‘Off-grid Rural electrification in Ethiopia’

NAMA developed within the Mitigation Momentum project
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In name of the Ministry of Water, Irrigation and Energy and Ministry of Environment and Forestry, Ethiopia

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The Mitigation Momentum project is a collaboration between ECN Policy Studies Netherlands and Ecofys Germany.
A cooperation of:

The Mitigation Momentum (www.mitigationmomentum.org) project aims to support the development of Nationally Appropriate Mitigation Actions (NAMAs) by contributing to the concrete development of NAMA proposals and by bringing NAMAs into finance. The Mitigation Momentum project is financed by the International Climate Initiative of the German government.

Within the Mitigation Momentum project NAMAs have been developed in Chile, Peru, Tunisia, Kenya, Ethiopia, Georgia, Thailand and Indonesia.

Within the framework of the Mitigation Momentum project, Ecofys has support the development of a NAMA proposal for the energy sector on the topic of off grid rural electrification. This NAMA has been developed by Ecofys in cooperation with SNV Ethiopia for the Ethiopian government.
Executive summary

**Ethiopia has set the goal to a low carbon energy future.** Ethiopia is a frontrunner in the field of renewable energy deployment and climate actions. It has set ambitious targets for carbon neutral growth towards 2025, aligned with its sustainable development and poverty reduction goals.

As the late Prime Minister Meles Zenawi describes in his foreword to the CRGE strategy: “For Ethiopia, green growth is a necessity as well as an opportunity to be seized. It is an opportunity to realize our country’s huge potential in renewable energy and a necessity so as to arrest agro-ecological degradation that threatens to trap millions of our citizens in poverty”.

Ethiopia has abundant natural resources for the production of renewable energy, such as solar, water and wind. Most of the current electricity production is already based on these types of sources, generally in the form of large scale grid connected systems. Over recent years the government has invested in grid extension, increasing national grid coverage from 13% in 2002 to 55% in 2011 (although the rate of actual connections to rural households is a lot lower than this number) nevertheless, the rate of rural electrification is still slower than that needed to achieve the targets set for electricity access.

The Ethiopian landscape, population spread and rural population density cause grid extension in some regions to be inefficient and costly, especially when assessing per capita connection costs.

**Ethiopia’s low carbon energy future includes off-grid rural electrification and realising this will need overcoming certain barriers.** Only recently, with the ‘Growth Transformation Plan II (GTPII) for the period 2016-2020, the government has diversified their strategy for electrification. While before all focus was on grid extension and large scale grid connected projects, the government’s strategy now includes stand-alone alternatives like mini-grids or household energy systems based on renewable energy resources.

However several barriers still exist preventing the development of these mini-grids, namely:

- Market uncertainty preventing private and other stakeholders from starting developments: for example uncertainty about where large scale grid extension will go, what will happen to mini-grids if the grid reaches the same area, no agreements on tariffs or options for connection to the main grid;
- Difficulties with economic feasibility of mini-grids: very low grid connected electricity prices in Ethiopia, grid extension costs are not recovered in the electricity price, no successful business models demonstrated in Ethiopian context;
- No policy guidance/framework: absence of overall plan and approach, no clear targets on how many or where to develop mini-grids.
The off-grid rural electrification NAMA is a step towards overcoming the barriers and achieve transformational change in the rural electrification sector. The proposed Nationally Appropriate Mitigation Action (NAMA) aims to address these barriers through a combination of policy and regulation development, capacity building and demonstration projects. Figure 1 summarises the elements of the NAMA and their link to the intended outcomes and impact.

The NAMA is set to drive transformational change by imbedding alternative off grid electrification options in the Ethiopian power sector. This would move the sector away from costly, and sometimes inefficient large scale grid extension towards a market with modern, diversified on and off grid electricity provision. It would also reduce the proliferation of small diesel units in rural areas by introducing functional, renewable energy based alternatives that provide the same services for a comparable cost.

Overcoming the barriers could open up a potential of mini-grid development of up to 555 units before 2025 (following the targets set in GTPII and by EEA) and thereby achieve 1.5 Mton in avoided CO$_2$ emissions by 2025. With an even more ambitious target of reaching 10% of the rural population without electricity access on the medium/long term could generate a cumulative GHG emission reduction of near to 8 Mton. The cost of implementing the proposed NAMA is a minimum of $5,680,000 USD, (excluding the costs for financial measures to deploy the 355/555 minigrids after the pilots and implementation of the MRV system) and will take 3-5 years (depending on the target set for deployment of the replication projects).

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**Figure 1. Proposed NAMA activities, outputs, outcome and desired impact.**

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1. The costs for the incentives for the deployment of the 355/555 minigrids are not included in this amount, since this estimate will strongly depend on the type and size of incentive the Ethiopian government will want to provide. This will however be a large contribution to the overall costs of the NAMA.
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1 Introduction

1.1 Ethiopia’s transition towards a climate resilient economy

In 2010 the Government of Ethiopia set a development agenda to eradicate poverty through an accelerated economic growth. This agenda is defined in the Growth and Transformation Plan (GTP II), which extends until 2025. The vision is to "to build an economy which has a modern and productive agricultural sector with enhanced technology and an industrial sector that plays a leading role in the economy" (MoFED, 2010). The government quickly realised that achieving this vision could be hindered by climate change impacts; it’s GDP growth could be reduced between 0.5-2.5% per year due to climate change effects (World Bank, 2010). The government’s answer to this challenge was to develop a strategy for climate resilient growth that would help the country achieve the development agenda. The strategy was launched in 2011, under the name Climate Resilient Green Economy (CRGE).

The CRGE sets the direction to transform Ethiopia to a middle-income country through climate resilient growth and reduction of greenhouse gas emissions. Under the leadership of Ethiopia’s Prime Minister and the Ministry of Forestry and Environment, the CRGE sector teams are identifying opportunities that will help to lift the country economic status while reducing poverty, increasing climate change adaptation, and reducing greenhouse gas emissions.

The Ministry of Water, Irrigation and Electricity (MoWIE) identified 11 priorities in four dimensions: power generation, energy access, irrigation for agriculture, and water, sanitation and hygiene (Figure 2). The importance of power generation and energy access is evident as only half of the population is currently in regions with grid coverage. Those without electricity rely on fuel wood, kerosene or diesel.

The government of Ethiopia has already started to make significant progress to expand the grid and increase access, one example is the USD 4 billion investment in the construction of the Ethiopian Grand Renaissance Dam, in the region of Benishangul-Gumuz along the Blue Nile. The hydroelectric plant will produce 15,000 GWh per year.

While this represents significant progress, the government has realised that increasing power generation and grid connection has to be complemented with mini-grids and stand-alone systems. This is especially recognised in the context of energy access for remote rural areas where extending the grid comes at a high economic cost and utility or state budgets for electrification are limited. Under these conditions, mini-grids often emerge as the most cost-effective way to provide electricity (EUEI, 2014).

Under this premise, MoWIE has committed to accelerate off-grid energy access by putting mini- and micro-grid solutions high on its agenda. This is one of the strategic priorities under the CRGE (Figure
2). To achieve this the government needs to enhance the Rural Electrification Fund and invest in pilot projects to demonstrate the feasibility of mini- and micro grid solutions.

![Diagram](image)

Figure 2. CRGE strategy for Water and Energy.

1.2 Ethiopia’s climate mitigation targets

Ethiopia was the first least developed country (LDC) to submit their INDC to the United Nations Framework Convention on Climate. The country intends to limit its net greenhouse gas (GHG) emissions in 2030 to 145 Mt CO$_2$e or lower, equivalent to a 64% reduction from the business as usual (BAU) scenario in 2030. The target is ambitious and encourages a transformational change in all sectors of the economy. For reference, under the BAU, Ethiopia would increase its emissions by more than 50% in 2030. The INDC’s ambitious target is based on the country’s Climate Resilient Green Economy Strategy (CRGE), which was developed under its national development plan “Growth & Transformation Plan II” (GTPII). The INDC focuses on six sectors: agriculture, forestry, transport, electric power, industry and buildings (Figure 3). Under electric power, the country is committed to expand its electricity generation from renewable energy sources.

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2 CRGE Water and Energy (2015)
3 CRGE Water and Energy (2015)
Ethiopia’s Growth & Transformation Plan II

Figure 3. Overview of the interaction GTP, CRGE and INDC in Ethiopia.

While Ethiopia is an LDC, responsible only for 0.3% of GHG emissions and with half of its population without electricity, the country is committed to develop on a low-carbon path with the goal of becoming middle income country by 2025.

Under the Copenhagen accord\(^5\), Ethiopia proposed to develop Nationally Appropriate Mitigation Actions (NAMAs) on electricity generation from renewable energy for off-grid use and direct use of renewable energy\(^6\). The NAMA on mini-grids presented in this proposal responds to Ethiopia’s commitment to expand clean energy to off-grid communities while avoiding GHG emissions from the use of fossil fuels such as diesel and kerosene.

Both the INDC and proposed NAMAs are conditional upon available international support in terms of finance, technology transfer and capacity building.

1.3 The NAMA on rural electrification

The development of the NAMA started in May 2015, when the Ministry of Water Irrigation and Electricity (MoWIE) and the Ministry of Environment and Forest (MEF) confirmed their interest in developing the NAMA on rural electrification with the technical support of Ecofys and the financial support of the International Climate Initiative of the German Government.

\(^5\) http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php  
\(^6\) Source: http://unfccc.int/meetings/cop_15/copenhagen_accord/items/5265.php
MoWIE led the development process of the NAMA by guiding the inter-institutional dialogue and shaping the NAMA concept. Ecofys, together with SNV local experts, supported MoWIE in the process through background research, guiding the stakeholder consultations and reporting.

