Government of Malawi

# Malawi National Electrification Strategy & Action Plan

## Ministry of Natural Resources, Energy and Mining

**November 2019**

# Executive Summary

In March 2018, the Government of Malawi (GoM) presented the National Energy Policy (NEP) to Cabinet. The NEP was approved in August 2018. The overall goal of the NEP 2018 is to establish a guiding framework including policy and strategic direction for achieving increased access to affordable, reliable, sustainable, efficient and modern energy for every person in the country. It emphasises the importance of establishing the institutional and regulatory framework to support achievement of energy access goals. It also focuses on the need for a conducive environment for stakeholder participation, be it in the form of direct investment, public-private partnerships (PPP), participation of independent power providers (IPP) or other vehicles, with particular emphasis on power generation and exploitation of renewable energy resources, both for grid and off-grid electricity service.

To date, electricity service in Malawi has been limited to a relatively small segment of the population situated in close proximity to the medium voltage distribution network operated by the Electricity Supply Corporation of Malawi (ESCOM) along the development corridor that is situated roughly along the north-south axis of the country, serving approximately 423,455 consumers as of December 2018. ESCOM service has been stifled by limited power generation capacity due to a prolonged drought and by a lack of investment in power supply resources. To address power generation needs, the Government developed the Integrated Resource Plan (IRP) to provide strategic direction and guide investments in the electricity generation sector towards ensuring power adequacy at least cost and establish an IPP procurement framework.

With respect to expansion of access to electricity service, Malawi has subscribed to the Sustainable Energy for All (SE4All) Initiative whose overall goal is to achieve universal access to affordable, reliable, sustainable, efficient, and modern energy services. The GoM has placed increasing emphasis on expanding access to electricity service through a combination of the Malawi Rural Electrification Program (MAREP) and through increasing efforts on the part of ESCOM to expand service connections to houses and small businesses within reach of existing distribution transformers and low voltage (LV) distribution lines. These efforts have contributed to a significant increase in electricity service in recent years; ESCOM has added approximately 34,000 customers per year since 2013. Off-grid expansion is nascent and up to this point lacking comprehensive design and development.

Development of the NEP 2018 evolved via a consultative process that included a wide range of stakeholders including government ministries, parliamentarians, development partners, private sector, academia, Civil Society Organizations, local leaders and communities. Lessons learned from various countries' energy policies and systems in Africa and Asia further informed the process and outcome of NEP 2018. The National Electrification Strategy (NES) described herein seeks to establish an actionable strategic framework through which the NEP priorities can be implemented with a clear understanding of the roles and responsibilities of the principal government, private sector, donor community and non-government stakeholders in Malawi.

**The National Electrification Strategy**

The NEP 2018 presents a series of electrification-specific policies that focus on strengthening existing distribution networks and distribution licensees to support expansion of grid infrastructure and connectivity; promote restructuring rural electrification/renewable energy program management; and provide support to

scale-up off-grid renewable initiatives through establishing quality standards, providing fiscal incentives for solar devices and support local manufacture of renewable, off-grid devices. There remains a clear need for a cogent, coordinated and strategic vision of how these policies will be integrated and how the vision will be realized by the stakeholders responsible for implementation. This is the purpose of the NES.

The NES presented herein proposes a framework through which the Government of Malawi (GoM) will guide accelerated access to households and businesses at acceptable quality and levels of service that is anchored in the priority policies presented in the NEP 2018. The strategic elements are summarized in Figure E1 and are organized in four thematic pillars that taken together define the means and processes by which electrification expansion will be implemented.

**Figure E1.** NES Elements

| | |
|---|---|
| **Pillar I – Institutional** | E1. Roles and responsibilities of grid and off-grid electrification implementation agencies<br>E2. Develop and implement capacity building programs to strengthen electrification stakeholders at all levels of the value chain |
| **Pillar II – Policy and Regulatory** | E3. Define minimum level of service with which access expansion will be measured<br>E4. Adopt sound licensing, quality of service standards, fiscal exemptions, and material/equipment standards required to support sustainable off-grid electrification; define connection fee policy for low-income grid consumers<br>E5. Scale-up mini-grid and standalone off-grid system development |
| **Pillar III – Technical and Planning** | E6. Identify power supply shortfalls that may impact grid densification and expansion planning on a temporal basis with which ESCOM and EGENCO can identify power supply options<br>E7. Establish a least-cost geospatial planning framework for on- and off-grid electrification<br>E8. Evaluate & establish low-cost electrification design standards |
| **Pillar IV - Financial** | E9. Promote affordable access to electricity service for both grid and off-grid electricity service<br>E10. Develop a financing plan to support the electrification expansion goals |

The NES prescribes the elements and actions required to achieve the national electricity access goals described in the distribution and electrification policies presented in the NEP. The strategic elements provide a synergistic approach to accelerate the pace of electrification expansion in Malawi. Pillars I and II provide a series of elements designed to create an enabling environment to support electrification program implementation. The development of a least-cost geospatial planning process is at the heart of Pillar III and is designed to establish targets for grid expansion/densification/intensification, mini-grid development, and solar home system deployment. Pillar IV focuses on creating mechanisms to facilitate affordable

electricity access for all Malawi households and businesses and concurrently evaluating the financial resources needed to meet 60% electricity access in compliance with 2030 electrification goals.

**Pillar I - Institutional**

**Element 1: Roles and responsibilities of grid and off-grid electrification implementation agencies**

Expanding access to electric service from 15 to 60% over a twelve-year time frame will require a significant expansion in scope of and institutional capacity for planning and project management responsibilities, and concurrent strengthening of engineering, geospatial, financial management and program monitoring expertise.

At present, electrification activities are managed in parallel by two principal stakeholders. ESCOM is the national transmission and distribution service provider, and as such has been responsible for expanding access to electricity service to communities in urban and peri-urban areas. MAREP, a program that is managed by the Rural Electrification Division (RED) of Department of Energy Affairs (DoEA) has complemented ESCOM's efforts by financing grid expansion projects to extend service to rural villages and housing clusters that to date do not have electricity service. While the combined efforts of ESCOM and MAREP has resulted in increased expansion of access, efforts have not achieved the access rates needed deliver the 2030 targets.

Electrification program management agencies established in neighboring countries have worked in collaboration with large national distribution utilities such as ESCOM to achieve electrification expansion goals. Rural electrification agencies/authorities such as the Kenya Rural Electrification Authority, the Tanzania Rural Electrification Agency, and the Uganda Rural Electrification Agency were formed and given responsibility to manage grid expansion and to coordinate off-grid programs. In recent years, each of these agencies has shifted focus from connecting trading centers and public facilities to connecting households and businesses in similar fashion to the recent emphasis on connections in Malawi. The distribution utility counterparts have focused not on infrastructure expansion, but on accelerating connection of new consumers and commercializing electricity service through newly built medium and low voltage distribution systems. The electrification agencies in turn have taken responsibility for planning, engineering design and construction oversight functions related to grid extensions to connect rural areas while the national distribution utilities have focused on connecting all consumers within their service footprint. In contrast to significant progress with grid electrification and connectivity scale up efforts, off-grid planning and program implementation are still in the nascent stages in all three countries, and while solar home system service providers have made significant impacts in all three markets, mini-grid service is still in the very early stages of implementation.

Drawing from these examples and others, several options can be considered for the Malawi electrification program going forward. These include:

1. Business as usual. In the present model, ESCOM is focused primarily on expanding connections within its existing medium voltage footprint and integrating MAREP grid expansion projects as they are completed. The NEP has noted that electrification efforts should include scaling up connections by focusing on offering service to all possible consumers, installing new transformers and low voltage lines where needed, and reducing connection barriers wherever possible – in addition to expanding service to villages and trading centers.

This will require scaling up and systematizing grid densification (connections focus) and expansion, and both ESCOM and MAREP appear to be under-staffed. Unless staffing constraints can be effectively addressed, the business as usual approach is not likely to achieve the projected expansion goals.

2. Significantly increase MAREP's accountability and commensurately its capacity to enable and facilitate off-grid access scale up targets, especially by private sector. MAREP has managed a relatively modest program for more than a decade and has relied on ESCOM engineering assistance for design and construction oversight. If MAREP is mandated to oversee a much more aggressive expansion program, it will need to significantly increase its engineering design, procurement, construction oversight and planning capabilities. Without more significant engineering design and construction oversight personnel, the increase in responsibility could be problematic. Moreover, given that MAREP is organized under MoNREM, which is in essence a policy-making body as opposed to an electric utility with an executive and engineering focus, there will likely be significant challenges in hiring and training design and planning engineers needed to satisfy electrification growth projections.
3. Establish the Rural Electrification Agency referenced in the NEP. Specifically, the NEP refers to establishing the Rural Electrification Agency (REA) to "manage the Rural Electrification Fund and Rural Electrification activities for both grid extension and off-grid options". While this is a logical step to consolidate capacity and competencies needed to manage both grid and off-grid electrification program efforts, establishing the REA will take time. Moreover, just as MAREP will need to rapidly build capacity to achieve grid electrification expansion capacity over a short period of time and concurrently develop and implement an effective off-grid strategy to address the significant off-grid needs, timeliness of response may prove very challenging for a newly established REA over the short term.
4. ESCOM expands grid electrification, while DoEA focuses on rural connectivity and off-grid strategy, as well as implementation in the interim till such time the REA is in-place operationally. Under this scenario, the Alternative Energy Division (AED) of DoEA would significantly increase off-grid program activities while ESCOM would significantly increase its role in grid densification and grid strengthening, that would be required as a function of increased sales and load on existing ESCOM MV infrastructure. While AED/MAREP would continue grid extensions in rural areas, there would be a program-wide shift in focus to grid connections densification. The initial geospatial plan results reveal that over 80% of the population of Malawi lies within 5 km of existing ESCOM MV lines and over 95% within 10 km of the system. Assuming ESCOM has the funding to significantly increase grid densification efforts, it will need to acquire the human resources to manage the efforts this commitment represents – and will likely require funding to support its human resource costs. Expanding ESCOM staff would have the advantage of significant embedded expertise to lead the expansion effort. MAREP (and later REA) will continue to selectively expand grid resources to trading centers where expansion is needed, shifting focus from expansion to connectivity in coordination with ESCOM while AED/DoEA develops a practical and effective off-grid expansion strategy that would combine mini-grid and stand-alone solar PV program components to complement the ESCOM connections (grid densification) and grid expansion activities.

The last option is the recommended approach for the Malawi NES. Establishing the REA will take some time after a final decision is made, and during the interim period, MAREP will continue to identify and finance grid expansion to trading centers ensuring that as many consumers as possible are connected, while the AED will focus on identification and implementation of mini-grid and stand-alone solar solutions for off-grid expansion. Once REA has been established, it will assume responsibility for a combination of grid extension projects for trading centers and rural communities as well as scale-up of off-grid access in coordination with private sector parties. This will require additional financial resources that may be provided primarily through donor programs in early years but will require GoM contributions over time.

The REA will be established to separate rural electrification program implementation from the more traditional role of MoNREM policy setting given the increasing scope of electrification efforts in Malawi, the need to manage multiple program components, to monitor and report on progress, and to make adjustments as the program matures. REA design options will be informed from technical assistance activities financed through the Malawi Electricity Access Project that will include analysis of funding requirements, staffing requirements, legal framework, autonomy and off-grid program design emphasis. For its part, ESCOM will require significantly greater human and financial resources to support the grid densification growth, and both ESCOM and MAREP (and later REA) will need to build capacity to use geospatial software for electrification planning and program management.

Furthermore, it is recommended that an Energy Strategy Secretariat (ESS) be established in early years to address coordination requirements; with representatives from DoEA/MAREP, ESCOM, Rural Electrification Management Committee (ReMAC), and Malawi Energy Regulatory Authority (MERA). The ESS will be a small, high-level working group with representation as described above and that will meet as and when needed. Ministry of Natural Resources, Energy, and Mining (MoNREM) should assume the lead role in the formation and organization of the ESS, which would be responsible for finalizing the NES design and implementation planning, for oversight of consulting activities and integrating results into NES implementation, and for oversight of the reporting and monitoring the progress of the implementation activities for the ten strategic elements articulated in the NES.

**Element 2: Develop and implement capacity building programs to strengthen electrification stakeholders**

MoNREM and ESCOM are faced with limited staff resources to plan, design and supervise implementation of electrification projects. To address staffing needs, two key activities are required: 1) recruit staff to fill vacancies for critically important planning, design and project management functions; and 2) establish training and capacity building programs to introduce advanced planning, engineering design and improved project management skills across all areas of electrification program management.

Critical skills development will be needed in geographic information system (GIS) platform use to identify, evaluate and perform preliminary design for grid densification, grid expansion and off-grid electrification projects. Engineering design and construction oversight skills also need to be strengthened to support the massive expansion in grid densification and expansion projects necessary to meet the national electrification goals.

AED and later REA will need to gain expertise in a number of critically important technical areas that will include but may not be limited to: 1) use of the GIS platform to evaluate mini-grids and stand-alone solar

markets; 2) off-grid project identification and viability analysis; 3) mini-grid design, capital and operating cost analysis; 4) solar home system industry best practice, capital costs and business models; 5) public-private partnership models for off-grid electrification projects; and 6) affordability study design and analysis.

Technical team members would profit from a well-defined capacity building program designed to enhance productivity, and both would benefit significantly from hiring additional engineering personnel to expand existing technical capacity.

**Pillar II – Policy and Regulatory**

**Element 3: Define minimum level of service with which access expansion will be measured**

To measure progress towards the national electrification goals and objectives, a minimum level of service must be defined for households that participate in the electrification program. The NEP 2018 references the Global Tracking Framework (GTF) with regards to measuring access (Policy Priority 3.1.6), but it does not establish the minimum level of service that will be used to define an electrified household. Tier 1, as defined in the GTF, is a multi-light solar home system with cell phone charging capacity and has been accepted as the minimum level of service for purposes of electrification tracking in Ethiopia, Kenya and Uganda in recognition of consumer energy spending patterns and needs. Low income households in these countries use traditional energy resources for lighting, cell phone charging and limited entertainment needs – just as they do in Malawi.

GTF Tier 1 service can meet these basic electricity needs and is therefore recommended as the minimum level of service for the Malawi NES. Counting solar lanterns or other Tier 0 technologies that are highly mobile devices as "fractional connections" will present significant monitoring and verification challenges, but most importantly, these technologies do not meet minimum consumer energy needs.

**Element 4: Adopt licensing, quality of service standards, fiscal exemptions, and material/equipment standards required to support sustainable off-grid electrification; define connection fee policy for low-income grid consumers**

The purpose of this strategic element is to support scale-up of off-grid electrification by ensuring that developers and service providers have clear guidance regarding design, construction and operation of reliable and sustainable energy solutions, and that the fiscal incentives needed to achieve affordable solutions are available to the off-grid, renewable energy community.

The Regulatory Framework for Mini-Grids recommends that mini-grid operators be required to apply and receive approval for separate generation and distribution licenses and recommends that this process should be overseen by the Rural Electrification Management Committee (ReMAC). In an effort to streamline the licensing and review process, MERA should consider establish a more simplified licensing approach that requires a single license to be issued, and that the review/approval process managed by ReMAC be streamlined. While the "light-handed" regulatory approach relieves mini-grids with installed generation capacities of less than 50 kW from licensing requirements, it would be useful to concurrently establish a simplified application process that includes a pro-forma business plan requirement and combined generation-distribution licensing application process for all mini-grids over the minimum threshold. In

addition, power system components for generation and distribution systems qualify for duty-free importation. The list of materials for power generation does not yet explicitly refer to solar PV panels, racking systems, controllers, and other components for mini-grids and solar home systems. It is recommended that the list be expanded to include all components directly related to solar home systems and solar-diesel-battery mini-grids.

The Malawi Bureau of Standards (MBS) maintains a number of standards related to renewable energy materials and equipment. Many of these standards are outdated. An evaluation and update of these standards is recommended to ensure that Malawi's standards are current with respect to international best practices. In cases where the Malawi standard incorporates an established international standard, it is also recommended that the MBS consider adopting those standards by reference.

Since the Malawi Grid Code does not include quality of service standards or performance indicators for distribution system performance, it is recommended that MERA consider development of a quality of service standard for distribution service. Such a standard could be modeled after what has been developed by the electricity regulator OSINERGMIN in Peru[1] with a specific focus on defining three key elements as follows:

1. Establishing standard rules and procedures for interconnection of mini-grids that focus on, among other issues, engineering standards for fault coordination, anti-islanding and that address line worker safety concerns.
2. Establishing quality of service standards and tariff methodologies to address both affordability and sustainability concerns for consumers and mini-grid operators
3. Consider flexibility in tariff setting that might include allowing mini-grid operators to propose cross-subsidies between consumer groups and other mechanisms that take into account business models and specific revenue recovery needs.

Lastly, it is recommended that the Government of Malawi define and implement a connection fee policy that takes into account affordability issues faced by new consumers to ensure that connection fees that exceed affordability issues do not become a significant barrier to electricity service for low-income consumers.

**Element 5: Scale-up mini-grid and standalone off-grid system development**

Given that power supply deficits will continue through at least 2022 and the very low rate of electrification access today in rural Malawi, there is an immediate need to scale-up off-grid electrification access to include mini-grids and stand-alone solar solutions. To do so will require identification of clearly exploitable mini-grid opportunities using the geospatial least-cost platform, and a careful analysis of costs and affordability for both stand-alone solar and mini-grid service. The challenge for both mini-grids and stand-alone solar solutions will be to both identify and evaluate barriers to service and incentives to serve larger segments of the off-grid population.

