Vanuatu National Electrification Master Plan (NEMP)

(2026-2030)

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Executive Summary

1. Introduction

The **National Energy Road Map (NERM) 2016-2030** and its **Implementation Plan (NERM IP)** form the overall policy framework for developing the energy sector in Vanuatu. NERM has five priority policy objectives targeting energy that is accessible, affordable, secure and reliable and sustainable, with green growth. By 2030 it is planned that all households in Vanuatu will have access to an electricity supply.

The **Department of Energy (DoE),** through the Ministry of Climate Change (MoCC), is responsible for developing energy policies, legislation and regulations. The DoE has identified the need to develop a **National Electrification Master Plan (NEMP)** that will complement the NERM/NERM IP, to meet the NERM targets related to electricity access by 20230.

The **NEMP's objective is to offer Vanuatu a comprehensive and systematically staged plan to improve and further accelerate universal electrification coverage in alignment with the NERM**.

2. Geospatial analysis

This chapter describes the methodology and results of the geospatial analysis for national-scale least-cost electrification planning on the settlement level, including its underlying datasets. **All analysis results are interactively visualized in VIDA's online software**, which has been customized for this specific project of national least-cost electrification planning with a specific focus on off-grid systems.

The 2020 Vanuatu Census identified **61,345 households in the country**, of which nearly **40% are connected to the main grids** of the existing concessions (UNELCO, VUI, and VanPawa). **The geospatial analysis** presented in this report **assesses the least-cost electrification approach to serve the remaining 60%,** which represents a total of 33,979 households.

The least-cost analysis considers **three main options to electrify a settlement** that is currently not electrified: **Grid extension** if existing power infrastructure can easily be extended to reach the target customers; **Mini-grid** if the number of customers, their respective demand, and the density of the customers justifies building a mini-grid to connect them all; and **Standalone system** if none of the previous two is possible.

According to the least-cost analysis, mini-grids are the preferred electrification approach for 52% of the unelectrified customers, standalone PV solutions for 33%, and grid extension for 15%. Eventually, if the entire country were to be electrified using the proposed approaches, 42% of the customers would be electrified through the existing concessions (UNELCO/VUI/VanPawa), 30% through the newly implemented mini-grids, 19% through standalone, and 9% through grid extension.

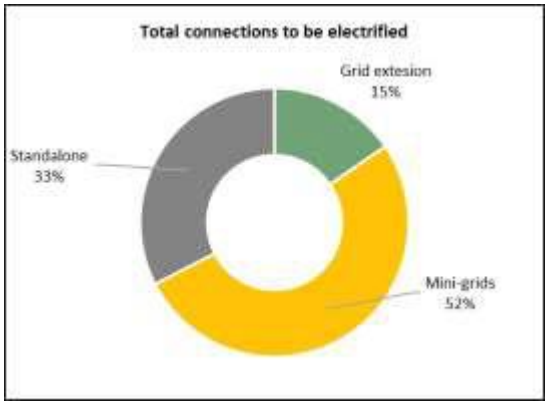

Figure 1. Proposed electrification approach for the currently unelectrified connections.

The following table provides the proportion of total connections to be electrified by each least-cost electrification solution by province and nationwide.

Province	Grid extension		Mini-grid		Standalone		Total # connections
	% of total connections	Grid extension connections	% of total connections	Mini-grid connections	% of total connections	Standalone connections	(to be electrified)
Tafea	3.7%	256	54.3%	3,713	42.0%	2,873	6,842
Shefa	24.4%	1180	51.2%	2,474	24.4%	1,182	4,836
Penama	11.3%	808	56.8%	4,064	31.9%	2,278	7,150
Malampa	22.0%	1751	54.3%	4,310	23.7%	1,882	7,943
Torba	2.9%	62	58.0%	1,224	39.1%	824	2,110
Sanma	21.2%	1481	40.9%	2,864	37.9%	2,651	6,996
Nationwide	**15.4%**	**5538**	**52.0%**	**18,649**	**32.6%**	**11,690**	**35,877**

Table 1. Least-cost electrification solution and percentage of total unelectrified connections by province

Mini-grids are the least-cost electrification approach for a total of 61 medium and large settlements in Vanuatu. These mini-grids have daily demands above 100kWh/day. The provinces with more of these mini-grids are, by order, Malampa (19), Tafea (11), and Penama (12). The least cost-electrification analysis also identifies 232 small mini-grids with a demand below 100kWh/day.

It is estimated that **an investment between 125 million USD and 160 million USD** (in low-cost and high-cost scenarios, respectively) **is needed to electrify the entire population of Vanuatu:**

- **The proposed mini-grids would require an overnight investment ranging from 83 to 104 million USD**, around 65-67% of the investment required for electrification, and would electrify 52% of the unelectrified population.
- **Standalone solar systems are the preferred approach for the electrification of 33% of total connections in Vanuatu and would require total investments ranging from 46 to 61 million USD** for low and high scenarios, respectively.
- Lastly, Grid extension requires the least upfront investments, **nearly 4 to 5 million USD**, to electrify 15% of total unelectrified connections in Vanuatu; however, it is important to highlight that these costs only include expanding the transmission and distribution network and exclude any potential increase required in the generation capacity.

It is worth mentioning that **around 5,418 connections to be electrified fall within the boundaries of the existing four main concession**s. Around half of these are proposed to be electrified through grid extension, and the rest are proposed to be electrified through mini-grids and standalone systems in equal proportions.

This report presents some of the key results of the analysis, but **all the information is easily available to the government on the VIDA platform**. This map-based online software is a **convenient tool for implementing and monitoring the Master Plan**. As an example, it facilitates project selection and prioritization through the flexible application of filters and sorting. This can help the government of Vanuatu in the process of clustering the targeted communities. The combination of settlements into larger clusters allows for economies of scale, simplifying not only the construction but also the later operation and maintenance of the infrastructure, especially if the clustering criteria are based on geographical proximity. Other applications of VIDA include the integration of survey data and KPIs from each operating system and the possibility of adding any additional spatial data layers.

3. Institutional Framework

This chapter analyses the policy and planning framework's strengths and opportunities for enhancement to support the NEMP. The **legal and regulatory framework** in Vanuatu is primarily defined by:

- Electricity Supply Act 1972;
- Utilities Regulatory Authority Act 2007;
- National Energy Road Map 2013-2030 (updated in 2016) and its Implementation Plan, which was prepared in 2019

Regarding sector institutions, the **Department of Energy (DoE)** is the primary party responsible for electrification planning and activities. It primarily focuses on policy matters and has challenges handling ongoing projects. It is currently resource-constrained, and its electrification unit is very small.

The electricity supply in Vanuatu is primarily offered by three **concessionaires** that operate in delimited geographical areas (UNELCO in Efate island, VUI in Luganville, VanPawa in Tanna and Malekula islands). The **Utilities Regulatory Authority (URA)** has primary responsibility for regulating electrification and electricity supply activities. The **National Green Energy Fund (NGEF)** is an already established vehicle to financially support projects and activities aimed at achieving the objectives of the National Energy Road Map in providing accessible, affordable, secure, reliable and sustainable energy and green growth. Other government departments also play a relevant role in the off-grid sector despite inter-ministerial collaboration for off-grid areas, which is reportedly not optimal at the moment. Finally, it should be noted that Vanuatu has strong and enduring relationships with its international development partners, many of whom have supported electrification initiatives.

Based on the current institutional and regulatory framework the following recommendations are proposed:

- **Ensure DoE's capacity to implement the NEMP**. Additional resources are required as the DoE's electrification team is resource-constrained and currently lacks the capacity to implement the NEMP.
- **Establish a structure to facilitate inter-ministerial collaboration**. The DoE should establish a platform for itself and the other relevant Government Departments, ie, Industry, Cooperatives, Tourism, Agriculture, Fisheries, Health, Education, and the Telecommunications Radiocommunications and Broadcasting Regulator (TRBR), to coordinate their support for rural development across Vanuatu. The VIDA platform customized for the NEMP offers an excellent digital platform for integral planning.
- **Develop appropriate electricity supply regulations for off-grid areas**. In partnership with the DoE, the URA should develop appropriate electricity supply regulations for areas outside existing concession areas.
- **blish a development partner energy working group**. The DoE has made efforts to better coordinate the support from its development partners by founding the Vanuatu Joint Energy **Esta**Sector Working Group, and this should remain a priority.

4. Delivery Models

After examining some of the latest trends in off-grid delivery models internationally, with their advantages and disadvantages, this chapter provides recommendations on the delivery models for off-grid electrification, as on-grid connections will form part of the existing concessionaire's planning approach:

- **Adopt large-scale concessions where possible**. Among the communities identified in the least-cost electrification analysis, larger 'clusters' of communities are identified to be supplied under concessions, operating under new concession contracts similar to those existing across Vanuatu and as defined in the Electricity Supply Act.
- **Facilitate Energy as a Service (EaaS) business models.** Off-grid projects have high due diligence, transactional and mobilization costs. These can be optimized if the same service provider offers additional services besides electricity retailing. Examples of services that can be integrated as part of EaaS models include:
    - **Appliances**: Operators might choose to include high-efficiency appliances as part of their service.
    - **Bundling of Services**: Electricity suppliers should be encouraged to benefit from economies of scope by providing complementary services, e.g., water supply and agricultural extension services if they can enhance the value of the electricity supply.
    - **Community Productive Uses**: The Service Provider might be interested in not selling kWh but its final use in productive applications such as cold storage, water pumping or processing tools.
- **Adopt a technology-agnostic approach for large-scale concessions and wherever possible**. The Electricity suppliers should be able to decide which is the most appropriate approach to electrify the community based on the local needs and socio-economic conditions. Different approaches can coexist in the service area, tailoring the technical solution to the local specific needs. It is recommended to contemplate the following electrification approaches under the regulation:

  - **Collective Electrification Systems (CES),** such as mini-grids, swarm-grids, or solar kiosks, provide service to multiple users using a single or multiple energy resource points.
  - **Individual Electrification Systems (IES)**, such as solar home systems, provide service to one user.
  - **Single-Appliance Electrification Systems (SAES)**, such as solar pumps, provide an end-use Service to single or multiple users through a single type of appliance. They are an end-use system with embedded generation.
- **Facilitate interaction with other stakeholders to maximize the sustainability of connections**. In the absence of a mature off-grid sector in Vanuatu, cooperation with existing stakeholders not necessarily related to the energy sector but engaged in rural development is essential and will bring mutual benefits.
- **Adopt a Build-own-operate-transfer (BOOT) model for large-scale concessions**. Vanuatu's existing large concessions have clauses requiring them to return assets to the Government after the concession contracts. We recommend that the new concession contracts contain the same clauses for all assets, including standalone solar, primarily for alignment with the existing framework.
- **Allow specific mini-grid models in certain circumstances**. For all communities not identified with large-scale concessions in the least-cost plan, rather than being actively solicited, prospective suppliers ("small-scale electricity suppliers") can apply to the URA to receive a license to supply electricity
- **Allow specific standalone solar models in certain circumstances**. A pay-as-you-go model will only be available to the official service provider under a technology-agnostic delivery model, under either a large-scale or smaller-scale concession/license, but to any supplier outside these areas. Private sale and leasing arrangements should be possible anywhere and not otherwise restricted.

5. Electricity supplier procurement and approvals

This chapter addresses the process for identifying electricity suppliers to apply for the right to supply electricity within a concession or license area and the process for their approval. The following recommendations result from the assessment:

- **A top-down approach for procuring off-grid electricity suppliers in larger (technology-agnostic) concessions will maximise the possibility of achieving the electrification objective.** It is recommended that Vanuatu adopts top-down procurement approaches for identified larger concession areas.
- **Ensure evaluation criteria in top-down tenders consider more than just price.** The incorporation of weighted criteria in addition to the price should be considered. Furthermore, it is recommended to give extra scoring for initiatives that incorporate PUE, or that include multi-sector approach (water, telecomunications, waste, e-mobility, etc).
- **Bottom-up procurement should be allowed for identifying mini-grid and technology-agnostic developers/suppliers.** The DoE and URA will develop a procurement process for bottom-up approval of unsolicited mini-grid developers for areas outside the large concession areas.
- **Bottom-up procurement should be allowed for identifying sellers of standalone systems.** Vanuatu's existing standalone solar suppliers should continue using their supply models alongside the top-down procurement.

6. Tariffs

When regulating electricity utilities, the URA must ensure that utilities provide a safe, reliable, and affordable service to consumers. It sets the maximum price of electricity and water that a utility can charge its customers. Affordability ensures that tariffs and charges determined by the URA for electricity utilities, customer connections, and other utility-related services directly linked to its responsibilities as an electricity utility are fair to customers and sufficient to sustain the utility service. While tariffs within the existing concession areas are determined through a tariff review process with the URA, following the URA's prescribed tariff methodology, there is currently no specific guidance for determining tariffs outside concession areas.

The following tariff approach is recommended under the NEMP:

Contract type	Tariff recommendation	Explanation
Top-down concession	Bid tariff	• Costs will vary across service areas, so a national benchmark will not be appropriate • The competitive bidding process for concessions should direct tariffs to cost-recovery levels • If there is inadequate competition in the bidding process, the individualised cost-based tariff limits may be considered • After the top-down concession has been operating for three years, individualised cost-based tariff limits will be applied, as approved by the URA
Community license	Willing buyer, willing seller	• As the customers of a community-owned supplier are also its owners, those same customers should be able to determine tariffs that allow cost recovery without exploiting themselves • Customers can approach URA for assistance in determining tariffs if there are any concerns
'Light-handed' license	Willing buyer, willing seller	• Allowing customers to agree on tariffs with the electricity supplier will assist with keeping costs (and therefore, tariffs) low • If there are many of these sites, this approach will minimise the cost burden on the URA • Customers can approach the URA for assistance in determining tariffs if there are any concerns
Full commercial license	Individualized cost-based tariff limits	• These sites are likely to be larger settlements where the costs of a tariff application and approval can more easily be shared across customers • We do not expect many sites to operate under a full commercial license, keeping the cost burden on the URA at a manageable level

The following additional recommendations are proposed for the tariff approach:

- **Tariff structures should be flexible for all operators,** i.e., there should be no restrictions on the balance between fixed, variable, time-of-use, and other charges.
- **Under the BOOT model the tariffs charged should either ensure full cost-recovery** by the end of the concession or for the remaining value at that time to be paid to the operator as compensation for the assets acquired.
- **No tariff regulation should be applied for standalone solar suppliers** (effectively choosing the willing buyer, willing seller approach), except where these form part of a large-scale, technology-agnostic concession. In this case, the standalone solar will be considered part of the electricity supplier's regulatory asset base alongside any mini-grid assets and its costs recovered accordingly.
- **Concession contract for concessions** – as Vanuatu already has concessionaires operating under concession contracts, these contracts should be the basis for new concessions.
- **Draft regulations for licensees** – we recommend that URA engage a technical consultant to assist in preparing regulations for licensees, including the license template for each of the three licensees identified in this report.

7. Implementation costs and funding

This chapter first suggests an implementation strategy of the NEMP, structured into four phases, aiming to reach universal access by 2030 as established by the NERM. The strategy builds around the idea of

implementing the NEMP in the six provinces of Vanuatu in parallel, and structuring the interventions by area councils (municipalities), which aligns well with the proposed approach of the NERM's Implementation plan. The following table summarises the investment needs for each of the proposed phases:

Phase	CAPEX (low)	CAPEX (high)
Phase 1	32,273,114	41,513,815
Phase 2	52,075,491	66,860,023
Phase 3	21,787,859	27,847,384
Phase 4	27,498,370	35,136,058
TOTAL	**133,634,834**	**171,357,280**

This chapter then assesses how to address the NEMP's financial needs. It first estimates the funding requirements based on an approximation of the expected viability gap and then describes the potential financing options for mini-grids and standalone solar systems. Finally, it draws the following recommendations:

- **Assess affordability**. Identifying the capacity (willingness and ability) of those customers being connected to pay for their connection and ongoing supply. This amount is currently proxied by the commercial funding required as assessed in the chapter. If there is a viability gap between this and the cost to serve, consider support from other customers in the sector. A similar affordability assessment to that for those customers being connected should be undertaken to assess the maximum levy that could be added to customer bills; a priori, we expect this will be in the range of 1-3%.
- **Assess and enhance the capacity of the NGEF to support electrification**. Its governance structures, should be assessed and enhanced to enable it to become an effective conduit for Government and development partner funding.
- **Determine the best subsidy instruments**. A results-based framework approach to provide subsidies to companies supplying standalone solar to remote areas could apply to Vanuatu. Demand-side subsidies can also be considered as an additional component to address the lack of affordability that supply-side mechanisms alone cannot tackle.

8. Technical Regulation

This chapter analyses the current technical framework of the electricity sector in Vanuatu, specifically focusing on all areas yet to be electrified. It identifies gaps and challenges within the existing regulations and offers recommendations for developing a technical framework that ensures a quality and safe supply of electricity.

The current legal technical framework in Vanuatu is primarily composed of the Electricity Supply Act 1972, the Utilities Regulatory Authorities Act 2007, the Electricity Reliability Standards Notice No. 150 of 2018, the Electricity Safety Standards and Rules Notice No 434 of 2014, and the Solar PV Standards 2016.

Based on the existing framework and identified gaps, some of the recommendations made are:

- **Define Electricity access**. It is deemed essential to integrate the Operations and Maintenance vector into the definition of access to electricity, especially for those households and institutions being electrified through standalone systems.
- **Define the service**. The categorization of services offered by the Service Providers should be based on a predefined set of tiered energy attributes. All service providers will use the same attributes to define the service they wish to offer, and they will be included as part of the contract agreements with communities and customers. These attributes shall include Service Quality (Capacity, Availability and Reliability) and Power Quality.
- **Clarify the technical standards**. The *AS/NZS 3000:2018, Electrical installations,* also known as the *Wiring Rules*, should be the preferred candidate for regulating wiring and safety standards.
- **Establish grid interconnection requirements**. It should be noted that Vanuatu is an archipelago, which drastically reduces the probability of grid encroachment. Therefore, the recommendation is not to be very restrictive from a technical standards standpoint to facilitate the development of cost-effective projects in remote areas. It is recommended that the future technical regulation

establishes Interconnection Readiness Levels (IRL) for mini-grids. Whereas in some cases, it might be beneficial to require mini-grids to be grid-ready (adhere to technical requirements of an existing nearby grid), it is not needed for all the projects. In either (i) remote areas with no prospect of interconnecting or (ii) very small mini-grids, it would not be justified to require grid readiness as it would not be cost-effective. The IRL could set grid-readiness requirements depending on the proximity to one of the existing main grids of Vanuatu.

- **Develop a digital platform.** It is recommended that the entire application procedure be digitized to facilitate the application from developers and their processing by the regulator. Also, the same platform should facilitate service providers conveniently reporting their KPIs during operation. Furthermore, this same platform can be used for market information dissemination, which is essential during early stages of market development.

9. Environmental and Social

This chapter supports Objective 11 of the NERM ('*to minimise adverse environmental, social and health and safety impacts of energy infrastructure in Vanuatu*') by **identifying the key risks associated with expanding electrification in Vanuatu and developing environmental and social safeguards (ESS) processes to prevent or mitigate harmful impacts**.