The 1st open stakeholder workshop was held in June 2015 to discuss issues in rural energy sector, possible focus areas for the NAMA and the stakeholders who should be involved. The Minister of MOWIE (Ato Alemayehu Tegenu) opened the workshop and joined the first part of the presentations and discussions. About 25 participants attended the workshop.

At the workshop four possible ideas for the NAMA were presented:
- Solar systems for pastoral communities;
- Integrated rural household energy strategy/policy;
- Mini-grid systems for off-grid communities;
- Sustainable conversion of wood residues into charcoal, bio-gas and briquettes.

The workshop served to explore the barriers to off-grid rural electrification and the various options that could work to unlock off-grid electricity access; it also served to narrow down the NAMA ideas. Further discussions with MOWIE after the workshop led to select ‘clean mini-grids for rural off grid communities’ as the topic for the NAMA.

The 2nd open stakeholder workshop was held in the beginning of September 2015. For this workshop the Ecofys/SNV team drafted a NAMA concept based on the insights that came out from the previous stakeholder discussions. The 2nd workshop was used to refine the NAMA concept and outline in detail the components, as well as to define and discuss barriers and mitigation activities in detail.

The 3rd open stakeholder workshop was held on the first week November 2015. Prior to this workshop the Ecofys/SNV team drafted the detailed proposal and held meetings with MoWIE directorates to obtain feedback and refine the document accordingly. This helped the team to ensure that every component aligns with the Ministry’s agenda. At the 3rd workshop the team presented the detailed NAMA proposal and lead discussion with experts from governmental and non-governmental institutions.

1.4 The structure and goal of this proposal

The goal of this NAMA proposal is to present the outcomes of a multi-stakeholder process that defined the priorities and actions to increase clean energy access to off-grid rural communities of Ethiopia. Chapter 2 sets the scene by providing a description of relevant elements of the national energy sector, including the state of rural electrification, national policies, sector emissions, barriers that prevent the acceleration of off-grid clean energy access, and the possible options to tackle the barriers.

Chapter 3 focuses on the NAMA proposal by describing the objectives and activities, while chapter 4 presents the expected impacts of the NAMA. Chapter 5 describes the outlines and components for MRV and Chapter 6 provides an implementation plan.
2 Current situation: the sector in national context

In this chapter, we describe the current situation in the Ethiopian rural energy sector. We will focus on the energy situation in rural areas, describe the policy setting influencing the rural sector and indicate the barriers currently hampering electrification of the rural sector.

2.1 Status quo of rural electrification in Ethiopia

Ethiopia has been making considerable progress in the electricity sector since the turn of the millennium. The grid-based Universal Electricity Access Program has made progress in connecting off grid villages and regions to the national electricity grid through public investment. Furthermore it has worked on expanding capacity of the national grid. The grid expansion program will continue in the GTPII.

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>Current estimate (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National grid coverage to rural towns ('electricity access')</td>
<td>13%</td>
<td>55%</td>
</tr>
<tr>
<td>National electricity connectivity (percentage of households actually connected to the grid)</td>
<td>7%</td>
<td>30%(^8)</td>
</tr>
<tr>
<td>Electrification rate</td>
<td>6 rural centres/year</td>
<td>500 rural centres/year</td>
</tr>
<tr>
<td>Installed generation capacity</td>
<td>450 MW</td>
<td>&gt;2000 MW</td>
</tr>
<tr>
<td>Urbanization rate</td>
<td>15%</td>
<td>17%</td>
</tr>
<tr>
<td>Per capita electricity consumption</td>
<td>21 kWh/year</td>
<td>70 kWh/year</td>
</tr>
</tbody>
</table>

The impressive extension of the national electricity grid does not automatically mean that all rural households in those regions are connected. In many areas, grid is present, but limited villages or households have been connected, making actual grid connection in rural areas well below the 55% geographical coverage of the grid. Energy poverty is thus quite severe because of the limited ability to access adequate, affordable, reliable, quality, safe, and environmentally sound energy services to support human and economic development.

Therefore the rural electrification effort in Ethiopia has to face up to new and existing challenges, including:

- Scaling up electrification capacity to levels unachieved to-date;
- Dealing with electricity supply sources outside the national grid;
- Scaling up connectivity in the rural areas to get electricity to the nearly 14 million rural homes that are currently without any supply;

\(^7\) Electricity access is commonly understood to mean having low voltage electricity supply infrastructure nearby but does not necessarily mean being connected to it.

\(^8\) 2011 figure from WMS of CSA
• Tackling technical challenges associated with the proliferation of long lines in the grid that carry very small loads into the rural areas.

Efforts to extend the grid and increase generation capacity are ongoing and will continue to connect more regions and towns. While grid extension used to be the only option promoted for rural electrification in the GTP II a more diversified range of strategies are included to achieve rural electrification.

Current rural electrification efforts are focused on creating access to rural towns while it is not foreseen that the grid will connect all households and villages in rural areas (either because the grid is not extending to that area, it is not cost effective or because dispersed households in a region with grid are not connected). Furthermore, providing electricity from the grid to remote (and small) rural villages has relatively high costs (due to high connection and maintenance costs, which currently are managed through a centralized distribution and bill collection process).

This new strategy is in line with the realities of the increasing cost competitiveness compared to fossil fuels, technical reliability and market availability of decentralized renewable electricity supply units.

As indicated in the previous paragraph many rural communities and households are not connected to modern electricity services. Currently energy needs are mostly covered by the use of traditional biomass sources (e.g. fuel wood or agricultural waste for cooking and heating), kerosene (especially for lighting) or small battery or thermal generator units (for lighting, communication etc.), and diesel. PV lanterns and solar home systems (especially small systems) are starting to gain momentum in Ethiopia with deployment and sales increasing (annual sales of 0.3 million units9), but this concerns mainly small systems and do not fully cover the electricity needs of multiple households or whole villages.

Figure 4. Energy used for lighting in Ethiopia, 2011.

Issues related to the use of these types of energy are for example health risks (e.g. flammability of kerosene, respiratory impacts of fuel wood burning), high costs and absence of constant supply. In addition to household energy services, there are also several services provided by or shared in the rural villages like potable water supply (water pumping systems), irrigation, agro processing (e.g. milling) or community services (electricity for schools, health centres, community centres). At the moment these services are often fulfilled through small diesel generators, resulting in issues with high fuel prices, system failures, and high maintenance costs. The country uses standalone thermal generator units as a backup and standalone supply to the order of over 2000 MW, which is slightly higher than the total grid based system currently in operation (Off-grid generators study, Mitsubishi Research Institute/ PROCEED, 2012).

These decentralized and mostly fossil based energy services as used in rural households and communities also result in considerable greenhouse gas emissions. As it concerns quite large part of the population and there is strong population increase (with a population growth of over 2% annually), electricity needs and consumption are strongly increasing. In combination with the abundance of renewable energy sources available at rural sites in Ethiopia, these emissions contrast with the ambitions of Ethiopia to be a frontrunner in renewable energy and climate policies and practices.

Ethiopia does not have its own oil production, and is thus highly dependent on imported fossil fuels. Ethiopia spends nearly all of its export earnings to import petroleum products, putting pressure on foreign exchange reserves. This causes a substantial threat on the economy when there are global oil price hikes. This disrupts security of energy supply where escalating oil prices threaten the country’s economy and balance of payment. Availability of fossil energy carriers in rural areas are thus under increasing pressure (both price and availability).

Finally, Ethiopia depends largely on hydropower for its centralized (grid connected) electricity generation, which is susceptible to climatic changes. The country is prone to recurrent drought and other harsh weather conditions have become common, causing water shortage and high level of silting on existing and potential hydropower dams. Off grid diversification of energy sources would contribute to a reduction of possible risks in future situations.

The above sketched current situation provides sufficient reasons and needs to alter the current rural energy situation.

2.2 Current national policies in the sector

The overall vision of the government of Ethiopia for their energy policy is to ensure access to affordable, clean and modern energy for all citizens and become a renewable energy hub in the Eastern Africa Region by 2025. The mission underlying this vision is to play a significant role for socio-economic development and transformation of the country through provision of a sustainable, reliable, affordable and quality energy service for all sectors in an environmentally sound manner.

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10 **http://www.worldometers.info/world-population/ethiopia-population/**
The overarching strategy for this vision is the Climate Resilient Green Economy strategy. The CRGE sets the direction to transform Ethiopia to a middle-income country through climate resilient growth and reduction of greenhouse gas emissions. In the focus area of water and energy within the CRGE strategy MoWIE has identified 11 priorities in four dimensions: ‘power generation’, ‘energy access’, ‘irrigation for agriculture’, and ‘water, sanitation and hygiene’. The importance of power generation and energy access is evident as electricity only reaches around 30% of the population. Those without electricity rely on fuel wood, kerosene or diesel (see section 2.1).

Until recently, government policy focused to the larger extent on grid expansion and large scale hydropower development. Most of these developments were government sponsored and outside of urban areas major rural towns were the targeted scope (not smaller or scattered rural villages). Quite some effort has been spent on expansion of the grid to increase energy access. While this progress is noteworthy, the government has realized that increasing power generation and grid connection has to be complemented with mini-grids and stand-alone systems (Ethiopian National Energy Policy 2013). They increasingly see the importance of minigrid options as a cheaper and cleaner way forward for rural electrification. Therefore MoWIE committed to accelerate off-grid energy access by putting mini- and micro-grid solutions high on its agenda.