The geospatial screening process will allow AED to identify and evaluate the first group of mini-gird projects that can be prioritized for development in the immediate time frame, with a view to foster and

[1] Source: From the Bottom Up: How Small Power Producers & Mini-Grids Can Deliver Electrification and Renewable Energy in Africa (World Bank, 2014)

facilitate private sector investment and private operator operations accountability business model and scaled up engagement thereof. The Malawi Renewable Energy Strategy proposed that Malawi invest in at least 50 mini-grid projects by 2025, so it is recommended that AED identify and evaluate at least 25 mini-grids in 2019 that can be prepared to be developed through a public-private partnership with local and/or international mini-grid development firms. Selection criteria should include the largest villages and trading centers that will not be connected to grid service over the next five years including those with the highest potential for productive use applications and those that have the most significant need for water supply, primary health and educational service. In subsequent years, additional mini-grids can be identified and prepared for development.

**Pillar III – Technical & Planning**

**Element 6: Identify power supply shortfalls that may impact grid densification and expansion planning**

The power supply deficit that has arisen due to low flow rates on the Shire River basin coupled with high growth in demand is an issue that will impact continuity of service to present and future ESCOM consumers. The current available generation capacity of 277 MW satisfies 62% of the current estimated demand of 449 MW. To address the deficit, the GoM and ESCOM are negotiating cross-border power purchase agreements; contracts are already in place for emergency power generation from multiple suppliers; and capacity expansion projects are underway through ESCOM as well as Electricity Generation Company Malawi Limited (EGENCO) with independent power producers for hydroelectric, liquid fuel, solar, biomass and other power generation sources.

Looking ahead to 2020, the Malawi Integrated Resource Plan (IRP) projects a demand of 719 MW versus an installed capacity of 709 MW indicating a substantial improvement in power supply resources that will be almost on par with expected peak demand – if water levels in Lake Malawi allow available capacity to rise substantially.

Available capacity will need to be monitored concurrently with the need to more aggressively pursue cross-border energy purchases while IPP projects move forward in development. Meanwhile connections and grid expansion initiatives may suffer if power deficits cannot be overcome in the near to medium-term.

**Element 7: Establish a least-cost geospatial planning framework for on- and off-grid electrification**

When the First Order Least Cost Geospatial platform is further elaborated and is used to evaluate a comprehensive least cost roll-out plan for grid and off-grid electrification, the platform should be transferred to ESCOM and MAREP as the principal framework to guide future planning and project management activities at the sector level; and to inform preparation of detailed ground level operational plans and design for implementation of on-grid and off-grid. The preliminary results of the geospatial plan indicate that the vast majority of households in Malawi are within 10 kilometers of existing ESCOM service, indicating that grid densification and expansion are very likely to remain the most dominant modalities of expansion of access in Malawi. Importantly, as the geospatial framework is refined to provide a higher level of resolution to distinguish between electrification modalities in the next phase of development, it will facilitate the means and opportunity for improved analyses to support establishment of an integrated electrification planning framework for sector planning and program management purposes.

The platform should then be integrated with the newly established ESCOM GIS to facilitate grid strengthening with the expansion planning process. MAREP and the successor REA will coordinate with ESCOM to evaluate grid densification priority areas; to plan grid expansion projects that interconnect trading centers, villages and housing clusters; and to identify more remote housing clusters that present viable mini-grid opportunities on an annual basis. The platform will also be used for program monitoring and verification purposes by MoNREM/MAREP and REA, after it has been established.

**Element 8: Evaluate & establish low-cost electrification design standards**

A review of ESCOM design standards indicates that while the standards are robust and satisfy the needs for high population density urbanized areas, these standards result in higher than necessary delivered costs when applied to lower population density areas. As the ESCOM distribution system expands to peri-urban and lower population density areas, lower-cost designs will result in significant savings and higher development impact. For medium population density environments, standard three phase feeders should continue to be used, while two phase laterals can be extended to housing clusters and businesses. In low density areas, single phase service can be considered. The cost savings potential for two phase service is approximately 55% over the traditional three phase cost and just less than 70% for the single wire earth return standard[2].

**Pillar IV – Financial**

**Element 9: Promotion of affordable access to electricity service for both grid and off-grid electricity service**

ESCOM submitted a tariff request for a 61% increase in the tariff that if approved would have covered the full cost of service including future costs of expansion; the approved increase was 31.8% over the previous tariff level. The need for lifeline tariffs is recognized in the NEP 2018 for low-income consumers – and it is quite possible that a majority of newly connected consumers in coming years will be low-income lifeline consumers. It will therefore be important to monitor ESCOM operating costs and revenues closely to define how lifeline consumer costs can be financed such that ESCOM's financial health is not compromised. MONREM and MERA will work with ESCOM to evaluate the magnitude of the lifeline tariff program and will design a revenue neutral mechanism for ESCOM in the event it is needed. In addition, should the GoM determine that mini-grids will follow a uniform national tariff equivalent to ESCOM tariff levels, AED will evaluate the magnitude of subsidies that will be required and will work with MONREM to design a mechanism to finance them.

Affordability analyses are essential to understand the relationship between energy service pricing, consumption of energy resources and how many consumers are likely to purchase energy services as a function of cost. Affordability analyses are used to characterize the market by establishing price points for each decile of the target population in terms of likely energy sales and ability of the population to pay for energy services and are needed to understand affordability levels across all segments of the Malawi economy, and in turn inform capital subsidies and lifeline tariff considerations in Malawi.

If a uniform national tariff is applied in Malawi to address affordability and equity concerns, this tariff policy will necessitate a mechanism to distribute subsidies from a funding stream such as a levy on energy

[2] Technical Assistance for Low Cost Electrification Approach Design, report submitted to the Rural Electrification Agency, Tanzania by NRECA International, 2013.

sales to service providers that have cost structures that are higher relative to the cost that can be recovered via a uniform national tariff. Managing cross-subsidies within the sector is a straight-forward process if all areas are served by a single utility or service provider. However, in the event that the off-grid program establishes multiple new service providers, a clear and transparent mechanism will be needed to transfer funds from larger and perhaps more affluent consumers to service providers with fewer and less affluent consumers.

Mechanisms to support this could include:

- Capital subsidies allocated through a reverse auction process for qualified off-grid service provides, managed by AED through a funding mechanism established for this purpose. The funding mechanism would derive resources from a combination of donor and government allocations.
- Establish an operating subsidy mechanism overseen by MERA through which levies on ESCOM revenues would be deposited into a special subsidy account and allocated to off-grid service providers on the basis of licensing/tariff agreements negotiated with and approved by MERA. The operating subsidies would be time-bound and subject to quarterly review/adjustment.

This activity is intimately linked with analysis of willingness to pay/affordability data mentioned above. The balance between enterprise sustainability and affordability of service are directly linked; tariffs set above the threshold of consumer affordability may unintentionally limit consumer participation in ESCOM and/or mini-grid service.

**Element 10: Develop a financing plan to support the electrification expansion goals**

The financing plan will be evaluated by defining connection targets by delivery modality (grid densification, grid expansion, mini-grid systems and off-grid solar market stand-alone solutions) over five and ten-year time intervals. The geospatial platform will be used to evaluate base case, aggressive and conservative connection growth rates that will be used to inform the financing plan. Using unit cost estimates for densification, grid intensification, grid expansion and off-grid solutions, investment requirements will be projected for medium and longer-term program needs.

To the extent that lower-cost design standards are adopted by the ESCOM and REA, these standards could reduce the program costs for grid densification and expansion significantly in comparison to the business as usual approach.

The REF that currently finances rural area grid extension projects should in the future balance grid extensions and off-grid electrification projects; off-grid solar market scale up and isolated mini-grids, emphasizing private investment and services delivery. Additional resources will be needed to achieve 2030 connectivity targets that may be generated from increases in electricity sales as generation resources are added and distribution consumers increase. Technical assistance provided through the upcoming Malawi Electricity Access Project may be used to evaluate means of significantly expanding REF resources in future years.

**NES Design Risks**

The implementation of a new strategy is not without potential risks. This section discusses risks and assesses the impact these risks may have on the success of the NES moving forward.

The **institutional pillar** focuses primarily on restructuring roles and responsibilities for grid and off-grid planning, project analysis and construction oversight. As stated above, the NES proposes that ESCOM take full responsibility for grid densification while MAREP will continue to identify and develop grid expansion projects in the interim period while REA is being established. Once established, grid expansion responsibilities will shift to REA in addition to the responsibility to scale up off-grid service by developing mini-grid projects with private sector involvement and creating incentive structures and co-financing mechanisms for stand-alone solar PV systems. In the case of ESCOM's role, the program risk has to do with the uncertainty in building ESCOM's engineering and project management capacity to meet the significant increase in responsibility. With respect to the off-grid program, risks include private sector management and financial capacity to respond to the demand for service, as well as the ability to acquire skilled and experience personnel to manage the new off-grid program.

Little risk is anticipated for activities related to capacity building for planning, project design and implementation, as well as activities related to regulatory and fiscal incentives as articulated in the **policy/regulatory pillar**. Capacity building will be undertaken with training curricula using data, information and training methods that have been successfully used in other effective planning and design programs for electrification agencies. Regulatory support including streamlined licensing procedures, quality of service standards designed to meet requirements for grid and off-grid technology solutions will be drawn from similar rural electrification programs in the region.

Implementing activities in the **technical and planning** presents several specific risks. Ensuring that power supply resources are developed and brought on line will require very careful coordination between GoM power sector representatives, developers, and collaborating partners in Mozambique, Tanzania and other neighboring countries. Should suppliers fail to maintain completion schedules, should international agreements run into unforeseen complexities, or should private developers fail to perform in a timely manner, commissioning dates may slip and power supply availability may suffer. Delays in commissioning schedules could impact electrification program outcomes.

With respect to least-cost geospatial planning, development of the geospatial planning framework will require timely completion of the platforms but planning and engineering staff at both ESCOM and MAREP/REA will need to acquire the capacity to manage both platforms at an expert level.

Evaluation of affordability for marginal consumers should present no significant challenges, nor should evaluating subsidy mechanisms to address affordability concerns. The greatest uncertainty is how subsidy mechanisms can be financed within the Malawi power sector and how they might impact the financial sustainability of ESCOM. These issues will require thoughtful analysis.

**Funding requirements to achieve 2030 electrification goals**

Approximately 116,000 connections will need to be added per year to achieve the NEP access goals. This will result in approximately 1.5 million newly connected consumers – approximately 1.85 million in total.

While there is insufficient data to evaluate the exact expansion cost at this time, an estimate can be derived as shown in Table E2 below and using the following assumptions:

1. Grid densification will continue to connect up to 500,000 equal to roughly twice the currently served consumers given the total distribution transformer capacity compared to the total estimated load on the ESCOM distribution system. Additional consumers will be served at an **average cost of $400 per consumer** ($115 per service connection and about 5% of low voltage distribution cost). The current distribution transformer capacity and presumably, feeder capacity will not likely accommodate more than 500,000 additional consumers for the existing distribution infrastructure.
2. Taking into account the recent results of the first order electrification expansion analysis by Millennium Promise, grid expansion is likely to account for approximately 700,000 new consumers at an approximate cost of **$900 per connected consumer** – considering that the average present cost has been $1000 per consumer combined with cost savings due to proposed low cost technology of up to 20% of present cost.
3. Off-grid service will serve up to 300,000 consumers, 50,000 via mini-grid and 250,000 using solar home systems. Mini-grid costs estimated at $1,000 per consumer, stand-alone solar solutions at $200.

**Table E1.** Funding requirements to achieve 2030 electrification connection targets

| **Electrification solution** | **Connection Estimate** | **Estimated cost per unit** | **Total cost** |
|---|---|---|---|
| Grid densification | 500,000 | $400 | $200,000,000 |
| Grid expansion | 700,000 | $900 | $630,000,000 |
| Mini-grid | 50,000 | $1,000 | $50,000,000 |
| Stand-alone solar | 250,000 | $200 | $50,000,000 |
| **Totals** | **1,500,000** | | **$930,000,000** |

Source: UNSE4ALL Action Agenda for Malawi & author's elaboration

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# List of Acronyms and Abbreviations

| | |
|---|---|
| AAC | all aluminum conductor |
| ABC | aerial bundled cable |
| AfDB | African Development Bank |
| CPC | Customs and Procedure Code |
| DoEA | Department of Energy Affairs |
| EGENCO | Electricity Generation Corporation (Malawi) Ltd |
| ESCOM | Electricity Supply Company of Malawi |
| ESS | Energy Strategy Secretariat |
| GIS | Geographic Information System |
| GoM | Government of Malawi |
| IPP | Independent Power Producer |
| KfW | Kreditanstalt fur Wiederaufbau |
| km | kilometer |
| KPI | key performance indicator |
| kV | kilovolt |
| kVA | kilovolt-ampere |
| kWh | kilowatt-hour |
| LV | low voltage |
| MAREP | Malawi Rural Electrification Program |
| MBS | Malawi Bureau of Standards |
| MCC | Millennium Challenge Corporation |
| MERA | Malawi Energy Regulatory Authority |
| mm2 | square millimeter |
| MoFEPD | Ministry of Finance, Economic Planning and Development |
| MoNREM | Ministry of Natural Resources, Energy, and Mining |
| MRA | Malawi Revenue Authority |
| MTF | Multitier Framework |
| MWK | Malawian Kwacha |
| MV | medium voltage |
| MW | megawatts |
| NEP | National Electrification Plan |
| NES | National Electrification Strategy |
| NRECA | NRECA International |
| OSINERGMIN | Organismo Supervisor de la Inversión en Energía y Minería |
| PPA | Power Purchase Agreement |
| PV | photovoltaic |
| QOS | quality of service |
| ReMAC | Rural Electrification Management Committee |
| SE4ALL | Sustainable Energy for All |
| SHS | Solar Home Systems |
| SOGERV | Sustainable Off-Grid Electrification of Rural Villages |
| SWER | single wire earth return |

| | |
|---|---|
| TOR | Terms of Reference |
| UNICEF | United Nations Children's Fund |
| UNDP | United Nations Development Program |
| USAID | United States Agency for International Development |
| USD | United States Dollars |
| WTP | Willingness to Pay |

# Malawi National Electrification Strategy

## 1 Background

In March 2018, the Government of Malawi (GoM) presented the National Energy Policy (NEP) to Cabinet. The NEP was approved in August 2018. The aim of the NEP is to establish revised goals, objectives, strategies and energy sector priorities to support long-term economic growth in Malawi by providing the energy resources required to industries, commercial enterprises and households in accordance with their present and future needs. The Malawi National Electrification Strategy (NES) described in this document presents the means by which expansion of grid and off-grid electric resources will support the goals, objectives and priority activities as articulated in the NEP.

To date, electricity service in Malawi has been limited to a relatively small segment of the population situated in close proximity to the medium voltage distribution network operated by the Electricity Supply Company of Malawi (ESCOM) along the development corridor that is situated roughly along the north-south axis of the country, serving approximately 374,000 consumers as of January 2018. ESCOM service has been stifled by limited power generation capacity due to a prolonged drought and by a lack of investment in power supply resources. The attention of the GoM and donor community is now focused on resolving the power generation shortfalls and aggressively addressing the issues with a number of initiatives. However, while resources have been allocated to address the power supply deficit through multiple supply options - time will be needed to bridge the deficit.

The GoM has meanwhile placed increasing emphasis on expanding access to electricity service through a combination of the Malawi Rural Electrification Program (MAREP) and through increasing efforts on the part of ESCOM to expand service connections to houses and small businesses within reach of existing distribution transformers and low voltage (LV) distribution lines. These efforts have contributed to a significant increase in electricity service in recent years; ESCOM has added approximately 34,000 customers per year since 2013. Off-grid expansion is nascent and up to this point lacking comprehensive design and development. While there is evidence of several small private sector start-up activities in Malawi, the off-grid market has been relatively quiet in comparison to solar home system and mini-grid activities in other neighboring countries including Tanzania, Rwanda, Uganda, and Kenya. Given the low level of electrification, significant efforts are required to increase both grid and off-grid coverage.

As are articulated in the NEP, the GoM intends to promote a more rapid rate of growth of electricity connectivity to serve households and businesses nationwide. Towards this end, one of the key adjustments to the ongoing electrification program efforts will be to redefine the institutional framework through which planning, financing and implementation are coordinated to integrate the technical modalities and financial requirements to rapidly expand electrification coverage throughout urban, peri-urban and rural areas of Malawi. To address these institutional, technical, financial and policy needs, the Government of Malawi through the Ministry of National Resources, Energy and Mining (MoNREM) has prepared the NES through which all elements of policy setting, regulatory, institutional, planning, financing, and implementation can be rationalized. This document has been prepared to articulate the attributes and rationale of the NES that will lead to increased access to electricity service by accelerating the pace, lowering the cost, and increasing

the impact of investment, infrastructure construction, and connections, in line with goals, objectives and priorities presented in the 2018 NEP.

In coordination with other project development and strategic processes already underway, the NES will focus on the institutional framework for planning, financing, and implementing electrification projects in Malawi, and make recommendations for more efficient roles and responsibilities to increase the pace of electrification. In addition, the NES will evaluate electrification planning practices and methodologies, design and construction standards, and financial requirements required to achieve expansion targets for a combination of grid and off-grid electrification service. The NES will result in an integrated electrification policy that will support the stated goal of achieving universal access by expanding grid and off-grid resources to residential, commercial and institutional consumers as stated in the NEP.

The document describes the characteristics, activities and roles of the key stakeholders that will contribute to the National Electrification Strategy. These characteristics and activities are organized into four fundamental pillars – institutional, policy/regulatory, technical/planning, and financial – each supported by specific elements that define the challenges and proposed solutions to achieve increased electrification access for urban, peri-urban and rural communities in Malawi.