The current legal and regulatory framework with environmental and social implications for the NEMP includes international commitments; energy legislation and implementation policies; waste management frameworsk, land laws and policies; climate and disaster regulations; and finally gender equality, disability and social inclusion regulations.

As part of this assignment**, a series of agency-level ESS consultations were conducted with state and non-government organisations (NGOs) active in the energy sector**. The main concerns identified by stakeholders include the potential land disputes, the capacity constraints at the community level and also for future operators, the e-waste that will be associated with NEMP interventions, the lack of data for sector planning, and the need for a staged approach in implementing the NEMP.

The NEMP includes an **Environmental and Social Safeguards (ESS) Screening** and a **Preliminary Environmental and Social Management Plan** (ESMMP). The final types and sizes of interventions resulting from the NEMP are unknown and will be determined during implementation. Furthermore, the Government of Vanuatu, and possibly also the private sector, will identify potential locations for the interventions. Therefore, the purpose of this screening and the following ESMMP is to guide the DoE, on the environmental and social screening and subsequent environmental and social assessment of sub-projects during project implementation.

In terms of potential social and environmental impacts identified by the ESS Screening and their respective mitigation, the following is highlighted:

- **Pre-construction phase**. As applicable by law, a preliminary Environmental Assessment (PEA), together with an Environmental (and Social) Impact Assessment (EIA) and an Environmental and Social Management and Monitoring Plan (ESMMP), will be required for future NEMP projects. These shall identify, among other things, an analysis of resettlement requirements, land use impacts, and natural hazards.
- **Construction phase**. A range of impacts associated with this phase can be addressed through effective stakeholder engagement and by using best-practice industry standards at all development sites. The DoE developed an Environmental Code of Practice for Health and Safety and Land Permission as part of the VREP project, which can serve as a guide for the NEMP. Furthermore, it is recommended that a Worker Code of Conduct or Community Code of Practice also be adopted.
- **Operation Phase**. The main ongoing impacts during operations involve security and aesthetics of the installations, fuel use for generators (if any), proper maintenance of electricity infrastructure and the impacts of natural disasters. Furthermore, the management and disposal of e-waste are important for the maintenance of long-term community and environmental health.

It is recommended that the DoE work with provincial governments to appoint an **ESS Officer** who will be responsible for ensuring ESMMPs are properly implemented and reported on for all NEMP projects. The

ESS Officer will oversee the implementation of public consultations (thorugh Stakeholder Engament and Communication Action Plans – SECAP) and develop a formal grievance redress mechanism (GRM) to register project complaints. Given the high prevalence of gender-based violence in Vanuatu, it is essential that the GRM incorporate a specific pathway for addressing complaints concerning sexual exploitation, abuse and harassment (SEAH). Furthermore, the ESS Officer will coordinate the preparation of a Code of Practice for Construction, Health and Safety and Land Permission, as well as a Code of Practice for Waste Management.

E-waste generation due to the NEMP implementation is a shared concern across stakeholders. This includes not only the waste caused directly by the power generation and distribution assets at their end of life (PV modules, batteries, cabling, and accessories) but also the appliances that will result from electrifying the off-grid communities for the first time. A high-level estimation suggests that over a 20-year period, the direct e-waste generated by the NEMP could be in the range of 2,000 tones, and the indirect e-waste generated could be in the range of 800,000 basic appliances. A detailed analysis is recommended to refine these preliminary calculations and quantify the magnitude of the e-waste issue.

The contracts with future Service Providers shall incorporate clauses on basic practices for handling e-waste in off-grid communities. To further examine how to manage the waste associated with the NEMP, the country can expand on the PACWASTE initiative.

10. Implementation action plan

Based on the analysis and key recommendations provided in the previous chapters, this last chapter provides a roadmap for Vanuatu's National Electrification Master Plan to facilitate its implementation.

1. Introduction

1.1. Background

Energy is seen as the catalyst for economic development and is cross-cutting with all the 3 pillars of the **Vanuatu National Sustainable Development Plan (NSDP)** (Figure 2). This directly includes goals in health care, quality education, social inclusion, strong institutions, food and nutrition security, blue/green economic growth, climate and disaster resilience and natural resource management and indirectly all other goals.

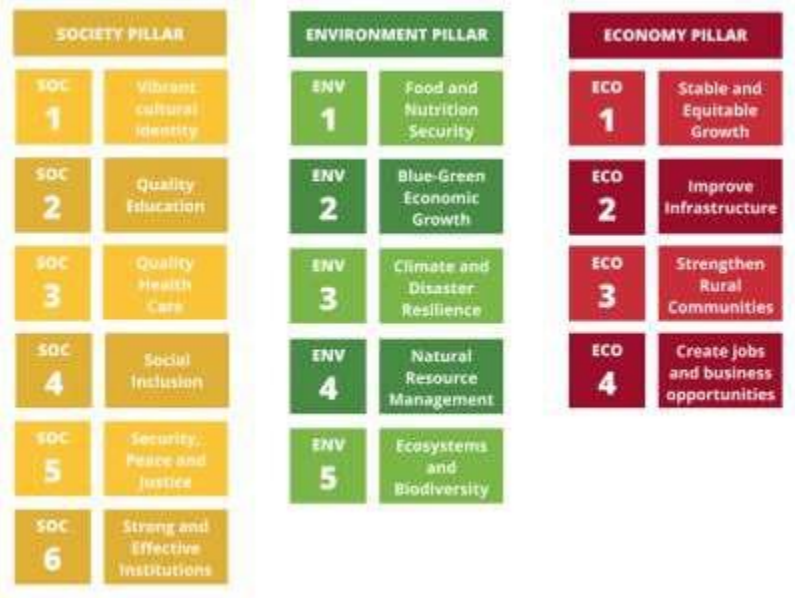

Figure 2: Overview of goals of the Vanuatu National Sustainable Development Plan (NDSP)

The **National Energy Road Map (NERM) 2016-2030** and the Implementation Plan (NERM IP) form the overall policy framework for developing the energy sector in Vanuatu. NERM has five priority policy objectives targeting energy that is accessible, affordable, secure and reliable and sustainable, with green growth. By 2030 it is planned that all households in Vanuatu will have access to an electricity supply, including those outside of the defined 'concession' areas as illustrated in Figure 2.

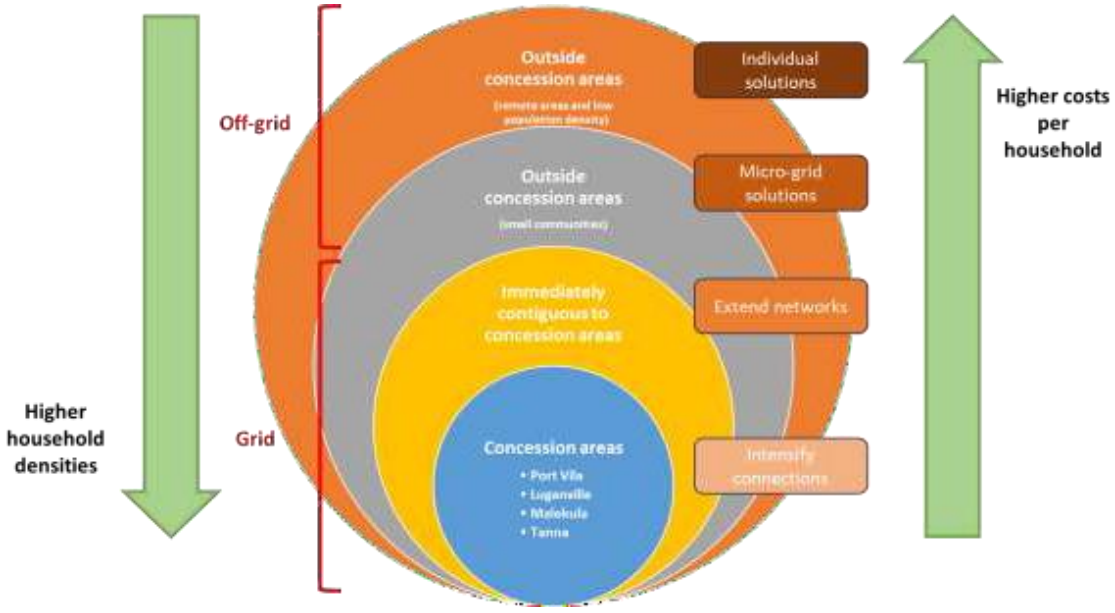

Figure 3: Strategic framework for NERM

Table 2: Priorities and objectives of the National Energy Road Map 2016-2030

Accessible energy	Affordable energy	Secure & Reliable	Sustainable energy	Green Growth
1. Extend electricity access to all households and public institutions. 2. Extend access to modern cooking fuels.	3. Develop mechanisms to facilitate competitive, affordable prices for electricity, liquid fuels and cooking fuels. 4. Promote investment in least-cost electricity projects. 5. Improve the supply-side energy efficiency of electricity generation.	6. Achieve a greater diversity of energy sources. 7. Reduce the likelihood and impact on consumers of volatility in the prices of imported petroleum products. 8. Facilitate the development of energy infrastructure that is resilient to natural disasters.	9. Increase the use of renewable energy as a way to reduce GHG emissions; provide affordable, reliable energy access; and facilitate green growth. 10. Promote energy efficiency across the public and private sectors. 11. Minimise the adverse environmental, social and health and safety impacts of energy infrastructure and use.	12. Promote green energy as a catalyst for sustainable development. 13. Consolidate and expand the use of locally produced biofuels. 14. Promote the use of renewable energy sources in Vanuatu's main economic sectors. 15. Promote the appropriate use of renewable energy and energy efficiency technologies in the water sector. 16. Improve energy-related business and technical skills among rural island people.

Table 3: Revised targets in the Updated NERM

✸ = *New target*

Accessible energy	Affordable energy	Secure & reliable	Sustainable energy	Green growth
Electricity access in and near concession areas (% of HH connected) 2020 90% 2030 100%	**Efficiency of diesel generation** (% reduction in g/kWh fuel use) 2020 20% 2030 20%		**Renewable electricity generation** (% of electricity generated from renewable sources) 2020 65% 2030 100%	**Electricity generation from biofuels** ✸ (% of electricity generated from biofuels) 2020 10% 2030 14%
Electricity access in off-grid areas (% of HH connected) 2020 100% 2030 100%	**Cost of distributing petroleum products** (% reduction in cost) 2020 10% 2030 15%		**Electricity sector and end-use efficiency improvement** ✸ (% saving on BAU projection) 2020 5% 2030 14%	**Rural tourism bungalows using renewable energy** ✸ (% of bungalows using renewable sources of electricity) 2020 25% 2030 65%
Electricity access by public institutions (on- and off-grid) (% of institutions connected) 2020 100% 2030 100%			**Transport energy efficiency improvement** ✸ (% saving on BAU projection) 2020 2% 2030 10%	
			Biomass end-use efficiency improvement ✸ (% saving on BAU projection) 2020 5% 2030 14%	
			Energy infrastructure projects complying with government and donor environmental and social safeguard requirements ✸ (% of projects complying) 2020 100% 2030 100%	

According to the Vanuatu 2020 National Population and Housing Census, about 78% of the population lives in rural areas, and more than 70% of the rural population has little or no access to secure and reliable energy services.

The **Department of Energy (DoE),** through the Ministry of Climate Change (MoCC), is responsible for developing energy policies, legislation and regulations. The DoE has identified the need to develop a **National Electrification Master Plan (NEMP)** that will complement the NERM/NERM IP, with the aim of meeting the NERM targets related to electricity access and establishing monitoring frameworks by 2030. Vanuatu has about 6 years to meet these NERM targets.

The NEMP will indicate the resources required and influence how the DoE should prioritize its resources to achieve the NERM electrification targets in a timely and effective manner. It will also propose rational and coherent solutions for continuing electrification programs after the 2030 targets are met.

1.2. Existing barriers to off-grid electrification

The major barriers identified through the main stakeholder consultations are summarized below:

1. **Unclear enabling and sustainable framework.** The business models to be used are not clearly defined, which has resulted in failed electrification projects in the past. The legal framework outside the concession areas remains unclear
2. **Challenging logistics in remote ares.** Logistics are complex due to the limited accessibility of some rural areas. This makes the resulting systems very expensive.
3. **Lack of sustainability for off-grid projects**. One of the sector's challenges is ensuring the sustainability of the operation of the assets (mini-grids and standalone systems) through robust management models that ensure affordability.
4. **Electrification remains unattractive to the private sector**. To promote its investment, the private sector needs a more stable and clearer framework. Furthermore, the lack of financial support to the private sector is identified as a major limitation.
5. **Lack of resources at DoE**. The DoE is under-sourced; the electrification unit is very small and primarily focused on policy matters. As a result, the unit can hardly handle ongoing projects. It cannot collect the right data and analyse it to offer useful information to stakeholders. They are currently relying on information from other departments as they can't collect their own.
6. **Unknown least-cost electrification approach.** It is now difficult for the DoE to establish where each electrification approach (grid extension, mini-grids or standalone solutions) should be applied.
7. **Unclear implementation path**. The DoE does not have clarity on where to start and how.
8. **Lack of data for decision-making**. Stakeholders lack a reliable centralized database to support decision-making. Data from the census is the primary source to date.
9. **Extended timeframe to secure donor funding**. Mobilizing donor funding takes a long time. There is a need to systematize engagement with the private sector and donors.
10. **Lack of cross-ministry coordination**. Inter-ministerial coordination is difficult despite being identified as essential to promoting a meaningful positive impact on rural communities. This is hindering their development.
11. **Electrification definition**. Despite the government's policy targets regarding electrification, electrification is not defined.
12. **Lack of skilled labour**. There is a serious lack of skilled labour in the electrical sector. Local companies indicate that they try to train technicians, but soon after they are trained, some leave the company.

1.3. NEMP Objectives

This document aims to offer a comprehensive and systematically staged plan for Vanuatu to improve and further accelerate universal electrification coverage in alignment with the National Energy Road Map (NERM) 2016-2030. Additionally, it aims to propose rational and coherent solutions to continue electrification programmes.

Specifically, the objectives of this document include:

- Assess the implementation readiness of Vanuatu's electricity sector designated institutions and implementation agents key to directly and effectively undertake their respective roles in a rapid scaling-up of connectivity nationwide at the scale for which the enabling policy, regulatory, financing framework and supporting processes, procedures, and mechanism(s) and stakeholders must all come together in an effective and sustained manner at the national level going forward to implement on-ground rollout (grid and off-grid).
- Identify the critical impediments to mounting a physical program at the scale and speed required going forward to achieve universal connectivity by 2030, and adequately finance the plan year-in-and out 2022-2030. These potentially include technical challenges (including planning and design for the grid and off-grid rollout, service, and other standards on-grid and off-grid); enabling policy framework and mechanisms aimed at ensuring affordability of access to the poorer households and overall coordination and progress monitoring; institutional aspects (including regulatory oversight, compliance verification); and critically mobilizing adequate financing for the Capex investment required that is orders of magnitude higher than requirements under business-as-usual.

- Recommend the best workable option(s) and associated mechanisms where required to address the essential priority fixes and effectively enable the NEMP implementation rollout in an efficient and sustainable manner for each of the key focal areas—institutional, policy, and regulatory, technical (design and planning, implementation of physical program), and financing—at the sector level.

2. Geospatial analysis

This chapter describes the methodology and results of the geospatial analysis for national-scale least-cost electrification planning on the settlement level, including its underlying datasets. All results are interactively accessible in the *Vanuatu National Electrification Platform*, a customized version of the VIDA software, as a comprehensive electrification planning tool, which is further described in this report.

2.1. Data Inputs

Initially, geospatial datasets across various thematic areas were collected from public and private sources, the latter mostly being governmental agencies of the Republic of Vanuatu contacted by TTA. A thorough quality assessment was conducted before deciding whether to include them in the analysis and software. The quality assessment included, amongst others, visual inspection, cross-checking and comparison between various sources as well as publicly available very-high-resolution satellite imagery and quantitative assessments (e.g. aggregated statistics). For some datasets, VIDA applied post-processing steps such as merging, duplicate removal, or manual corrections of metadata and location.

The selected datasets are presented in two tables below, categorized into public and proprietary sources. All listed datasets have been used in the geospatial analysis and/or for visualization in the VIDA software, as described in the subsequent chapters. VIDA may provide additional public global datasets for map visualization only, such as elevation, and land use.

Additional datasets have been requested unsuccessfully; they were either not delivered at all or in a suitable geospatial format. This includes, amongst others, information on touristic, industrial, and financial activities or infrastructure as well as up-to-date, extensive information on education facilities.

Table 4: Overview of public geospatial datasets included in the analysis and software (collected by VIDA).

Type	Source	Quality	Description / Remarks
Buildings	HOTOSM (2023) / PCRAFI (2022)	Good (varying coverage and quality across islands).	Polygons delineating building footprints based on very high-resolution satellite imagery and/or manual crowd-sourced data collection. VIDA used HOTOSM buildings as a baseline dataset and complemented it with PCRAFI buildings while removing duplicates (buffer analysis).
Roads	HOTOSM (2023)	Good (varying coverage and quality across islands).	Road lines are based on very high-resolution satellite imagery and/or manual crowd-sourced data collection, partially including type information (e.g. primary, secondary, etc.; partially inconsistent).
Points of interest	HOTOSM (2023)	Mixed (strongly varying coverage).	Locations of various points of interest by type, such as businesses, markets, touristic sights and infrastructure, financial institutions, and public or religious institutions. Coverage and classification consistency vary strongly, therefore only used for map visualization.
Regional hubs	HOTOSM (2023)	Good	Locations of larger settlements of socio-economic importance (categories "city" and "town").
Water resources	DoWR Information System (2023)	Mixed (extensive, but geolocation inaccuracies).	Water systems of various types were collected from various sources within DOWR's NIP-CAP Information System (WRI Data reporting table). The geolocations seem inaccurate; further investigations are needed.
Lakes and rivers	HydroSHEDS (2023)	Good (extensive, limited geolocation accuracy).	Lakes and rivers, including hydrological variables (e.g., classification by water volume). Extensive coverage, whereas geolocation has limited accuracy on the local level.
Nighttime satellite imagery	NASA (2023).	Good.	VIIRS nighttime satellite imagery (monthly cloud-free mosaics at approx. 500m resolution) from June 2022 to May 2023. This is an input to VIDA's *GridLight* algorithm to detect regularly lit-up areas.
Administrative boundaries	GeoBoundaries (2022).	Good (yet unofficial).	National and subnational (provinces, area councils) administrative boundaries.

Table 5: Overview of main proprietary geospatial datasets included in the analysis and software (collected by TTA, post-processed by VIDA).