Similarly, government policy towards power sector development has been dominated by public managed and public owned utility, leaving little room for concrete private sector interest and participation. The private sector could however play an essential role in accelerated development of the rural energy sector, especially when an enabling environment for this is created by a policy shift at the government.

One element reducing the enabling environment for private sector participation in the power sector has been the fact that electricity tariffs in Ethiopia remain one of the lowest in the world. While domestic low price for electricity is defendable from the perspective of poverty reduction and energy access, regional export power tariffs could be an option to open the door to enable private sector investments for the export market. This could then replicate to the internal rural energy sector. This policy shift to increasing focus on off grid solutions and involvement of the private sector will generate interest and commitments towards mini-grids development.

This ambition for short term electrification of rural villages is to meet basic energy needs and also stimulate energy use for economic purposes to contribute to overall development of rural livelihoods. This ambition has been translated into the ‘GTP II’ (Growth and Transformation Plan II) which focuses on the period of 2016-2020. The draft of this plan for the energy sector was published in January 2015. Within the GTP, besides targets for grid extension also an Alternative Energy Development plan (2015-2020) is presented. This Alternative Energy Development plan presents a diversified strategy towards rural electrification combining various technologies and target sizes. The targets as set within this are shown in Table 1.
In total 355 decentralized grid systems are targeted (solar and micro hydro) by the Ministry of Water, Irrigation and Electricity to be created in the coming 4-5 years. However to realise these targets several institutions will have to be involved. The EEP (Ethiopian Electric Power) also has plans to develop 200 other mini grids in the same period.

The Rural Electrification Fund is the entity within the Ministry of Water, Irrigation and Electricity charged with the roll out of rural electricity services. They are responsible to coordinate and ensure the implementation of the alternative energy services, including mini-grids. Since attention for these type of services has only recently emerged, the Fund still has limited capacities and/or experiences with extensively deploy mini-grids.

Another example of a significant role in the implementation process is for the Ethiopian Energy Authority (EEA), which is the regulator for electricity investment and operations in Ethiopia (Proclamation 810/2013). The EEA mandate covers both grid and off-grid electrification including regulation of generation, transmission, distribution, and sale. Both technical and economic regulations are undertaken by the EEA (technical standards for grids, tariffs). For off grid technologies, and particularly for mini grids, the EEA is responsible for approving the technical standards and reviewing/approving consumer tariffs. The EEA provides investment and operation licenses for off-grid projects where consumers purchase power from a supplier at commercial basis. The EEA also reviews and approves tariffs for off-grid projects (it has also prepared a guideline that decentralized minigrid operators can use to determine tariffs). Feed in tariffs (if a minigrid would be connected to the central grid) are also within the responsibility of the EEA. The EEA also supervises that projects meet technical standards for generation and distribution. Once off-grid operators

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### Table 1. Alternative Energy Development plan (2015-2020).

<table>
<thead>
<tr>
<th>No</th>
<th>Type, systems</th>
<th>Target 2020, number of units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Biomass energy</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Improved fuel saving cook stoves</td>
<td>11.45 million</td>
</tr>
<tr>
<td>1.2</td>
<td>Biodiesel stoves, biodiesel processing technologies</td>
<td>20,000</td>
</tr>
<tr>
<td>1.3</td>
<td>Biogas</td>
<td>31,400</td>
</tr>
<tr>
<td>2</td>
<td>Solar energy</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Solar home systems</td>
<td>400,000</td>
</tr>
<tr>
<td>2.2</td>
<td>Institutional solar systems</td>
<td>3,600</td>
</tr>
<tr>
<td>2.3</td>
<td>Solar lanterns</td>
<td>3,600,000</td>
</tr>
<tr>
<td>2.4</td>
<td>Solar water heaters</td>
<td>5,000</td>
</tr>
<tr>
<td>2.5</td>
<td>Solar cookers</td>
<td>3,600</td>
</tr>
<tr>
<td>2.6</td>
<td>Solar mini grids</td>
<td>250</td>
</tr>
<tr>
<td>2.7</td>
<td>Solar water pumps</td>
<td>50</td>
</tr>
<tr>
<td>2.8</td>
<td>Solar technician training</td>
<td>1,500</td>
</tr>
<tr>
<td>3</td>
<td>Wind water pumps</td>
<td>300</td>
</tr>
<tr>
<td>4</td>
<td>Micro hydropower systems</td>
<td>105</td>
</tr>
<tr>
<td>5</td>
<td>Alternative energy studies</td>
<td>33</td>
</tr>
</tbody>
</table>
receive investment licenses from the EEA they will benefit from tax exemptions for renewable energy equipment they may import.

It will be very important that institutions like the ones mentioned above are strengthened to make the ambition for deployment of mini-grids feasible.

In the following chapter we will discuss in more detail institutional and other barriers currently impeding the deployment of mini-grids in Ethiopia.

2.3 Barriers to securing clean energy access in rural communities

Despite the abundance of natural resources, the difficulties (financial and in supply) of fossil supply and the absence of modern electricity sources, renewable energy mini-grids have not been widely deployed yet in rural Ethiopia. Several types of barriers can be identified which are hampering the deployment of these renewable mini-grids:

- Economic barriers;
- Market;
- Institutional;
- Technical/technological;
- Information and awareness.

In the following section we will briefly address the types of barriers as presented above.

**Economic barriers**

Currently it will be difficult to operate a mini-grid on renewable energy in an economically profitable manner. In rural areas, affordability is an issue, mostly because the willingness to pay is lower. The main driver for this is the fact that on-grid tariffs for electricity are currently very low, so all consumers (on and off grid) expect to be serviced for that same price. However if the grid tariffs would reflect real costs for supplying to remote areas, they would be a lot higher than the current grid tariff. Off grid solutions would be a more economically favourable solution if comparing to real grid extension costs (see ECA 2013, which indicates real connection costs for households to be in the range of $1000-$3000, micro/minigrids could be developed for lower costs per connection).

Furthermore grid expansion is state financed, making the extension of grid to rural areas seem cheaper than construction of mini-grids, even if overall it is actually more expensive. If similar subsidies to grid extension would be applied to mini-grids, they would be able to operate in economically sustainable manner.

Financial capacity and willingness to pay of rural households for modern energy services is growing fast. The development of economic activities in the region could be combined with the construction of modern energy services. So far the combined benefits of connections for household energy services and economic activities has not been looked into in detail.
Another aspect for private developers is the initial investment costs required for the development of a mini-grid, while income would only be generated during the lifetime of the mini-grids. Start-up finance (e.g. in the form of soft loans) would enable private developers to overcome this barrier.

**Market barriers:**
At the moment the involvement of private developers in the rural electricity sector, especially in mini-grids deployment is very low. This is due to two main reasons, namely uncertainty and quality assurance.

The main source for uncertainty for private developers is due to the ‘unknown’ path of grid extension. The plans and areas targeted for grid expansion in the coming 5-15 years are not clear to private developers. Furthermore it is also uncertain what happens if grid is extended to an area where a mini-grids are already in place. Private developers’ main questions and concerns include: Could they connect to the grid as a decentral producer, what would tariffs then be, what technological changes are then required, would it be allowed to continue off-grid operation etc.

Regarding quality assurance, at the moment there is no clear system to label or certify certain systems to ensure quality, safety and efficiency in the deployment of mini-grids. Quality assurance will also create more confidence of consumers and private developers in the long term operation of their mini-grids.

**Institutional barriers:**
The Rural Electrification Fund has been set up as the entity responsible for coordinating all efforts on rural electrification. This is already a big step forward. Before the creation of this entity within the Ministry of Water, Irrigation and Electricity, there was limited coordination between different ministries and donors on their efforts to establish initiatives on rural electrification. This caused a sometimes weak integration in infrastructure planning among all sectors, leading to inefficiencies.

At the moment there are insufficient capacity (technical and financial) and experiences at the Rural Electrification Fund available to actually steer the developments on rural electrification.

Another barrier (mixture between institutional and financial barrier) is the challenge in Ethiopia to finance the energy sector programs. The energy sector is highly capital intensive, requiring substantial investment for energy sector development and for promoting the transition from traditional solid biomass fuels to modern energy services. The combination of new energy generation projects, grid extension and off grid options place quiet some financial burden on the Ethiopian government.

**Technical/technological:**
Some regions in rural areas are remote and therefore difficult to reach (especially those further away of roads).
Due to insufficient technology transfer and underdeveloped industry for manufacturing, most of the energy technological hardware is imported, which leads to high foreign exchange spending.

**Technical capacities, information and awareness:**
One of the major bottlenecks in the Ethiopian energy scene remains to be limited capacity in human, technical and lack of stable institutional arrangement. The development of a vibrant energy sector requires substantial development of energy sector management, investment, technical know-how, and institutional capacity.

Information is scanty for investors on resource potentials, available provisions, tax regime, and possible benefits on mini-grids development, especially in the international arena, but also from pilot projects within Ethiopia experiences and lessons learned are available. These seem not to filter through to other possible developers. There is an absence of a central ‘learning/knowledge platform’ where new possible developers could turn for tips and lessons learned.
If developers, or government would have better insights in what type of projects, business models or financing models would work, it would be easier and faster to deploy new projects.

2.4 Why a NAMA in the rural electrification sector?

The proposed NAMA will help accelerate off-grid energy access

- Faster and cost-effective rural electrification with clean and modern energy sources;
- The energy poverty gap will be reduced and rural communities will be able to join the country’s transition to middle-income status;
- Mini-grids will provide clean energy to those rural communities that are far off in remote villages where grid extension becomes a lot more expensive to build;
- These communities will enjoy electricity access by 2025 through a mini-grid system; which will be designed to be grid-ready so it can easily integrate to the national grid in the future in case that would be necessary.