# 2 Electrification Challenge

The 2018 Population and Housing Census presents an estimate of 17.5 million people who reside in Malawi[3]. With an average household size of 4.3 this equates to 4.13 million households. ESCOM reports that it serves approximately 423,455 consumers resulting in an electrification index of 10.3%. With a population growth rate of 2.75%, the household population grows by approximately 113,000 households each year.

Using these growth rates, the projected population in 2030 is 26.58 million, or 5.9 million households. The NEP aligns Malawi with a full access agenda setting an ambitious target of 80% coverage by 2035 (approximately 60% by 2030) that will require providing on average over 250,000 households with electricity service each year during this period using a combination of grid and off-grid resources. Achieving this rate of electrification growth will require mobilizing significant technical, financial and program management resources in a well-coordinated fashion from all sector stakeholders.

Modern day national electrification programs consist of several modalities of service expansion. In former times, the primary modality of electrification was considered connection of households, businesses, and institutions to grid electricity service via national transmission-distribution grids, or isolated distributed grids. In recent years, the concept of electrification has broadened to include several additional modalities. These include grid densification/intensification[4]; grid expansion consisting of larger-scale medium voltage extensions, placement of transformers and service connections; mini-grid expansion, which consists of developing islanded generation-distribution systems for communities that cannot be economically connected to the grid; and provision of individual self-generation systems, such as solar home systems.

[3] Source: 2018 National Population and Housing Census, December 2018, Preliminary Report.

[4] Grid densification refers to connection of unserved consumers by service drops or small extensions of low voltage line. Grid intensification refers to short medium voltage line extension, placement of transformers and connection of consumers.

Grid densification and intensification are normally undertaken in areas of higher population density, while grid extension and the two off-grid modalities are used to expand service in areas that do not yet have service – usually lower population density areas.

In alignment with the NEP, the NES will address all four modalities of service expansion. The degree to which grid and off-grid modalities will contribute will be determined through future electrification planning analysis that will be the topic of a companion study to the NES. However, all modalities of service will need to contribute significantly towards the electrification goals.

# 3 Description of NES Structure & Elements

The principal objective of the NES is to define a national, inclusive approach to rapidly increase electricity service to households and businesses at acceptable service levels and quality of service. The NES will be composed of multiple themes organized under more general pillars. When taken together, they define the means and processes by which electrification activities can be organized and implemented by the agencies that participate in program management. Organized by priority, the ten themes contributing to the NES will include:

1. Definition of the roles and responsibilities of the agencies responsible for program implementation and the roles of contributing stakeholders for national electrification activities.
2. Definition of capacity building programs to strengthen electrification stakeholders at all levels of the value chain.
3. Establish minimum level of service to measure electrification progress.
4. Adaptation of legal/regulatory guidelines to support off-grid business models, licensing, quality of service standards, duty exemptions, and other related regulatory provisions.
5. Scale-up off-grid electrification efforts to more significantly contribute to national electrification coverage.
6. Definition and quantification of power supply challenges that directly impact Malawi electrification expansion efforts.
7. Using a comprehensive least-cost geospatial platform, development of a grid and off-grid expansion plan to meet short, medium and long-term expansion targets.
8. Development/adoption of lower-cost design standards for grid expansion projects.
9. Promotion of affordable access to electricity service for both grid and off-grid electricity service.
10. Development of a financing plan designed to support electrification expansion goals.

These attributes of the NES will be organized under four programmatic pillars. The pillars include institutional, policy/regulatory, technical/planning, and financial categories. The institutional pillar focuses on defining the agencies and their roles/responsibilities related to program implementation, as well as developing comprehensive training and capacity building programs for all stakeholder institutions in the value chain. The policy/regulatory pillar will include definition of the minimal level of service for the Malawi NES, establishing regulations and quality of service standards for off-grid service, and support scale-up of off-grid electricity access. The technical/planning pillar covers three themes that include: identifying levels of power supply deficits will inform grid expansion planning, definition of a master planning framework, and developing low-cost design solutions for grid expansion. The financial pillar

consists of two elements including facilitation of affordable access to grid and off-grid service and developing the NES financing plan. These pillars and elements are summarized in Figure 1 below.

**Figure 1.** Malawi NES Pillars and Elements

| | |
|---|---|
| ***Pillar I – Institutional*** | E1 – Roles and responsibilities of grid and off-grid electrification implementation agencies<br><br>E2 – Develop and implement capacity building programs to strengthen electrification stakeholders at all levels of the value chain |
| ***Pillar II – Policy and Regulatory*** | E3 – Define minimum level of service with which access expansion will be measured<br><br>E4 - Adopt sound licensing, quality of service standards, fiscal exemptions, and material/equipment standards required to support sustainable off-grid electrification; define connection fee policy for low-income grid consumers<br><br>E5 - Scale-up mini-grid and standalone off-grid system development |
| ***Pillar III – Technical and Planning*** | E6 – Identify power supply shortfalls that may impact grid densification and expansion planning on a temporal basis with which ESCOM and EGENCO can identify power supply options<br><br>E7 - Establish a least-cost geospatial planning framework for on- and off-grid electrification<br><br>E8 - Evaluate & establish low-cost electrification design standards |
| ***Pillar IV - Financial*** | E9 - Promote affordable access to electricity service for both grid and off-grid electricity service<br><br>E10 - Develop a financing plan to support the electrification expansion goals |

The NES elements are designed to holistically address barriers and challenges to acceleration of electrification coverage in the most efficient, effective and cost-effective manner. As an example, decisions made in Elements 3, 4, 7 and 9 will have a direct impact on the financing plan elaborated in Element 10. Element 3 will define the service threshold used to qualify households as "electrified". The duty exemptions recommended under element 4 will result in leveling the playing field for off-grid service providers. Allowing for low-cost electrification design standards (Element 8) that are more appropriate for dispersed, rural communities expands the impact of available financial resources in meeting the goal. The affordability studies required for Element 9 are necessary inputs to the financing plan to evaluate how to

overcome affordability barriers and to ensure required revenues can be recovered from served consumers to ensure long-term sustainability of grid and off-grid infrastructure.

## 3.1 Pillar I: Institutional

The activities proposed in Pillar I describe institutional arrangements that will be needed to facilitate implementation of the National Electrification Strategy. The principle issue that is addressed in Element 1 is the need for a more formal coordination function leading to establishing the Rural Electrification Authority that may take many months to establish and organize into a fully functioning institution. In the interim period, it will be essential to clearly differentiate and clarify the roles and responsibilities of MoNREM, Department of Energy Affairs (DoEA), MAREP, Rural Electrification Management Committee (ReMAC), and Malawi Energy Regulatory Authority (MERA) to support accelerated grid and off-grid expansion through coordinated planning, construction and program monitoring activities.

### 3.1.1 Element 1: Roles and responsibilities of grid and off-grid electrification implementation agencies

#### *Purpose*

At present, electrification activities are managed in parallel by two principal stakeholders. ESCOM is the national transmission and distribution service provider, and as such has been responsible for expanding access to electricity service to communities in urban and peri-urban areas. In recent years, ESCOM's role has primarily been to expand access to consumers that located in close proximity to existing medium and low voltage service. MAREP, a program that is managed by the Rural Electrification Division (RED) of DoEA, has complemented ESCOM efforts by financing grid expansion projects to extend service to rural villages and housing clusters that to date do not have electricity service. While the combined efforts of ESCOM and MAREP has resulted in increased expansion of access, efforts have not achieved the access rates needed deliver the 2030 targets.

Electrification program management agencies that have been established in multiple neighboring countries have worked in collaboration with large national distribution utilities such as ESCOM to achieve electrification expansion goals. Rural electrification agencies/authorities such as the Kenya Rural Electrification Authority, the Tanzania Rural Electrification Agency, and the Uganda Rural Electrification Agency were formed and given responsibility to manage grid expansion and to coordinate off-grid programs. These institutions focused in early years on providing electric service to public facilities primarily through grid extension projects. They worked in coordination with distribution utilities such as Kenya Power and Lighting Company (KPLC), Tanzania Electric Supply Company Limited (TANESCO), and seven rural distribution service providers in Uganda to which medium and low voltage infrastructure were delivered post-construction by the respective rural electrification agencies. The distribution utilities were thereafter responsible for connecting and serving these new consumers and expanding service to residential and commercial clients.

In recent years, each of these three agencies has shifted focus from connecting trading centers and public facilities to connecting as many households and businesses as possible in similar fashion to the ESCOM connections program in Malawi. These electrification agencies have, however been responsible for the full suite of planning, engineering design and construction oversight functions related to grid expansion

programs while the respective distribution utilities have focused their efforts on densification of service within their service footprint. While the REAs have taken responsibility for medium voltage line extension and low voltage network installation, they have not as a rule performed system strengthening analysis to ensure that grid expansion activities conform to power quality standards.

With respect to off-grid expansion, efforts have been mixed. In Kenya, Uganda and Tanzania, off-grid electrification has been the purview of private sector service providers – until very recently. Electrification strategies in both countries have taken a more pro-active approach to off-grid expansion in recognition of the significant needs that will not be met by grid expansion in the short- to medium-term. The changes in off-grid planning and program implementation are still in the nascent stages in all three countries, and while solar home system service providers have made significant impacts in all three markets, mini-grid service is still in the very early stages of implementation.

With respect to the means by which the electrification program can be structured going forward, there are several options that could be considered. The options available for the NES in Malawi include the following:

1. Business as usual. In the present model, ESCOM is focused primarily on expanding connections within its existing medium voltage footprint and integrating MAREP grid expansion projects as they are completed. The NEP has noted that electrification efforts should include scaling up connections by focusing on offering service to all possible consumers, installing new transformers and low voltage lines where needed, and reducing connection barriers wherever possible – in addition to expanding service to villages and trading centers. This will require scaling up and systematizing grid densification (connections focus) and expansion, and both ESCOM and MAREP appear to be under-staffed. Unless staffing constraints can be effectively addressed, the business as usual approach is not likely to achieve the projected expansion goals.
2. Significantly increase MAREP's accountability and commensurately its capacity to enable and facilitate off-grid access scale up targets, especially by private sector. MAREP has managed a relatively modest program for more than a decade and has relied on ESCOM engineering assistance for design and construction oversight. If MAREP is mandated to oversee a much more aggressive expansion program, it will need to significantly increase its engineering design, procurement, construction oversight and planning capabilities. Without more significant engineering design and construction oversight personnel, the increase in responsibility could be problematic. Moreover, given that MAREP is organized under MoNREM, which is in essence a policy-making body as opposed to an electric utility with an executive and engineering focus, there will likely be significant challenges in hiring and training design and planning engineers needed to satisfy electrification growth projections.
3. Establish the Rural Electrification Agency referenced in the NEP. Specifically, the NEP refers to establishing the Rural Electrification Agency (REA) to "manage the Rural Electrification Fund and Rural Electrification activities for both grid extension and off-grid options". While this is a logical step to consolidate capacity and competencies needed to manage both grid and off-grid electrification program efforts, establishing the REA will take time. During the development/implementation period of REA, MAREP will continue to oversee grid expansion investments. Once the REA has been staffed and the staff are trained, REA will assume grid

expansion responsibilities as well as off-grid planning, design and project management duties building capacity as needed to manage an effective and proactive off-grid program.

4. ESCOM expands grid electrification, while DoEA focuses on rural connectivity and off-grid strategy, as well as implementation in the interim till such time the REA is in-place operationally. Under this scenario, the Alternative Energy Division (AED) of DoEA would significantly increase off-grid program activities while ESCOM would significantly increase its role in grid densification and grid strengthening, that would be required as a function of increased sales and load on existing ESCOM MV infrastructure. While MAREP would continue grid extensions in rural areas, there would be a program-wide shift in focus to grid connections densification. The initial geospatial plan results reveal that over 80% of the population of Malawi lies within 5 km of existing ESCOM MV lines and over 95% within 10 km of the system. Assuming ESCOM has the funding to significantly increase grid densification efforts, it will need to acquire the human resources to manage the efforts this commitment represents – and will likely require funding to support its human resource costs. Expanding ESCOM staff would have the advantage of significant embedded expertise to lead the expansion effort. MAREP (and later REA) will continue to selectively expand grid resources to trading centers where expansion is needed, shifting focus from expansion to connectivity in coordination with ESCOM while AED/DoEA develops a practical and effective off-grid expansion strategy that would combine mini-grid and stand-alone solar PV program components to complement the ESCOM connections (grid densification) and grid expansion activities.

The last option is the recommended approach for the Malawi NES. Establishing the REA will take some time after a final decision is made, and during the interim period, MAREP will continue to identify and finance grid expansion to trading centers ensuring that as many consumers as possible are connected, while the Alternative Energy Division of the DoEA will focus on identification and implementation of mini-grid and stand-alone solar solutions for off-grid expansion. The means of scaling-up off-grid investment will require as shift in off-grid program focus to work closely with private sector partners. This shift will include enabling and facilitating off-grid private sector investments; both in the off-grid solar markets development and for isolated mini-grid development where appropriate. The shift will require additional financial resources that may be provided primarily through donor programs in early years but will require GoM contributions over time.

The REA will be established to separate rural electrification program implementation from the more traditional role of MoNREM policy setting given the increasing scope of electrification efforts in Malawi, the need to manage multiple program components, to monitor and report on progress, and to make adjustments as the program matures. REA design options will be informed from technical assistance activities financed through the Malawi Electricity Access Project that will include analysis of funding requirements, staffing requirements, legal framework, autonomy and off-grid program design emphasis. For its part, ESCOM will require significantly greater human and financial resources to support the grid densification growth, and both ESCOM and MAREP (and later REA) will need to build capacity to use geospatial software for electrification planning and program management.

Under this institutional arrangement, MoNREM will retain the overall responsibility for electrification program management and monitoring, which will necessitate a high degree of coordination and

collaboration of several GoM parties. For this purpose, it is recommended that an Energy Strategy Secretariat (ESS) be established in early years to address this need that will include representatives from DoEA/MAREP, ESCOM, ReMAC, and MERA. The ESS will be a small, high-level working group with representation as described above and that will meet as and when needed. MoNREM should assume the lead role in the formation and organization of the ESS that would be responsible for finalizing the NES design and implementation planning, for oversight of consulting activities and integrating results into NES implementation, and for oversight of the reporting and monitoring the progress of the implementation activities for the ten strategic elements articulated in the NES.

Moving forward, achieving the national electrification goals will require a clear understanding of roles and responsibilities of the key agencies (ESCOM, MoNREM, MAREP, AED and later, REA), as well as an effective means of coordination to ensure the complementarity of program activities. In highly effective electrification programs, expanded access and connectivity is achieved by identifying load centers that have not been served, optimizing the resources available to provide service at the most economic cost, and coordinating with existing service providers and un-electrified communities to ensure that all stakeholders are substantively engaged in the process.

This step-wise scale up will require significantly improved coordination across project identification, project prioritization, project design and oversight of investments in grid densification, grid expansion and off-grid service provision. Going forward, ESCOM will continue to be the primary responsible party for grid densification planning, while MAREP/AED and afterward REA will be responsible for grid expansion and off-grid planning/implementation and coordination of planning functions with ESCOM. Over time, REA will thus assume all MAREP responsibilities while supporting ESCOM's grid expansion planning responsibilities. Given the more formal structure that electrification agencies require, REA will develop more formal policies, practices and procedures to provide structure and program discipline with respect to planning, program oversight and monitoring functions to achieve the level of collaboration and coordination that is needed.

### *Activities*

Improving program effectiveness will require building upon existing capacities to significantly improve functional capacities to plan, evaluate, design, and implement a large portfolio of grid and off-grid investments. These functional capacities will need to be strengthened in both MAREP and ESCOM and will need to be exercised through the program coordination team. For purposes of the National Electrification Strategy, it is proposed that over the short term, the coordination function will be accomplished through the ESS and that these functions will be assumed when a Rural Electrification Agency is established, as proposed under the NEP.

As the REA is established, there will be a need to establish practices and procedures to address all functions of a well-planned and implemented electrification program. The ESS will assume these responsibilities in the interim period that will be transferred to the REA once established. These responsibilities and functionalities will include:

1. Provide oversight and coordination for NES implementation and monitor progress of NEP targets by gathering data and evaluating performance indicators.
2. Mobilize financing and coordinate with development and private sector partners for all electrification investments.

3. In direct coordination with ESCOM, prepare annual electrification investment plans employing the geospatial platform. While the geospatial platform will provide an initial high-level investment analysis, this function will need to be institutionalized to allow project preparation and investment analyses to be performed on an ongoing basis. The annual plans will include investment analyses for both grid and off-grid investments.
4. Design an off-grid expansion strategy that defines how the AED will facilitate stand-alone solar and mini-grid projects in conjunction with private sector investment. This will be informed by off-grid technical assistance supported by the Malawi Electricity Access Project.
5. Design and implement demographic surveys to inform the planning process to evaluate affordability levels, evaluate energy consumption patterns and to project electricity demand for grid and off-grid projects.
6. Establish a community outreach/information program to ensure that communities are informed of the safety issues related to first-time use of electricity service and understand how to use electricity for purposes of income generation.
7. Support ESCOM efforts to expand the engineering design team to provide improved design services for grid densification.

### *Stakeholders and Roles*

**MONREM/DoEA:** As the policy setting body, MoNREM/DoEA will be the principal responsible agency for establishing and leading ESS activities, while preparing for establishment of the REA. MoNREM and DoEA will define the organizational structure of REA, draft the policies, and procedures and will manage the institutional requirements to establish it as a functioning institution.

**ESCOM, MAREP & AED:** As the principal implementing agencies for the electrification expansion program, both agencies will collaborate and coordinate efforts under the ESS to ensure that planning, design and construction activities are closely coordinated over the near term until such time as the REA is established. The AED of DoEA will significantly increase off-grid electrification activities while ESCOM will increase staff and consultants required to manage grid densification planning and implementation requirements. MAREP and ESCOM will coordinate grid planning through the ESS. Thereafter, REA and ESCOM will continue to coordinate planning and program implementation in future years.