Type	Source(s)	Quality	Description / Remarks
Households	Vanuatu Bureau of Statistics	Good	Point locations of households according to the most recent national (Census 2020) survey, which has full national coverage. One household can consist of several separate buildings. Precision is good overall, whereas geolocation does not seem accurate for a few households compared to very high-resolution satellite imagery. Information on each household's electricity supply is available.
Communities	Vanuatu Bureau of Statistics	Mixed (geo-location partially not precise)	Point locations and names of communities according to the most recent national survey, which has full national coverage. The geolocation of several communities does not seem to be accurate compared to very high-resolution satellite imagery, and no information on the actual extent of the communities is available.
Healthcare facilities	Department of Health	Good	Point locations of healthcare facilities are categorized by type and include names.
Education facilities	Department of Education	Mixed (no uniform type information)	Point locations of education facilities of different types; no uniform type classification, only names partially indicating type (e.g. primary, secondary), but for many, the type is entirely unknown. The more comprehensive and up-to-date annual survey data from the previous year has not been shared yet.
Concessions and existing mini-grids	Department of Energy / TTA	Good	Coverage (polygons) of concessions and mini-grids was manually digitized by TTA and VIDA based on information from the Department of Energy. Within these areas, (mini)grid infrastructure is already in place or in the implementation stage. A map of the legal concession areas was digitized in addition, including areas falling under concessions but currently being unelectrified.
BRANTV mini-grid sites	Department of Energy / TTA	Good	Point location and partially coverage (polygons) of existing and planned BRANTV hydro- and PV-mini-grids. Extensive information on the installed systems, customers and financiers is available for many sites.
NGEF energy projects (standalone)	NGEF	Good	Point locations of NGEF-funded standalone systems with non-uniform additional information, e.g., load and vendor.
Potential hydropower sites	TTA	Unknown	Point locations of potential hydropower sites.
Telecommu-nication towers	Telecommu-nications	Good	Point locations of telecommunication towers including average daily demand, peak power, status and more detailed descriptions.
Seed banks	Department of Agriculture	Good	Point locations of 6 seed banks, including name.
Agronomy potential zones	Department of Agriculture	Good	Areas classified according to agronomy potential (7 classes).

2.2. Methodology

This section provides information on VIDA's geospatial analysis methodology to identify and characterize all settlements in Vanuatu, to assess their current electrification status and least-cost electrification options with a techno-economic assessment, and finally, to visualize them in the interactive map-based VIDA online software for smart electrification planning, both at national scale and at settlement level (summary see Figure 4 below).

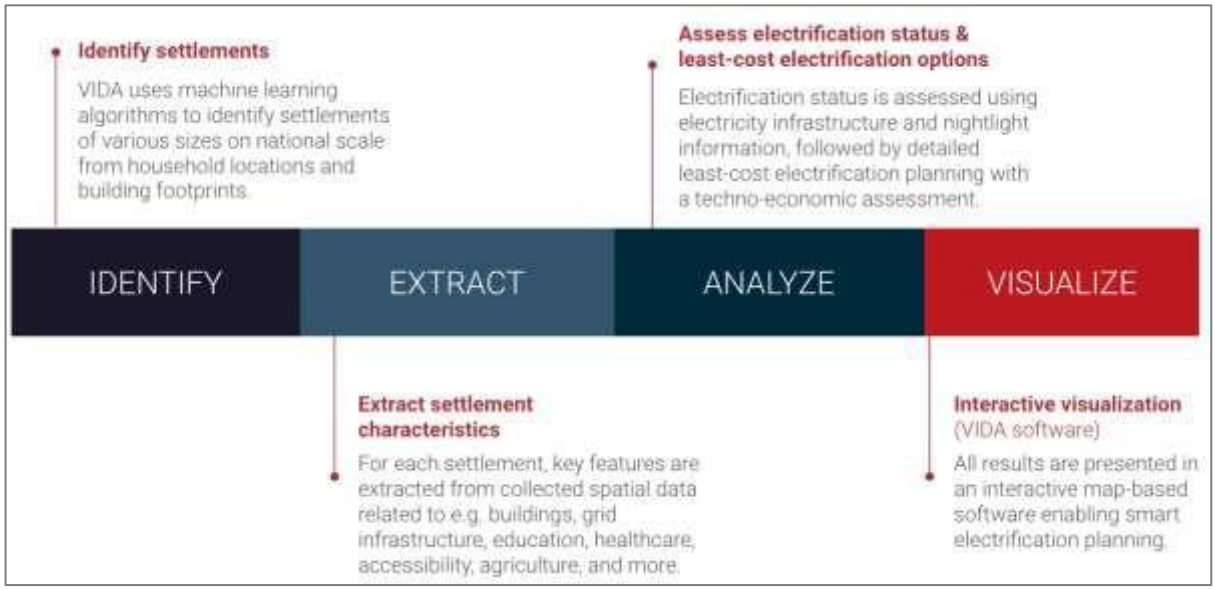

Figure 4: Overview of VIDA's geospatial analysis methodology.

2.2.1. Settlement identification

Settlements are at the core of this geospatial study—they are the central assessment unit as electrification planning is typically conducted down to this level. Thus, initially, all settlements across Vanuatu, including larger towns as well as very small rural communities, needed to be identified.

The core datasets for this mapping exercise are households, the smallest assessment unit. This is where people live and ultimately get access to electricity. The Vanuatu National Bureau of Statistics (VNSO) provided the geolocation of households from the most recent national survey (census 2020). One point coordinate is available per household, consisting of several buildings in its vicinity (whereas the exact extent is unknown). Also, buildings representing businesses or serving other non-residential purposes, which can also be relevant for electrification planning, are unavailable or at least shared with the Consultant.

Accordingly, this household dataset was then complemented by building footprints: polygons representing building structures automatically or manually extracted from very high-resolution satellite imagery. Globally available building datasets from providers such as Google or Microsoft do not include Vanuatu. Therefore, VIDA reviewed several alternative data sources and ultimately complemented crowd-sourced OpenStreetMap buildings with an additional building dataset from PCRAFI where no OpenStreetMap buildings were present (buffer zone of 50 meters). This resulted in the final national database of over **118,000 buildings**.

VIDA then applied a density-based clustering algorithm (DBScan) to a merged dataset of households and buildings to identify settlements within Vanuatu's national administrative boundaries. This algorithm builds a rough convex hull and a more accurate alpha shape around dense built-up areas corresponding to the settlement boundaries (also called clusters). In addition, a minimum spanning tree connecting all households within each cluster was generated, representing an indicative mini-grid design (see Figure 5, next page).

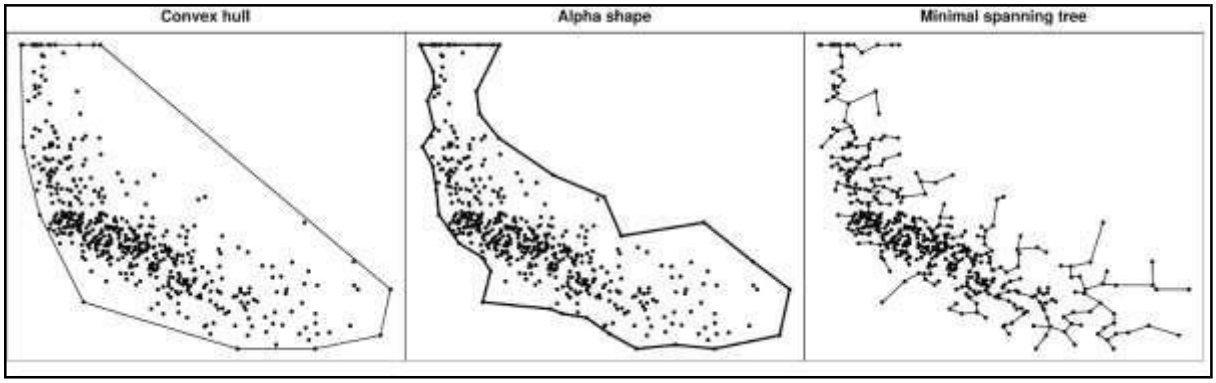

Figure 5: Settlement identification using a density-based clustering algorithm (DBScan): Examples of a convex hull, alpha shape, and minimum spanning tree of a dense cluster (points representing building centroids).

This algorithm uses several input parameters related to the density and size of clusters to be generated. These parameters were selected based on experience from other countries and experiments with subsequent result assessment using visual inspection of high-resolution imagery and generating aggregated statistics.

The following parameters were finally applied:

- **Minimum building size:** 10 m^2
  - Smaller buildings are more likely unpopulated, e.g. storehouses, sheds, and kitchens. They are still displayed on the map and counted within each site's building statistics (for more details, see next subsection).
  - Household locations from VNSO data were fully utilized (no exclusion).
- **Maximum distance between neighbours:** 200 meters
- **Minimum number of neighbours within this distance:** 5
- **Minimum size of a settlement:** 4 buildings (> 10 m^2) or households

VIDA identified **2,157 settlements** in the country using these input parameters (see Figure 6). These include very small rural villages and larger cities such as Port Vila or Luganville. However, most of these settlements are very small, with 64 per cent comprising less than 10 households. In total, 195 settlements have at least 50 households, and 66 have at least 100 households.

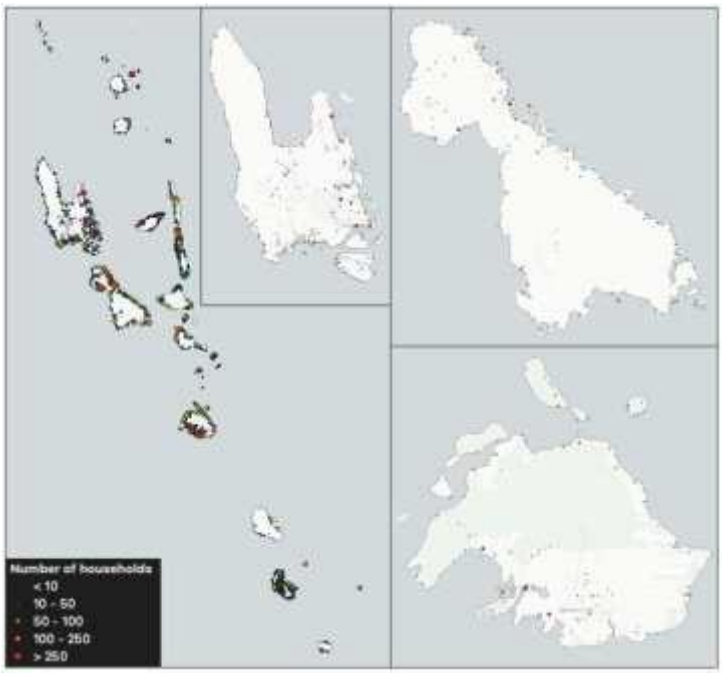

Figure 6: Overview maps of the 2,157 settlements identified in Vanuatu, coloured by size (number of households).

2.2.2. Extraction of settlement characteristics

Next, VIDA extracted characteristics for each identified settlement based on the spatial datasets (map layers) collected from various sources, as described in the previous chapter. Spatial analysis methods were applied, ranging from calculating distances or counting features to more advanced, customized methods to assess, e.g. security risk. These characteristics relate, amongst others, to general settlement statistics, accessibility, social infrastructure, security, and energy access. Over 50 quantifiable characteristics are extracted per settlement, as further outlined below.

Figure 7 shows how these characteristics and map layers are displayed on VIDA for an exemplary settlement in Vanuatu (Olal). They are described in the subsequent subsections. All mentioned datasets are available as map layers in the VIDA software, including any metadata as pop-ups, and can be downloaded from there.

Note that additional information related to energy infrastructure, electrification status, and mini-grid viability, such as energy demand or cost estimates, was extracted or generated for each settlement. These are described in more detail in the next subsection.

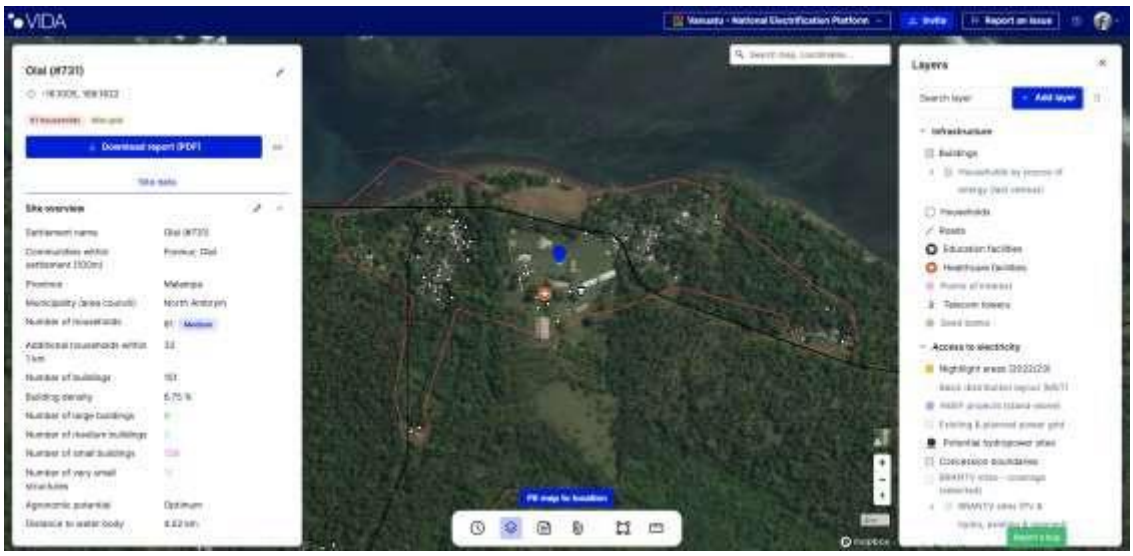

Figure 7: Subset of extracted characteristics and map layers of an exemplary settlement in Vanuatu (Olal), as displayed on VIDA. White dots represent households from the national survey; polygons represent buildings identified from very high-resolution satellite imagery (coloured by size).

2.2.2.1. Site overview (general settlement statistics)

Using a reverse geocoding algorithm, VIDA used coordinates to look up the settlement names from OpenStreetMap and other public data sources. For 78 percent of the settlements, names could be extracted (local names may differ). As local names and community boundaries might differ, the names of all communities, according to the national survey, within 100 meters of each settlement was extracted in addition. It shall be noted that names can be added or edited manually in VIDA platform following on-ground visits to the locations or based on local knowledge. Also, the name of the province and municipality/area council, within which the settlement is located, was extracted (source: geoBoundaries).

Then, VIDA counted the number of households within the settlement boundaries as well as additional households within one kilometre. The household counts were split into the following intervals, which are also available as filtering criteria:

- Very high (> 250 households): 14 settlements (including e.g. Port Vila, Luganville)
- High (100 - 250): 52 settlements
- Medium (50 - 100): 131 settlements
- Low (10 - 50): 677 settlements
- Very low (< 10): 1,513 settlements

The household information is complemented by building density (built-up area as a percentage) and the total number of buildings within the settlement in total, as well as four different building size categories:

- Very small structures (< 10 m^2)
- Small buildings (10 - 120 m^2)
- Medium-sized buildings (120 - 200 m^2)
- Large buildings (> 200 m^2)

Finally, the agronomic potential, according to data from the Department of Agriculture, as well as the distance to water bodies (rivers or lakes; source: HydroSHEDS), was extracted. For the latter, labels and filters were added using distance categories.

2.2.2.2. Accessibility

Next, VIDA collected information on the accessibility of each settlement. Here, the selected proxy is the direct distance to and name of the closest regional hub, which is a larger city or town of socio-economic importance (source: OpenStreetMap). Thus, this is an indicator of both the accessibility and the socio-economic importance of a settlement as, for example, larger markets can be accessed more or less easily.

In addition, main road access and the distance to any nearby road were extracted and added as filter criteria. Main roads were obtained from OpenStreetMap filtering by type (attribute *highway*: *trunk*, *primary*, *secondary, tertiary*); these are mostly paved or wide unpaved roads. According to this analysis, almost one-third of all settlements have access to a main road. However, the limited data coverage, especially in rural areas, and inconsistencies in type classification need to be taken into consideration.

Finally, the distance to the nearest telecom tower as well as the count of towers within 500 meters of a settlement were extracted (source: Telecommunications Department). To avoid double counting if a telecom tower is within 500 meters of several settlements, it was counted only for the largest settlement within 500 meters (by household size). Related labels and filters with distance categories were added—for example, 57 settlements have at least one telecommunication tower in their close vicinity (500 meters). This information is relevant not only to assess mobile coverage but also as the towers can serve as anchor loads for mini-grids.

2.2.2.3. Social infrastructure

To assess social infrastructure, a vital part of each settlement as well as potential anchor load, VIDA extracted the total number of healthcare and education facilities within 500 meters of each settlement using datasets from the Departments of Education and Health. To avoid double counting if a facility is within 500 meters of several settlements, it was counted only for the largest settlement within 500 meters (by household size).

18 per cent of settlements have at least one education facility, and 15 per cent have at least one healthcare facility. These facility access criteria are available for filtering as well. To provide more details, counts were also provided by facility type: Primary, secondary, and unknown type for education facilities, hospitals, health centres, clinics, aid posts, and dispensaries for healthcare facilities.

In addition, the number of points of interest representing various potential electricity customers and anchor loads or productive uses (source: OpenStreetMap) was extracted within each settlement. Note that this dataset is not extensive, and coverage varies across the country.

2.2.3. Least-cost electrification methodology

2.2.3.1. Electrification status

A key element of this analysis is assessing each settlement's access to electricity infrastructure and the associated electrification status. These characteristics are essential for national-scale least-cost electrification planning as a baseline assessment of current energy access rates to define the assignment's starting point.

A settlement is labelled as "**electrified**" if more than 50% of households in the settlement are electrified by the main grid (UNELCO/VUI/VanPawa). The electrified status is assigned according to household-level VNSO data on current electrification status. If less than 50% of households are electrified, the settlement is assigned "**Partly electrified**". In the case of settlements where none of the households is electrified through the main grid

(UNELCO/VUI/VanPawa), then they are considered as **"not electrified"**. Table 6 presents the percentage of electrification status by province and highlights the nationwide electrification status.

To complement the existing power infrastructure information, VIDA used nighttime satellite imagery to identify areas where light was regularly detected. VIDA's *GridLight* algorithm uses cloud-free, stray light-corrected VIIRS monthly nighttime mosaics from 2022 (more information here). For each settlement, the **nightlight** coverage (in percentage) was generated. This and a binary filter of any nightlight detection are added as filters.

In addition, information on whether any NGEF project[1] reached a settlement was added as a settlement characteristic and filter. This information was not used to assess the electrification status as the extent or current condition of the systems is unknown.

Ultimately, VIDA used a minimum-spanning-tree-based algorithm to generate a preliminary mini-grid layout. This provides a high-level estimation of the distribution lines that are required to connect every household, healthcare and education facility (mobile towers are yet to be included in a final update). This was used as an input to the least-cost electrification analysis (see subsequent sections). This preliminary network layout should not be confused with a detailed or even a basic design. The preliminary layout is a good proxy to estimate network length. Still, since it is generated automatically, it does not consider physical barriers or preferred routings (e.g. following existing streets or roads). Therefore, it does not replace the need to conduct site visits to the settlement and the subsequent engineering design standard process.

Aggregated statistics on national and province-level electrification status are presented below in Table 6 (household-level). On a national level, every second household does not yet have access to electricity (not considering standalone systems). Significant variations exist between some provinces; notably, over 90 per cent of households in Torba province are considered unelectrified, whereas Shefa province has the lowest share of unelectrified households (21.6 %).