The NAMA will link directly to barriers as described in section 2.3 by providing solutions to overcome them:

- **Economic barriers:**
  - Provide various financial measures to stimulate deployment of mini-grids and to make operation of mini-grids more economically feasible (covering the gap between operation costs and capacity to pay of consumers);
  - Perform feasibility studies to analyse what business models would be most economically feasible for the rural Ethiopian setting;
  - Identify opportunities for mini-grids in which household consumption can be combined with economic or community activities to strongly increase their feasibility.

- **Market:**
  - Reduce uncertainty by drafting regulations for financial measures and standards to ensure stability and return on investment for private developers;
  - Reduce uncertainty by drafting options for operators in case the grid does extend to the region of the minigrid.

- **Institutional:**
  - Centralization of the mandate for mini-grids deployment at the Rural Electrification Fund, including financial means to push the desired deployment;
- Arrange external funding to contribute to a long term financially sustainable programme for deployment.

- **Technical/technological:**
  - Test various technological combinations in pilot projects to ensure their functioning;
  - Through standardisation ensure clarity on technological best solutions;
  - Perform several feasibility to analyse technological options which would work for rural Ethiopian setting.

- **Information and awareness:**
  - Make information on grid expansion plan available to wider public;
  - Create a knowledge sharing platform including lessons learned;
  - Set up a set of pilot projects to provide concrete examples and lessons learned of projects as created in rural Ethiopia.
3 The NAMA proposal

3.1 Objective

The objective of the NAMA is to increase clean energy access in Ethiopia’s rural communities through the creation of mini-grids powered (mostly) on renewable energy. This aims to accelerate the transition from the use of fossil fuels (such as diesel, kerosene, and fuelwood) to sustainable energy sources, while improving livelihoods.

With its objective the NAMA contributes to two main goals of the Ethiopian government, namely:

- **Reduction of the energy poverty gap** in the near future: the CRGE (Clean Resilient Green Economy) strategy of Ethiopia sets three important targets to reduce the energy poverty gap; these are (i) development of the rural areas, (ii) increase of GDP and (iii) increased access to modern energy services. This NAMA directly contributes to this by enabling faster and cheaper electrification of remote rural communities with clean energy sources in comparison to grid extension programmes;

- **Reduction of GHG emissions** as pledged in the country’s INDC: the NAMA will contribute by replacing current fossil energy sources with small scale renewables. Furthermore the NAMA will demonstrate a close synergy between achieving GHG emissions reductions and generating strong co-benefits (e.g. improved livelihoods, poverty reduction, employment).

The NAMA will contribute to the transformational change of the Ethiopia’s energy sector, focusing on the rural population. The combination of policy, demonstration pilots and knowledge sharing elements in the NAMA are essential to its overall success in contributing to this transformational change.

3.2 Scope and timeframe

The scope of the NAMA includes three pillars:

- Policy and regulation;
- Knowledge and information sharing;
- Pilots and replication framework.

The combination of these different pillars is essential for the overall success of the NAMA, including ensuring replication in many minigrids within Ethiopia through increased private sector participation. The NAMA itself includes 5 pilot projects and the design of a replication framework (including financing mechanism) to ensure scale up to the 355 minigrids to be developed in Ethiopia.\(^\text{11}\)

The underlying activities and elements in scope will be in detailed discussed in section 3.4.

The timeframe for the NAMA is 2016-2020, this is to benefit most from the current momentum in the field of alternative approaches to rural electrification and to contribute as much as possible to achieving the targets as identified in the GTP II.

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\(^{11}\) The total of 355 is currently based on the targets as set within GTP II, 355 renewable energy minigrids in 2020. The exact amount will be defined in more detail in the component of the NAMA on defining the programme (including targets and timeline).
3.3 Stakeholders (and their role)

The institutional set up for the implementation of the NAMA includes the following stakeholders:

- Ministry of Water, Irrigation and Electricity;
- Ministry of Forestry and Environment;
- Ministry of Finance;
- Implementation entities and private investors (e.g. project developers);
- Rural households and community services;
- Regional and woreda\(^{12}\) level governing bodies;
- Community organisations/NGOs;
- International development agencies.

Several stakeholders are described in more detail in the following section.

**Ministry of Water, Irrigation and Electricity (MoWIE):** this ministry is the lead responsible for the implementation of the NAMA. MoWIE’s interest and commitment is to accelerate off-grid energy access and diversify the country’s energy mix. In combining both elements, MoWIE is pursuing the deployment of renewable energy-based mini-grids in rural Ethiopia, especially in villages that are off the reach of the grid system in the near future. MoWIE’s interest and goal is aligned with the national CRGE strategy.

**Ministry of Forestry and Environment (MoFE):** MoFE is the national focal point of the United Nations Framework Convention of Climate Change (UNFCCC). It is responsible for overseeing the NAMA activities in Ethiopia and approving them before they are publicly registered in the UNFCCC NAMA Registry.

**Ministry of Finance and Economic Development (MoFED):** This ministry provides guidance to MoWIE on international climate finance available to implement the NAMA.

**Ethiopian Rural Energy Development and Promotion Centre:** MoWIE’s department in charge of formulating rural energy policy and promoting renewable energy technologies in rural areas; hence, it will play a key role in developing the policy components of this NAMA. The Centre also manages the **Rural Electrification Fund (REF)**, which assists in the financing of capital expenditures of users (households and businesses) for connection to the national power grid and the development of off-grid energy systems.

**Ethiopian Energy Authority (EEA),** which is in charge of formulating energy regulations. It will work together with the Rural Energy Development and Promotion Centre to develop the appropriate policy and regulatory framework proposed in this NAMA.

**Ethiopian Electric Power (EEP), and Ethiopian Electric Utility (EEU):** Also under MoWIE, the EEP is a public entity that is responsible for upstream activities of electricity generation, transmission and substation construction as well as operation in Ethiopia. The EEP also oversees the activities of the Universal Electricity Access Program (UEAP).

**Private Investors and Implementation Entities:** these include energy service providers, private sector contractors and consultants.

**Woreda office:** The local administrative government level covering rural and urban neighbourhoods.

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\(^{12}\)Woredas are the third level administrative division of Ethiopia, they are composed of wards or neighbourhood associations, which are the smallest unit of local government in the country.
**Beneficiaries:** the direct beneficiaries are the citizens of rural villages that will gain access to clean electricity for their households and small businesses; as well as community services such as schools and health centres. Beneficiaries will replace their current types of energy sources (e.g. fuel wood, kerosene and diesel) and pay the fees to the minigrid owner for the electricity consumed.

### 3.4 Programme design

Figure 5 shows the theory of change underlying this Ethiopian NAMA on clean mini-grids. The theory of change indicates the long term desired impact, expected outcomes, required outputs and activities identified to achieve those.

![Figure 5. Theory of change.](image)

As shown in the theory of change the simultaneous approach on the policy/regulation side, combined with pilot projects and knowledge transfer will lead to a transformational change of the Ethiopian rural energy sector.

An overview of the components of the NAMA is presented in the following figure (Figure 6).
3.5 National Mini-grids programme

The NAMA will create a national programme on mini-grids within the framework of the clean energy strategy. The multiple benefits of minigrids are recognised with the ministries (especially MoWIE). However no concrete programme on creating an enabling environment, stimulating development or showcasing pilots is available and thus the potential for mini-grids to provide services in rural areas is not being realised. With the available amount of natural resources in Ethiopia, the costs of complete grid expansion to remote areas (especially smaller communities) and the increased pressure on grid capacity, mini-grids are a suitable alternative for remote small/medium scale villages outside of near term grid expansion areas. They can provide electricity services to households, but also to other services available in the villages like schools, health care, small enterprises, solar pumping etc. At the moment the development of mini-grids in Ethiopia is at a starting point. Not many examples exist yet, but a lot of potential is available.

The national programme on mini-grids aims to develop a systematic plan to deploy mini-grid systems in rural communities using proven off-grid technologies. The national programme will also outline financial measures the Ethiopian government will use to stimulate the deployment of mini-grids.
The programme would define the following:

- **Overall goals and specific objectives:** goals and objectives of the project will be specified, indicating detailing the amount of mini-grids and/or population targeted;\(^\text{13}\)
- **Strategic issues and priority areas of intervention:** relating to the three pillars of intervention and other strategic considerations included in the programme, for example links to other policies of programmes;
- **Scope and geographical coverage:** nationwide but limited to a maximum community size, including its local economic activities; also limited by national plans to extend the grid. The regions which are suitable will be identified and detailed;
- **Technology scope:** in principle technology neutral, though proven renewable energy technologies should be the norm (indicating maybe which technologies are optional/best suitable);
- **Minimum/Maximum size of mini-grids:** related to geographical scope (i.e. community size) and possible economic activities to be included;
- **Action items or specific areas of intervention:** for example, an overview of all regulations needed to set the conditions for a market transformation: standards, supporting policies such as fiscal instruments and incentives (e.g. mechanisms that impact prices of technologies and electricity, taxes aiming at fostering renewable based mini-grids, or financial measures to overcome initial costs);
- **Financial measures:** (e.g. outline of measures, who they target, how they are financed and how they can be accessed);
- **Information and awareness raising campaigns:** to share information on the national mini-grid programme with project developers, local governments, beneficiaries, and all stakeholder groups interested.