## 3.1.2 Element 2: Develop and implement capacity building programs to strengthen electrification stakeholders

### *Purpose*

While ESCOM is faced with a need to grow its planning, procurement and project management staff resources, AED and MAREP (and later, REA) will need to build capacity to gain the experience and expertise to use geospatial resources for grid expansion (MAREP) and to build an aggressive off-grid electrification expansion program (in the case of AED). Both ESCOM and MoNEM will need to hire planning and design engineers in the immediate future and will need to expand team resources over time to meet GoM electrification expansion goals. To address staffing needs, two key activities are required: 1) recruit staff to fill vacancies for critically important planning, design and project management functions; and 2) establish training and capacity building programs to introduce advanced planning, engineering

design and improved project management skills across all areas of electrification program management. In addition, private sector engineering design and construction capabilities will need to be expanded to be able to adequately respond to grid expansion needs. Concurrently, programs designed to provide information and assistance to mini-grid and solar home system service providers will likely facilitate duty-free importation of materials, while mini-grid service providers will profit from synopses regarding MERA licensing and regulatory requirements.

### *Activities*

ESCOM has experienced planning and design engineers responsible for project identification, evaluation, design, and implementation of electrification expansion projects but resources are limited, and vacancies have gone unfilled. MAREP will also need to expand engineering design and project management capacity for its continued responsibility for grid expansion, given that the ESCOM engineering team will be resource-challenged going forward and MAREP will likely be forced to manage all design and project management responsibilities for the grid expansion program in the future. Technical resources will need to be expanded to meet expansion needs, while technology training will be required for geographic information systems (GIS) and tracking mechanisms to allow ESCOM and MAREP to geographically locate all newly connected consumers and to register them in the ESCOM GIS that is nearing operational deployment. Specific training needs for grid densification and expansion will include:

1. Use of the GIS platform to evaluate densification and grid expansion projects.
2. Digital design of grid expansion projects.
3. Using the GIS platform and load flow software to evaluate system strengthening requirements.
4. Low cost design attributes and engineering design practices.

AED and later REA will need to gain expertise in a number of critically important technical areas that will include but may not be limited to:

1. Use of the GIS platform to evaluate mini-grids and stand-alone solar markets.
2. Use of the platform to digitally design and evaluate financial viability of grid expansion projects.
3. Off-grid project identification and viability analysis.
4. Mini-grid design, capital and operating cost analysis.
5. Solar home system industry best practice, capital costs and business models.
6. Public-private partnership models for off-grid electrification projects.
7. Affordability study design and analysis.

These capacity building topics can likely be provided through a combination of short-term consultancies and study tours, but ESCOM and MoNREM/DoEA would profit from institutionalizing these training activities that could be offered through local resources as new staff members are on-boarded over time. Technical team members would profit from a well-defined capacity building program designed to enhance productivity, and both would benefit significantly from hiring additional engineering personnel to expand existing technical capacity.

Addressing planning needs will require training in GIS software as well as understanding how a geospatial platform can be used to identify, evaluate and perform preliminary design for grid densification, grid expansion and off-grid electrification projects. The planning team will profit from learning how to update the geospatial platform and to develop annual investment plans in the platform environment. In addition

to training and capacity building, there is a concurrent need to provide technical staff with workstations as well as advanced planning, design and project management software. Staffing levels will moreover need to be evaluated taking into account the significant growth in planning, design, procurement and project management required to respond to the electrification challenge in Malawi.

### *Stakeholders and Roles*

**MoNREM/ESCOM:** The MoNREM/DoEA and ESCOM teams involved in the electrification program should conduct a thorough needs assessment regarding their capacity building and human resource constraints as they apply to their future needs for planning, engineering design, project management, communications and outreach, and program oversight functions. Each entity should then share their needs and develop training and capacity building programs that can benefit both entities where possible, and potential share human resources where possible.

## 3.2 Pillar II: Policy & Regulatory

Successful electrification programs are grounded in clearly established policies and regulatory guidelines that define how investments will be identified and prioritized, how program activities will be implemented, how program responsibilities will be assigned to all participating agencies, as well as how regulations will be designed and applied to provide clear and transparent procedures for service providers and investors. Element 3 defines the minimal level of service for purposes of monitoring electrification progress in Malawi to enable MoNREM to track and report program progress. Element 4 defines the legal, regulatory and fiscal provisions that are needed to support a significant expansion of off-grid program activities. Element 5 describes the need and means to accelerate off-grid electrification access that is needed to address service needs beyond where grid resources are able to reach. These elements are described in greater detail below.

### 3.2.1 Element 3 Define minimum level of service with which access expansion will be measured

### *Purpose*

The purpose of this activity is to define the minimum level of service for purposes of financing and monitoring electrification solutions within the national electrification program to measure progress towards the NES goals and objectives.

The NEP refers to use of the Global Tracking Framework (GTF) to measure electrification progress in Policy Priority Area 1.6 and presents an illustrative breakdown of the electrification rates by GTF tier. While NEP states that the GTF should be used for tracking progress, it does not address the issue of establishing a minimum level of service – that is, which tier in the GTF will be used to classify households as electrified. This is important because lower levels of service, and specifically the use of solar lanterns, could distort access rates if they are used to track household electrification rates. The NES seeks to further clarify the process of classifying and monitoring progress towards universal access. Towards this goal, the minimum level of Tier 1 service is hereby recommended. Tier 1 service is characterized by a multi-lamp solar photovoltaic system that offers a minimum of 1000 kilo-lumen hour of service per day, with at least one hour of nighttime service and four hours of total service per day. Figure 2 below provides an illustration

of the United Nations/World Bank Multi-Tier Framework (MTF) [5] also known as the Global Tracking Framework that is used measure access by service level.

**Figure 2.** Multi-Tier Framework for Energy Access

TABLE ES.1
Multi-tier Matrix for Access to Household Electricity Supply

| ATTRIBUTES | | | TIER 0 | TIER 1 | TIER 2 | TIER 3 | TIER 4 | TIER 5 |
|---|---|---|---|---|---|---|---|---|
| | 1. Capacity | Power[1] | | Very Low Power Min 3 W | Low Power Min 50 W | Medium Power Min 200 W | High Power Min 800 W | Very High Power Min 2 kW |
| | | AND Daily Capacity | | Min 12 Wh | Min 200 Wh | Min 1.0 kWh | Min 3.4 kWh | Min 8.2 kWh |
| | | OR Services | | Lighting of 1,000 lmhrs per day and phone charging | Electrical lighting, air circulation, television, and phone charging are possible | | | |
| | 2. Duration | Hours per day | | Min 4 hrs | Min 4 hrs | Min 8 hrs | Min 16 hrs | Min 23 hrs |
| | | Hours per evening | | Min 1 hrs | Min 2 hrs | Min 3 hrs | Min 4 hrs | Min 4 hrs |
| | 3. Reliability | | | | | | Max 14 disruptions per week | Max 3 disruptions per week of total duration < 2 hours |
| | 4. Quality | | | | | | Voltage problems do not affect the use of desired appliances | |
| | 5. Affordability | | | | | Cost of a standard consumption package of 365 kWh per annum is less than 5% of household income | | |
| | 6. Legality | | | | | | Bill is paid to the utility, prepaid card seller, or authorized representative | |
| | 7. Health and Safety | | | | | | Absence of past accidents and perception of high risk in the future | |

[1] The minimum power capacity ratings in watts are indicative, particularly for Tier 1 and Tier 2, as the efficiency of end-user appliances is critical to determining the real level of capacity, and thus the type of electricity services that can be performed.

The MTF/GTF illustrated above shows traditional lighting technologies such as kerosene lamps, flashlights and more modern solar lanterns with less than 1000 kilo-lumen hours of illumination capacity are categorized as **Tier 0**. Tiers 1 and 2 represent solar home system solutions classified according to level of lighting, mobile phone charging, and other services. **Tier 1** service is equivalent to a pico solar home system with sufficient capacity to power two LED lamps and mobile phone charging, while **Tier 2** represents a larger system of at least 50 W capacity able to supply multiple lamps, a fan, small TV and other appliances for at least four hours of service per day of which at least two hours should be nighttime service. **Tier 3** refers to what many electrification programs would consider the service level offered by mini-grids. Tier 3 service is defined by average system capacity of 200 watts designed to meet average residential consumption levels of 1 kWh per day. **Tier 4** refers to traditional diesel mini-grids and to utility grid systems that offer limited grid service (at least 800 watts of capacity) with poor reliability and less than 24-hour service. **Tier 5** service is characterized by much improved reliability and greater availability at 23 hours/day.

## *Activities*

[5] Beyond Connections: Energy Access Redefined. ESMAP, 2015.

Setting a minimum level of service for household electricity service is required to address the basic energy requirements for low-income households in view of affordability constraints for peri-urban and rural inhabitants. Again, Tier 1 service as defined in the MTF/GTF is recommended to address these basic energy needs.

Note that quality of service standards are also required for mini-grid systems, and there already exists quality of service standards for grid service, both of which fall under the purview of MERA. These regulatory issues are discussed in the following sections of this document.

### *Stakeholders and Roles*

**MoNREM:** As the policy and planning body, the MoNREM/DoEA will play a leading role in tracking progress of off-grid service expansion and will coordinate with ESCOM to track grid expansion progress. After REA has been established, it will assume the responsibility for coordinating annual planning targets and tracking progress with ESCOM.

**MERA:** As the regulatory agency within the electricity sector, the Malawi Energy Regulatory Authority (MERA) will be responsible for integrating the minimum level of service requirements as well as establishing quality of service standards for mini-grids. Service standards for grid service have already been established by MERA and shall remain unchanged for purposes of the NES.

**MAREP and ESCOM:** MAREP and ESCOM are responsible for rural electrification (MAREP) and expansion of consumer connections (ESCOM); both institutions shall continue to report expansion of connections through MoNREM/DoEA to the GoM.

**UNDP, UNICEF, SOGERV, and other off-grid stakeholders:** These stakeholders are currently funding mini-grid and off-grid projects in Malawi and should be included in the stakeholder engagement process.

## 3.2.2 Element 4: Adopt licensing, quality of service standards, fiscal exemptions, and material/equipment standards

### *Purpose*

The purpose of this strategic element is to support scale-up of off-grid electrification by ensuring that developers and service providers have clear guidance regarding design, construction and operation of reliable and sustainable energy solutions, and that the fiscal incentives needed to achieve affordable solutions are available to the off-grid, renewable energy community. MERA developed the Regulatory Framework for Mini-Grids in Malawi (approved in 2018) that acknowledges the role that mini-grids will play as stated in the Renewable Energy Strategy (2017) wherein a target of 50 mini-grids is stipulated, and renewable energy resources more generally in the 2018 NEP. The mini-grid regulatory framework requires that all mini-grids with installed capacity greater than 50 kW must be licensed and provides a comprehensive list of studies that must be undertaken to demonstrate project viability to MERA for approvals of both licensing and tariff approval. In addition, the Malawi Tax Incentive Handbook describes conditions that apply to specific industries and products for duty-free clearance and tax incentives for priority industries. While stand-alone solar home systems should qualify for duty-free clearance, it is not evident that all materials for solar solutions will qualify nor that larger

solar-diesel mini-grid materials will qualify for duty-free clearance. Moreover, the priority industry qualification that grants a ten year corporate tax holiday for priority industries will likely not apply since it requires a minimum investment of USD 30 million and a full feasibility study. The MERA Regulatory Framework for Mini-Grids in Malawi could be modified to soften some of the specific reporting and regulatory requirements for mini-grids that will operate in remote areas and for relatively small communities where outage clearances and call center services may prove prohibitively expensive, and to modify the tax incentives to recognize the importance and distinct nature of the off-grid market and the service providers that will serve it.

### *Activities*

The Regulatory Framework for Mini-Grids recommends that mini-grid operators be required to apply and receive approval for separate generation and distribution licenses and recommends that this process should be overseen by the Rural Electrification Management Committee (ReMAC). In an effort to streamline the licensing and review process, MERA should consider establish a more simplified licensing approach that requires a single license to be issued, and that the review/approval process managed by ReMAC be streamlined. While the "light-handed" regulatory approach relieves mini-grids with installed generation capacities of less than 50 kW from licensing requirements, it would be useful to concurrently establish a simplified application process that includes a pro-forma business plan requirement and combined generation-distribution licensing application process for all mini-grids over the minimum threshold.

While power system components for generation and distribution systems qualify for a duty-free importation, the list of materials does not explicitly refer to solar PV panels, racking systems, controllers, and other components for mini-grids and solar home systems. It is recommended that the list be expanded to include all components directly related to solar home systems and solar-diesel-battery mini-grids.

The Malawi Bureau of Standards (MBS) maintains a number of standards related to renewable energy materials and equipment but many of these standards are now outdated. Updating these standards is recommended to ensure that standards reflect international best practices. In cases where the Malawi standard incorporates an established international standard, it is also recommended that the MBS consider adopting those standards by reference. Specific to solar home systems, it is also recommended that the MBS evaluate and adopt the Lighting Global Quality Standards for pico-PV (<15 W) and SHS kits (10 – 350 W).

Given that the Regulatory Framework for Mini-Grids in Malawi does not include quality of service standards mini-grid performance, it is recommended that MERA consider development of a quality of service standards. Such a standard could be modeled after what has been developed by electricity regulator OSINERGMIN in Peru[6] with a specific focus on defining three key elements as follows:

1. Establishing standard rules and procedures for interconnection of mini-grids that focus on, among other issues, engineering standards for fault coordination, anti-islanding and that address line worker safety concerns.

[6] Source: From the Bottom Up: How Small Power Producers & Mini-Grids Can Deliver Electrification and Renewable Energy in Africa (World Bank, 2014)

2. Establishing quality of service standards and tariff methodologies to address both affordability and sustainability concerns for consumers and mini-grid operators
3. Consider flexibility in tariff setting that might include allowing mini-grid operators to propose cross-subsidies between consumer groups and other mechanisms that take into account business models and specific revenue recovery needs

Likewise, the Malawi Grid Code does not differentiate quality service standards for rural areas as opposed to urban areas. In Peru, the outage benchmarks are a more stringent 12 outages/year for urban high-density communities but are relaxed to 40 outages per year for rural dispersed communities. Likewise, commercial metrics require reconnection of service within 24 hours after a bill is paid in urban communities but allow up to 48 hours in rural communities. Similar differentiated quality of service standards could be adopted in Malawi to recognize the challenges of managing rural electric distribution systems. Table 1 below summarizes the regulatory changes that will benefit the NES going forward.

**Table 1**. Regulatory Implementation Activities

| Regulatory Area | Recommendation | Lead Agency | Activity |
|---|---|---|---|
| Mini-grid License | Single generation and distribution license | MERA | Revise Malawi Regulatory Framework for Mini-grids |
| Mini-grid review & approval | Streamlined review & approval process | MERA | Revise Malawi Regulatory Framework for Mini-grids |
| Duty & VAT Exemptions | Expand list of eligible equipment | MRA | Revise Tax Incentives in Malawi Handbook |
| Material and Equipment Standards | Update existing standards | MBS | Revise existing MBS standards relating to renewable energy materials and equipment |
| Materials and Equipment Standards | Incorporate existing standards by reference | MBS | Incorporate existing industry standards by reference |
| Materials and Equipment Standards | Adopt Lighting Global quality standards | MBS | Expand list of renewable energy materials and equipment to include Pico PV and SHS Kits Quality Standards |
| Quality of Service | Develop quality of service standards for mini-grids and rural electricity service | MERA | Consider less stringent standards for mini-grids and rural distribution circuits |

Lastly, a connection fee policy should be established that takes into account affordability issues faced by new consumers to adjust connection fees to such that connection fees do not become a significant barrier to electricity service for low-income consumers.

### *Stakeholders and Roles*

**MERA:** MERA will be responsible for all changes and approvals for regulatory actions under the NES. Specific to the Regulatory Framework for Mini-Grids, MERA is responsible for the evaluation and adoption of licensing and regulating quality of service for mini-grid service providers and is responsible for establishing and enforcing all quality of service standards for grid service.

**MBS:** The MBS is responsible for updating and maintaining materials and equipment standards. These activities include review and evaluation of existing MBS standards related to renewable energy materials and equipment, incorporation of existing industry standards by reference, and evaluation/adoption of the Lighting Global Pico PV and SHS kits quality standards.

**MRA:** The Malawi Revenue Authority (MRA) is responsible for overseeing duty exemptions. With respect to renewable energy duty exemptions, MRA will be responsible for expanding the list of renewable energy materials and equipment that are eligible for a duty & VAT free exemption under the electricity generation and distribution section of the Tax Incentives in Malawi Handbook and make the appropriate changes to the Customs and Procedures Code (CPC).

**MoFEPD:** The Ministry of Finance, Economic Planning and Development (MoFEPD) is responsible for granting the duty exemption described above which will then be implemented by MRA through changes in the CPC.

**MONREM:** As an alternative to the duty exemption described under MRA and MoFEPD, MoNREM may consider lobbying the MoFEPD to designate the rural electrification sector as "Priority". This designation would allow for a blanket benign fiscal regime including tax and duty waivers for anything related to rural electrification.

**ESCOM:** As the distribution utility, ESCOM serves a supporting role in implementing the Quality of Service (QOS) Standards for Electricity Service Providers. As the System and Market Operator, they will also be responsible for providing an Interruption Report to MERA on a periodic basis.