Table 6. Electrification status of households (HH) by province

Province	Electrified		Partly electrified		Not electrified		Total	
	Total HHs	No of settlements	Total HHs	No of settlements	Total HHs	No of settlements	Total HHs	No of settlements
Tafea	13.3%	4.6%	3.6%	1.2%	83.1%	94.2%	7,750	412
Shefa	76.3%	16.6%	2.1%	2.8%	21.6%	80.7%	21,043	326
Penama	1.8%	0.8%	2.0%	0.5%	96.1%	98.6%	6,918	364
Malampa	12.7%	4.5%	4.0%	1.3%	83.3%	94.1%	8,933	376
Torba	0.0%	0.0%	8.0%	2.7%	92.0%	97.3%	2,137	111
Sanma	36.6%	3.5%	7.1%	0.7%	56.4%	95.8%	11,695	568
Nationwide	**38.7%**	**5.2%**	**3.8%**	**1.3%**	**57.5%**	**93.5%**	**58,476**	**2157**

The VIDA tool visualizes existing concessions in shaded areas. These are the geographical regions covered by the four main power supply concessions in Effate, Santo, Malekula, and Tanna islands. The following table provides an overview of the total number of households located in settlements that are completely within, without, or partially overlapping these four concessions.

Table 7. Categorization of households in settlements within, without or overlapping the 4 concessions.

Households By Province	Inside the concession area	Overlapping with concession boundaries	Outside the concession area
Tafea	1,783	19	5,948
Shefa	18,204	172	2,667
Penama	0	0	6,918
Malampa	2,145	28	6,760
Torba	0	0	2,137

[1] Project from the National Green Energy Fund that distributed standalone systems to rural areas.

Sanma	6,192	269	5,234
Nationwide	**28,324**	**488**	**29,664**

2.2.3.2. Least-cost electrification options

The assignment considers three main options to electrify a settlement that is currently not electrified, namely:

- **Grid extension**: if existing power infrastructure (from UNELCO, VUI, VanPawa or existing mini grids) can easily be extended to reach the target customers.
- **Mini-grid**: if the number of customers, their respective demand, and the density of the customers (how scattered they are) justify building a mini-grid to connect them all.
- **Standalone system**: if none of the above are viable.

It shall be noted that, for simplicity, only one of the options above is defined for each settlement. In reality, it can happen that a settlement is best electrified through a combination of more than one option (e.g., mini-grid for the more clustered customers and standalone systems for a few customers within the cluster but more remote or with lower demand).

Grid extension

The direct distances from each settlement's boundary to the nearest existing or planned electricity infrastructure (coverage area from main existing concessions and other mini-grid sites) are used to estimate the potential grid extension. Existing and planned infrastructure is drawn as polygons, which have been manually digitized by TTA in collaboration with the Vanuatu Department of Energy. Any settlement that is within or less than 500 meters away from the existing or planned infrastructure coverage area is identified as a potential site for grid extension.

Mini-grid vs Standalone solar PV

The remaining settlements are then compared in the least-cost electrification analysis, comparing mini-grids against standalone solar systems for each settlement. This is described in the simplified flowchart in Figure 8.

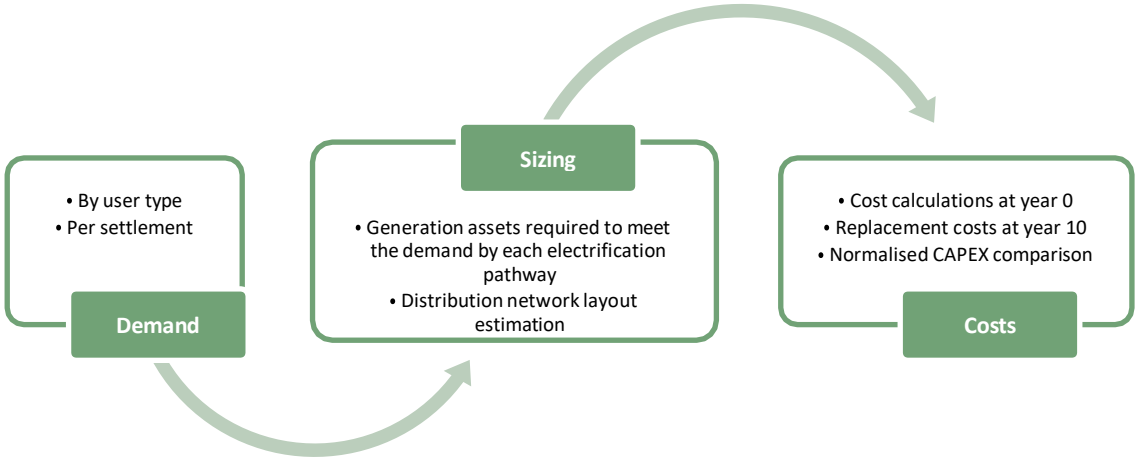

Figure 8. Least-cost analytical framework.

In the first step, the total demand for each settlement is estimated based on the total number of end-users in each category and their assigned demand. Then, in the second step, the Consultant calculated the generation capacity required for each settlement to meet their estimated total demand (only for solar mini-grids and standalone solar systems). Transmission and distribution losses are considered when calculating the generation assets' total capacity.

The sizing calculation incorporates a correction factor for the distribution network derived from VIDA's algorithm. VIDA used a minimum-spanning-tree-based algorithm to generate a preliminary mini-grid layout. This provides a high-level estimation of the distribution lines required to connect every household, healthcare and education facility and mobile tower. This preliminary network layout should not be confused with a detailed or basic design (since it is generated automatically, it does not consider physical barriers or preferred routings -e.g.

following existing streets or roads). However, the preliminary layout is a good proxy for estimating network length.

In the third step, the Consultant estimated the normalized Capital Expenditures (CAPEX) required to electrify each cluster using mini-grids and standalone systems. This estimation includes the initial capital needed to install systems that meet the estimated total demand. Subsequently, the total lifecycle costs are factored in for both electrification strategies over 20 years, including replacement costs for batteries, battery inverter and PV inverter (in year 10). The cost of replacement is the present value of the future cost of goods calculated based on the discount factor. These calculations include a discount rate of 10% in Vanuatu, with an additional inflation rate of 2.5% considered.

As a final step, the normalised CAPEX for both standalone and solar mini-grids in each cluster was compared settlement by the settlement to assign the preferred least-cost electrification option. The cost of grid extension is not compared to standalone and mini-grid systems because the cost only includes the extension of transmission lines and does not include the cost of generation assets. This is in contrast to standalone systems and mini-grids, which have a significant portion of their cost attributed to generation assets.

Certainty of comparison Mini-grid vs Standalone solar PV

It is important to note that this geospatial analysis (as any other high-level planning exercise) involves a number of assumptions that, if changed, can impact the results substantially. This is particularly relevant in the case of the cost and demand assumptions. Changes in the cost assumptions can result in a different preferred electrification approach, with mini-grids over standalone or vice versa. In order to reduce the impact of cost uncertainty, the consultant has developed an attribute called "**Certainty level**" that gauges the level of assurance on whether to electrify a settlement using standalone solutions or with a mini-grid. Here's how it operates: first, the settlement is identified as a least-cost electrification approach based on the cost difference between standalone systems versus mini-grids. Then, an additional attribute of certainty levels is incorporated based on the total demand. This is to increase the level of assurance that the system chosen due to the cost difference is, indeed, highly certain for a specific settlement.

Table 8. Level of certainty

Certainty levels	Total demand (kWh/day)	
	Mini-grids	Standalone
High	>100 kWh/d	<20 kWh/d
Medium	<100 & >40	>20 & <40
Low	<40 & >20	>40 & <100

This attribute warns that when electrifying a community with low certainty, it is worth reassessing in detail the preferred electrification approach. For instance, in some settlements with standalone as the preferred approach in the NEMP but with low certainty, these communities might be better served with a different approach because the demand could be high enough for clustering them in a DC micro-grid or mesh-grid setting. On the contrary, if the preferred approach is mini-grids but with low certainty, then standalone systems may be a better option if the respective project has access to competitive standalone systems.

2.2.3.3. Demand estimation

To estimate the total demand from each cluster, the Consultant categorized archetypes of end-users. Subsequently, reference daily demand values (kWh/day) for each end-user type were assigned. The next table describes the estimated demand for each customer with the source of this information.

Table 9. Estimated demand for electricity for various categories of end-users.

End-user archetype	Categories	Demand	Unit	Source	Comments
Residential	Households	0.9	kWh/day	BRANTV +VREP II Assessed HH demand	The demand for households in Vanuatu is determined through surveys conducted in 17 sites, consultation with concessionaires, and data from existing mini-grids.
Commercial	Independent Businesses	4.0	kWh/day		Businesses' average energy daily demand is assessed based on surveys and site visits conducted by the Consultant.
Education	Primary School	2.6	kWh/day	NGEF program	Schools on VIDA are classified as Primary (PS) or Secondary (SS), Average demand is calculated based on 43 PS and 24 SS in the NGEF project sheet. The demand is assessed by NGEF staff, subject to validation by Vanuatu's Department of Education. Demand for campus-based schools is estimated from Vanuatu's Department of Education information.
	Secondary School	9.3	kWh/day	NGEF program	
	Large School	-			
Healthcare	Aidpost	0.1	kWh/day	Delineation policy	
	Dispensary	5.1	kWh/day	Delineation policy	
	Health centre	6.5	kWh/day	Delineation policy	
	Hospital	-			All hospitals are electrified
	Clinic	6.5	kWh/day	Delineation policy	
Streetlights	Lights	3%	Of total demand	TTA experience*	

Brief notes on the rationale behind the demand estimations are given below:

- The Government of Vanuatu, along with the Department of Health, has published a delineation policy for healthcare facilities in Vanuatu. This policy includes a list of services available at each type of healthcare facility, as well as a list of equipment that is available. The Consultant identified energy-consuming equipment from this list and estimated the daily energy allowance for each category. This estimation was made using the powering healthcare calculations portal developed by ESMAP at the World Bank[2].
- The demand for streetlights is calculated as 3% of the total demand, based on the Consultant's experience with previous mini-grid projects. However, this percentage may vary for standalone solar PV options due to the impact of the distribution network.
- The Consultant´s previous experience with similar projects has shown the importance of considering transmission and distribution losses (T&D) when planning for generation capacities. Based on observations in Vanuatu, a 7% T&D loss is assumed. Additionally, a demand annual growth factor of 6% is estimated based on The Consultant's experience with similar electrification projects in similar contexts.

Overall, references for each value assigned as energy demand for different categories of end-users are derived from existing sources of information from the Government, desk research and literature review as well as the Consultant´s previous experience in the country and the region. Some of these values should be cross validated with real data from ongoing or future electrification projects and verified with relevant government agencies.

[2] Powering Healthcare tool by ESMAP and HOMER https://poweringhealth.homerenergy.com/

2.2.3.4. System sizing

Mini-grids have been assumed to be mainly powered by Solar PV (renewable fraction higher than 90%) and equipped with a lithium-ion Battery Energy System Solution (BESS). The batteries store the excess generation during the day and are dispatched at night. A backup diesel generator has been added as a base scenario to avoid oversizing PV and BESS. The generator would charge the batteries when the State of Charge (SOC) is lower than a certain threshold.

The main assumptions taken for the sizing of the components are listed below. The sizing exercise focuses on the key generation and distribution components.

The resulting total demand for the clusters identified has been increased by a factor to consider the distribution losses in the grid and adequately size the generation assets. The assumption and reference taken are listed in Table 10.

Table 10. Distribution losses assumption

Parameter	Value	Comments
Distribution losses	7%	Based on Consultant experience and analysis of existing mini-grids

The capacity of the Battery Energy Storage System (BESS) is calculated according to the days of the autonomy that it needs to provide in case the generation assets are not working. The assumptions taken are shown in Table 11.

Table 11. BESS sizing assumptions

Parameter	Value	Comments
Max. DoD	90%	Based on market current standards
Lifespan	10 years	Based on Consultant experience
Autonomy	1 Day	

The solar PV capacity has been defined using an empirical ratio between the daily demand required and the PV capacity installed, extrapolated from several sizing exercises conducted in the country for feasibility studies and detailed design. The value is provided in Table 12.

Table 12. PV sizing assumptions

Parameter	Value	Comments
Ratio kWp solar per kWh/day demand	1.7	Based on simulations conducted for several projects in Vanuatu

The battery inverter is sized using a peak load to daily load factor, which is based on simulations and sizing conducted by the Consultant for mini-grids in Vanuatu. The value is shown in Table 13.

Table 13. Battery inverter sizing assumptions

Parameter	Value	Comments
Peak load to daily load factor (empirical)	20%	Based on simulations conducted for several projects in Vanuatu

As mentioned in previous section, VIDA algorithm estimates the distribution network length using the Minimum Spanning Tree (MST) Algorithm. This figure was compared with the actual distribution network length from the detailed design of real mini-grids under construction. An adjustment factor was estimated from this comparison and applied uniformly to all the clusters. The resulting value is given in Table 14.

Table 14. Distribution network sizing assumptions.

Parameter	Value	Comments
Adjustment factor for VIDA minimum spanning tree	85%	Based on detailed design of distribution networks for real mini-grids in Vanuatu.

2.2.3.5. Costing

In the assessment of cost input parameters, the Consultant has thoroughly analyzed recent mini-grid tenders for mini-grid projects in Vanuatu. The analysis includes material costs of generation assets, installation, and distribution network expenses. The cost breakdown is also inclusive of different types and sizes of mini-grids and on-site conditions. The costs are given in ranges to accommodate the variability introduced by factors such as the remoteness of the project and the associated complexity of logistics, the scale of the development (if multiple projects are developed at once or individually), the type of PV mounting (rooftop, ground-mounted or canopy), etc. The cost inputs for mini-grids are as follows:

Table 15. Cost input parameters

	Component	Unit Cost (Low)	Unit Cost (High)	Unit Cost (Average)	Unit	Comments
Generation assets	PV	1,583	1,979	1,781	USD/kWp	This includes the cost of panels, mounting structure, installation, civil works fees, and related accessories like charge controllers and switch boxes.
	Battery	452	565	509	USD/kWh	Cost of batteries per kWh, cables, switch boxes, and other accessories
	Battery inverter	701	876	789	USD/kVA	Cost of batteries per kWh, cables, switch boxes, and other accessories
	Back-up genset	604	755	680	USD/kVA	Unit cost derived from an existing mini-grid project
	Powerhouse – PV size ≤ 100kWp 100kWp < PV size ≤200kWp 200kW < PV size ≤300kWp PV size >300kWp	 40,000 50,000 60,000 70,000	 50,000 62,500 75,000 82,500	 45,000 56,250 67,500 76,250	Fixed cost USD	This cost threshold is defined based on PV capacity
Distribution assets	CAPEX	30	38	34	USD/m	Cost of cables, distribution and transmission line materials and accessories, transport, and logistics related to the power network, excluding service lines.
Connection costs		589	736	663	USD/connection	Cost includes service lines, metering,

	Component	Unit Cost (Low)	Unit Cost (High)	Unit Cost (Average)	Unit	Comments
						indoor wiring, and similar accessories

The Consultant analysed the cost inputs of standalone solar systems by examining the catalogue of systems installed by NGEF[3] in various categories for end-users, such as households, schools, cooperatives, etc., in Vanuatu. The catalogue offers a variety of options for systems with different batteries, including lead-acid and lithium-ion batteries, with and without backup generators. These batteries have a range of 3-4.5 days of autonomy and a lifespan of 4.5-16 years. To ensure consistency in the analysis, only standalone systems with lithium-ion batteries are considered for cost inputs. Table 16 shows the cost of standalone systems for each type of user in Vanuatu. It is important to mention that telecom towers are not included in this analysis due to their high demand and, therefore, not suitable for standalone systems. Additionally, the cost of standalone systems includes material costs for generating assets, freight to islands, and installation costs. However, an additional cost of 450 USD is added for indoor wiring.

Table 16. Cost inputs for Standalone solar systems.

Category of End-user	Demand kWh/day	Unit cost (Low) USD	Unit cost (High) USD	Unit cost (Average) USD
Residential	0.9	3,000	4,000	3,500
Commercial	4	10,214	13,618	11,916
Primary School	3.5	10,214	13,618	11,916
Secondary School	9.3	19,788	26,384	23,086
Aid posts	0.1	735	979	857
Dispensary	5.1	12,835	17,114	14,975
Health centre	6.5	17,669	23,559	20,614
Clinic	6.5	17,669	23,559	20,614

2.2.4. Visualization

All analysis results are interactively visualized in VIDA's online software, which has been customized for this specific project of national least-cost electrification planning with a specific focus on off-grid systems.

The 2,157 identified settlements in Vanuatu are the central units of the VIDA software's map-based visualization. They are, on the one hand, displayed on an interactive overview map together with several other collected map layers (see Figure 9), and on the other hand, characterized in detailed pages with all extracted information as described above (see Figure 10).

On VIDA, customized sub-selections of settlements for prioritization can be quickly built based on filters related to extracted characteristics. Filters are available for, amongst others, administrative units, the number of households, the least-cost electrification option, distance to main grids, the presence of at least one school or healthcare facility, nightlight coverage, and distance to potential hydro sites (see a second panel from the left in Figure 9). They can be combined arbitrarily, and in combination with the possibility of sorting settlements by any extracted characteristics, any VIDA user can easily prioritize or shortlist sites. The shortlisted sites can then be stored in a group that is accessible to different users.

In addition to filtering and grouping, all settlements or a filtered sub-selection, including extracted characteristics, can be downloaded in an Excel or GIS (GeoJSON) format for sharing with collaborators. This also allows for integration with other software or workstreams, for example tendering platforms such as Odyssey, which have been connected to VIDA data in various similar projects. Also, the information available for each site can be downloaded as a PDF report.

[3] https://ngef.vu/catalogue/

Collaboration on VIDA is facilitated by features to add custom text notes as well as geo-located file attachments such as reports, images, or videos to any site. These features are accessible via the toolbar at the bottom of the map in the settlement view (see Figure 10). New datasets can be uploaded and integrated into the analysis, and additional information layers developed by the VIDA team can be installed. New features are continuously added and will be available for this project, considering future license agreements.

The software is accessible via this link with personal user accounts, which can be assigned to five different user roles to manage access rights. It will be freely available to the Vanuatu Department of Energy for one year, starting with the final workshop on October 22, and can be extended upon. Regardless, the geospatial analysis results derived from this assignment will be shared in raw GIS formats.

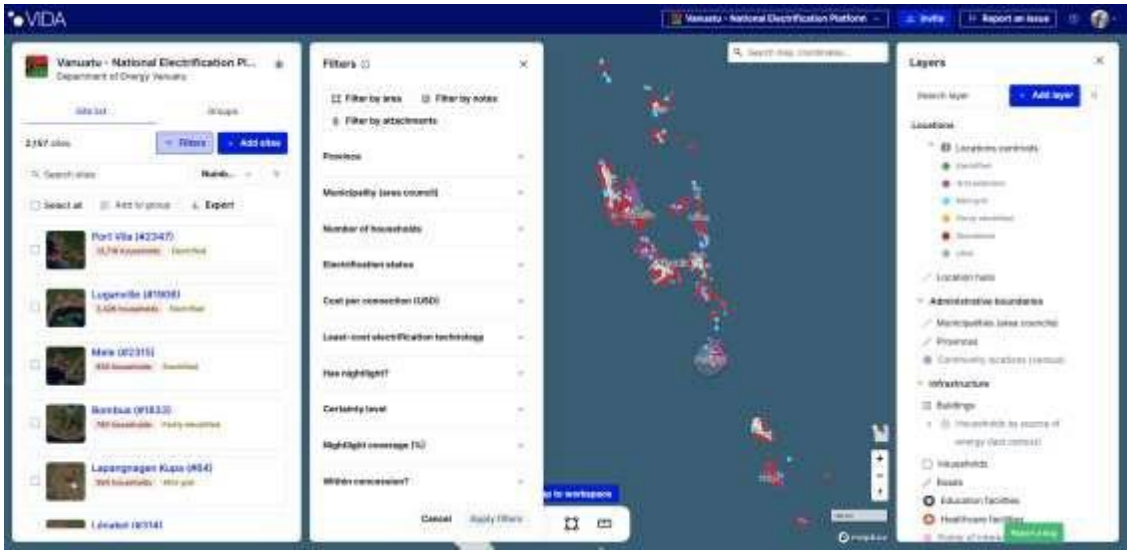

Figure 9. Country overview map as presented on VIDA, with the list of identified settlements as well as collapsible filter panel in the left and map layers in the right panel. Settlements are represented by red dots.