The development of this National programme will be initiated by the Rural Energy Development and Promotion Centre and its Rural Electrification Fund (part of MoWIE), and will consist of a set of consultation workshops with relevant ministry staff and stakeholders and intensive coordination with EEP and EEU. The Rural Electrification Fund will be supported in this process by international Technical Assistance\(^\text{14}\), which will provide guidance on the most effective steps to develop a national programme on mini-grids. This first component should have systematic consultations that lead to a national programme that aligns with the government development and energy plans, and that is ultimately approved by the Minister of Energy.

The definition of this national programme will be the first step in the implementation of the NAMA, it will be used as input for the other components (e.g. regulations, pilots). Therefore it will be essential to finalize this national programme at the start of the NAMA.

\(^{13}\) The targets as indicated in the GTP II of 355 mini-grids in 2020 gives a possible indication of the targeted amount within the national programme. However since GTP II focusses on 2020, the national programme might also set targets for beyond that year (e.g. target 2020, but also a target for further deployment towards 2025 or towards a certain coverage of non-grid connected areas. Furthermore the EEP (Ethiopian Electric Power) also has plans to develop 200 other mini-grids in the same period.

\(^{14}\) This technical assistance will focus on increasing the technical capacities of the REF during the process, bringing international experiences and together with a national consultants provide input on possibilities, limitations and focus areas for mini-grids.
<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Month 1 - Month 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs required</td>
<td>None (NAMA proposal and funding assigned)</td>
</tr>
<tr>
<td>Outputs</td>
<td>National programme with specific goals, targets and defined scope for the development of rural mini-grids.</td>
</tr>
<tr>
<td>Stakeholders involved:</td>
<td>Rural Energy Development and Promotion Centre, Rural Electrification Fund (leading), Ethiopian Energy Authority, MoWIE, CRGE</td>
</tr>
</tbody>
</table>

### 3.6 Mini-grids regulations & support measures

The proposed NAMA will also develop a regulatory framework to enable a level playing field and a market transformation for mini-grids. Within the national programme component, a full list of regulations to be detailed and implemented will be drafted.

The barrier analysis in the NAMA development phase shows that there is a lack of quality assurance and reliable certification for renewable energy technologies and products in the country. The NAMA will create quality assurance standards for mini-grid deployment, as well as capacity building and awareness raising about quality assurance standards, certifications and product guarantees. Other supporting policies will be considered, such as fiscal instruments that incentivise the supply and demand of certified products in the Ethiopian market. Furthermore, currently some kind of financial incentive will be required to make mini-grids developments in Ethiopia economically feasible\textsuperscript{15}.

Guidelines or where necessary regulations will also be drafted to indicate the standards or characteristics to which mini-grids must adhere, to enable connection to the main grid in case of expansion in the region of the mini-grids. Furthermore an analysis will be done into technical options for connecting the grid, minigrids and privately producing co-generation systems. This analysis should clarify and technical barriers and possible solutions.

As indicated, one of the essential elements in this component is the financial incentive that will be set up for the deployment of the mini-grids.

Options for financial measures that could be applied to stimulate deployment of mini-grids are:
- Commercial or soft loans to make money available or reduce the initial capital investment required for mini-grid construction which can be (partially) paid back once income from selling electricity is generated;
- Commercial/soft loans or technical assistance support for the feasibility and development phase of the mini-grids;
- Risk guarantee insurance (e.g. a buy out for developers in case the grid does expand in their direction and the value of their mini-grids is lower, they lose income or they cannot pay the ‘connection costs’);

\textsuperscript{15} Comparing production costs to user affordability. In comparison to grid expansion costs, the mini-grids are on macrolevel economically more efficient.
• Tariff subsidy which can be applied to lower the price per kWh (the costs of production are likely to be higher than the affordability of users or higher than on-grid electricity tariffs, especially in the near future);
• Grant (part of capital investment provided by government).

The financial resources required for these incentives could come from multiple sources:
• International donors (e.g. governments, banks, climate funds, NGOs);
• Funds currently allocated to the grid expansion budget of Ethiopia;
• Funds coming from an increase of on-grid electricity prices;
• Funds coming from an increase in the power export tariff, which can be used to cross subsidize private sector participation in minigrid development;
• Funds allocated from the national budget by the Ministry of Finance of Ethiopia;
• Or a combination or mixture of any of the above mentioned sources (e.g. in the beginning 50% from international donors, and later on increasing share from the grid connection budget, or through gradual on-grid tariff increase).

Regarding timing, it will be important to have the main elements of the regulatory framework in place before the pilots are developed. However some detailing or the actual implementation of the regulation can be done while the pilots are developed, since these process can take some time.

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Month 1 - Month 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs required</td>
<td>National programme, input from project developers</td>
</tr>
<tr>
<td>Outputs</td>
<td>Set of regulations providing a solid regulatory framework for the development of mini-grids including market participation.</td>
</tr>
<tr>
<td>Stakeholders involved:</td>
<td>Ethiopian Energy Authority (leading), Ethiopian Rural Energy Development and Promotion Centre, Rural Electrification Fund, MOWIE, CRGE.</td>
</tr>
</tbody>
</table>

3.7 Mini-grids business models

The NAMA will develop innovative business models to guarantee the sustainability of mini-grid systems, to ensure community ownership and high potential for replication nationwide. The preliminary components of the model include: possible technical configurations, possible financial schemes, ownership options and roles of various stakeholders, as well as types of capacity building and awareness raising campaigns suitable for each business model. Through feasibility studies several questions or options for business models and feasible project types should be identified. Examples of the questions to be addressed in these studies within this component are:
• For the main technologies (or hybrid combinations) what would be the average kWh production costs?
- What would be the average tariffs that consumers would be able and willing to pay (split over the categories of types of users/uses like households, local business, local services (e.g. schools, households), irrigation activities)?
- What would be the average tariff that would be paid by users if the grid would be expanded?
- What would be the additional costs for setting up the mini-grids in such a manner that it allows for grid-connection in a later stage during its lifetime (to avoid mini-grids becoming ‘obsolete’)?
- Are there strong networks of community based organisations which could be useful in the development and deployment of mini-grids?
- What would be possible combinations of mini-grids with economic activities that could improve the business case (e.g. combination with agri-processing or irrigation)? Analyse possible impacts on seasonality, affordability or economic feasibility? Identify if these combinations could be tested in a pilot (for example could they reduce the tariff pressure and make a good base for minimum consumption, do they have stable consumption or does it fluctuate a lot?);
- Will the financial burden on mini-grids from the administrative part be reasonable (since the mini-grids will be relatively small)? Or would there be alternative solutions to reduce the share of administrative burden?
- What would be possible business/ownership models that could work within the Ethiopian setting? Examples of models that can be taken into account in this analysis would be:
  - Private developer: a private party develops a mini-grids and sells electricity to the local community and consumers;
  - Community organisation: A local community organisation (NGO, women’s group) initiates and manages the mini-grids. Usually non-profit oriented but often including the provision of electricity to services like schools, health care, irrigation etc.;
  - Hybrid model: A combination of a private developer and community organisation, for example one being the owner or developer while the other the operates or manages the mini-grids;
  - ESCO model: For example a group of companies that have an energy resource available, or which have an energy demand which does not have a satisfactory solution at the moment who together develop the mini-grids, in which they include local households or villages to increase the base of the minigrid.

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Month 1 - Month 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs required</td>
<td>Outline of national programme and regulations for minigrids.</td>
</tr>
<tr>
<td>Outputs</td>
<td>Reports indicating appropriate business models for Ethiopian setting and information on feasibility of minigrids.</td>
</tr>
<tr>
<td>Stakeholders</td>
<td>Rural Electrification Fund, MOWIE, Ministry of Finance, consultants could be hired for the execution of these studies (especially in cases where the capacity or the expertise is not available within the initiating ministry).</td>
</tr>
</tbody>
</table>

### 3.8 Mini-grids pilot project

Within the NAMA, a set of pilot projects will be designed and implemented to test the selected mini-grid business models. The pilots will have specific goals and an implementation plan taking into account the geographical and technological scope defined in the mini-grid national programme, as
well as the priority areas of intervention. The pilots can be used to ‘test’ a set of possible business models which the Ethiopian government might want to stimulate in the roll out of the mini-grids. The lessons learnt from this pilot can also serve as information and examples for developers interested in replication. Furthermore lessons learnt from the different business models applied could serve as input for the ministry to revise (if necessary) financial measures for the wider deployment of mini-grids.

Within the NAMA a maximum of 5 pilot projects will be developed. The pilot project will have the following characteristics:

- The average size of the pilot project will be determined in more detail in the national programme, but sizes of 20-100 kW are foreseen;
- Target region: Off grid areas, with reasonable population density;
- Technology: depending on exact location and resource and market availability, but probably including back up of either biofuel generator, diesel generator or battery pack;
- Business model: in the previous component, different business models will be assessed. One or multiple of these will be selected in the pilot projects for use in representing possible replication areas;
- Per pilot a clear set of targets/goals will be defined before implementation. Indicators to measure these targets/goals will also be defined at the start to allow the setup of a ‘evaluation framework’ to measure the success of the pilots. This evaluation framework will be combined with broader lessons learnt.