## 3.2.3 Element 5: Scale-up mini-grid and standalone off-grid system development

### *Purpose*

Given the power supply deficits that will continue through at least 2022 and the very low rate of electrification access today in rural Malawi, there is an immediate need to scale-up off-grid electrification access to include mini-grids and stand-alone solar solutions. To do so will require identification of clearly exploitable mini-grid opportunities using the geospatial least-cost platform, and a careful analysis of costs and affordability for both stand-alone solar and mini-grid service. Mini-grids in close proximity to the grid may be interconnected as grid resources expand while other larger and more remote mini-grids may be operated for some years into the future, depending upon resources allocated for grid expansion. All the

same, mini-grids are likely to take time to achieve scale and therefore do not represent an immediate solution to challenges raised by the power supply deficits in the early years of electrification roll-out.

The challenge for both mini-grids and stand-alone solar solutions will be to identify and evaluate barriers to service, given that off-grid service has significantly lagged markets in the region including Mozambique, Tanzania, and Zambia. These barriers likely include financial resources of developers and consumers. A more proactive approach will be needed to scale-up off-grid access. Towards this end, more aggressive objectives should be established for AED/DoEA to explore opportunities to reduce costs to consumers, to develop government-private sector partnerships, and to systematically characterize the off-grid market to evaluate opportunities to expand off-grid service.

### *Activities*

The first order electrification geospatial platform indicates that the predominance of households in Malawi are located very close to ESCOM distribution infrastructure but in the near term, generation capacity shortfalls will limit how many housing clusters can be connected to ESCOM resources. The least cost geospatial planning process, once completed will evaluate the most logical progression for grid densification, grid expansion and high-priority mini-grid projects as well as defining where stand-alone solar solutions are likely be to be the most practical approach to access.

The geospatial screening process will allow AED of DoEA to identify and evaluate the first group of mini-gird projects that can be prioritized for development in the immediate time frame, with view to foster and facilitate private sector investment and private operator operations accountability business model and scaled up engagement thereof. The Malawi Renewable Energy Strategy proposed that Malawi invest in at least 50 mini-grid projects by 2025, so it is recommended that AED identify and evaluate at least 25 mini-grids in 2019 that can be prepared to be developed through a public-private partnership with local and/or international mini-grid development firms. Selection criteria should include the largest villages and trading centers that will not be connected to grid service over the next five years including those with the highest potential for productive use applications and those that have the most significant need for water supply, primary health and educational service. In subsequent years, additional mini-grids can be identified and prepared for development.

To evaluate the need for the public-sector share of capital cost of these mini-grids, DoEA will need to sponsor willingness to pay surveys as will be discussed in more detail in the Financial Pillar. The results of willingness to pay surveys will determine the fraction of the capital cost that will require capital subsidies by the GoM to achieve affordable electricity prices to the communities to which these systems will provide service.

It is further recommended that AED evaluate incentive options for expanding stand-alone solar solutions that may include output-based results incentives designed to buy-down the cost of service to lower-income consumers; challenge grants to support off-grid service providers to move into new areas to defray transition and working capital expenses; and voucher programs that facilitate a greater freedom of choice to consumers for pre-qualified service providers. It is also clear that funding above the present REF level will be needed to significant expand off-grid service. In the short run, funds provided by the donor community may be able to satisfy early funding requirements, but as the off-grid market builds momentum, funding mechanisms that go far beyond the REF will need to be defined.

In addition to developing financial mechanisms to bridge affordability gaps and facilitating private sector engagement in off-grid services, and as mentioned in Element 4, there will concurrently be a need to define quality of service standards, minimum service levels and monitoring mechanisms for mini-grid systems. While individual solar PV solutions will be governed by MTF Tier 1 service requirements, mini-grid service should be scaled to satisfy economically productive supply meaning that service to satisfy a Tier 3 threshold given that they will serve communities with higher population densities that integrate multiple public facilities that may include schools, primary health centers, public administration facilities as well as small businesses with productive loads.

### *Stakeholders and Roles*

**MoNREM/AED/MAREP**: MoNREM/AED/MAREP will be responsible for establishing and overseeing scale-up of mini-grid and stand-alone solar solutions in collaboration with development partners and private entrepreneurs. Supported by development partners that have begun to establish mini-grid systems, AED/MAREP will evaluate multiple financial options to ensure that mini-grid consumers are not only provided with reliable service, but that the service will be affordable through a combination of capital buy-down mechanisms as well as possible tariff subsidies.

**MERA**: The Malawi Energy Regulatory Authority will be responsible for establishing and enforcing regulations as they pertain to mini-grid systems and the service that is offered.

**REA**: When and if the Rural Electrification Agency is formed, it will assume responsibility for mini-grid scale-up as an integral part of its responsibility for electrification planning, financing and program management.

## 3.3 Pillar III: Technical & Planning

The success of the Malawi electrification program will depend in part on the technical proficiency that is developed by ESCOM, MAREP and the future REA to plan, design and oversee construction activities for grid densification, grid expansion and off-grid energy systems. Training will be required to build capacity. However, planning tools and revised construction standards are issues of equal importance towards the goal of achieving significantly increased electrification access. The three themes that will be addressed in the technical & planning pillar include:

1. Identify power supply shortfalls that may inhibit grid expansion activities
2. Establish a geospatial least-cost planning framework for grid and off-grid electrification expansion
3. Establish and apply lower-cost electrification design/construction standards

These themes are explored in greater detail below.

### 3.2.4 Element 6: Identify power supply shortfalls that may impact grid densification and expansion planning

### *Purpose*

The power supply deficit that has arisen due to low flow rates on the Shire River basin coupled with high growth in demand is an issue which will impact continuity of service to present and future ESCOM

consumers. As such, it has attracted significant interest and effort to resolve the deficit over the shortest time period possible. The GoM and ESCOM are negotiating cross-border power purchase agreements; contracts for emergency power generation from multiple suppliers have been signed to deliver power to multiple supply points; and ESCOM and EGENCO are pursuing multiple expansion opportunities for projects they will develop as well as projects that may be developed by independent power producers for a combination of hydroelectric, liquid fuel, solar, biomass and other power generation sources. Some of these interventions, such as the emergency power supply contracts, will have near immediate impacts on power supply. Others such as the hydroelectric, solar and biomass generation plants, will require several years to provide new generation capacity. A summary of the contrast between projected demand as projected in the Integrated Resource Plan for Malawi[7] and the schedule of available generation supply is shown in Table 2 below. Available generation capacity was derived from data provided by ESCOM and EGENCO for projects that are under development and projected for commissioning as presented the Gap Analysis report.

**Table 2.** Demand versus available generation capacity by year through 2030

| Year | Projected Demand (MW) | Installed Capacity (Existing MW) | Available Capacity (MW) | Installed Capacity (New MW) | Total Installed Capacity (MW) | Available Power Supply Surplus/Deficit (MW) |
|---|---|---|---|---|---|---|
| 2018 | **449** | 489 | 290 | 56 | 545 | -159 |
| 2019 | 584 | | 436 | 146 | 691 | -148 |
| 2020 | **719** | | 454 | 18 | 709 | -265 |
| 2021 | 834 | | 811 | 357 | 1066 | -23 |
| 2022 | 949 | | 811 | | 1066 | -138 |
| 2023 | 1064 | | 1144 | 333 | 1399 | 80 |
| 2024 | 1179 | | 1234 | 90 | 1489 | 55 |
| 2025 | 1294 | | 1234 | | 1489 | -60 |
| 2026 | 1409 | | 1453 | 219 | 1708 | 44 |
| 2027 | 1524 | | 1453 | | 1708 | -71 |
| 2028 | 1639 | | 1453 | | 1708 | -186 |
| 2029 | 1754 | | 1714 | 261 | 1969 | -40 |
| 2030 | **1873** | | 1714 | | 1969 | -159 |

As Table 2 shows, while power capacity additions include a 20 MW Zambia-Malawi interconnector in 2018 and a 57 MW Mozambique-Malawi interconnector in 2021, capacity shortfalls remain significant through 2020. These deficits can be offset by additional cross-border energy sales if agreements and infrastructure development can be accelerated.

[7] Integrated Resource Plan (IRP) for Malawi, Norconsult, May, 2017.

## *Activities*

Drought conditions that have affected water levels in Lake Malawi as well as siltation and the need for rehabilitation of some of the cascaded hydroelectric facilities on the Shire River basin resulted in reduction of available power capacity from 359 MW to as low as 144 MW in early 2018. Both ESCOM and EGENCO commissioned high speed diesel generation resources by the end of 2018 that provide 130 MW of peak capacity. The impact of the high-speed diesel generation resources will be offset by the planned rehabilitation of Nkula A and Tedzani III hydroelectric stations scheduled for later this year.

Up to 50 MW of additional capacity was scheduled for completion by the end of 2018 that includes the Zambia-Malawi Cross Border Interconnection and repairs/upgrades to Kapichira, Nkula A and Tedzani III hydroelectric stations. In 2019, 146 MW is scheduled for completion including two solar projects, another upgrade to the Tedzani hydroelectric station, the 10 MW Gebis waste to energy project, and the 10 MW Ndiza hydroelectric project. A modest increase in capacity (18 MW) is expected from the new Tedzani IV hydroelectric plant in 2020, followed by a significant increase of 357 MW in 2021 from the Mozambique-Malawi Interconnector and the Kamwamba Coal Fired Power Plant. The remaining generation projects, expected to come online between 2023 and 2029, are planned but not confirmed at this time.

Looking ahead to 2020, the Malawi Integrated Resource Plan (IRP) projects a demand of 719 MW versus an installed capacity of 709 MW noted in Table 2 above – indicating a substantial improvement in power supply resources that will be almost on par with expected peak demand – if water levels in Lake Malawi allow available capacity to rise substantially.

Available capacity will need to be monitored concurrently with the need to more aggressively pursue cross-border energy purchases, but connections (grid densification) and grid expansion programs may suffer if power deficits cannot be overcome in the near to medium-term.

## *Stakeholders and Roles*

**ESCOM:** ESCOM is the designated System and Market Operator as well as serving as the Single Buyer for the Malawi transmission grid and as such has the statutory mandate to oversee generation expansion planning for the GoM. It is engaged in negotiations with private sector independent power producers interested in developing power generation facilities in Malawi, as well as in bilateral discussions with foreign power generation companies with regard to cross-border power purchase agreements.

**EGENCO**: For its part, EGENCO has developed its internal power generation expansion plan. EGENCO intends to use this investment plan to attract investment capital to finance future hydroelectric generation and to evaluate the feasibility of coal-fired generation in future years. EGENCO has undertaken a series of rehabilitation and modest expansion project enhancements for Nkula and Tedzani power stations that while small, are important to extending power supply in the short term.

**MERA:** MERA is responsible for the review and approval of Power Purchase Agreements (PPAs).

**MoNREM:** MoNREM is responsible for negotiation and signing of memoranda of understanding (MOUs) with prospective independent power producers (IPPs) and for signing implementation agreements.

**MoFEPD:** MoFEPD is responsible for facilitating and guaranteeing the funding for hydroelectric, solar, diesel and other generation plants in Malawi. It is also responsible for signing implementation agreements with investors.

### 3.2.5 Element 7: Establish a least-cost geospatial planning framework for on- and off-grid electrification

#### *Purpose*

As stated earlier electrification investments will be undertaken through four principal electrification expansion modalities including grid densification/intensification; grid expansion; mini-grid development; and stand-alone solar solutions. At the present time, ESCOM is primarily engaged in grid densification efforts through which households and small businesses that are situated a short distance from low voltage infrastructure are prioritized for connection. Grid intensification is a complementary activity to densification to connect consumers through short, medium and low voltage line extensions to housing clusters less than 2-3 kilometers from existing grid service. While MAREP has been responsible for grid intensification and expansion project planning and oversight, these duties will be shifted to the new REA when it is formed in the short- to medium-term future. Until that happens, MAREP through the Rural Electrification Division of DoEA will continue to manage these duties and will coordinate with ESCOM for grid expansion planning, passing assets and newly connected consumers to ESCOM once projects are completed.

The expansion of the Malawi electrification program will require a more systematic approach to expand both grid and off-grid resources that uses well-defined decision guidelines to differentiate between grid and off-grip delivery options. Investing in a master planning framework that provides the required level of resolution for ESCOM and MAREP to evaluate grid densification and intensification potential, identifies the universe of viable grid expansion projects, and demarcates a rational division for mini-grid and stand-alone off-grid investments will significantly enhance electrification investment planning (with AED leading the off-grid spatial analysis). The least-cost first order geospatial plan is the first step in creating a master planning process. The geospatial plan developed through this project will be expanded and integrated into ESCOM, MAREP, and AED workflows in a future phase that will provide more specificity to the planning platform, evaluating a comprehensive portfolio of grid and off-grid projects over a ten-year timeframe. Ideally, the platform will be designed to be integrated with the newly established ESCOM GIS to facilitate grid strengthening with the expansion planning process. Future elaboration of the geospatial planning platform and grid/off-grid roll-out plan will need to be coordinated between ESCOM, MAREP, AED, and REA once it is established.

#### *Activities*

Two significant activities are ongoing in tandem with development of the Malawi NES. ESCOM is in the final stages of digitizing its medium and low voltage distribution network as well as geo-locating all connected consumers. The first-order geospatial electrification plan was completed in 2018 to "conduct a rapid techno-economic screening analysis to approximately delineate the high level spatial contours of the immediate term investment program for national electrification within the horizon of 2018-2023." The results of the first-order geospatial plan indicate that the vast majority (over 95%) of households in Malawi

are within 10 kilometers of existing ESCOM service[8], indicating that grid densification and expansion are very likely to remain the most dominant modalities of expansion of access in Malawi. Importantly, as the geospatial framework is refined to provide a higher level of resolution to distinguish between electrification modalities in the next phase of development, it will facilitate the means and opportunity for improved analyses to support establishment of an integrated electrification planning framework that can be shared by ESS/REA and ESCOM for planning and program management purposes.

Distribution expansion planning normally focuses on extending grid infrastructure to communities and housing clusters that do not yet have electricity service, but concurrently focuses on reinforcing grid capacity in areas where load growth has outstripped feeder and/or distribution transformer capacity. In the context of a national electrification program, an expansion plan should evaluate grid densification, grid intensification and expansion of service – taking into account investments in connecting consumers as well as investments in sustaining or improving quality of service. This is, in essence, the purpose of a master plan; to identify the universe of potential electrification projects, to evaluate project costs and benefits, and to prioritize the expansion process taking into account multiple benefit streams.

Given the low rate of grid service in Malawi, off-grid service provision will play a significant role in electrification expansion in future years. The extent to which off-grid expansion will occur will depend upon the rate of grid expansion in the near to medium term, as well as the affordability of off-grid solutions where they are likely be in higher demand. Thus, while ESCOM uses the least-cost geospatial framework for grid densification and expansion purposes, AED/DoEA (then REA) will use the framework to identify and develop mini-grid projects and to define a practical expansion strategy for stand-alone solar solutions for those areas that can neither be served by grid or mini-grid service. In order for both ESCOM and MAREP/AED to use the same platform and to concurrently update the information in the platform, the platform will need to be hosted either locally or via cloud resources to allow dual real-time access. Maintaining the data base will require either a third-party service agreement with a consultant or a very well designed collaborative partnership between ESCOM and MAREP/AED.

### *Stakeholders and Roles*

**ESCOM**: Will use the geospatial platform to (1) update ESCOM distribution asset base as line extensions funded through MAREP are completed and interconnected to the ESCOM distribution system; and, (2) evaluate potential and select areas for grid densification, updating consumer database as new connections are completed.

**MoNREM**: MAREP and AED will coordinate with ESCOM to integrate grid and off-grid expansion planning in the master planning platform, sharing results with ESCOM to ensure that all parties have full knowledge and agree to the planning projections.

**Rural Electrification Agency**: When a rural electrification agency is formed, it will take responsibility for management and coordination of the master planning process. It will coordinate with both ESCOM and MoNREM for all grid and off-grid expansion analyses, prioritization of projects and integration of

[8] Interim Report: Progress and Plans for Final Project Report and Training, MPA, 2018. The report states that 30% of all households are located within 1 km of ESCOM service; 80% within 5 km, and 95% within 10 km.

completed projects into the geospatial platform. The platform should be hosted by a single institution but shared by all participating parties.

### 3.2.6 Element 8: Evaluate & establish low-cost electrification design standards

#### *Purpose*

The cost of grid extension is directly related to the design and construction standards that are used to govern line design and construction practices. A review of ESCOM design standards indicates that while the standards are robust and satisfy the needs for high population density urbanized areas, these same design standards result in higher than necessary delivered cost when applied to lower population density areas. Table 3 below summarizes the results of a World Bank study undertaken in multiple countries in 2012 that illustrates how construction costs vary by country of application. A contributing factor to the variance in cost has to do with how well design principles are applied in the construction process, while another highly important factor has to do with how the procurement process is managed. Use of international competitive bidding and consolidation of construction activities into larger lots provide significant economies of scale, and can also contribute to pushing down costs by as much as 20-30% - as seen in the difference between costs in Uganda/Tanzania and those in Kenya.

**Table 3**. Cost of 33 kV construction in Uganda, Tanzania, and Kenya

| MV Lines and Transformers | Type | Size | Uganda | Tanzania | Kenya |
|---|---|---|---|---|---|
| 33kV 3P Distribution Line (USD/km) | Wood Poles | 100 $mm^2$ | $28,000 | $27,200 | $20,900 |
| 33kV 3P Distribution Line (USD/km) | Wood Poles | 50 $mm^2$ | $26,000 | $25,000 | $17,890 |
| **Transformers (USD/unit)** | | | | | |
| | 33 kV | 315 kVA | $11,542 | $15,000 | $12,257 |
| | | 200 kVA | $8,825 | $14,000 | $9,000 |
| | | 100 kVA | $7,245 | $10,600 | $6,500 |
| | | 50 kVA | $5,900 | $8,972 | $4,500 |
| **LV Line and Service Drops** | | | | | |
| 0.4 kV three phase (USD/km) | AAC or ABC | 50$mm^2$ | $14,000 | $22,500 | $21,000 |
| | | 100$mm^2$ | $19,400 | $21,300 | $25,537 |
| Single phase service drop (USD/unit) | | | $180 | $370 | $191 |
| Three phase service drop (USD/unit) | | | $230 | $620 | $520 |

Source: NRECA International Low-Cost Design report to REA, Tanzania, 2012.