Figure 10 Exemplary settlement detail map as presented on VIDA, with selected extracted characteristics in the left and map layers in the right panel, plus map and collaborative features are accessible via the toolbar on the bottom.

2.3. Results

2.3.1. Number of connections

This geospatial analysis considers 62,219 connections, which include five main categories: residential, commercial, education facilities, healthcare facilities, and telecom towers.

2.3.1.1. Residential

The Vanuatu census report estimates 61,345 households in the country, spread across six provinces. Our settlement identification process includes 58,476 of these residential customers clustered in 2,157 settlements, which are presented on the VIDA platform. The difference of 2,869 households is scattered out of the VIDA settlements. From all the settlement sand households identified by the VIDA platform, only the ones identified as not electrified are considered for the analysis. Table 18 presents the number of households considered in each of the six provinces.

2.3.1.2. Commercial

Based on the Consultant's previous experiences in the country, the analysis accounted for 1 commercial entity per every 20 households (e.g., for a given settlement that has 60 households, a total of 3 commercial entities is assumed). The term "commercial activities" refers to independent businesses; they do not include small businesses conducted inside households. Vanuatu also witnesses tourism as one of the main income-generating commercial activities. Whereas the Consultant wanted to integrate this information in the analysis given its importance, we have not received suitable information. As such, it is not part of the current version of the geospatial analysis.

2.3.1.3. Healthcare facilities

The Government of Vanuatu and the Department of Health have published a delineation policy and locations of all healthcare facilities in the country. There are five different types of health facilities available: aid posts, dispensaries, health centers, clinics, and hospitals. On the VIDA platform, a total of 402 healthcare facilities are identified within settlements and categorised by type. Table 17 gives the total number of each facility accounted for in the analysis except for 2 facilities that are assigned unknown type.

Table 17. Total number of healthcare facilities in Vanuatu

Healthcare facility type	Total number
Aid posts	246
Dispensaries	114
Health centers	32
Clinics	3
Hospitals	5

2.3.1.4. Education facilities

A total of 664 education facilities are considered in this analysis, of which 531 are assigned primary schools and 133 are secondary schools. Of 531 primary schools, 169 are of 'unknown type' on the VIDA platform due to lack of data. For these, the demand assumed has been the one of primary schools (conservative hypothesis).

2.3.1.5. Telecom towers

There are 145 telecom towers in Vanuatu, and 11 more are planned for installation. The Consultant has applied a criterion for electrifying telecom towers in this geospatial analysis. If a telecom tower is inside the settlement boundaries or within 500-meter distance from the boundary, it qualifies for electrification through either a mini-grid or grid extension. Following this criterion, 57 towers are eligible for electrification using one of the

considered electrification pathways. Table 18 presents the total number of connections by province and estimated electricity demand for all types of end-users described above.

2.3.2. Estimated demand

Table 18 shows the demand estimation for the customers considered in the assignment (i.e. not the total customers in the country, but only the ones to be electrified), broken down by province and category of end-users. The largest province in terms of customers to be electrified is Malampa, with 7,444 households and 335 commercial activities. The smallest province in terms of customers is Torba, with 1,966 households and 89 businesses to be electrified.

Table 18 Total number of categories of user type and their estimated electricity demand in kWh/day

Province	Households		Business		Education facilities		Healthcare facilities		Telecom tower	
	Units	kWh/d	Units	kWh/d	Units	kWh/d	Units	kWh/d	Units	kWh/d
Tafea	6,441	5,797	246	984	91	400	54	92	10	518
Shefa	4,539	4,085	198	792	51	254	43	67	5	259
Penama	6,651	5,986	269	1,076	148	611	70	145	12	622
Malampa	7,444	6,700	335	1,340	88	372	65	126	11	570
Torba	1,966	1,769	89	356	25	122	29	52	1	52
Sanma	6,593	5,934	232	928	94	422	63	142	14	725
Nationwide	**33,634**	**30,271**	**1,369**	**5,476**	**497**	**2,180**	**324**	**625**	**53**	**2,745**

The total demand for healthcare facilities is low despite the fact that there are a total of 324 facilities to be electrified. This is because the majority of healthcare facilities are in the aid post category, with a very low demand of only 0.1 kWh/day. However, demand is higher for schools, as the majority of them are primary schools, with an average demand of 3.5 kWh/day. Furthermore, the estimation for total demand includes the consideration of streetlights, amounting to 3% of the aggregated demand. Figure 11 shows a share of total customers and Figure 12 shows the share of total demand by each category of end-user in Vanuatu.

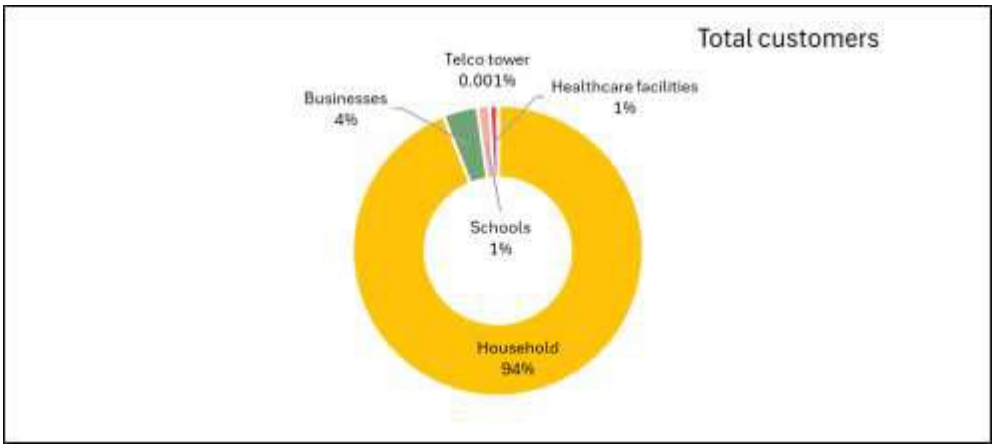

Figure 11 Share of total customers by each category.

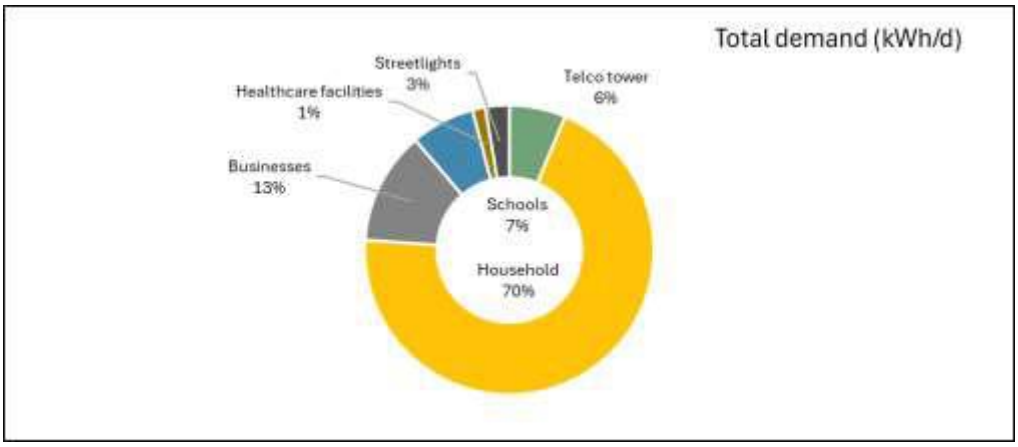

Figure 12 Total demand breakdown by category of end-users in Vanuatu.

2.3.3. Least-cost analysis results

The Consultant analyzed 2,157 settlements derived from the VIDA platform. Of these, 113 are considered connected to the main grid (UNELCO/VUI/VanPawa), 28 are identified as partly electrified, and the remaining 2,016 are analyzed under the least-cost analysis.

According to the least-cost analysis, mini-grids are the preferred electrification approach for 52% of the unelectrified customers, standalone PV solutions for 33%, and grid extension for 15%. Eventually, if the entire country were to be electrified using the proposed approaches, 42% of the customers would be electrified through the existing concessions (UNELCO/VUI/VanPawa), 30% through the newly implemented mini-grids, 19% through standalone, and 9% through grid extension.

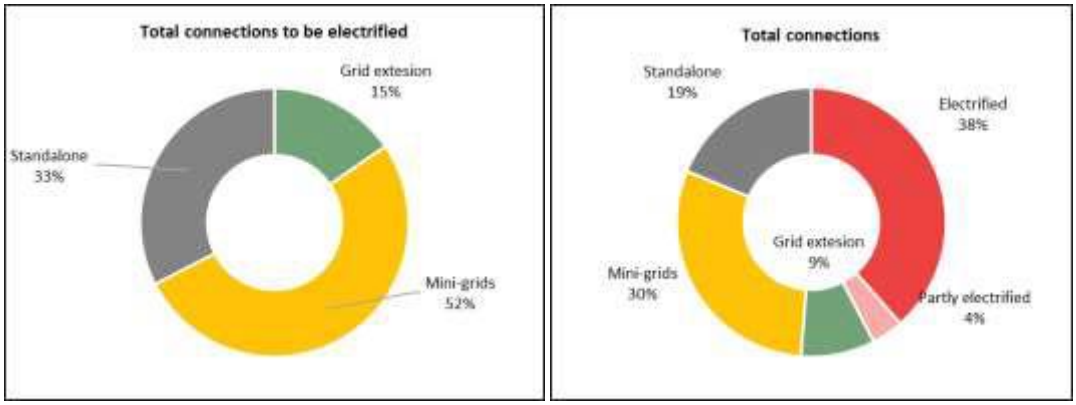

Figure 13. Proposed electrification approach for the currently unelectrified connections (left) and distribution of the electrification approach for the entire country if the recommended approaches are implemented (right).

Table 19 provides the proportion of total connections to be electrified by each least-cost electrification solution by province and nationwide.

Table 19. Least-cost electrification solution and percentage of total unelectrified connections by province

Province	Grid extension		Mini-grid		Standalone		Total # connections
	% of total connections	Grid extension connections	% of total connections	Mini-grid connections	% of total connections	Standalone connections	(to be electrified)
Tafea	3.7%	256	54.3%	3,713	42.0%	2,873	6,842
Shefa	24.4%	1180	51.2%	2,474	24.4%	1,182	4,836
Penama	11.3%	808	56.8%	4,064	31.9%	2,278	7,150
Malampa	22.0%	1751	54.3%	4,310	23.7%	1,882	7,943
Torba	2.9%	62	58.0%	1,224	39.1%	824	2,110
Sanma	21.2%	1481	40.9%	2,864	37.9%	2,651	6,996

Nationwide	15.4%	5538	52.0%	18,649	32.6%	11,690	35,877

Torba is a small province with a limited number of households, and it is sparsely populated. Therefore, 39% of the total unelectrified connections in Torba are better served by standalone electrification solutions, while only 2.9% are suitable for grid extension. In contrast, Malampa has a higher potential for electrification through mini-grids, although most of these mini-grids are smaller than 100kWp. In Penama province, mini-grids can serve a similar number of connections as the least-cost solution. In this case, though, several mini-grids are larger than 100kWp.

It is also observed that the mini-grid preference is not linearly associated with the total number of end-users but also the type of end-users. For clusters with a telecom tower within less than 500m, it is assumed that it would be connected to the mini-grid. Hence, the total demand for each settlement is significantly affected by the presence of a telecom tower, as it automatically entails an additional demand of 51.8kWh/day.

Figure 14 presents the least-cost technology for the range of demand per connection. Higher demand per customer tends to favor mini-grids over standalone systems. In the case of grid extension, there is no specific correlation with the demand per customer, as the decision to propose this electrification approach is based on the settlement's geographical location.

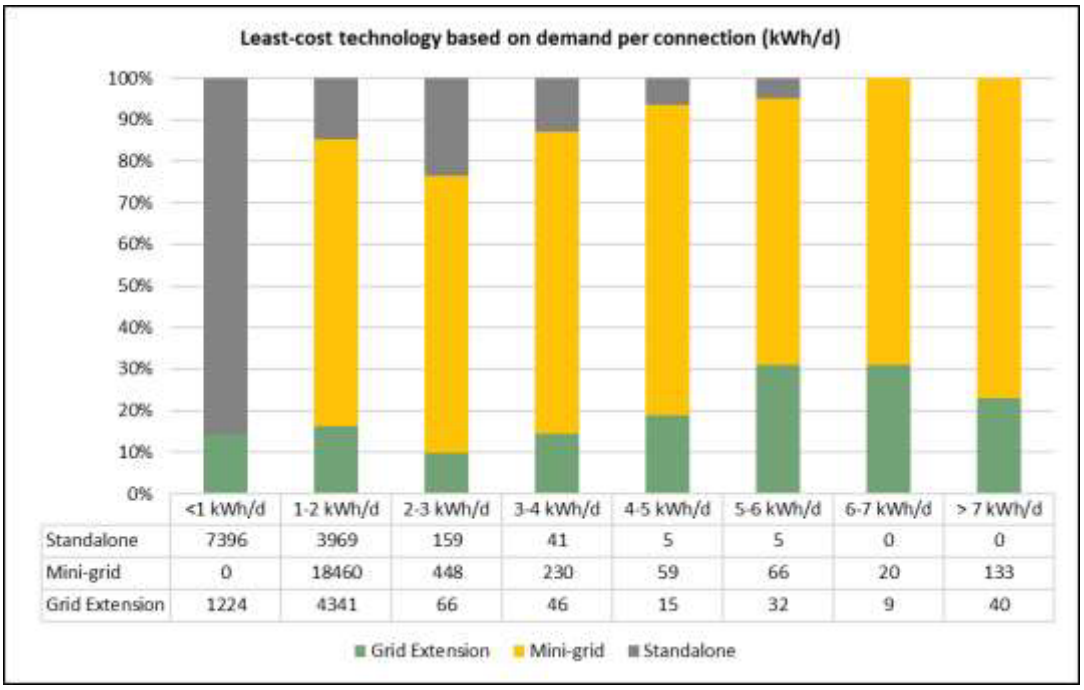

Figure 14. Least-cost electrification technology by the range of average demand per connection.

Furthermore, the ***Certainty*** of each electrification technology (mini-grid vs standalone) is assessed based on the total demand associated with it (see section 0 for more information about this attribute). Table 20 shows the breakdown of these levels for mini-grids and standalone systems. According to this analysis, there are 63 mini-grids for which this electrification approach is highly certain (i.e. the cost of electrifying these communities with mini-grids is lower than electrifying them with standalone solutions, and their total demand is substantially high).

Table 20. Certainty levels of least-cost electrification pathways for settlements

Certainty levels	Mini-grid	Standalone
Low	78	16
Medium	154	87
High	61	1326
Total	**293**	**1,429**

2.3.3.1. Potential mini-grid sites

Mini-grids are the least-cost electrification approach for a total of 61 medium and large settlements in Vanuatu. These mini-grids have daily demands above 100kWh/day. The provinces with more of these mini-grids are, by order, Malampa (19), Tafea (11), and Penama (12), but Penama has larger mini-grids overall (7 out of 18).

Table 21. Distribution of mini grids by total demand

Province	# Mini-grids	# Small Mini-grids (demand <100 kWh/day)	# Medium Mini-grids (demand between 100-200 kWh/day)	# Large Mini-grids (demand >200 kWh/day)
Tafea	47	36	6	5
Shefa	46	40	4	2
Penama	53	41	5	7
Malampa	75	56	18	1
Torba	19	15	2	2
Sanma	53	44	8	1
Nationwide	**293**	**232**	**43**	**18**

The least cost-electrification analysis also identifies 232 small mini-grids with a demand below 100kWh/day. In fact, 107 of these mini-grids would have a demand below 50kWh/day and, therefore, would be very small. These settlements have been identified as potential mini-grids because they have a high average demand per customer and/or have a clustered distribution of households, which minimizes the extension of the distribution network, thus making it less costly than a standalone solution. Nevertheless, this group of *small* mini-grids should be taken carefully, as their viability might be compromised due to their scale. Standalone solutions can easily be an alternative solution for these settlements, and the Certainty filter can help in this regard (78 mini-grids have low Certainty levels).

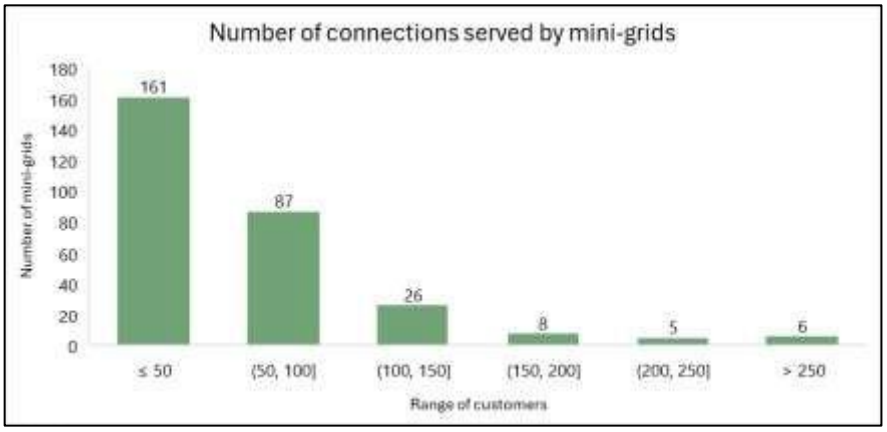

Figure 15. Range of total connections served by the proposed mini-grids.

The length of the distribution layout is another important factor in determining whether a mini-grid is the most cost-effective solution for a particular settlement. For instance, Lelualu village in Malampa province, with 103 connections, benefits from a compact distribution layout spanning only 1km. This makes the mini-grid the most economical choice for electrification in this village; hence, it has a "high" Certainty. On the contrary, Lesus in Torba province, with approximately 79 connections, is assigned standalone systems as an electrification solution with 'low' certainty due to the larger distribution layout of over 5km, resulting from the sparse distribution of its buildings. Consequently, standalone systems would prove to be only marginally costlier than mini-grids in this scenario. This indicates that the total number of end-users does not necessarily determine the least-cost electrification option. Other factors, such as the length of the distribution network, carry significant weight in this determination.