As mentioned earlier, the pilots can be used to test specific findings from the previous component (business models). For example, assuming 5 pilots in total, the following differentiations could be ‘tested’:

- At least 2 different technology types representing those that seem feasible in costs and have largest replication potential (so not a technology which can only be used in 1 location);
- Include (at least) 2 pilots with economic activities, so as to test the combination of households, social services and economic activities (since this is expected to strongly increase economic stability and feasibility);
- Optional would be to include 1 pilot in which a community organisation is the driving force (e.g. the project developer is a local community organisation). This might strengthen social cohesion, local sense of responsibility and ownership, strong embedment in local existing organisations, increasing for example willingness to pay;
- Include some pilots (e.g. 2) with a private developer as initiator;
- At least 2 including community services (to test if this feasible to include this in the financial side, can these services pay for their electricity, or how can this be arranged with the community);
- Optional one with a more ‘innovative’ system for payments (e.g. prepaid cards, fixed amount not depending on consumption metering).
3.9 Replication assessment framework

Replication of the pilot projects to a wide deployment of mini-grids is essential to the success of the NAMA and to ensure the transformational change of the rural energy sector. This component as part of the NAMA ensures this connection of the pilots and programmes to the wider deployment of the mini-grids. A key for replication or scaling up pilot projects nationwide is to identify the elements that worked well and the ones that did not. Learning from the pilots will help to adjust the mini-grid business models to ones that effectively contribute to expanding off-grid rural electrification in Ethiopia. The NAMA will create an assessment framework to evaluate the impact of each pilot, as well as their potential for scalability throughout rural Ethiopia. It will also design a platform to share the lessons learned and best practices from the pilots, with capacity building modules to share the information with a wider audience.

In addition to the evaluation & knowledge sharing component, the other major component of the replication assessment framework is to ensure financial measures are implemented for the further roll out of the mini-grids development. Under current conditions, mini-grids will not be economically feasible for project developers as a standalone investment. Since the development of mini-grids will be more economically and financially advantageous for society as a whole compared to grid extension, it will be worthwhile to stimulate the development of mini-grids. This can be done by various financial measures (as described in section 3.6). Within this component, a reflection will be made on how the business models functioned in the pilots and if alterations should be made to the implemented or to be implemented financial measures required for further deployment. Any other further steps or requirements which would be necessary to get the wider deployment of mini-grids (beyond the pilot and to reach the target) will be identified and actions taken within the scope of this component.

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Month 5 - Month 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs required</td>
<td>Results from all previous components (national programme, regulations, business models).</td>
</tr>
<tr>
<td>Outputs</td>
<td>Maximum 5 developed and constructed pilot mini-grids</td>
</tr>
<tr>
<td>Stakeholders involved:</td>
<td>Project developers, local stakeholders (village dwellers, community leaders, leaders community services), regional bureaus, REF, MOWIE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Month 17 - Month 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs required</td>
<td>Finalization of the other components of the NAMA</td>
</tr>
<tr>
<td>Outputs</td>
<td>Wider successful deployment of mini-grids (up to the amount targeted).</td>
</tr>
<tr>
<td>Stakeholders involved:</td>
<td>REF, MOWIE, Ministry of Finance, pilot project developers, community leaders and beneficiaries</td>
</tr>
</tbody>
</table>
4 Expected impacts

This section describes the expected NAMA impacts in terms of GHG emissions reductions, sustainable development benefits and transformational change. NAMA impacts are compared to the Business as Usual (BAU) scenario, which takes into account the current status of existing programmes in the energy sector of Ethiopia.

4.1 Avoided emissions

We have assessed avoided emissions resulting from the NAMA in two scenarios, namely:

- Scenario 1 – Following the GTPII targets, namely 355 mini-grids installed in 2020;
- Scenario 2 – Assuming GTP II targets, but a slower deployment, 355 mini-grids installed in 2025;
- Scenario 3 – Assuming both the GTP II targets as well as the additional 200 minigrids as currently mentioned by the EEA are implemented before 2025;
- Scenario 4 – The Ethiopian government supersedes their current targets and connects 10% of the medium to long term off grid households\(^\text{16}\), all operation before 2030.

In both scenarios the deployment of the 5 pilot projects are included as a first step. An average size of mini-grids of 50kW has been used for the calculations\(^\text{17}\). We have focused the calculation on a typical small non-electrified village and made conservative estimates on energy consumption.

In the assessment we have included the following energy services that can be replaced by the mini-grids:

- Kerosene use of households (e.g. for lighting);
- Community services using a small diesel generator (e.g. lighting, communication, schools, health centres);
- Water pumping in the village (usually community shared system in the village);
- Grain milling (usually community shared system in the village).

Figure 7 shows the development of total GHG emission resulting from the targeted population in the baseline (the total of villages targeted through the 355 mini-grids), as well as under the two scenarios for the period up until 2025. Furthermore the graph displays the line relating to the pilots (5 mini-grids). The area between the baseline and the scenarios indicates the total avoided emissions resulting from the deployment of the mini-grids. These avoided emissions are displayed in Figure 8.

Please note that the graphs presented do not include any of the further future roll out of minigrids for which there is besides the indicated targets, still a large potential in Ethiopia. The financial mechanisms as to be designed within the NAMA proposal would need to stimulate reaching the target, but also a further stimulation of roll out of minigrids. An example of the effect of a wider roll out (scenario 4) is presented in Figure 9.

\(^{16}\) Medium to long term off grid households are around 13 million according to Fichtner 2015.

\(^{17}\) During the consultation workshops, it was discussed that the focus size of the mini-grids will probably be around 20-50 kW installed capacity. Larger villages might earlier be targeted by grid extension.
Figure 7. Total GHG emissions related to the targeted population in the baseline, pilots only and the two scenarios.

Figure 8. Annual GHG emissions savings resulting from the deployment of mini-grids in two scenarios.

As showed in Figure 9, the NAMA could already result in a cumulative total of up to 1.5 Mton of avoided GHG emissions by 2025. If a wider push is given to minigrid deployment, aiming to reach 10% of the rural population without electricity access in 2030, cumulative savings until 2030 could reach up to 8Mton of avoided GHG emissions.
4.2 Sustainable development and poverty reduction benefits

The implementation of the clean mini-grids NAMA will contribute to Ethiopia’s plans for green growth and poverty reduction. We identified positive impacts to the environmental, social and economic aspects of Ethiopia’s rural dwellers. We used the NAMA Sustainable Development Tool, developed by UNDP, to guide the evaluation of these impacts against the Sustainable Development Goals (SDGs) agreed in 2015. We propose the use of this tool on the MRV section to systematically track the SD benefits over the lifetime of the NAMA. summarises the impacts we identified; these are linked and contribute to realise specific targets of seven SDGs in Ethiopia.

Figure 9. Cumulative GHG savings resulting from the mini-grids deployment.
<table>
<thead>
<tr>
<th>SDG</th>
<th>Identified impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 NO POVERTY</td>
<td>Poverty reduction / improved livelihoods</td>
</tr>
<tr>
<td>2</td>
<td>- Reduction of fuel expenditures (diesel/kerosene), enable income-generating activities, enhancing lighting conditions, and preventing fires due to kerosene mishandling.</td>
</tr>
<tr>
<td>3 GOOD HEALTH AND WELL-BEING</td>
<td>Improved indoor air quality</td>
</tr>
<tr>
<td>4</td>
<td>- Reduction of kerosene use in cooking and lighting which causes high-level of household (indoor) air pollution from soot particles and hazardous fumes.</td>
</tr>
<tr>
<td>5</td>
<td>Improvement of health and health care conditions</td>
</tr>
<tr>
<td>6</td>
<td>- By improving indoor air quality, people’s health will improve, reducing respiratory illnesses caused by soot.</td>
</tr>
<tr>
<td>7 QUALITY EDUCATION</td>
<td>Better learning conditions / more education opportunities</td>
</tr>
<tr>
<td>8</td>
<td>- Better operating conditions to health centres, which will benefit from electrical lighting and refrigeration for vaccines and blood preservation.</td>
</tr>
<tr>
<td>9</td>
<td>More jobs to women</td>
</tr>
<tr>
<td>10</td>
<td>Creation of opportunities for new income-generating activities for women, e.g. handicrafts, food processing.</td>
</tr>
<tr>
<td>11 AFFORDABLE AND CLEAN ENERGY</td>
<td>Improved energy security and</td>
</tr>
<tr>
<td>12</td>
<td>- Foster the use of local energy sources: solar, wind, geothermal, biomass</td>
</tr>
<tr>
<td>13</td>
<td>- Increase access to clean and sustainable energy to remote villages which currently are dependent on</td>
</tr>
<tr>
<td>14 DECENT WORK AND ECONOMIC GROWTH</td>
<td>Jobs creation</td>
</tr>
<tr>
<td>15</td>
<td>- The implementation of the NAMA will require the use of several local/national entities to undertake: renewable energy technology supply and installation, mini-grid operation, entry survey, awareness raising,</td>
</tr>
</tbody>
</table>
**Poverty reduction and improved livelihoods (SDG1)**

By 2030 countries should ensure that poor communities have access to basic services, including electricity, and ultimately invest in poverty eradication actions. Through this NAMA, the government of Ethiopia will invest in poverty reduction by providing electricity to remote rural communities that currently live without access to this service. By deploying mini-grids in a systematic manner the government of Ethiopia seeks to create an thriving environment for off-grid rural dwellers.

In rural Ethiopia diesel, kerosene and fuel wood are the most common fossil fuels used for cooking and lighting. Diesel and kerosene are particularly expensive in relation to electricity prices in the country. By changing the sources of electricity to cleaner ones, this NAMA will be able to reduce fuel expenditures and increase the purchasing power of rural communities. This will empower the rural poor to invest in income-generating activities as well as to afford electricity prices.

Furthermore, 24 hours electricity will enhance significantly the lighting conditions and foster other productive uses of electricity. For example, adults would be able to develop economic activities after sunset, use refrigeration to preserve food longer and allow the creation of food processing. The latter is important because it adds value to agriculture products grown by rural communities.