A third factor that affects construction cost is use of standards that maintain safety and quality of service requirements, while recognizing that lower load densities do not require identical design principles as those used in high population density environments.

#### *Activities*

As the ESCOM distribution system expands to peri-urban and lower population density areas, it would be useful to consider adoption of lower-cost design principles – to include the use of two phase and single phase technology. Table 4 below presents an analysis of low-cost design that has been adopted for

distribution expansion in medium and low-density areas. For medium population density environments, standard three phase feeders are used, while two phase laterals are extended to housing clusters and businesses. In low density areas, single phase service can be considered. The cost savings potential for two phase service is approximately 55% over the traditional three phase cost (using Kenya data) and just less than 70% for the single wire earth return standard.

**Table 4.** Low Cost Design/Construction Cost Estimates

| Type of Construction | Unit | Avg. Span | Unit Cost |
|---|---|---|---|
| **Two Phase System** | | | |
| 33kV 25mm$^2$ Two Wire | km | 100 | $8,896 |
| LV w 25mm$^2$ Triplex | km | 50 | $11,783 |
| 33kV 15kVA Transformer | | | $1,793 |
| 33kV 25kVA Transformer | | | $1,989 |
| **Three Phase Four Wire System** | | | |
| 33kV 150mm$^2$+75mm$^2$ | km | 77 | $19,810 |
| 33kV 4c 75mm$^2$ | km | 90 | $14,773 |
| 19kV single phase 25mm$^2$ | km | 100 | $7,039 |
| LV w 25mm$^2$ Triplex | km | 50 | $11,783 |
| 19kV 10kVA Transformer | ea. | | $1,352 |
| 19kV 15kVA Transformer | ea. | | $1,484 |
| 19kV 25kVA Transformer | ea. | | $1,699 |
| **SWER Single Phase Lines and Equipment** | | | |
| 19kV SWER 25mm$^2$ | km | 100 | $6,475 |
| LV w 25mm2 Triplex | km | 50 | $11,783 |
| 19kV 10kVA Transformer | ea. | | $1,532 |
| 19kV 15kVA Transformer | ea. | | $1,664 |
| 19kV 25kVA Transformer | ea. | | $1,880 |
| **Consumer Connection** | | | |
| Low Cost Consumer Connection | ea. | | $148 |

Source: Kenya National Electrification Strategy report, 2017.

### *Stakeholders and Roles*

**ESCOM**: Responsible for reviewing and adopting lower-cost design and construction standards in collaboration with MoNREM.

**MoNREM/MAREP**: Adopt ESCOM-defined design and construction standards for all grid extension projects. In the event MAREP or other MoNREM programs finance mini-grid systems, adopt low-cost low voltage distribution design standards for application in mini-grids.

## 3.4 Pillar IV: Financial

Financial requirements for electrification programs span a broad spectrum of issues all of which must be defined to support successful and effective electrification expansion strategies. Financial aspects include establishing tariff policies that on the one hand, provide sufficient revenue recovery to support long-term

sustainability of service providers, and on the other hand facilitate affordable energy services to residential, commercial and industrial electricity consumers. In addition, the financial strategy should address needs for all modalities of electrification including densification, grid expansion and off-grid service. Financial resources are needed to support infrastructure development, to support planning and project development, to support program monitoring and reporting functions, and to support capacity building and training needs for a broad spectrum of stakeholders that play important roles in electrification program activities.

The financial themes of greatest strategic importance to support accelerated expansion of electricity access include the following:

1. Support affordable access to electric service by addressing barriers to access for grid and off-grid service provision.
2. Develop a financing plan to generate and deploy the financial resources needed to support grid densification, grid expansion and rapid expansion of off-grid service throughout Malawi.

These three themes are discussed in greater detail below.

### 3.3.1 Element 9: Promotion of affordable access to electricity service for both grid and off-grid electricity service

#### *Purpose*

ESCOM submitted a tariff request to MREA in 2018 for a 61% increase intended to cover the full cost of service including future capital expansion requirements. In response, MERA approved a 31.8% increase. The need for lifeline tariffs is recognized in the NEP 2018 for low-income consumers – and it is quite possible that a majority of newly connected consumers in coming years will be low-income lifeline consumers. It will therefore be important to monitor ESCOM operating costs and revenues closely to define how lifeline consumer costs can be financed such that ESCOM's financial health is not compromised. MONREM and MERA will work with ESCOM to evaluate the magnitude of the lifeline tariff program and will design a revenue neutral mechanism for ESCOM in the event it is needed.

In addition, should the GoM determine that mini-grids will follow a uniform national tariff equivalent to ESCOM tariff levels, MAREP/REA will evaluate the magnitude of subsidies that will be required and will work with MONREM to design a mechanism to finance them. In Kenya where mini-grids are being financed by the Government of Kenya and will be operated by Kenya Power & Lighting Company (KPLC), the operating costs of the mini-grids will be integrated into overall operating costs of KPLC and any change in overall cost will be internalized in future KPLC tariff levels approved by the Kenya Energy Regulatory Commission.

For the Malawi case, AED/DoEA may elect to sponsor mini-grid development through reverse auctions to private developers in a public-private partnership arrangement. These capital cost subsidies would derive resources from a combination of donor and government allocations. In addition, should operating subsidies be required to achieve a uniform tariff with ESCOM, an operating subsidy mechanism would need to be designed and managed by MERA through which levies on ESCOM revenues would be deposited into a special subsidy account and allocated to off-grid service providers -- similar to the Kenya mini-grid model. These operating subsidies would be allocated on a connected consumer basis and would be time-bound and subject to quarterly review/adjustment.

Affordability analyses are essential to understand the relationship between energy service pricing, consumption of energy resources and how many consumers are likely to purchase energy services as a function of cost. These studies are used to characterize the market by establishing price points for each decile of the target population in terms of likely energy sales and ability of the population to pay for energy services and are needed to understand affordability levels across all segments of the Malawi economy, and in turn inform capital subsidies and lifeline tariff considerations in Malawi.

There are two principal objectives for this element of the NES. As the grid expansion process unfolds, it will be extremely important to evaluate the impact of tariff levels that do not fully recover the cost of service on ESCOM's long-term financial position in light of the rate of acceleration of ESCOM consumers, and as ESCOM service moves into increasingly more economically marginal communities. Secondly, in the event that the GoM determines that it will follow a uniform national tariff for ESCOM grid and mini-grid service alike, it will be necessary to evaluate the magnitude of subsidies that may be required, and concurrently to evaluate options to generate the funds required for off-grid service providers.

### *Activities*

Many electrification programs have been designed to ensure full cost recovery for all service providers in recognition that the cost of service varies depending upon the number of consumers that are served, the population density of the market that is served; and the cost of purchased or generated energy, among other factors. When and where mini-grids are employed, the cost of service may vary dramatically from communities that are served via grid service.

One of the most critical factors used to evaluate the viability of electrification projects is the relationship between consumption and price that is in large part described by results from willingness to pay (WTP) surveys. WTP/affordability analyses provide critically important information needed to understand consumer price points, evaluate economic benefits, facilitate program decision making regarding the relative value of grid versus off-grid technology options on a geographically specific basis, and inform analysis of lifeline electricity tariff requirements.

Willingness to pay/affordability studies will be undertaken in selected locations with the use of economic productivity indicators (urban, peri-urban, and rural locations in the north, central and southern regions represents one approach). The indicators will be defined as a measure of diversity of economic productivity in an effort to differentiate areas of higher and lower income potential, and relative demand for electricity consumption.

If a uniform national tariff is applied in Malawi to address affordability and equity concerns, this tariff policy will necessitate a mechanism to distribute subsidies from a funding stream such as a levy on energy sales to service providers that have cost structures that are higher relative to the cost that can be recovered via a uniform national tariff. Managing cross-subsidies within the sector is a straight-forward process if all areas are served by a single utility or service provider. However, in the event that the off-grid program establishes multiple new service providers, a clear and transparent mechanism will be needed to transfer funds from larger and perhaps more affluent consumers to service providers with fewer and less affluent consumers.

Mechanisms to support this could include:

- Capital subsidies allocated through a reverse auction process for qualified off-grid service provides, managed by MoNREM/REA through a funding mechanism established for this purpose. The funding mechanism would derive resources from a combination of donor and government allocations.
- Establish an operating subsidy mechanism overseen by MERA through which levies on ESCOM revenues would be deposited into a special subsidy account and allocated to off-grid service providers on the basis of licensing/tariff agreements negotiated with and approved by MERA. The operating subsidies would be time-bound and subject to quarterly review/adjustment.

This activity is intimately linked with analysis of willingness to pay/affordability data mentioned above. The balance between enterprise sustainability and affordability of service are directly linked; tariffs set above the threshold of consumer affordability may unintentionally limit consumer participation in ESCOM and/or mini-grid service. Design of subsidy mechanisms will use the data gathered from willingness to pay/affordability studies to inform the need for lifeline or other forms of subsidies. This evaluation should be accompanied by an analysis of how subsidies can be financed effectively through within the sector, should they be required to bridge the cost-affordability gap.

### *Stakeholders and Roles*

**MoNREM/MAREP**: MoNREM/MAREP will be responsible for drafting the scope of the studies that will comprise this activity, as well as for hiring and supervision of the consultants contracted to complete this analysis. The AED team will also provide substantive input for the mini-grid cost/tariff analysis and may also participate in evaluating the magnitude and sources of subsidy requirements.

**MERA**: As the principal agency involved in tariff review and approval, MERA will play a significant role in reviewing and contributing to analyses prepared by consultants hired to support this activity.

**ESCOM**: ESCOM's participation will be essential to share cost and commercial data to facilitate the sustainability analysis – and to carefully review and comment on the analysis for completeness and accuracy

**MoFEPD:** MoFEPD is responsible for defining subsidy policies that are defined under this element.

## 3.3.2 Element 10: Develop a financing plan to support the electrification expansion goals

### *Purpose*

Implementation of the Malawi National Electrification Strategy will require sufficient capital to achieve grid densification, grid expansion and off-grid connection goals. Each modality of electrification expansion will be associated with a unit cost of expansion (average cost per connected consumer), and each of these costs will be associated with technology choices that are defined as an integral part of the NES design. To the extent that lower-cost design standards are adopted by the ESCOM and REA, these standards could reduce the program costs for grid densification and expansion significantly in comparison to the business as usual approach. Two-phase and single-phase options are directly applicable for rural service in Malawi, while ESCOM should continue to use three-phase service for distribution service to higher population density urban areas.

Similarly, decisions made regarding the level of service that is selected for stand-alone energy solutions will have a direct and potentially significant impact on program financing costs. Tier 1 systems are much less costly than Tier 2 solar solutions, for example.

### *Activities*

The financing plan will be evaluated by defining connection targets by delivery modality (grid densification, grid expansion, mini-grid systems and off-grid solar market stand-alone solutions) over five and ten-year time intervals. The geospatial platform will be used to evaluate base case, best case and worst case scenarios. Using unit cost estimates for densification, grid intensification, grid expansion and off-grid solutions, investment requirements will be projected for medium and longer-term program needs.

Projections will include population growth estimates derived from National Statistical Office data and projections. A census was undertaken in 2018 and preliminary results have already been prepared and circulated that can be used to support projections of financial requirements for grid and off-grid service expansion.

The REF that currently finances rural area grid extension projects should in the future balance grid extensions and off-grid electrification projects; off-grid solar market scale up and isolated mini-grids, emphasizing private investment and services delivery. Additional resources will be needed to achieve 2030 connectivity targets that may be generated from increases in electricity sales as generation resources are added and distribution consumers increase. Technical assistance provided through the upcoming Malawi Electricity Access Project may be used to evaluate means of significantly expanding REF resources in future years.

### *Stakeholders and Roles*

**MoNREM/MAREP:** MAREP will provide input on the costs of rural electrification as well as off-grid development.

**ESCOM:** In its role as the distribution utility, ESCOM will contribute to the development of the financial model in terms of the costs of grid densification, grid intensification, and grid expansion. In its role as the System and Market Operator and Single Buyer, ESCOM will provide input regarding the financial resources necessary to address the power supply deficit.

**MERA:** MERA will contribute to the financing plan in the areas of tariff and subsidy designs.

**MoFEPD:** MoFEPD will participate in setting MAREP energy levy, since this Rural Electrification fund is designated as a Treasury Fund.

# 4 Implementation Plan

The Implementation Plan is organized into preparatory activities, program implementation, and stakeholder/donor contributions to the strategy. The **preparatory activities** present the steps required to organize program implementation and to ensure the strategy is implemented in a timely, effective, and efficient manner. Creating actionable tasks and establishing milestones will require consensus building, stakeholder engagement, and decision-making process in the months after the NES is approved for implementation. In addition, selected studies are needed to inform policy and regulatory decisions, including affordability analyses and opportunities to reduce design and construction costs.

At the heart of the Implementation Plan are the specific **program implementation** tasks necessary to translate this strategy into results which support access expansion to meet a full access goal as stated in the NEP. Each of the strategic elements is elaborated by presenting discrete activities and milestones that are illustrated in the project schedule in Gantt chart format.

## 4.3 Preparatory Activities

As indicated in Section 3 above, MoNREM will be responsible for driving NES activities and achieving the goals by refocusing MAREP, sponsoring the establishment of REA and providing a high-functioning coordinating mechanism in the form of the Energy Strategy Secretariat to provide structure to the organizing principles for the NES in early years of implementation. The ESS will include representation from DoEA/MAREP/AED, ESCOM, ReMAC, MoFEPD, and MERA. The ESS will be responsible for finalizing the NES design and implementation planning, for oversight of consulting activities and integrating results into NES implementation, and for oversight of the reporting and monitoring the progress of the implementation activities for the ten strategic elements articulated in the NES.

The decision-making process will be critical to ensure that required actions are taken to move the implementation process forward for the NES. The key policy agencies will need to review, evaluate and take decisions to address each strategic element, weighing proposed activities and impacts with budgetary requirements to achieve electrification goals. Table 5 below indicates the nature of the decision (technical, financial, or policy) for each of the ten strategy elements and the expected decision timeframe.

**Table 5.** Nature of Decision Making Requirements for NES Elements

| Pillar | NES Element | Decision Making - Technical, Financial, or Policy | Decision Timeframe |
|---|---|---|---|
| I: Institutional | E1: Roles & responsibilities of implementation agencies | Policy | August 2019 |
| | E2. Develop capacity building programs | Technical | October 2019 |
| II: Policy & Regulatory | E3: Define minimum level of service | Policy | Defined herein |
| | E4: Licensing, QOS, duty exemptions, equipment standards | Policy | November 2019 |
| | E5: Scale up off-grid development | Policy/financial | December 2019 |
| III: Technical & Planning | E6: Identify power supply shortfalls | Technical/Financial | December 2019 |
| | E7: Least-cost geospatial planning | Technical | January 2020 |
| | E8: Low cost electrification design standards | Technical | January 2020 |
| IV: Financial | E9: Affordable access | Technical/Financial | March 2020 |
| | E10: Financing Plan | Policy/Financial | March 2020 |

Decisions that require immediate action include those related to Elements 1 and 2 – defining roles and responsibilities of principal implementing agencies and establishing the minimum level of service. Preparatory actions for Elements 3, 4, 6 and 10 require decisions in the short term -- within approximately four months of completion of this project. Decisions related to Elements 5, 7, 8, and 9 can be deferred until about March to May of 2019.

Prior to initiating NES supporting activities, the implementing agencies must draft, review and approve terms of reference (TORs) for consulting services for the supporting studies/analyses. Consulting services are expected to be required for the activities summarized in Table 6 below. Note that for the purposes of Table 6, the implementing agency will take primary responsibility for drafting the terms of reference,

management of consultants, & oversight of quality control, while coordinating agency will participate in review and input to the work product prepared by consultants.

**Table 6.** NES Consulting Services Requirements

| NES Element | Consulting Services | Implementing Agency | Coordinating Agency |
|---|---|---|---|
| **E2:** Capacity Building Program | curriculum design & training, employee recruitment | ESCOM/MONREM | MAREP & AED |
| **E4:** Licensing, QOS, Duty Exemption, Equipment Standards | revision and updating of existing standards, development of QOS standard, adoption of Lighting Global Standards | MBS, MOF, MERA | AED/DoEA |
| **E5:** Scale-up off-grid development | evaluate business models & affordability options to scale up off-grid development | AED/DoEA | MERA |
| **E7:** Least-cost planning framework | Integrate geospatial planning methodology at ESCOM, MAREP & AED for grid/off-grid | MAREP & AED | ESCOM |
| **E8:** Low cost electrification design standards | develop design/construction standards | ESCOM | MAREP |
| **E9:** Affordable access | Cost sharing, lifeline tariffs and subsidy design study | MERA | MAREP, AED & ESCOM |
| **E10:** Affordability analysis | willingness to pay study | MAREP | National Statistical Office (NSO) |

## 4.4 Program Implementation

This section of the report presents the implementation activities that support each of the eleven strategic elements, estimates the duration of each element, and also presents the implementation schedule for the NES.