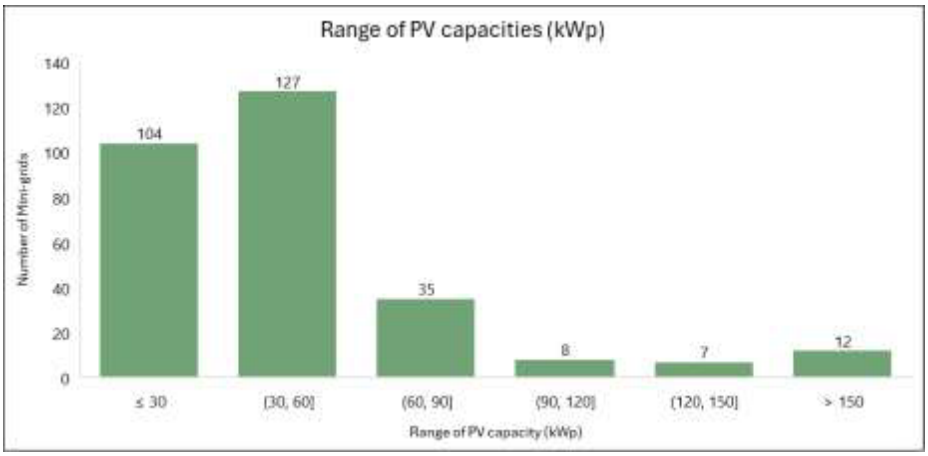

Figure 16. Range of PV capacities in least-cost mini-grids

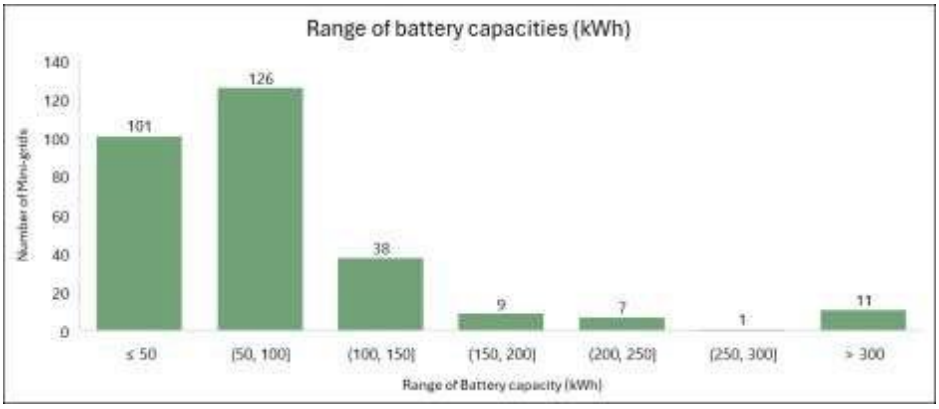

Figure 17 Range of battery capacities in least-cost mini-grids

Of the proposed mini-grids, 268 out of 293 are located outside the existing concession areas. This represents 16,773 customers. On the contrary, a total of 41 mini-grids (2,708 connections) would fall within the existing concessions and, therefore, would have to be implemented in coordination with the respective concessionaires (UNELCO, VUI or VanPawa).

Table 22. Mini-grids inside and outside the concession area (note: in case of partial overlap with the concession, the respective settlement is considered inside the concession)

Province	Inside concession		Outside concession	
	# connections	# settlements	# connections	# settlements
Tafea	156	3	3,557	44
Shefa	534	7	1,940	39
Penama	0	0	4,064	53
Malampa	291	2	4,019	73
Torba	0	0	1,224	19
Sanma	895	13	1969	40
Nationwide	1,876	25	16,773	268

2.3.3.2. Potential Standalone Solar sites

Standalone solar PV systems are proposed as the least-cost electrification approach for 1,429 settlements, which represent a total of 11,690 customers. Out of the total of 1,429 settlements, 1,272 are identified to be electrified by standalone systems that are outside the concession area. The majority of these settlements are scattered and have less than 20 connections. The province of Sanma has the largest number, with 293 standalone systems recommended for electrification with a "high" level of certainty. In Torba, 87 settlements

are also recommended to be electrified with standalone systems that are outside concession. Overall, 19% of all connections are suitable for standalone as the least-cost electrification solutions.

Around 10% of the connections to be electrified through standalone PV systems are located within the existing concessions. These are distributed in 157 settlements, most of which are in Sanma and Shefa provinces.

Table 23 Standalone system for customers inside and outside concession

Province	Inside concession		Outside concession	
	# connections	# settlements	# connections	# settlements
Tafea	214	20	2659	310
Shefa	334	47	848	89
Penama	0	0	2278	273
Malampa	82	14	1800	220
Torba	0	0	824	87
Sanma	660	76	1991	293
Nationwide	1,290	157	10,400	1,272

2.3.3.3. Potential Grid extensions

294 settlements are within 500m of an existing or planned distribution network, making them most suitable for grid extension as the least-cost option for electrification. These 294 settlements account for 15% of the total connections that need to be electrified. Table 24 shows the percentage breakdown of the recommended least-cost technology for electrifying all unelectrified connections in Vanuatu. Grid extension is recommended as the least-cost solution for 5,773 customers.

Around 40% of the connections to be electrified through grid extension fall within the existing concession areas, and 21% are in Shefa province. The other 60% that are outside concession are mostly located in Penama, and Sanma.

Table 24 Grid extension for customers inside and outside the concession area

Province	Inside concession		Outside concession	
	# connections	# settlements	# connections	# settlements
Tafea	147	7	109	4
Shefa	1,180	81	0	0
Penama	0	0	808	33
Malampa	721	31	1,030	14
Torba	0	0	62	2
Sanma	204	22	1,277	100
Nationwide	2,252	141	3,286	153

2.3.4. Investment needs

It is estimated that an investment between 125 million USD and 160 million USD is needed to electrify the entire population of Vanuatu. The next figure shows the breakdown of the total investments required by each electrification option. In this analysis, the low- and high-cost scenarios are presented to account for the variability expected for cost estimates due to differences in scale, remoteness, and other factors. These figures are initial investments (do not account for any cost of replacements during the project's lifetime).

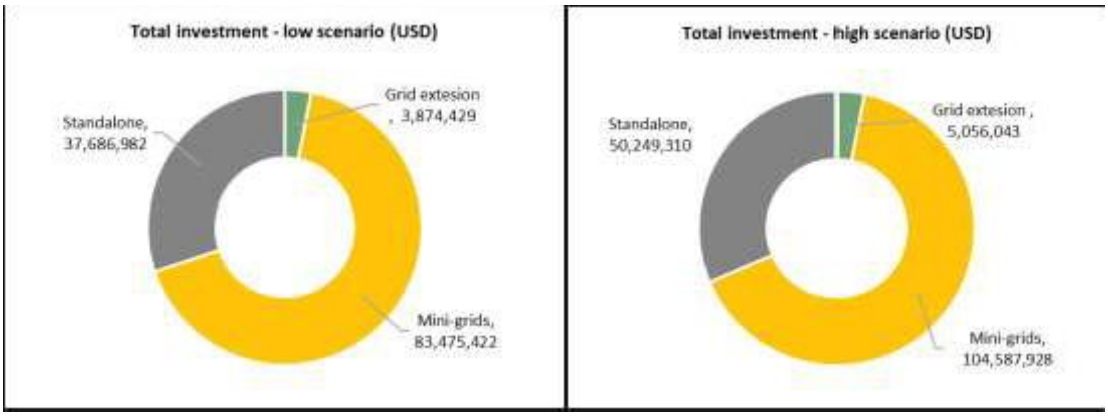

Figure 18. Total investments required for each category of electrification pathway.

The proposed mini-grids would require an overnight investment ranging from 83 to 104 million USD, around 65-67% of the investment required for electrification, and would electrify 52% of the unelectrified population.

Standalone solar systems are the prefered approach for the electrification of 33% of total connections in Vanuatu and would require total investments ranging from 37 to 50 million US dollars, which represents 30% of the investment needs. This excludes the 2,869 census households that are not included in the settlement list considered in this geospatial analysis. Hence, the investment in standalone solar systems would increase when incorporating these 2,869 scattered households. Assuming that these scattered households are each given a standalone solar PV system, the investment needs would increase to **46 and 61 million USD for low and high scenarios, respectively**. Similarly, there are healthcare facilities and schools that are too remote and sparse and not considered within cluster boundaries. A total of 103 healthcare facilities and 18 schools are not accounted for in this geospatial analysis; assuming their remote locations, it is likely that these facilities will be provided with standalone systems. Subsequently, the cost of electrifying them will increase investments by **0.8 million USD to 1 million USD.**

Lastly, Grid extension requires the least upfront investments, **nearly 4 to 5 million USD**, to electrify 15% of total unelectrified connections in Vanuatu; however, it is important to highlight that these costs only include expanding the transmission and distribution network and exclude any potential increase required in the generation capacity.

2.3.4.1. Investment needs by province

Table 25 provides a breakdown of each province's investment needs. The average cost per connection for grid extension ranges from 702 USD/connection (Sanma) to 1,419 USD/connection (Torba). For mini-grids, it is around 5,042 USD/connection, and for standalone, it is around 3,761 USD/connection.

Table 25. Average Investments by province.

Province	Grid extension		Mini-grid		Standalone	
	Total connections	Investment (USD)	Total connections	Investment (USD)	Total connections	Investment (USD)
Tafea	256	335,958	3,713	18,515,524	2,873	10,809,159
Shefa	1180	878,972	2,474	12,380,729	1,182	4,489,989
Penama	808	765,152	4,064	21,530,296	2,278	8,520,425
Malampa	1751	1,357,031	4,310	21,085,912	1,882	7,012,894
Torba	62	87,955	1,224	6,108,236	824	3,124,495
Sanma	1481	1,040,169	2,864	14,425,977	2,651	10,011,183
Nationwide	**5,538**		**18,649**		**11,690**	

2.4. Conclusions of geospatial analysis

The 2020 Vanuatu Census identified **61,345 households in the country**, of which nearly **40% are connected to the main grids** of the existing concessions (UNELCO, VUI, and VanPawa) or mini-grids. **The geospatial analysis** presented in this report **assesses the least-cost electrification approach to serve the remaining 60%,** which represents a total of 33,979 households.

The geospatial analysis has used the census data as the primary source to identify the number of households and their geolocation. This approach has ensured full alignment of the exercise with the country's official statistics. Based on the consultant's field experience in the rural areas of Vanuatu, the census information tends to be reliable in terms of number of households within each village. However, the use of this data source entailed some limitations, such as limited spatial accuracy. Several households are recorded outside of inhabited areas when compared to other maps and satellite imagery. This was partially mitigated by adding building location information from several sources, and overall was regarded as no major limitation.

At the core of this geospatial study are settlements, the central unit of assessment. By automatically drawing boundaries around neighboring households, **VIDA identified a total of 2,157 settlements in the entire country**, of which 113 are considered electrified (connected to the main grid of UNELCO/VUI/VanPawa), 22 are partially electrified, and **2,016 unelectrified**. Most of the unelectrified settlements are rather small: up to 1,351 settlements (67% of the unelectrified settlements) have 10 or fewer households, and **only 66 settlements have more than 100 households**. This fragmentation of the rural population favours decentralized electrification solutions rather than grid-based solutions. In addition to the households, the analysis considers other customer types. A total of 62,219 connections are considered in this geospatial analysis, and five main categories of connections are contemplated under this total: residential, commercial, education facilities, healthcare facilities, and telecom towers.

The least-cost analysis considers **three main options to electrify a settlement** that is currently not electrified: **Grid extension** if existing power infrastructure can easily be extended to reach the target customers; **Mini-grid** if the number of customers, their respective demand, and the density of the customers justifies building a mini-grid to connect them all; and **Standalone system** if none of the previous two is possible.

According to the least-cost analysis, **mini-grids are the preferred electrification approach for 52% of the unelectrified customers, standalone PV solutions for 33%, and grid extension for 15%:**

- **Mini-grids** are the least-cost electrification approach for a total of 61 medium and large settlements in Vanuatu. These are mini-grids that have daily demands above 100kWh/day. The least cost-electrification analysis also identifies 232 small mini-grids, which have a demand below 100kWh/day. These settlements have been identified as potential small mini-grids because they have a high average demand per customer and/or have a clustered distribution of households, which minimizes the extension of the distribution network. Nevertheless, this group of small mini-grids should be taken carefully, as their viability might be compromised due to their scale. Within this group, it might be worth observing alternative approaches such as DC mini-grids or mesh-grids.
- **Standalone solar PV** systems are proposed as the least-cost electrification approach for 1,429 settlements, mainly consisting of a few households only, which represent a total of 11,690 customers;
- **Grid extension.** 294 settlements are within 500m of an existing or planned distribution network, which makes them most suitable for grid extension as the least-cost option for electrification.

It is worth mentioning that **around 5,418 connections to be electrified fall within the boundaries of the existing four main concession**s. Around half of these are proposed to be electrified through grid extension, and the rest are proposed to be electrified through mini-grids and standalone systems in equal proportions.

The results of the least-cost analysis are subject to the uncertainties associated with the inputs used in the assignment. This is especially important in the case of cost and demand assumptions. Regarding costs, the Consultant has used ranges (low and high-cost scenarios) to accommodate these uncertainties. In the case of demand, a certainty attribute has been considered to categorize the projects.

The **least-cost analysis conducted entails some limitations** in addition to the uncertainties in the data inputs. One important limitation is that, for simplicity, **only one of the three electrification approach options is defined per settlement**. In reality, it can perfectly happen that a community or a settlement is best electrified through a combination of more than one option (e.g. mini-grid for the customers that are more clustered and standalone

systems for some few customers that are within the cluster but more remote or that have lower demand). Furthermore, other electrification approaches, such as mesh grids or DC mini-grids, might be relevant in certain communities, as indicated above.

In fact, the Consultant strongly recommends observing the possibility of having **technology-agnostic tenders** for the implementation of the NEMP, in which the tender specifies the service levels to be attained and leaves it to the bidders to decide on which is the most effective way to satisfy the needs, be it a connection through mini-grid or standalone systems. It should be noted that the geospatial analysis provided in this assignment provides a high-level, nationwide analysis of the best technical solutions to electrify each community. However, only a detailed analysis on a project-by-project basis, along with specific knowledge of the local characteristics of each village, will ensure the truly least cost of electrification for each community. This will positively impact the resulting tariffs, as the technical solution is optimized at the most. As far as the service levels are defined beforehand, and the service provider is responsible for the quality of the service of both solutions, there should be no preference for one or the other. In this context, it gains relevance to the Energy-as-a-Service (EaaS) model for operating standalone systems. Also, this approach gives space to emerging solutions in the market, such as mesh grids.

Another important limitation is that **the geospatial analysis presented herein does not reflect the potential energy demand that could be promoted through Productive Uses of Energy (PUE) applications** (other than education, health, and telecommunication connections), as their identification requires a detailed local analysis and a deep understanding of each community's socio-economic conditions. However, they can be the cornerstone of profitable business models for some communities.

It is estimated that **an investment ranging between 125 million USD to 160 million USD is needed to electrify the population of Vanuatu entirely: 83 to 104 million USD for mini-grids, 37 to 50 for standalone solar systems and 4 to 5 million USD for grid extension**. It is important to highlight that demand is an essential element for the viability of the proposed projects. While promoting PUE should be an essential part of the electrification efforts (to stimulate demand, but more importantly, to maximize the impact of the interventions), this estimation does not consider the investments required to promote PUE.

This report presents some of the key results of the analysis, but **all the information is easily available to the government on the VIDA platform**. This map-based online software is a **convenient tool for implementing and monitoring the Master Plan**. As an example, it facilitates project selection and prioritization through the flexible application of filters and sorting. This can help the government of Vanuatu in the process of clustering the targeted communities. The combination of settlements into larger clusters allows for gaining economies of scale, which simplifies not only the construction but also the later operation and maintenance of the infrastructure, especially if the clustering criteria are based on geographical proximity. Other applications of VIDA include the integration of survey data and KPIs from each operating system and the possibility of adding any additional spatial data layers.

3. Institutional Framework

This chapter analyses the policy and planning framework's strengths and opportunities for enhancement to support the NEMP.

3.1. Legislation, policies, programmes, and regulations

3.1.1. Electricity Supply Act 1972

The primary Act guiding Vanuatu's electricity sector is the Electricity Supply Act[4], which has received various amendments since its initial passing in 1972, most recently in 2019. The Act allows the Minister of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management to enter into agreements with a company for the exclusive rights to supply a concession area with electricity. Under the original Act, only the concession holder could generate and supply electricity within the concession areas. However, a later amendment[5] allowed anyone to generate electricity (the 2010 amendment to section 1B), but only the concession holder could supply electricity. The amendment permitted non-concession holders to supply the concession holder, effectively allowing Independent Power Producers (IPPs) to operate only in a wholesale supply capacity.

The Act targets Vanuatu's large-scale concessions (Efate, Luganville, Tanna, and Malekula) without considering smaller-scale electricity suppliers. While the Act guides the operation of concessions, nothing in the Act precludes the Minister from entering agreements (concession or otherwise) with smaller-scale electricity suppliers, nor would it appear to require what may be considered a 'heavy-handed' approach to smaller-scale agreements. These agreements are discussed further below.

3.1.2. Utilities Regulatory Authorities Act 2007

The Utilities Regulatory Authorities Act 2007[6] establishes the URA as the independent regulator responsible for regulating the electricity and water sectors[7] with functions and powers as follows:

- Act in a policy advisory role;
- Inform the public of matters relating to utilities;
- Issue safety and reliability standards;
- Regulate prices;
- Help consumers to resolve grievances; and
- Uphold the legislation in the Act and the Electricity Supply Act.

The URA and the Government are redrafting the Utilities Regulatory Authorities Act. If the new version is passed, the URA will be granted more powers to enforce regulation and regulate the sector.

Nothing in the URA Act relates explicitly to electrification and the regulation of systems smaller than the existing large concessions. Still, as with the Electricity Supply Act, nothing precludes the URA from drafting its own regulation(s) to support this. The URA currently regulates prices for mini-grids outside the concession areas, including the hydro system in Loltong. It is also currently engaged in the service level definition and associated price for all mini-grids to be developed in the country.

Donor agencies supported the URA for the first eight years of its establishment. Since 2016, the Authority has operated on 70% consumer levy monies collected and paid by utility operators and 30% Government grants.

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4 Republic of Vanuatu. 2006. The Electricity Supply Act of 1972.

5 Republic of Vanuatu. 2010. Electricity Supply (Amendment) Act 2010.

6 Republic of Vanuatu. 2007. Utilities Regulatory Authority Act 2007.

7 While URA's primary role in the NEMP is to regulate electricity activities, their dual function as water regulator provides synergistic opportunities to function as the single regulator for any electricity suppliers who also offer water supply services as part of their business model.

The right of the Authority to collect levies was granted through an amendment to the URA Act, which was introduced in Parliament by the Government - the Utilities Regulatory Authority (Amendment) Act No. 19 of 2016.

Today, the URA is a fully independent regulatory institution with a team of electrical engineers, economists, financial auditors, and legal and administrative staff. The URA regulates:

- Six Small Water Suppliers on Efate;
- Two main Water utilities (UNELCO and Department of Water);
- Three electricity concessionaires (VUI- Operating on Santo, Maewo, Ambae, and Sola); UNELCO (Operating only on Efate); VANPAWA (Operating on Malekula and Tanna Island); and
- Two electricity mini-grids (Wintua and Lorlow on Malekula and Loltong on Pentecost).