Finally, kerosene for lighting is responsible for property loss due to fires when it is mishandled. Transitioning away from the use of kerosene will reduce this risk significantly.

**Good health and wellbeing (SDG3)**

By 2030, countries should substantially reduce the number of deaths and illnesses from hazardous air, water pollutants, and provide access to affordable essential medicines and vaccines. This NAMA will help to phase out the use of kerosene in cooking and lighting, which is responsible for the production of soot particles and hazardous fumes that cause respiratory illnesses. By improving indoor air quality of households, we expect a reduction in kerosene-related respiratory diseases. The phase out of kerosene will also contribute to the reduction of related burns.

Moreover, rural health centres will benefit from 24 hours electricity access enabling better operating conditions, such as lighting for proper work throughout the day and refrigeration for preservation of vaccines, medicines and blood.

**Quality education (SDG4)**

By 2030, countries should substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship. Countries should also upgrade education facilities and provide effective learning environments. This NAMA will enable better learning conditions and more education opportunities in Ethiopia’s rural communities. The deployment of clean mini-
grids will ensure electricity access also to educational centres facilitating the installation of computer rooms and internet connection. We expect that this new conditions foster opportunities for distance and online education for youth and adults.

**Gender equality (SDG5)**
Countries should ensure women’s full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life. This NAMA will contribute to this target by creating opportunities that empower rural women through economic activities. Providing 24 hours electricity will foster other productive uses of electricity which women can benefit from such as the development of businesses of handicrafts, food processing, hair dressing, sewing workshops, or other activities where women can use their skills.

**Affordable and clean energy (SDG7)**
By 2030, countries should ensure universal access to affordable, reliable and modern energy services; they should expand infrastructure for supplying modern and sustainable energy services for all in developing countries; and promote investment in energy infrastructure and clean energy technology. This NAMA will contribute to these targets by deploying renewable energy technologies to provide clean electricity in rural Ethiopia. These will foster the use of local energy sources such as solar, wind, geothermal, biomass and mini-hydro. The ultimate impact is to increase access to clean and sustainable energy to remote villages which currently are dependent on expensive fossil fuels.

**Decent work and economic growth (SDG8)**
Countries should promote productive employment and encourage the formalization and growth of micro- and small- enterprises. The implementation of the clean mini-grid NAMA will require the participation of labour force to engineer the mini-grid, including supply and installation. It will also create local jobs for operation and maintenance of the system; the NAMA includes a strong capacity building component to ensure that local communities are trained on the skills needed.
5 Monitoring, Reporting and Verification System (MRV)

The objective of the MRV system will be to monitor the impacts of the NAMA, report and verify them. This section describes the monitoring process, including the selected indicators and responsible entities (section 5.1), how collected information will be reported (section 5.2) and verified (section 5.3).

The MRV system for this NAMA will be embedded in the MRV platform being developed for the country’s Climate Resilient Green Economy strategy. The CRGE’s MRV platform will be a web-based tool to track progress and impacts of Ethiopia’s climate change mitigation projects. It will allow the country to track and monitor sector level emissions, as well as to create reports to inform the UNFCCC on the country’s progress in relation to mitigation actions.

5.1 Monitoring

Regular monitoring will track the performance of the NAMA based on a set of indicators, which could lead to corrective actions in the course of implementation if appropriate. It will also help assess ex-post the NAMA impacts (including GHG and sustainable development impacts) and support. It will also help track the progress of NAMA activities on a regular basis through data collection from various sources. The indicators that will be monitored are explain in Table 3 and Table 4.
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Description</th>
<th>Measurement</th>
<th>Source of indicator data</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating renewable energy (RE) mini-grids</td>
<td>Number of systems</td>
<td>RE mini-grids under operation</td>
<td>Manufacturer’s warranty of the technology used</td>
<td>On-site verification</td>
<td>Annual</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Proven arrangements of equipment maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Procurement of systems and technologies is done under national guidelines (includes quality standards)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Energy meters will be installed and used for verification</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>On-site verification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity generated</td>
<td>MWh per year</td>
<td>Amount of electricity generated by the RE mini-grids</td>
<td>Energy meters will be installed and used for verification</td>
<td>On-site verification</td>
<td>Monthly</td>
</tr>
<tr>
<td>Number of households served</td>
<td>Number of customers</td>
<td>Customers served from the mini/micro grids</td>
<td>Record of energy bills</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Number of commercial service customers served</td>
<td>Number of customers</td>
<td>Customers served from the mini/micro grids</td>
<td>Record of energy bills</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Number of social institutions served</td>
<td>Number of customers</td>
<td>Customers served from the mini/micro grids</td>
<td>Record of energy bills</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Avoided emissions</td>
<td>tCO2e reduced</td>
<td>GHG emissions avoided by displacing fossil fuels</td>
<td>Calculation based on the clean electricity generated and used by consumers</td>
<td>Calculation</td>
<td>Annual</td>
</tr>
</tbody>
</table>
Table 4. Sustainable development impacts.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Parameter</th>
<th>Unit</th>
<th>Description</th>
<th>Measure</th>
<th>Source of indicator data</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poverty reduction / improved livelihoods</td>
<td>-Reduction of fuel expenditures (diesel/kerosene), enable income-generating activities, enhancing lighting conditions, and preventing fires due to kerosene mishandling.</td>
<td>Percentage</td>
<td>Share of household income spent on electricity</td>
<td>On-site verification</td>
<td>Metering and/or electricity bills</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>-24hr electricity will allow people to develop economic activities beyond daylight. Improve lighting conditions for children to study at night, and prevent property loss due to kerosene light fires.</td>
<td>Number</td>
<td>Households with access to RE</td>
<td>On-site verification</td>
<td>Audits</td>
<td>Monthly</td>
</tr>
<tr>
<td>Improved indoor air quality</td>
<td>-Reduction of kerosene use in cooking and lighting which causes high-level of household (indoor) air pollution from soot particles and hazardous fumes.</td>
<td>Number</td>
<td>Households where kerosene is replaced by RE electricity</td>
<td>On-site verification</td>
<td>Audits</td>
<td>Monthly</td>
</tr>
<tr>
<td>Improvement of health and health care conditions</td>
<td>-By improving indoor air quality, people’s health will improve, reducing respiratory illnesses caused by soot particles and hazardous fumes.</td>
<td>Number</td>
<td>Number of health clinics electrified</td>
<td>On-site verification</td>
<td>Audits</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>-Better operating conditions to health centres, which will benefit from electrical lighting and refrigeration for vaccines and blood preservation.</td>
<td>Number</td>
<td>Number of health clinics electrified</td>
<td>On-site verification</td>
<td>Audits</td>
<td>Monthly</td>
</tr>
<tr>
<td>Indicator</td>
<td>Parameter</td>
<td>Unit</td>
<td>Description</td>
<td>Measurement</td>
<td>Source of indicator data</td>
<td>Frequency</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
<td>------------</td>
<td>------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>--------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Better learning conditions / more education opportunities</td>
<td>- Reliable electricity access to not only households but also schools, allowing children to study during evening hours and adults to undertake opportunities of distance /online education.</td>
<td>Number</td>
<td>Number of schools electrified</td>
<td>On-site verification</td>
<td>Audits</td>
<td>Monthly</td>
</tr>
<tr>
<td>More jobs to women</td>
<td>- Creation of opportunities for new income-generating activities for women, e.g. handicrafts, food processing, hair-dressing, starting small shops, sewing workshops, etc.</td>
<td>Number</td>
<td>Number of new jobs for women</td>
<td>On-site verification</td>
<td>Interviews</td>
<td>Yearly</td>
</tr>
<tr>
<td>Improved energy security and decreased dependency on expensive fossil fuels</td>
<td>- Foster the use of local energy sources: solar, wind, geothermal, biomass</td>
<td>Percentage</td>
<td>Share of renewables in the rural energy mix</td>
<td>On-site verification</td>
<td>Audits/Interviews</td>
<td>Yearly</td>
</tr>
<tr>
<td>· Increase access to clean and sustainable energy to remote villages which currently are dependent on expensive fossil fuels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jobs creation and capacity building</td>
<td>- The implementation of the NAMA will require the use of several local/national entities to undertake: renewable energy technology supply and installation, mini-grid operation, entry survey, awareness raising, marketing, accounting and software development.</td>
<td>Number</td>
<td>Number of new jobs (per household)</td>
<td>On-site verification</td>
<td>Interviews</td>
<td>Annual</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Trainings provided (RE technologies, minigrid operation &amp; maintenance)</td>
<td>On-site verification</td>
<td>Feedback questionnaires</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- On-site verification: conducted by trained personnel in the field.
- Interviews: conducted with key stakeholders.
- Audits: conducted by independent third-party auditors.
- Feedback questionnaires: distributed and collected to collect feedback from the beneficiaries.
- Every time a training is conducted: regular follow-up to assess the impact of training.
5.2 Reporting

The information gathered throughout the monitoring activities will be stored in Ethiopia’s MRV database, developed for the CRGE. The MRV Database is a web-based tool created by the Government of Ethiopia to track the implementation and impacts of national climate mitigation projects. The database enables the creation of emission reduction reports, as well as reports on co-benefits. MoWIE will incorporate these specific reports in an annual status report to inform on the progress of the NAMA. The annual report will include the following general and specific information:

General information
- The objective(s) and the intended audience of the report;
- The year the report was developed;
- Whether the report is an update of a previous report;
- Progress of NAMA activities on the basis of data collected;
- The annual and cumulative sustainable development impacts calculated on the basis of indicators and data collected as presented in Table 3 and Table 4;
- The aggregated annual and cumulative GHG impacts in metric tons of avoided carbon dioxide equivalent;
- The aggregated annual and cumulative financial support provided.