### 4.2.1 Pillar I: Institutional

Definition of the separation of duties, responsibilities and contributions to planning, program implementation and monitoring is required to organize and systematize electrification expansion for grid and off-grid program management. Responsibilities for coordinated planning, project identification, timely procurement and construction, and effective reporting and program monitoring will contribute to long-term success and impact of NES activities. Implementation tasks and activities to support implementation of **Elements 1 and 2** include:

- Clarification of the roles and responsibilities of ESCOM, MAREP, and AED
- Formation and definition of ESS functionality and authority
- Conduct a training needs assessment related to electrification for all institutions that have implementation responsibilities for the NES
- Perform a recruiting and employee retention assessment for all institutions engaged in electrification
- Develop training curricula for electrification planning, distribution expansion planning, medium voltage and off-grid design, and project management functions
- Launch employee recruitment program to address critical staffing needs
- Establish off-grid program design in AED of DoEA
- Form REA

### 4.2.2 Pillar II: Policy and Regulatory

Establishing the minimum level of service defines the threshold that will be used to measure electrified households. That is, any household that has at a minimum Tier 1 level service will be considered electrified. Review and addressing regulatory gaps highlighted in the NES gap assessment and noted in this report is an essential need to support NES implementation. Regulatory issues include review and modification of service provider licenses, quality of service standards, evaluation of the benefit/need for duty exemptions for off-grid materials and review/modification of off-grid equipment standards taken together are intended to strengthen the enabling environment to support the acceleration of grid and off-grid electrification. The activities that will support **Elements 3 and 4** include:

- Draft a policy statement that defines Tier 1 as the minimum level of service for purposes of the Malawi National Electrification Strategy.
- Describe GTF/MTF and present rationale for Tier 1 as the minimum level of service at stakeholder workshop
- Update the Malawi Regulatory Framework for Mini-grids to reflect a single generation/distribution license for mini-grids
- Streamline licensing process for mini-grid service providers
- Develop quality of service guidelines for grid and off-grid distribution systems
- Clarify list of off-grid components to be included for duty exemptions
- Update renewable energy and electrification standards published by the Malawi Bureau of Standards
- Review, evaluate and adopt international standards for renewable energy electrification solutions as they complement/support the Malawi NES implementation goals
- Review, evaluate and adopt the Lighting Global Quality Standards for Pico PV and SHS kits as

they complement/support the Malawi NES implementation goals

Private sector participation, policy changes, and financing mechanisms are needed to accelerate development of the off-grid market. Implementation activities that will support **Element 5** include:

- Integrate results from Elements 4, 7, 8, 9, and 10 to prepare policies, design the policy and regulatory framework, and financing mechanisms to support scale up off-grid market
- Ensure off-grid projects (mini-grids and stand-alone solar projects) are identified and prioritized in project funding as a function of the annual integrated grid/off-grid NES planning process

### 4.2.3 Pillar III: Technical & Planning

While the scope of the NES does not include responsibility for providing additional generation resources, the power supply deficit may have a significant impact on program goals and implementation activities. With this in mind, the following implementation activities are recommended to support **Element 7**:

- ESCOM, as Single Buyer (and all generation companies supplying ESCOM), will be requested to provide a quarterly report to the ESS regarding installed and available generation capacity, available power supply from cross border interconnections, and progress on key generation and power purchase (cross boarder) agreements

Implementation activities that will be undertaken to support preparation, training and implementation of least-cost geospatial planning for **Element 7** include:

- Complete digitization of ESCOM MV and LV distribution system
- Digitize all households in Malawi and integrate in geospatial platform
- Completion of detailed geospatial electrification plan for grid and off-grid project identification and analysis
- Install geospatial facilities and provide training to ESCOM and MAREP for grid and off-grid planning, project design and monitoring purposes
- Define methodology and procedure to update geospatial platform and synchronize changes in ESCOM, MAREP and AED facilities

Evaluation and adoption of low cost electrification design standards provides the opportunity to extend to impact of available financial resources to meet the electrification needs of low population density, rural communities in a manner which is appropriate to household and business needs. Implementation activities that will support **Element 8** include:

- Preparation of low cost electrification design standards
- Discussion of low cost options with ESCOM, DoEA/MAREP and other stakeholders
- Integration of new standards into MAREP and ESCOM workflow and procurement process

### 4.2.4 Pillar IV: Financial

The ability of the Malawi NES to achieve its goals is a function of the availability of financial resources to fund the multiple program initiatives, combined with the ability of program beneficiaries to pay the cost

they will be charged for grid and off-grid electricity service. If capital or operating subsidies are needed, needs must be identified and quantified through objective analyses and included in the NES design.

The purpose of Pillar IV elements is to address financing requirements. Element 9 is designed to address promotion of affordable access to electric service for grid and off-grid consumers. Element 10 is designed to evaluate overall program financing needs for the NES.
Implementation activities required for **Element 9** include:

- Conduct affordability studies in areas where grid and off-grid service are expected
- Evaluate the need for capital and operational subsidies for grid and off-grid service
- Use results of affordability analyses to inform tariff and subsidy evaluations
- Collaborate with MERA to review and evaluate lifeline tariff options
- Evaluate means to reduce costs to consumers through capital subsidies, output based results mechanisms, voucher programs and other options.

A financing plan is needed to ensure that sufficient resources are available to support implementation of the Malawi NES. Implementation activities required for **Element 10** include**:**

- Project annual grid densification, grid expansion and off-grid connection targets through the Malawi NES implementation horizon (through 2030)
- Evaluate likely unit costs of grid densification, grid expansion, mini-grids, and stand-alone solar solutions for the Malawi NES
- Using annual projection targets and estimated unit costs, project annual and life of program financing requirements
- Identify and evaluate sources of funds, including the use of the existing Rural Electrification Fund (REF) for grid and off-grid development

Table 7 summarizes the implementation activities for all elements.

**Table 7.** Summary of implementation activities.

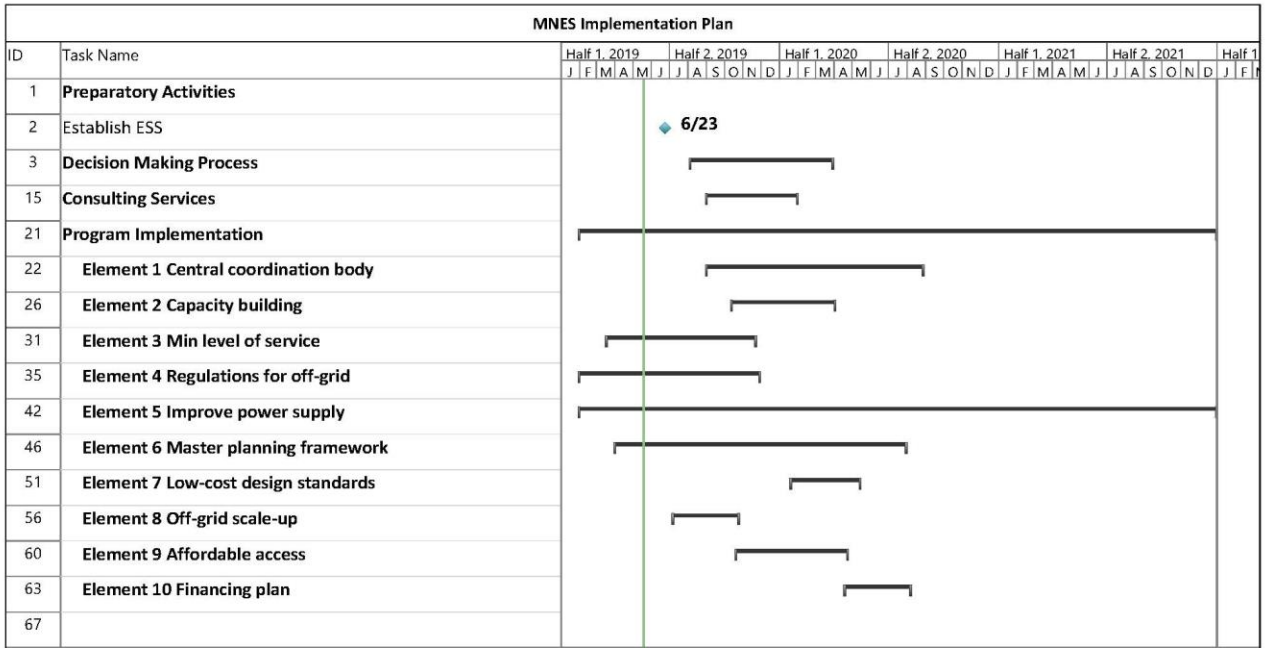
| Pillar | NES Element | Implementation activities: |
|---|---|---|
| I: Institutional | E1: Define roles & responsibilities of implementation agencies | ● Clarification of the roles and responsibilities of ESCOM, AED/DoEA, and MAREP<br>● Formation and definition of ESS functionality and authority<br>● Presentation of ESS functionality, role and authority at the NES stakeholder workshop<br>● Establish the ESS<br>● Determine when Rural Electrification Authority (REA) will be established, define functionality and authority, and legal status.<br>● Make decision on establishment of REA |
| | E2: Develop capacity building programs | ● Conduct a training needs assessment related to electrification for all institutions that have implementation responsibilities for the NES<br>● Perform a recruiting and employee retention assessment for all institutions engaged in electrification<br>● Develop training curricula for electrification planning, distribution expansion planning, medium voltage and off-grid design, and project management functions<br>● Launch employee recruitment program to address critical staffing needs<br>● Incentive mechanisms for improved staff performance |
| II: Policy & Regulatory | E3: Minimum level of service | ● Drafting a policy statement that defines Tier 1 as the minimum level of service for purposes of the Malawi National Electrification Strategy.<br>● Describing the MTF and presenting the rationale for Tier 1 as the minimum level of service at stakeholder workshop<br>● Revision of Malawi Renewable Energy Strategy to reflect minimum level of service decision<br>● Revision of Malawi National Energy Policy to reflect minimum level of service decision |
| | E4: Licensing, QOS, duty exemptions, equipment standards | ● Review and possible modification of the Malawi Regulatory Framework for Mini-grids, specifically to evaluate the degree to which a single generation/distribution license will benefit mini-grid development<br>● Evaluate licensing process for off-grid service providers to identify the means by which review/approval processes can be streamlined<br>● Develop quality of service guidelines for grid and off-grid distribution systems<br>● Evaluate the benefit of expanded duty exemptions for off-grid power solution systems and components |

| Pillar | NES Element | Implementation activities: |
|---|---|---|
| | | ● Review and update renewable energy and electrification standards published by the Malawi Bureau of Standards<br>● Review, evaluate and adopt international standards for renewable energy electrification solutions as they complement/support the Malawi NES implementation goals<br>● Review, evaluate and adopt the Lighting Global Quality Standards for Pico PV and SHS kits as they complement/support the Malawi NES implementation goals |
| | E5: Scale up off-grid development | ● Integrate results from Elements 4, 7, 9, and 10 to prepare policies, design the regulatory framework, and financing mechanisms to support scale up off-grid market<br>● Ensure off-grid projects (mini-grids and stand-alone solar projects) are identified and prioritized in project funding as a function of the annual integrated grid/off-grid NES planning process |
| III: Technical & Planning | E6: Power supply deficit | ● ESCOM (as Single Buyer) will be requested to provide a quarterly report to the ESS regarding installed and available generation capacity, available power supply from cross border interconnections, and progress on key generation and power purchase (cross boarder) agreements |
| | E7: Master planning framework | ● Complete digitization of ESCOM MV and LV distribution system<br>● Completion of geospatial electrification plan (by Millennium Promise)<br>● Design and establish electrification master planning process that will be managed by the NES coordinating body – integrating grid expansion planning by ESCOM and off-grid planning by DoEA/MAREP |
| | E8: Low cost electrification design standards | ● Preparation of low cost electrification design standards<br>● Discussion of low cost options with ESCOM, DoEA/MAREP and other stakeholders<br>● Integration of new standards into MAREP and ESCOM workflow and procurement process |
| IV: Financial | E9: Affordable access | ● Conduct cost of service analyses for grid and off-grid service<br>● Evaluate the need for capital and operational subsidies for grid and off-grid service<br>● Collaborate with MERA to review and evaluate rational tariff strategy<br>● Collaborate with MERA to design and implement stakeholder information and awareness campaign<br>● Design a national data collection framework for understanding consumer affordability and willingness to pay for electricity service<br>● Use results of affordability analyses to inform tariff and subsidy evaluations |
| | E10: Financing Plan | ● Project annual grid densification, grid expansion and off-grid connection targets through the Malawi NES implementation horizon (through 2030) |

| Pillar | NES Element | Implementation activities: |
|---|---|---|
| | | ● Evaluate likely unit costs of grid densification, grid expansion, mini-grids, and stand-alone solar solutions for the Malawi NES<br>● Using annual projection targets and estimated unit costs, project annual and life of program financing requirements<br>● Identify and evaluate sources of funds, including the use of the existing Rural Electrification Fund (REF) for grid and off-grid development |

Figure 3 below provides a project schedule for the NES Implementation Plan in a Gantt chart format.

**Figure 3.** NES Implementation Activities Gantt Chart



## 4.5 Stakeholder and Donor Contributions to the Strategy

Stakeholder roles in implementing the NES elements are presented in matrix below. Thereafter, donor-sponsored programs are reviewed with support/contributions to the NES analyzed.

### 4.5.1 Stakeholder roles and responsibilities related to NES elements

The matrix shown in Table 8 below presents NES elements as well as stakeholder roles and responsibilities. Primary responsibility for a strategic element is designated as "1" in the matrix implying that the stakeholder is responsible for implementation and stewardship of the respective NES element. "2" indicates that the stakeholder plays a supporting role but is not primarily responsible for implementation. Blanks spaces in cells of the matrix indicate that the stakeholder has no role or responsibility for the corresponding element.

**Table 8.** Stakeholder roles and responsibilities referenced to NES elements

| Pillar | NES Element vs Stakeholder | MONREM/DoEA | ESCOM | MERA | MBS | MRA | EGENCO | *Private Sector* | *FIs and MFIs* |
|---|---|---|---|---|---|---|---|---|---|
| I: Institutional | E1: Centralized coordinating body | 1 | 1 | 2 | | | | | |
| | E2: Capacity building program | 1 | 1 | | | | | | |
| II: Policy & Regulatory | E3: Minimum level of service | 1 | | 2 | | | | 2 | |
| | E4: Licensing, QOS, duty exemptions, equipment standards | 2 | 2 | 1 | 1 | 1 | | | |
| | E5: Scale up off-grid development | 1 | | 2 | | | | 1 | 2 |
| III: Technical & Planning | E6: Power supply deficit | 2 | 1 | 2 | | | 1 | 2 | |
| | E7: Least cost planning framework | 1 | 1 | | | | | | |
| | E8: Low cost electrification design standards | 1 | 1 | | | | | | |
| IV: Financial | E9: Affordable access | 2 | 1 | 1 | | | | | |
| | E10: Financing Plan | 1 | 1 | 2 | | | | 2 | 1 |

### 4.3.2 Donor program contributions to NES elements

In addition to contributions made by the GoM and private sector participants to the Malawi NES, the donor community has and will continue to provide funding, technical support and advisory services to the electrification program. Table 9 below presents donor programs that are contributing to NES strategic initiatives. "X" indicates that donor has either committed funds to a program element or is already financing activities that support the strategic element. A blank indicates no relationship between an element and a donor program.

**Table 9.** Donor Contributions to NES Elements

| Pillar | NES Element | World Bank | UNDP | UNICEF | AfDB | KfW | SOGERV | USAID/SAEP |
|---|---|---|---|---|---|---|---|---|
| I: Policy, Institutional, & Regulatory | E1: Stakeholder responsibilities | | | | | | | |
| | E2: Capacity building program | | | | | | | X |
| II: Policy & Regulatory | E3: Minimum level of service | X | | | | | | |
| | E4: Licensing, QOS, duty exemptions, equipment standards | | | | | | | X |
| | E5: Scale up off-grid development | X | X | X | | | X | X |
| III: Technic | E6: Power | X | | | X | X | | |

| Pillar | NES Element | World Bank | UNDP | UNICEF | AfDB | KfW | SOGERV | USAID/SAEP |
|---|---|---|---|---|---|---|---|---|
| al & Planning | supply deficit | | | | | | | |
| | E7: Least cost planning framework | X | | | | | | X |
| | E8: Low cost electrification design standards | | | | | | | X |
| IV: Financial | E9: Afford access | X | | | | | | X |
| | E10: Financing plan | X | | | | | | |

# 5 Electrification Program Funding

Funding for investments in electrification have been generated through power sector revenues and supplemented by support from development partners including the World Bank, the Millennium Challenge Corporation, and JICA. This section will review the historic funding levels and will also present an analysis of the funding that will be required to achieve the Government of Malawi electrification goals through 2030.