The Authority is also one of the three founding members of the Office of the Pacific Energy Regulator Alliance (OPERA) together with the Electricity Regulators of Tonga and Samoa. OPERA is a regional body that regroups the electricity regulators in the Pacific region.

3.1.3. National Energy Road Map

The NERM is the guiding document for energy development in Vanuatu. It was first developed in 2013 before being updated in 2016. An implementation plan was developed in 2019. No further updates have been drafted since then. Still, the Global Green Growth Institute (GGGI) will support DoE in reviewing the NERM, giving the ideal opportunity to ensure all aspects related to electrification are included in the revised version. The NERM sets five primary targets for Vanuatu's energy sector. The relevant target for this report is 'Accessible Energy'. Therefore, we may consider the NEMP as the detailed implementation of a component of the NERM.

3.1.3.1. ***Definition of electricity access***

Before setting a target, it is important to define it. Therefore, a clear and concise definition of electricity access is crucial to the NEMP. The 2016 NERM update notes that:

> *For this review, the definition of "electricity access by households in off-grid areas" includes the following households:*
>
> - *Households with own small-size (< 1,000 Watt) or medium-size (> 1,000 Watt) generator*
> - *Households with Pico (< 50 Watt), standard domestic (50-150 Watt) or commercial (> 150 Watt) Solar Home System*
>
> *Households with only solar or battery lamps are not considered as being electrified.*

However, it also notes that

> *One of the major targets of the NERM is to achieve electrification of households and public buildings. However, the NERM does not define what service level needs to be provided to qualify a household or public institution as electrified. This definition needs to be added in the NERM.*

This point was supported during the project kick-off meeting between the Consultant and the DoE when the DoE stated that there is no definition of electrification and requested the assignment to provide one. The DoE suggested a different definition for concession and non-concession areas, which we assume refers to the four main concession areas noted above. The DoE also suggested considering the ESMAP multi-tier framework (MTF) definitions of energy access, as summarised in Figure 19. The ESMAP MTF considers the output of a mode of electricity supply rather than the input and is, therefore, technology-agnostic. However, the figure suggests solutions that can meet the tier objectives. Different elements of the MTF can also be selected, e.g. different tiers for availability and formality.

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3+	TIER 4	TIER 5
Capacity	Power capacity ratings	Less than 3 W	At least 3 W	At least 50 W	At least 200 W	At least 800 W	At least 2 kW
	(W or daily Wh)	Less than 12 Wh	At least 12 Wh	At least 200 Wh	At least 1 kWh	At least 3.4 kWh	At least 8.2 kWh
	Services		Lighting of 1,000 lmhr per day	Electrical lighting, air circulation, television, and phone charging are possible			
Availability[a]	Daily Availability	Less than 4 hours	At least 4 hours		At least 8 hours	At least 16 hours	At least 23 hours
	Evening Availability	Less than 1 hour	At least 1 hour	At least 2 hours	At least 3 hours	At least 4 hours	
Reliability		More than 14 disruptions per week			At most 14 disruptions per week or At most 3 disruptions per week with total duration of more than 2 hours[a]	[> 3 to 14 disruptions / week] or [≤ 3 disruptions / week with > 2 hours of outage]	At most 3 disruptions per week with total duration of less than 2 hours
Quality		Household experiences voltage problems that damage appliances				Voltage problems do not affect the use of desired appliances	
Affordability		Cost of a standard consumption package of 365 kWh per year is more than 5% of household income			Cost of a standard consumption package of 365 kWh per year is less than 5% of household income		
Formality		No bill payments made for the use of electricity				Bill is paid to the utility, prepaid card seller, or authorized representative	
Health and Safety		Serious or fatal accidents due to electricity connection				Absence of past accidents	

Figure 19. ESMAP multi-tier framework definitions of electricity access. Source: ESMAP

Figure 20. ESMAP multi-tier framework definitions of electricity access. Source: ESMAP

Defining electricity access is a policy decision that should reflect the specific characteristics of the population being electrified and, as such, is provided as a recommendation in the following sections.

3.1.3.2. NERM targets

The Roadmap breaks down its targets across three indicators:

- Indicator 1: Increase electricity access by households in concession areas;
- Indicator 2: Increase electricity access by households in off-grid areas;
- Indicator 3: Increase electricity access by public institutions (on- and off-grid)

The main targets were set in the 2013 NERM and were subsequently revised in 2016 before being reported on most recently in the 2019 Implementation Plan. Vanuatu's progress against the NERM targets is presented in Table 26.

Table 26 Progress against NERM electricity access targets. SOURCE: NERM 2019 Implementation Plan

	Level 2018	Target 2020	Target 2030
Indicator 1 (concession areas)	71.7%[8]	75%	100%
Indicator 2 (off-grid areas)	64.4%	60%	100%
Indicator 3 (public institutions)	71.6%	80%	100%

The NEMP focuses on areas both inside and outside the concession areas and is, therefore, interested in progress against all three indicators.

The target establishes that different technologies may be adopted for other areas, as presented in Figure 21. While this is a helpful guide for determining potential electrification solutions, as noted above in reference to the ESMAP MTF, the definition of access should be based on the output of the electricity supply technology rather than the input.

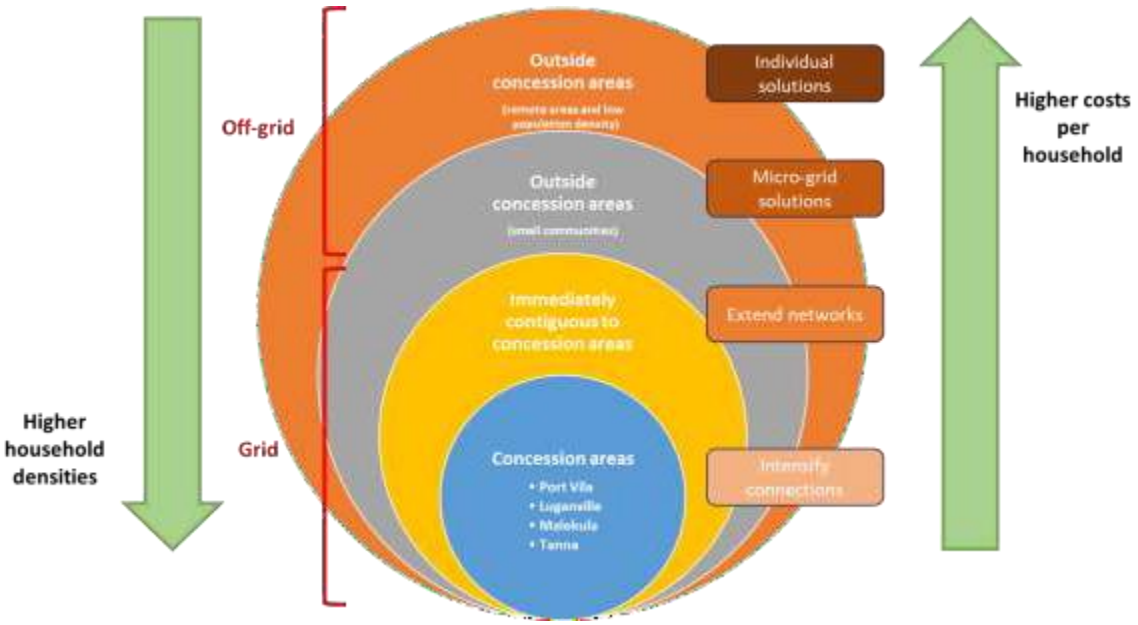


Figure 21 Technological solutions for electrification by area. SOURCE: Adapted from NERM (2013, 2016)

As a precautionary point, which will contribute to the choice of electrification technologies and NEMP, the 2019 NERM Implementation Plan also notes:

> *As currently defined in the NERM, electrification does not necessarily need to happen with renewable energies. It is defined as a benefit and as an enabler of economic and social development, but electrification does not need to be done with renewables. This is in contrast to the NDC (Nationally Determined Contribution), which aims at providing close to 100% of electricity from renewable energies. This inconsistency needs to be clarified.*

This should ultimately be a policy decision for the DoE. We recommend adopting the same approach for Vanuatu's national electricity supply, that all electricity supplied should be sourced from renewable energy to

[8] This value is presented for 2017 in the 2019 NERM Implementation Plan.

the extent that it makes economic sense. For example, the incremental cost of shifting from 95% to 100% renewable energy may be too high to justify the economic gains (including social and environmental gains)[9].

3.1.3.3. Identification of NEMP target areas

The NEMP focuses on electrification both inside and outside the four main concession areas. While electrification activities within the concession areas are likely to be undertaken by the concessionaires, they may choose not to supply some customers within their concession area for some reason and by agreement with the DoE and URA. Such populations may be identified as such because they are:

- Off-grid – the concessionaire may wish only to serve customers with their grid network[10]. This NEMP has identified some unconnected communities for off-grid connection that may be deemend within a concession area.
- Not accessible – there is no road access to enable the concessionaire to extend its grid to the area.
- Grid infrastructure not permitted – there are occasions when grid extensions would need to go through/into privately-owned land, and the landowner does not grant permission to have parts of the grid network traverse their land. Off-grid systems would be suitable in these instances.
- Dwelling structural integrity – a standalone off-grid system may be deployed when a concessionaire declines to connect a household because the dwelling's structure is unsuitable.

3.1.4. Regulations

Vanuatu does not have a regulatory framework to support mini-grids or technical standards appropriate for standalone solar. The annexes provide Terms of Reference to engage a consultant to support this. The recommendations of this NEMP guide what the regulatory framework should contain.

3.2. Institutions

Currently, responsibility for electrification planning sits within the DoE rather than a dedicated planning entity and is carried out by a small team within the DoE. This is not unusual for a country of Vanuatu's size. Similarly, no dedicated entity supports rural development, including economic activities and social outcomes (also not uncommon). The concessionaires have connected customers to main grid networks within their concession areas, but there has been no coordination of off-grid electrification. Instead, projects targeting specific areas have been developed with the blessing of the DoE's electrification department and sometimes with their participation, but typically without active procurement.

The following table summarises the key institutions involved in electrification in Vanuatu.

Table 27 Key institutions supporting electricity access in Vanuatu. SOURCE: TTA and ECA.

Institution	Role
Department of Energy	• Primary responsibility for electrification planning and activities. It primarily focuses on policy matters and has challenges handling ongoing projects. • It is currently resource-constrained, and its electrification unit is very small. • It has been unable to collect and analyse the correct data to offer helpful information to stakeholders, often relying on information from other departments.

9 The NERM Implementation Plan 2019, in its recommendations towards revisions of the NERM, notes:
The NERM defines the level to be achieved for a number of indicators as 100%. Whereas it is the correct approach to aim at 100%, it will in many cases technically not be possible to achieve a full 100%. It would be advisable to use the wording used in the NDC, which talks about "close to 100%". There is also a direct conflict of the definition of targets between NERM and NDC, where NERM defines the target for Indicator 6 (Increase the proportion of electricity generated from renewable energy sources) at 100%, whereas the same target is defined in the NDC as "close to 100%).

10 We note that VUI is currently electrifying users inside their concession with stand alone solutions.

Institution	Role
NGEF[11]	• The NGEF is already established as a vehicle to support electrification objectives: - to support projects and activities aimed to achieve the objectives of the National Energy Road Map in providing accessible, affordable, secure, reliable and sustainable energy and green growth and - to provide financial support and technical assistance to extend electricity access to a person using renewable energy sources and facilitate more efficient end-use of energy
URA	• Primary responsibility for regulating electrification and electricity supply activities. • Has good capacity for this but requires guidance on how best to do it and to develop the specific regulatory frameworks.
Department of Finance and Treasury	• They have identified key economic hubs in different islands, depending on where economic activity is, the presence of schools, connectivity (ICT needed for trading), wharf/port, etc. Electricity access is essential to increase revenues through additional registered businesses.
Other Government of Vanuatu Departments	Inter-ministerial coordination is complex despite being identified as essential to promote meaningful positive impact to the rural communities to be electrified. This is hindering the development of rural communities. • **Department of Industry.** Promotes economic activities on islands. They support value-adding activities. The Department is taking decentralisation seriously. To that end, they are carrying out mapping exercises in each province, where activities are based, value addition, etc, starting with Malampa province and will move to Sanma next. • **Department of Cooperatives.** Supports rural development with value-added activities from the primary sector. They promote management systems, accounts, etc. They have identified and mapped the 50 financially stronger cooperatives across Vanuatu. They are supporting some electrical cooperatives such as Lorlow and Wintua. They are working on financial cooperatives, essential to offer access to credit in rural areas but which require electricity access to monitor the activities. The most common cooperatives are the ones related to fishermen and retailers for consumer goods. There are more than 300 cooperatives, half of which relate to consumer and retail activities. • **Department of Tourism.** In the rural tourist facilities, electricity is needed to secure minimum standards for accommodation, to satisfy needs in cold storage, lighting, bookkeeping systems, marketing (Facebook, etc), etc. Most tourist infrastructure has already benefited from programmes offering small-scale solar photovoltaic (PV) systems, but larger systems are often required. Mini-grids might be challenging as tourist bungalows and resorts tend to be in remote and isolated locations far from the towns' economic centres. • **Department of Agriculture**. Their work is typically complemented by the Department of Cooperatives or Department of Industry for any activity beyond growing crops. Agriculture in Vanuatu is generally done for subsistence, so establishing cooperatives helps scaling up. Market access is often the main problem. Irrigation is not common, so they do not have that energy need very often. • **Fisheries Department**. The body charged with the implementation and enforcement of fisheries management laws, policies, regulations and principles under the Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB). Its mission is "to ensure sustainable management, development and conservation of fish resources in order to achieve maximum social and economic benefits to Vanuatu for the present and future generations". • **Ministry of Health** and **Ministry of Education and Training**. The bodies with responsibility for health and health services provision, and education and training, across Vanuatu. With decentralised health and education services, including in

[11] The NGEF is discussed further in Box 1.

Institution	Role
	areas without reliable electricity connections, they are a key stakeholder in electrification planning. • **Provincial and municipal governments**. As the key decentralised interface for public service provision, local governments represent cross-sectoral interests. Therefore, they are critical in ensuring the alignment of electricity service provision with the uses of electricity, both social and productive.
Development partners	Vanuatu has strong and enduring relationships with its international development partners, many of which have supported electrification initiatives. Some of these are detailed below. • **JICA.** They have collaborated primarily with the DoE in hydropower projects, provided some training, and intend to continue supporting the energy sector. • **KOICA.** They have supported providing subsidies for the supply of solar standalone solutions through NGEF. • **DFAT.** They have good relations with the Government and intend to support national electrification. • **MFAT.** They have funded the NEMP and mapped micro-hydro sites. They previously funded an assignment for the water sector in Vanuatu with a similar approach, which was successful, the "National Drinking Safety Water Plan", which included GIS mapping and an online dashboard. • **World Bank.** They have had exposure to energy projects in the past, and intend to contribute to the electrification goals. • **GGGI.** They are preparing a proposal for the GCF for 2,200 standalone solar systems and two mini-grids. • **ADB.** They have been supporting the development of the Brenwe hydro project. ADB also provided technical assistance to the DoE and URA through individual consultants. The DoE consultant's scope included support on rural electrification.
NGOs	• **Save the Children**
UNELCO	• Concessionaire for Efate. • Current focus is connecting everyone in Efate.
VUI	• Concessionaire for Luganville • Currently providing off-grid standalone solutions to users far from the grid and operating diesel-based mini grids.
VNPF	• Vanuatu's national pension fund. • Concessionaire for Tanna and Malekula (through operating subsidiary VanPawa). • Little operational capacity for its concession areas, instead relying on private entities to operate its assets through management contracts.
Private sector	• Some firms show cautious interest in operating systems after construction, discussing some of the complexities and highlighting that they need substantial support, especially in the first projects.

Unlike many other countries, Vanuatu does not have a national electricity utility with a broad mandate to provide electricity to all citizens. In these other countries, having such a utility offers the possibility of the utility being the vehicle for the public sector to participate alongside the private sector in providing solutions beyond simply financing and owning assets to supporting construction, operations, and maintenance of electricity supplies. While Vanuatu has large private sector concessionaires, their mandate is restricted to operating their concessions, and they cannot be expected to extend this to electrification objectives outside these areas (although they may choose to do so). Therefore, Vanuatu's electrification requires the participation of the private sector in some form, at least in developing and operating its electricity systems and supplying standalone solar under public ownership, if not also owning the systems and standalone solar.

3.3. Recommendations

3.3.1. Ensure DoE has sufficient capacity to implement the NEMP

As mentioned above, there is no dedicated off-grid electrification plan or planning entity, e.g., a rural energy agency, as seen in other countries. Instead, a team within the DoE oversees all off-grid electrification activities. This is not unusual for a country the size of Vanuatu, and the observation is not intended as a recommendation for such a new entity to be created; indeed, given the scale of the country and the resources available, the existing arrangements suffice for Vanuatu's purposes. However**, additional resources are required as the DoE's electrification team is resource-constrained and currently lacks the capacity to implement the NEMP**. As some of these activities will be time-based, i.e. for the duration of the NEMP, they will be better suited to a fixed-term employment contract within DoE or technical assistance for the DoE with development partner support. Expert consultants should be engaged on dedicated assignments for aspects of the NEMP, managed by the same additional DoE resources. As the DoE's capacity grows it will be better placed to support donor-supported projects, with the virtuous circle of continuing to grow the DoE's capacity to implement projects.

3.3.2. Establish a structure to facilitate collaboration with other Government Departments with complementary activities

Electrification activities are more likely viable for private investment if they are supported by complementary rural development activities. Table 27 identifies other Government Departments responsible for these activities. In the absence of any formal Department of Rural Development, **the DoE should establish a platform for itself and the other relevant Government Departments, ie, Industry, Cooperatives, Tourism, Agriculture, Fisheries, Health, Education, and the Telecommunications Radiocommunications and Broadcasting Regulator (TRBR), to coordinate their support for rural development across Vanuatu**. Wherever possible, the appropriate local government entities should also be involved. The DoE does not need to take the group's leadership but should at least ensure a formal structure behind the collaboration, e.g., a secretariat with adequate funding.

The VIDA platform customized for the NEMP promotes interministerial collaboration. It integrates information beyond the households in a geospatial format (education and health facilities, telecom towers, etc.) and, therefore, offers an excellent platform for integral planning.

3.3.3. Develop appropriate electricity supply regulations for off-grid areas

In partnership with the DoE, the URA will develop appropriate electricity supply regulations for areas outside existing concession areas. Figure 22 presents various aspects of the regulations, which are addressed with recommendations in the remainder of the report. The URA has adequate capacity to do this but should be supported with technical assistance from experts familiar with the requirements of such regulations. The annexes provide a ToR for a dedicated consultant to support the URA in developing the appropriate regulatory framework.