Specific information related to each component of the NAMA as applicable:
- The implementation period of the NAMA;
- The baseline scenario;
- The ex post GHG assessment period;
- The annual and cumulative GHG impacts in metric tons of carbon dioxide equivalent;
- The annual and cumulative support provided.

The reporting format could be adapted to fill expectations from specific entities, e.g. international funder(s). It is expected that the NAMA reporting process will align with reporting efforts in the context of the preparation of Ethiopia’s Biennial Update Report (BUR) to the UNFCCC, or other reports that might come as a result of the COP21 negotiations.

5.3 Verification

Third party verification is proposed for GHG and sustainable development impacts. Verifiers would be accredited according to the requirements by an accreditation body recognised by both the NAMA funder(s) and the Ethiopian government. The annual report will form the basis of the verification process.
6 Implementation plan

6.1 Steps towards implementation

The most important first step in the process towards implementation will be to attract sufficient funding to implement the elements of the NAMA in a coherent manner.

Figure 10 presents a suggested timeline for implementation. The timeline aims at implementing the NAMA in a brief timeframe to enable as many villages to benefit from the NAMA and be developed before 2020 (GTPII target date). The start date for implementation of the NAMA depends on when funding for the NAMA has been acquired. The replication phase which start during the NAMA, will take beyond the indicated timeline of 3 years as follow up could be generated up to 2025/2030.

Figure 10. Suggested timeline for implementation.
6.2 Costs and financial plan

Funding for the NAMA can be made available from different national and international sources. A mechanism to manage the required financing flows for the implementation of the NAMA would be to follow the CRGE approach and collect all input from donors and national contributions in a central location. The Rural Electrification Fund, which is one of the important stakeholders guiding the process of rural electrification, responsible for the minigrid roll out and suitable intermediary for the financial flows. The Rural Electrification Fund could manage the incoming funding streams and disburse these for required activities to implement the NAMA. In the roll out, project developers could then apply to this central fund for financial support in the forms agreed within the national programme and regulations.

Estimates have been made on the first steps of the NAMA, however the costs for the roll out of findings to the wider deployment of minigrids will depend on several elements:

- Financial mechanism for support defined in the national programme and regulations (e.g. grants, subsidies, soft loans, revolving fund);
- The targeted amount of minigrids for the deployment phase;
- Financing gap (gap between production costs of the minigrid system and the ability to pay of the consumers);
- Decision on a cap of off grid tariff (if this could vary per minigrid, or if this will in some way be compared/connected to other off or on grid tariffs).

Especially the total amount of minigrids targeted in the roll out and the extend and manner in which this is financed will have a large influence on the total size of the NAMA.

The following overview presents the estimated costs for the first four components of the NAMA as already identified and described in this proposal. Full costs for further deployment of minigrids to reach the target of the national programme depend on pilots’ results and government’s ambition when it comes to scaling up after the pilots; therefore these costs are not yet included in this overview.

The costs for the NAMA as described total to about 5,680,000 USD excluding costs for the financial measures for replication beyond the 5 pilots, the costs of defining a national programme by the Ethiopian government, the construction and detailing of the IT platform for knowledge sharing, the implementation of the MRV system and the future costs related to minigrid deployments (e.g. concessions, tenders). Although these costs are currently not budgeted, they should be regarded as part of the NAMA (especially the costs for replication). The costs for the financial measures to support further deployment could be a considerable additional expenditure.
Table 5. Estimate of cost ranges for NAMA implementation.

<table>
<thead>
<tr>
<th>Component</th>
<th>Element</th>
<th>Description</th>
<th>Estimated costs (all in USD)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Minigrids Programme</td>
<td>Identify potential and set target</td>
<td>Stakeholder workshops (e.g. 3) at ministry to align on targets and desirable national programme. Costs for workshops and locations. Time for government officials to develop proposals. Coordination with on grid coordinators.</td>
<td>200,000 - 400,000</td>
<td>Large part of this is time for government officials. Maximum estimate from Fichtner 2015\textsuperscript{18}</td>
</tr>
<tr>
<td>Capacity building and technical assistance</td>
<td></td>
<td>Technical assistance (consultant to guide &amp; prepare workshops, background research on potential, also consultations with regional governments on potential)</td>
<td>300,000</td>
<td>National and international consultants, work from REF, regions and UAEP (Fichtner 2015\textsuperscript{19})</td>
</tr>
<tr>
<td>Define national programme</td>
<td></td>
<td>Reporting and process to translate targets and financial support measures in a national programme</td>
<td>To be determined</td>
<td>Mostly time and process from government officials.</td>
</tr>
<tr>
<td>Minigrids Regulation</td>
<td>Development of regulation at Ministry</td>
<td>Development and implementation of all relevant regulation for the minigrid development.</td>
<td>300,000 - 500,000</td>
<td>Estimate from Fichtner 2015\textsuperscript{20}, unsure if technical assistance is included</td>
</tr>
<tr>
<td></td>
<td>Technical assistance regulation development</td>
<td>Support in regulation definition, tariff setting, review of similar regulation in different countries etc.</td>
<td>150,000</td>
<td>Combination of national and international consultants</td>
</tr>
<tr>
<td>Minigrids business models</td>
<td>Feasibility studies (technical, environmental, financial)</td>
<td>Detailed feasibility studies for the 5 pilot projects (feasibility, ESIA, design)</td>
<td>700,000</td>
<td>Estimate from Fichtner (partially done by consultants, partially time from REF)</td>
</tr>
</tbody>
</table>

\textsuperscript{18} Off grid Investment Plan for Ethiopia, August 2015, contact person Dietmar Mettler, Fichtner, Germany.  
\textsuperscript{19} Off grid Investment Plan for Ethiopia, August 2015, contact person Dietmar Mettler, Fichtner, Germany.  
\textsuperscript{20} Off grid Investment Plan for Ethiopia, August 2015, contact person Dietmar Mettler, Fichtner, Germany.
<table>
<thead>
<tr>
<th>Analyse possible business models</th>
<th>More general review of business models, which will also serve as input for regulations (e.g. tariff setting)</th>
<th>100,000</th>
<th>Technical assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity building regional authorities, relevant communities and possible developers</td>
<td>Training of national and regional experts to ensure long term capacity to work with and on minigrids (e.g. mini-grid operation, maintenance, repairing).</td>
<td>150,000</td>
<td>Fichtner estimate</td>
</tr>
<tr>
<td>Minigrids pilot projects</td>
<td>Identify 5 locations</td>
<td>Technical assistance in development of criteria list. Time from REF in selecting the locations</td>
<td>-</td>
</tr>
<tr>
<td>Tailored feasibility and design studies for 5 pilots</td>
<td>-</td>
<td>-</td>
<td>In feasibility studies for business models</td>
</tr>
<tr>
<td>Capacity building sessions for pilot stakeholders</td>
<td>One workshop at each pilot location.</td>
<td>100,000</td>
<td>Own estimate</td>
</tr>
<tr>
<td>Construction of pilot projects</td>
<td>Actual construction of the 5 pilot projects</td>
<td>2,500,000</td>
<td>Rough estimate, highly dependent on size, location &amp; type of technology(^\text{21})</td>
</tr>
<tr>
<td>Evaluation of pilots (lessons learned)</td>
<td>Costs for REF or assigned consultants to evaluate, for example through one session with all main pilot stakeholders per pilot location</td>
<td>100,000</td>
<td>Own estimate</td>
</tr>
<tr>
<td>Replication assessment framework</td>
<td>Set up a platform for knowledge sharing</td>
<td>For example construction of an IT platform to share lessons learned &amp; information, combined with</td>
<td>To be determined</td>
</tr>
</tbody>
</table>

\(^{21}\) Assuming 5 pilots of about 50-100 kWp on average and investment costs of 5000 USD/kWp, including costs for permits, development process, costs of equipment and transport and installation at location.
<table>
<thead>
<tr>
<th>MRV system</th>
<th>Detail and implementation of MRV system</th>
<th>Determining and detailing the baselines for all indicators (surveys might be needed); designing and agreeing on an MRV plan; design of a web based tool</th>
<th>To be determined</th>
<th>High dependence on development and possible alignment with CRGE’s MRV platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity building to possible users and those responsible of managing the MRV system</td>
<td>For example through 4 workshops (1st year); 2 workshops per year thereafter to exchange lessons learned, identify flaws and corrections to the MRV system</td>
<td>680,000 NAMA capacity building costs for 5 years (pg. 88 from Namibia NAMA) - counting only human resources and travel</td>
<td>5000 euro per minigrid</td>
<td>Cost estimate made by Fichtner 2015(^2)</td>
</tr>
<tr>
<td>Functioning of MRV system</td>
<td>Continuous costs related to functioning of MRV system</td>
<td>5000 euro per minigrid</td>
<td>Cost estimate made by Fichtner 2015(^2)</td>
<td></td>
</tr>
</tbody>
</table>

| Ensure long term replicability | Updating incentive system, updating/enforcing targets, regular evaluations of all installed systems | To be determined | Highly depending on results of pilot and required changes to regulations based on pilot experiences. |
| Replicate projects in additional minigrids | Concession tendering of future pilots, costs related to financial support measures for wider roll out of minigrids. | To be determined | Highly dependent on type and size of financial support measures identified in the national programme |

\(^2\) Off grid Investment Plan for Ethiopia, August 2015, contact person Dietmar Mettler, Fichtner, Germany.
7 Sources