## 5.1 Historic electrification program funding

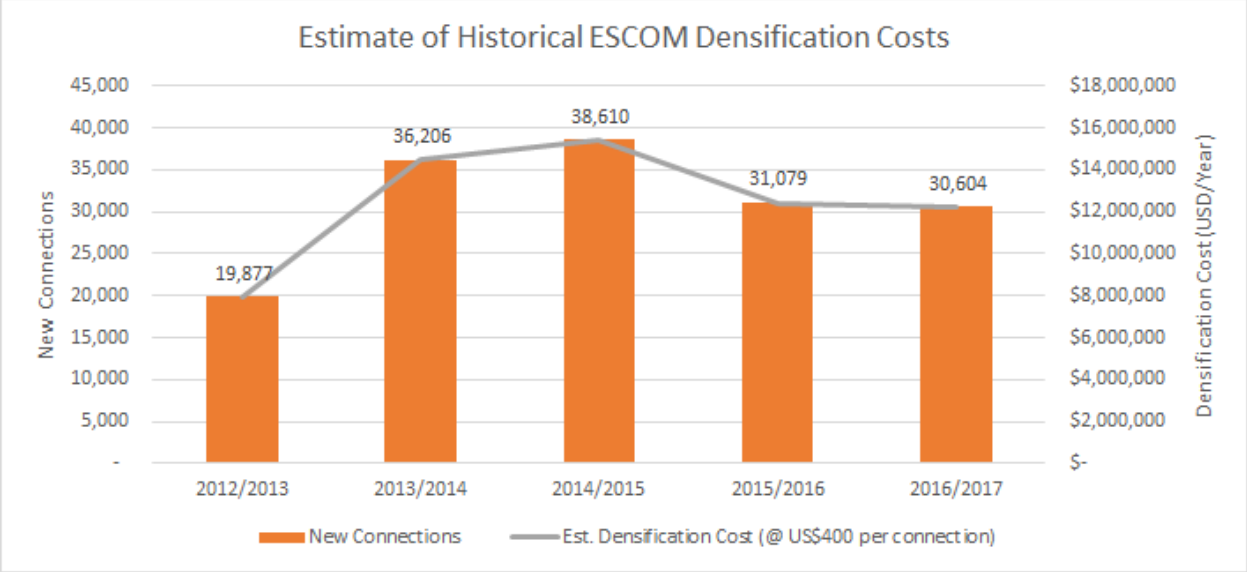
The World Bank is one of the principal sources of support for power sector development in general, and for the electrification program specifically. Beginning in 2011 the World Bank financed a program to support transmission and distribution system upgrades for ESCOM with a project value of US$84.7 million. This program included feasibility studies for expansion of the transmission backbone, expansion of hydropower generation capacity, and other supporting technical assistance

In 2013 the GoM signed a US$350 million Compact with the Millennium Challenge Corporation (MCC) of which US$269.2 million was allocated for urgent rehabilitation and modernization of the ESCOM

transmission system, grid substations, and Nkula hydroelectric power plant. The Compact further financed hydropower plant refurbishment and focused on power sector reform activities aimed at restoring the ESCOM's financial position. As of early 2018, 89 percent of the total MCC grant was committed and 57 percent expended.

An estimate of the historic cost of consumer connection by year, using a conservative value for average densification costs of US$400 per connection, is shown in Figure 4. Assuming that connections are limited to densification only – or that ESCOM-financed expansion connections are a small fraction of the densification connections, the pace of 30,000 connections per year results in a cost of approximately US$12 million per year.

**Figure 4.** Estimate of Historical ESCOM Densification Costs




Source: World Bank/ESCOM, NRECA estimates, 2018

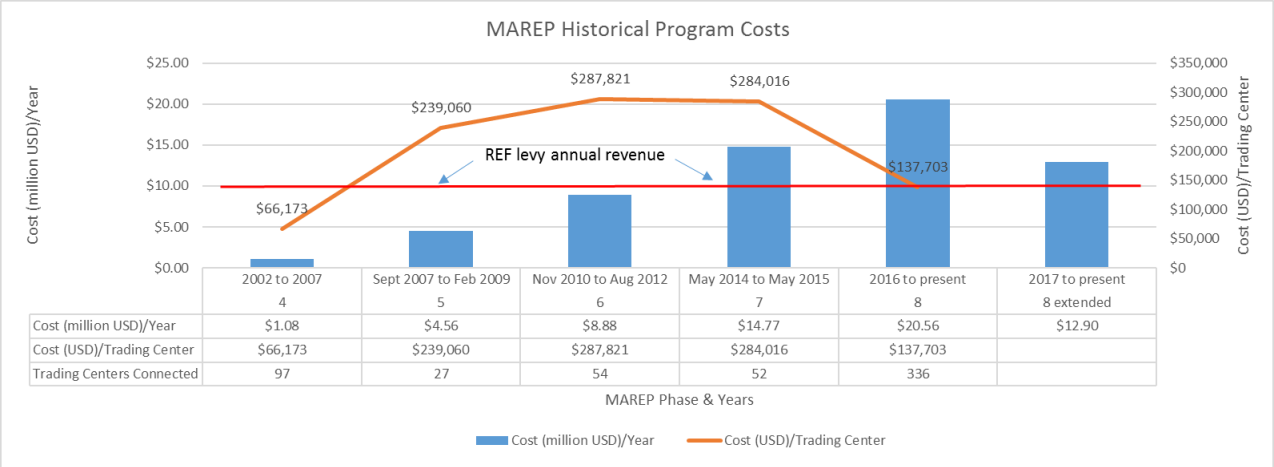
The MAREP program is financed through the Rural Electrification Fund that derives revenues via a 4.5% energy levy on all energy sales. The levy results in monthly collections of approximately US$ 833,000 or nearly US$ 10 million per year. MAREP has also received financial support from JICA through 2009, but funding has not been received since the conclusion of MAREP Phase 4. It is recommended that the ESS establish clear guidelines for the use of REF funds and that the ESS carefully consider allocation of as much as 50% or more of future REF funds to jump start expansion of AED off-grid electrification investments.

Figure 5 below presents MAREP's historical program costs per year by Phase. This figure also presents the cost of electrifying trading centers and the number of trading centers connected in each phase. MAREP has increased program scope from phase to phase resulting in a steady increase in impact over time. Program funding has totaled US$105.6 million since 2002.

MAREP has shifted program implementation modalities in an effort to manage costs, principally by beginning to use private construction contractors in parallel with ESCOM resources since Phase 7. However, additional measures to reduce costs and expand resources will be required to accelerate

electrification program impact. As can be noted in the estimate of annual program costs below, both Phase 7 and 8 require larger annual funding streams than the levy can achieve.

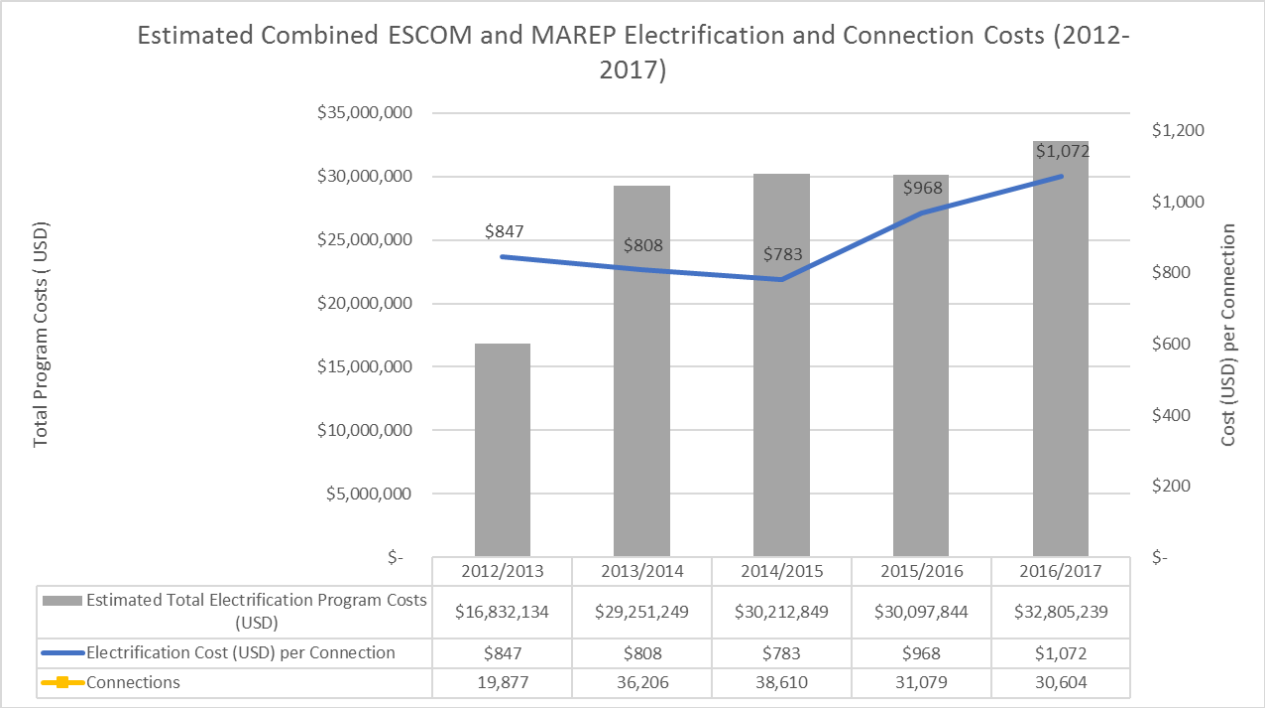
**Figure 5.** MAREP Program Costs




Source: MAREP, Description of Completed/Ongoing MAREP Phases Report, 2018

While it is clear that ESCOM and MAREP have made a more concerted effort to support a significant increase of consumer connections in recent years, connections and financing levels still fall short of the levels needed to achieve 2035 electrification goals outlined in the NEP. Figure 6 presents an estimate of the combined ESCOM and MAREP annual electrification program financing levels, as well as the connections achieved and cost per connection. As shown in Figure 6, annual program expenditures have averaged US$30-33 million since 2014, with an average cost per connection of approximately US$1,000.

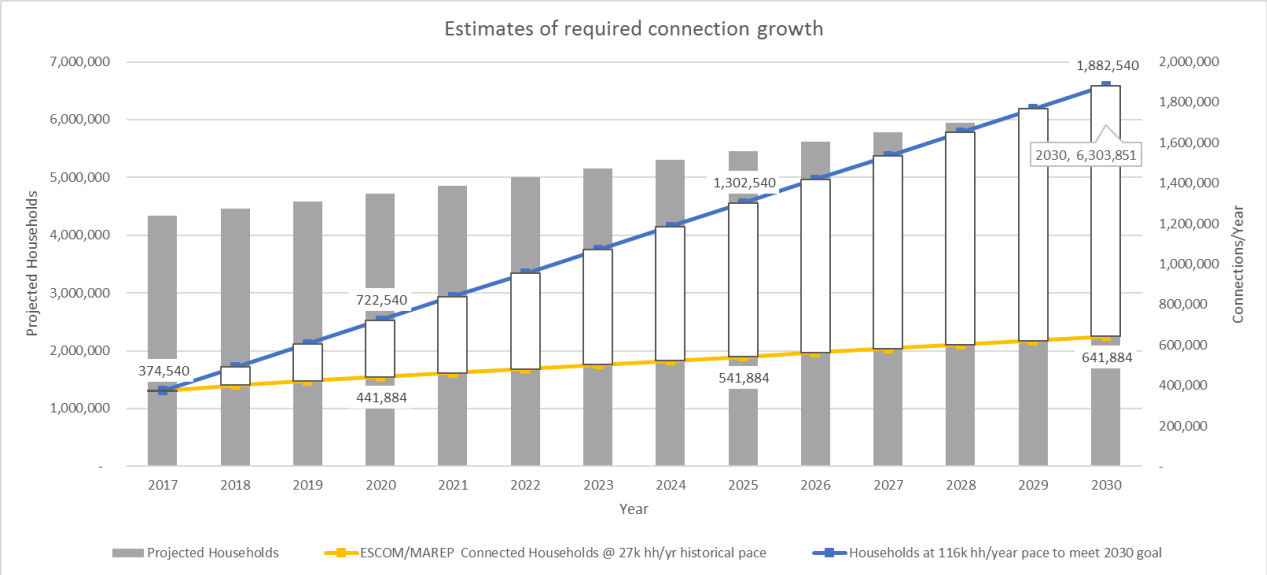
**Figure 6.** Estimate to combing ESCOM and MAREP historical costs




Source: World Bank/ESCOM, MAREP, NRECA estimates, 2018

ESCOM and MAREP programs combined account for an average of approximately 27,000 connections per year since 2012. Figure 7 illustrates the impact of population growth which results in a household growth rate of approximately 121,000 new households per year.

**Figure 7.** Household growth, ESCOM growth, and required connection growth




Source: Malawi IHS 2017, United Nations World Population Prospects 2017, NRECA estimates 2018

The existing sources of electrification expansion that include ESCOM customer fees and the REF levy do not provide sufficient funding to finance electrification program needs to achieve the NEP goals. This will be explained in greater detail in the following section.

## 5.2 Funding requirements to achieve 2030 electrification goals

Figure 7 from the preceding section illustrates that approximately 116,000 connections will need to be added per year to achieve the NEP access goals. This will result in approximately 1.5 million newly connected consumers – approximately 1.85 million in total.

While there is insufficient data to evaluate the exact expansion cost at this time, an estimate can be derived as shown in Table 10 below and using the following assumptions:

1. Grid densification will continue to connect up to 500,000 equal to roughly twice the currently served consumers given the total distribution transformer capacity compared to the total estimated load on the ESCOM distribution system. Additional consumers will be served at an **average cost of $400 per consumer** ($115 per service connection and about 5% of low voltage distribution cost). The current distribution transformer capacity and presumably, feeder capacity will not likely accommodate more than 500,000 additional consumers for the existing distribution infrastructure.
2. Taking into account the recent results of the first order electrification expansion analysis, grid expansion is likely to account for approximately 700,000 new consumers at an approximate cost of **$900 per connected consumer** – considering that the average present cost has been $1000 per consumer combined with cost savings due to proposed low cost technology of up to 20% of present cost.
3. Off-grid service will serve up to 300,000 consumers, 50,000 via mini-grid and 250,000 using solar home systems. Mini-grid costs estimated at $1,000 per consumer, stand-alone solar solutions at $200.

**Table 10.** Funding requirements to achieve 2030 electrification connection targets

| Electrification solution | Connection Estimate | Estimated cost per unit | Total cost |
|---|---|---|---|
| Grid densification | 500,000 | $400 | $200,000,000 |
| Grid expansion | 700,000 | $900 | $630,000,000 |
| Mini-grid | 50,000 | $1,000 | $50,000,000 |
| Stand-alone solar | 250,000 | $200 | $50,000,000 |
| **Totals** | **1,500,000** | | **$930,000,000** |

Source: UNSE4ALL Action Agenda for Malawi & author's elaboration

Given the limited information available for both ESCOM densification costs per consumer and MAREP grid expansion costs, it would be useful to evaluate the impact of higher than expected grid densification, expansion and mini-grid costs. For purposes of the sensitivity analysis, it is assumed that densification costs of $500 per consumer; expansion costs of $1,300 per consumer, and mini-grid costs of $1,500 per consumer. The results are shown in Table 11 below.

**Table 11.** Sensitivity analysis of program funding requirements

| Electrification solution | Connection Estimate | Estimated cost per unit | Total cost |
|---|---|---|---|
| Grid densification | 500,000 | $500 | $250,000,000 |
| Grid expansion | 700,000 | $1,300 | $910,000,000 |
| Mini-grid | 50,000 | $1,500 | $75,000,000 |
| Stand-alone solar | 250,000 | $200 | $50,000,000 |
| **Totals** | **1,500,000** | | **$1,285,000,000** |

# 6 Monitoring and Evaluation of the NES Implementation

Monitoring NES implementation is an important function to allow identification of the need for adjustments in specific activities, to allow for changes in market conditions, and to provide the basis for preparation and presentation of program updates to national policy makers. For this purpose, it is recommended that MoNREM define a monitoring framework to on the one hand, establish a baseline for NES impact evaluation, as well as to provide periodic impact analyses to GoM policy makers. The performance indicators and targets for all NES activities will be the subject of a specific consulting assignment that will be undertaken as a part of the NES implementation program. The table below presents an initial set of key performance indicates that can be used as a starting point in this process.

**Table 12.** Monitoring and evaluation approach

| NES Element | Monitoring Metrics | Periodicity of evaluation |
|---|---|---|
| **E1: Stakeholder responsibilities** | Completion metrics:<br>1. Establish REA<br>2. Transfer responsibilities between ESCOM, MAREP, & AED. | By end 2019. Semi-annual reviews thereafter. |
| **E2: Capacity building program** | Progress metrics:<br>1. Training needs assessment for ESCOM, MAREP, and AED. Establish training targets.<br>2. Training monitoring – completion of mission-critical training events, number of trainees.<br>3. Evaluation of achievement of core competencies. | By end of 2019<br>Annual assessment<br>By end of 2020 |
| **E3: Minimum level of service** | Completion metric:<br>1. Adoption of Tier 1 minimum level of service metric | End of 2019 |
| **E4: Licensing, QOS, duty exemptions, equipment standards** | Progress metrics:<br>1. Completion of revised licensing & approval process<br>2. Duty & VAT exemption adoption<br>3. Update MBS standards for mini-grids<br>4. MERA quality of service standards for mini-grids. | By mid-2020<br>By end of 2019<br>By end of 2020<br>By end of 2020 |
| **E5: Scale up off-grid development** | Progress metrics:<br>1. Develop & finance 25 near-term mini-grids<br>2. Establish financial incentives for solar system providers<br>3. Establish co-financing policy for mini-grid developers | End of 2019<br>End of 2020<br>By March 2020 |

| | | |
|---|---|---|
| **E6: Power supply deficit** | Monitor power supply shortfalls: update & projected | Six month updates |
| **E7: Least cost planning framework** | Progress metrics:<br>1. Integration of geospatial planning process at ESCOM and MAREP<br>2. Completion of least cost geospatial roll out plan<br>3. Advanced training for updating least cost planning | By December 2019<br>By December 2020<br>By June 2021 |
| **E8: Low cost electrification design standards** | Completion metric:<br>1. Low cost standards completed<br>2. Standards adopted for design/construction process by ESCOM & MAREP/REA | By October 2020<br>By January 2021 |
| **E9: Afford access** | Progress metrics:<br>1. Willing to pay studies completed<br>2. Capital subsidy mechanism for mini-grids<br>3. Off-grid operating subsidy mechanism designed | By March 2020<br>By June 2020<br>By December 2020 |
| **E10: Financing plan** | Progress metrics:<br>1. Evaluate program costs | Annually |