction advisory firm focused in Sub-Saharan Africa. Statera Capital acts as an advisor to organisations such as AFD and DFID on mini-grid investments, offering advice on capital structures and capital raising for renewable energy sources.

SUSTAINABLE AGRICULTURE COMMUNITY DEVELOPMENT PROGRAMME (SACDEP-KENYA)

Contact: Polly Wachira, Outreach and Networking Manager, 254-020-2614690, sacdepkenya@iconnect.co.ke

Link: www.sacdepkenya.org

SACDEP-Kenya's mission is to facilitate sustainable development for communities in Kenya and the East African Region that have low access to resources to enable livelihood improvement through sustainable agricultural principles and practices. SACDEP support to communities includes facilitating access to wind, biomass and solar for domestic uses.

ACCENTURE DEVELOPMENT PARTNERSHIPS

Contact: David Tailor, Senior Strategist, David.taylor.jr@accenture.com

Link: www.accenture.com/us-en/accenture-development-partnerships

Accenture Development Partnerships is a consultancy involved in strategic development, assessment and analysis of mini-grids in select developing countries. Their Energy Access for Development Impact (EADI) program provides technical assistance across all technology types.

ADDIS ABABA UNIVERSITY

Contact: Dr. Tassew Woldehanna, Vice President for Research and Technology Transfer, vprtt@aau.edu.et, +251-111-239769

Link: www.aau.edu.et

Ethiopia's main university has several schools and departments involved in renewable energies and rural electrification, including the Centre for Energy and Technology (Addis Ababa Institute of Technology) and the Horn of Africa Regional Centre for Environment. These are lead respectively by Dr. Ing. Abebayehu Assefa, Head of the Energy Center, and Dr. Araya Asfaw, Executive Director.

ARBBA MINCH UNIVERSITY

Contact: Dr. Damtew Darza Sozo, President, presidentoff@amu.edu.et, damtew.darza@amu.edu.et

Link: http://www.amu.edu.et

Arba Minch University has a number of courses and research groups relating to renewable energy and rural electrification within its Institute of Technology. The university set up a solar competence centre in cooperation with Sahay Solar Africa, which trains engineers, electricians and rural Ethiopians on solar technologies. It also runs an applied education entrepreneurship programme to develop off-grid business applications, in partnership with Neu-Ulm University of Applied Sciences.

WOLDIA UNIVERSITY

Contact: Professor Yalew Endawoke, President, +251 0335 400 609

Link: http://www.wldu.edu.et

Arba Minch University has a number of courses and research groups relating to renewable energy and rural electrification. The University is the host for a 100MW/annum Solar PV mini-grid manufacturing plant that has been built in partnership with Global Trade and Development Corporation and AIB Stimaken.

7. ANNEX. OBJECTIVES, SCOPE AND METHODOLOGY OF THE MARKET ASSESSMENT

7.1 OBJECTIVES OF THE MARKET ASSESSMENT

The objective of the Green Mini Grids Africa Market Development Programme is to support the scale-up of investments in commercially viable GMG projects through a broad range of interventions to improve the enabling environment. The project seeks to remove or reduce market barriers at regional scale and strengthen the ecosystem for the emergence of a thriving GMG sector in Sub-Saharan Africa – contributing significantly to the objectives of the SEforALL.

The Market Intelligence business line supports activities that foster the ability of project developers, investors and public entities in identifying market opportunities for GMGs, facilitating a coherent national approach and supporting the linkages between central authorities, local/national businesses, investors and communities with demand for power.

7.2 SCOPE OF THE MARKET ASSESSMENT

This report is one of the five country reports as part of the third deliverable for this project. All published deliverables are to be available through the African Development Bank and other dissemination channels. As written in the original terms of reference, the project had three main deliverables:

D1 – An evaluation of the methodologies and best practices available for assessing GMG potential; D1 will analyse the methodologies currently utilised to assess the GMG potential with top-down approaches. The assessment will include data requirements, software requirement, robustness, handling of data paucity, quality of outputs, facility of use, openness of the system, interoperability with other planning tools, cost and any other specific strength or weakness. The output of the D1 will be a report accompanied by an executive summary and a presentation or infographics.

D2 – Creation or choice of an opportunity assessment methodology in order to generate comparable data across countries, to the extent that is possible; On the basis of the methodological analysis made in D1, the consultant will present a methodology able to generate comparable data across countries. The methodology shall generate quality outputs, be robust, scalable, preferably based on open source or commonly used software and need only limited training. The output of the D2 will be a methodological paper or report and a presentation. If any new software tool will be developed to implement this methodology, it will have to be disseminated as open source.

D3 – The publication of country-level analysis on mini grid market opportunities, initially focussing on at least 5 countries in SSA that are prioritising GMGs, generated with the above methodology. AfDB will provide the country list and will support the consultant to get access to country institutions, notably the SEforALL focal points, and national sources of data to apply the methodology. The D3 Output will be a report with the assessment for the five countries.

7.3 METHODOLOGY

This methodology was developed in second phase of this project, the Green Mini Grids Market Development Program - Market Intelligence business line, which is also available via the African Development Bank.

This analysis, whose results are given in Section 2, considers the potential for mini grids by segmenting the countries into three areas, grid, mini grid and standalone areas. This split is based on the distance from the power network and population. We have used the planned power network for up to 2020, and the geospatial data provided in this annex. Mini grid regions are defined based on a distance of greater than 15km from the grid, as well as a household density greater than 50 household/km^2. Grid regions are defined as within 15km of the grid, and standalone systems make up the remaining area. Protected and wetland areas are excluded.

The GIS sources used in this analysis are detailed below.

POPULATION DENSITY GRID

Source: World Pop data portal

EXISTING AND PLANNED POWER GRID

Source: Elaborated by the Carbon Trust using data from the AICD - Africa Development Bank, 2009 and the report "USAID – The Electricity Sector in Mozambique: An Analysis of the Power Crisis and its Impact on the Business Environment", 2015.

PROTECTED AREAS

Source: The World Database on Protected Areas, 2014

LAKES AND WETLANDS

Source: Global Lakes and Wetlands Database, 2004

IDENTIFIED RENEWABLE SOURCES AND PROJECTS

Source: Renewable Energy Atlas, FUNAE, 2014

MEAN AVERAGE WIND SPEED

Source: DTU/IRENA, 2005

ANNUAL GLOBAL HORIZONTAL IRRADIATION

Source: DTU/IRENA, 2015

OTHER – MAP OF ELECTRIFICATION OF ADMINISTRATIVE POSTS AS OF 2015

Source: Translated and used with the permission of the Director of Planning, EDM, 2016

Green Mini-Grids
Market Development Programme
Document Series

Contacts:
The SEforALL Africa Hub Secretariat
hosted by the AfDB

African Development Bank
Statutory Headquarters
Immeuble du Centre de Commerce
International d'Abidjan-CCIA
Avenue Jean-Paul II
01BP1387
Abidjan 01, Côte d'Ivoire

SEforALL Africa Hub
Coordinator
Dr. Daniel-Alexander SCHROTH
d.schroth@afdb.org
www.se4all-africa.org
se4all.africa@afdb.org