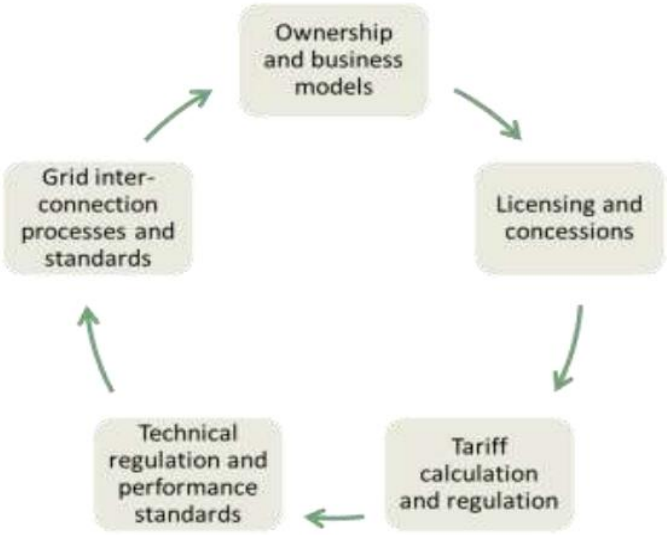


Figure 22. Aspects to be addressed in an off-grid regulatory framework. Source: ECA and TTA

3.3.4. Establish a development partner energy working group

The DoE has made efforts to better coordinate the support from its development partners through founding **the Vanuatu Joint Energy Sector Working Group**. This **should remain a priority** to ensure:

- there is no duplication of support;
- that gaps in support can be brought to the development partners as requests; and
- development partners can collaborate where their combined efforts can achieve results that working separately would not otherwise achieve.

4. Delivery Models

The NEMP establishes a least-cost electrification plan that recommends electricity connections through three possible technologies:

- Connections to the main concessionaire grid networks, where applicable (*on-grid*);
- Isolated mini-grids, which may or may not one day be interconnected with a more extensive concessionaire network or other mini-grids (*off-grid*); or
- Standalone solar PV systems (*off-grid*).

We assume most of the **on-grid connections** will form part of the existing concessionaire's planning approach. This section focuses on different aspects of **off-grid electrification** delivery models.

4.1. Large-scale concessions

Electricity supply, like many businesses, benefits from economies of scale, and not just through developing larger systems. Combining communities into concession areas that may include multiple mini-grids and/or standalone systems can also achieve similar benefits. Where possible, the NEMP combines electrification sites into larger concessions based on geography and demography. This should achieve the following benefits, among others:

- Overhead costs can be shared across broader customer bases.
- Larger customer bases give opportunities for cross-subsidies where customers who can afford to pay a bit more can benefit those who cannot afford their own cost-recovery tariff.
- The URA's regulatory oversight can focus on fewer operators, reducing its regulatory burden, which in turn both reduces its resourcing requirements and increases its focus on fewer operators.

Not all areas are suitable for large-scale concessions due to their geography or demography. Similarly, large-scale concessions limit the potential for community-owned electricity supply, and local suppliers of standalone systems who do not participate in the concessions. For these, alternative delivery models are required.

4.2. Technology-agnostic electricity supply

The least-cost electrification analysis identifies some connections as better suited for one technology while their neighbour is better suited to another. Off-grid electrification delivery models have traditionally been developed separately for each technology (mini-grid and standalone solar), but recent approaches have considered alternatives that combine technologies under a single business model.

A technology-agnostic electricity supply allows a single electricity supplier to determine the appropriate technology to connect each customer within its designated supply area. They are then regulated on the supply of electricity rather than the connection technology, i.e., an output-based regulatory approach where the concern for the quality of the supply is the responsibility of the concessionaire. It allows customers to upgrade (or downgrade) their connection to a larger (smaller) standalone system, or to (from) a mini-grid connection, depending on their demand and their willingness and ability to pay for their electricity supply. It is particularly well suited to countries with remote areas or islands as it allows a single supplier to serve an area, minimizing servicing costs as a proportion of customer bills.

Some of the advantages and disadvantages of the technology-agnostic approach are presented in Figure 23.

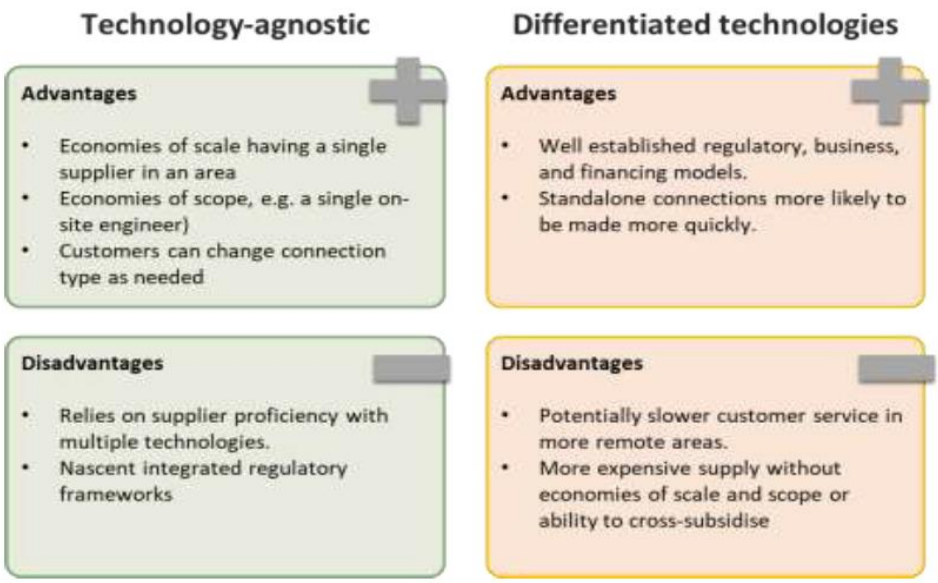


Figure 23 Advantages and disadvantages of the technology-agnostic approach. Source: ECA and TTA

If a technology-agnostic supply approach is chosen, a few points must be considered:

- Whether a technology-agnostic supply agreement for a given area should entail an exclusive right to generate electricity, to supply electricity (i.e., to sell electricity rather than sell a standalone system), or no exclusivity.
- The impact of exclusivity on the market for other companies supplying standalone systems. A few standalone suppliers in Vanuatu suggest that a market already exists in some form.
- The opportunity for local companies to participate, e.g., as partners supplying and/or maintaining standalone systems alongside an international supplier.

4.3. Sustainable electrification

While Vanuatu's electrification objective is to achieve 100% electricity access by 2030, achieving the target will not benefit the country's population if the connections are not sustainable. Unsustainable connections can occur when connections are not well maintained, parts are unavailable, or service providers are not financially sustainable, among other reasons.

The large-scale concession and technology-agnostic models will introduce economies of scale and scope that should reduce costs and increase viability (through lower tariffs). In particular, when part of a concession alongside mini-grids, standalone systems will focus on the supply of electricity rather than the supply of a connection, and it will be the responsibility of the technology-agnostic supplier to maintain that system. If that supplier is responsible for both standalone systems and mini-grids in the same area, e.g., on an island, they may be able to employ a single engineer with the capacity to manage both technologies.

In addition to the economies of scale and scope, sustainable electrification aims to grow customers' demand for electricity. For business customers, this is the productive use of energy; for households, it may involve using appliances; for public services, it may involve longer hours and increased services. Promoting such consumption is not typically an obvious responsibility or capability of the electricity supplier, and, therefore, is an area where coordination between electricity suppliers and other sectors, e.g., Government of Vanuatu entities responsible for Agriculture, Fisheries, and Tourism for productive uses, Health and Education for public services, alongside cooperation with NGOs and development partner programmes, should maximise mutual benefits. Encouraging the private sector both as an electricity consumer and appliance provider for households and businesses will also assist. Electricity suppliers should also be encouraged to broaden their business models into complementary utility services such as water and telecoms. Coordination from the relevant local government will facilitate collaboration across all sectors.

4.4. Mini-grids

Mini-grid-only business models can still be considered outside the large concession areas and if developed by communities.

Mini-grid business models consider the allocation of responsibility between private, public, and community entities for different phases of a mini-grid's life and the ownership of the assets, as summarised in the following chart.

Figure 24 Considerations in mini-grid business models. Source: ECA

Each way these responsibilities and ownership are allocated leads to different business models, as detailed in the following table. The table also presents the advantages and disadvantages of each of the models.

In countries with national utilities, typically state-owned, business models incorporate the utility working alone or in partnership with the private sector. While Vanuatu can engage models with public ownership, there is no public entity with the capacity to operate mini-grids, so Vanuatu's scope to utilise utility-based models is limited, and they are therefore not presented in the table.

Table 28 Summary of business models and their advantages and disadvantages. Source: ECA.

Business model	Description	Advantages	Disadvantages
Build-own-operate (BOO)	A private mini-grid developer is responsible for the entire process, ie, designing, financing, and operating the mini-grid.	Fully leverages private sector innovation and cost optimisation, as developers have complete control of the entire process. Limited costs of stakeholder engagement. Suitable for fast scale-up.	If the private sector in the country is not mature, it might not be easy to find private companies with the full range of capabilities required for this model. Difficult to remove an operator that does not perform as required or desired.
Build-own-operate-transfer (BOOT)	As for the BOO model but assets are transferred to the Government at the end of a fixed-term concession[12].	Competition at the end of the concession for a new operator stimulates efficiency gains and innovation. Poorly performing operators will not have their license renewed.	Additional requirements for contract negotiation, asset valuation, and Government financing should a new operator not be found.
Management PPP	A government entity is responsible for the entire process of mini-grid	Leverages private sector expertise.	Need for prolonged oversight by the public sector, leading to high transaction costs.

[12] This transfer component is what is applied for the existing Efate (UNELCO), Luganville (VUI), and Tanna and Malekula (VanPawa) concessions.

Business model	Description	Advantages	Disadvantages
	development until the commissioning stage (including financing it). After this, the mini-grid is operated by a private company (while still owned by the public entity). The construction is usually done by an EPC company commissioned by the government.	Limits the financial burden on the public budget.	
Split-asset PPP	A government entity procures and owns the distribution assets of a mini-grid, while the developer owns the generation assets. Investment costs are split between the public and private entities. The private operator undertakes operations and maintenance (O&M) and sales.	If the relevant processes are streamlined, it can facilitate quick rollout. Leverages private sector expertise.	Infrastructure development needs to be carefully timed and coordinated.
Cooperative model	One or more local communities finance (mainly through grants) and own mini-grids.	Increased sense of ownership and motivation to maintain the system. Lower return expectations compared to private companies, thus theoretically lower tariffs.	Less suitable for fast deployment and scale-up, as communities have little expertise.

This NEMP makes the following observations based on the least-cost electrification analysis:

- The middle two models depend on considerable involvement by a public entity. We have already noted the limited capacity of the Government of Vanuatu to administer its rural electrification objectives and the absence of a national utility, and, as such, we assume the Government will have limited capacity to participate in developing mini-grids through EPC contracts and managing private mini-grid operators of public mini-grid assets.
- The BOOT model is preferred over the BOO model as it is more familiar to Vanuatu (following the approach for the existing large concessions), and it reduces the risks of non-performing operators.
- Making the cooperative model possible allows communities to develop their own mini-grids, should they have the capacity to do so.

4.5. Standalone solar

There are limited considerations for standalone solar supplier business models:

- **System sales**. Systems are sold to customers. Payment may be made in instalments if cash availability is a constraint.
- **System lease**. The supplier owns the system and leases it to customers. Payments are made over an agreed-upon period. Lease-to-own business models may also be employed, in which ownership of the standalone solar eventually transfers to the customer.

- **Pay as you go** (and similar innovative electrification support schemes). The supplier owns the system, and customers pay for electricity consumption through fixed and variable charges (typically just variable charges).

Broadly-speaking, we do not recommend restricting the business model options of any private operator or a public provider of standalone solar under a public procurement approach, as different customers may have preferences for different models for various reasons. However, the pay-as-you-go model will only be available to the official service provider under a technology-agnostic delivery model, but to any supplier outside these areas.

4.6. Recommendations

4.6.1. Adopt large-scale concessions where possible

Among the communities identified in the least-cost electrification analysis, larger 'clusters' of communities are identified to be supplied under concessions, operating under new concession contracts similar to those existing across Vanuatu and as defined in the Electricity Supply Act. The scale economy benefits of large-scale concessions will accrue through procurement and operation, reducing the total cost of supply. This will either reduce the tariff or subsidy requirement of operators. Larger concessions also provide larger customer bases where, if there are more business customers, creates the possibility of cross-subsidising between customer categories, aiding affordability for poorer customers. Larger concessions will also be more attractive to international developers/suppliers who bring in knowledge of latest technologies, lower cost finance, and opportunities for local companies to partner and learn from them.

4.6.2. Facilitate Energy as a Service (EaaS) business models

The regulation should facilitate the transition towards service-based business models. Global market trends show a transition towards service-based business models, and the off-grid sector is no exception. On the contrary, there is growing interest in offering end-user services rather than just selling kWh. These are often called Energy-as-a-Service (EaaS) models. A good example is the recent publication by Engie Energy of their White Paper *Towards Universal Access to Energy: Enabling a Multi-Technolgy Approach in a mini-grid environment*[13].

Off-grid projects have high due diligence, transactional and mobilization costs. These can be optimized if the same electricity supplier offers additional services besides electricity retailing. From an operational perspective, once the Electricity supplier mobilizes to a remote location and has someone locally in the communities to operate the assets, it can greatly benefit from integrating other services. These models can increase the added value of the service to the communities, thus supporting their local development while at the same time improving the business case for Electricity suppliers. Traditional mini-grid operators then become integrated electricity suppliers.

While the purpose of the technical regulation is not to define the business model, it is important that the technical regulation is drafted considering this market trend so that later on, it does not become an obstacle to it.

Some illustrative examples of how services can be integrated as part of this transition:

- **Appliances**: Operators might choose to include high-efficiency appliances as part of their service. Extending the operator's service behind the meter has important benefits such as:
    - Facilitate access to electrical equipment, which might be challenging in remote locations either because of lack of financial means or simply because they are not available in the local market.
    - Promote the use of quality-certified and energy-efficient appliances.

13 https://engie-energyaccess.com/news/whitepaper_towards_universal_accesstoenergy

    - Incentivize circular economy. The operator can oversee the management of the appliances at the end of their life-cycle. This aspect has important benefits in terms of waste management, which can be better managed in a centralized way as opposed to individually be the customers.

- **Bundling of Services**: Electricity suppliers should be encouraged to benefit from economies of scope by providing complementary services, e.g., water supply and agricultural extension services if they can enhance the value of the electricity supply. The charges for these services can be bundled alongside electricity supplies in a single customer charge but should be identifiable by URA, and any cross-subsidies should be justified. It is acknowledged that the URA may also review water tariffs and service delivery. The potential for a combined application process (and combined license, or an aligned license) should be considered.
- **Community Productive Uses**: The electricity supplier might be interested in not selling kWh but in its final use in productive applications. Examples include:
    - Shared freezer: Instead of each household having its own freezer, the Electricity supplier offers the use of a freezer within the Service Area (so it is not selling kWh but "cold storage");
    - Water pump: The Electricity supplier incorporates this anchor load and offers pumped water for irrigation or for consumption as part of the services (so it is not selling kWh but m^3 of pressurized water);
    - Processing Tools: For agricultural/food processing, wood, textiles, etc.

4.6.3. Adopt a technology-agnostic approach for large-scale concessions and wherever else possible

The Electricity suppliers should be able to decide the most appropriate approach to electrify the community based on the local needs and socio-economic conditions. Different approaches can coexist in the service area, tailoring the technical solution to the local specific needs. The benefits of a technology-agnostic approach suggest that electricity connections are more likely to be sized appropriately for customers (and therefore cheaper) and that connections will be sustainable. A single supplier for each area will accrue economies of scope, e.g., having a single engineer to support all connection types, benefitting customers and allowing customers to upgrade or downgrade their connections as required.

It is recommended to contemplate the following electrification approaches under the future regulation[14]:

- **Collective Electrification Systems (CES),** such as mini-grids, swarm-grids, or solar kiosks, provide service to multiple users using a single or multiple energy resource points.
- **Individual Electrification Systems (IES)**, such as solar home systems, provide service to one user.
- **Single-Appliance Electrification Systems (SAES)**, such as solar pumps, provide an End-use Service to single or multiple users through a single type of appliance. They are an end-use system with embedded generation.

The proposed approach has a promising viability with the use of mobile technology like the one Computer World is using with its Pay As You Go (PAYG) solar systems in Vanuatu. URA can help regulate the monthly fees charged, which should recover capital costs, O&M, and RoR. Customers can be required to contribute a minimum amount or percentage for the service provided to do the installations.

[14] The electrification approaches CES and IES are terms already defined in the IEC 62257-1. The SEAS has been incorporated by the Consultant.

OFF-GRID SERVICE AREA

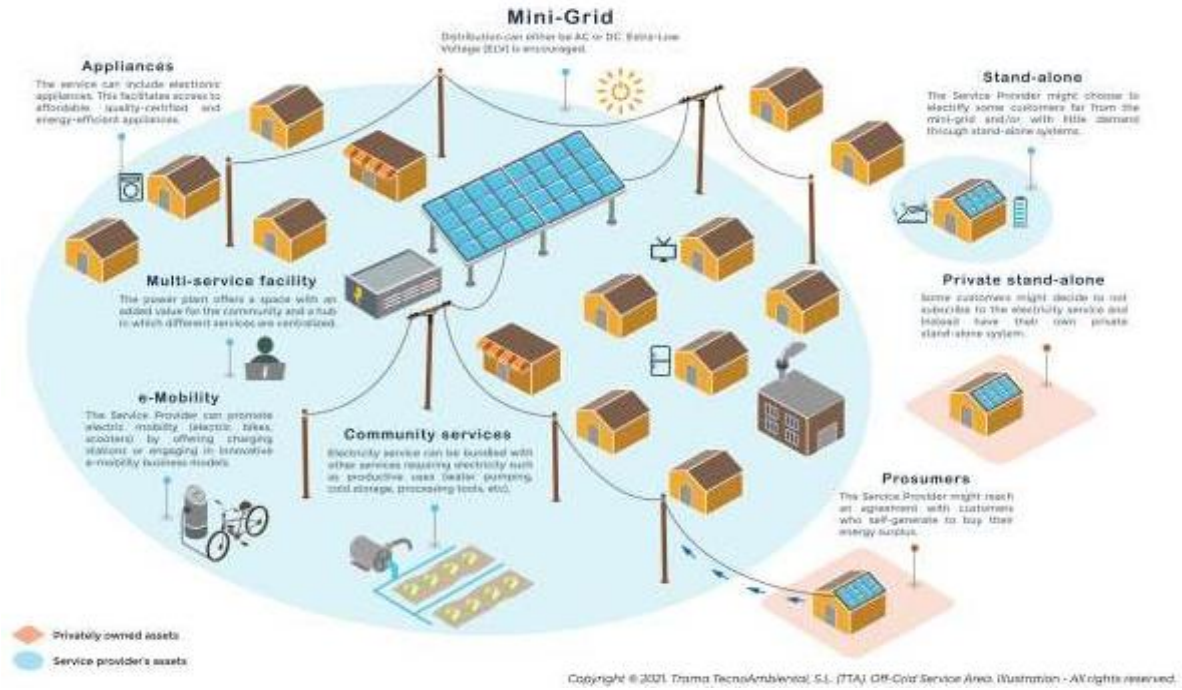


Figure 25. Schematic of a service area which includes an isolated mini-grid and standalone solar PV systems, both private and from the electricity supplier. (Source: TTA)

4.6.4. Facilitate interaction with other stakeholders to maximise the sustainability of connections

Electricity supply is a key component of rural development rather than an end in itself. **In the absence of a mature off-grid sector in Vanuatu, cooperation with existing stakeholders not necessarily related to the energy sector but engaged in rural development is essential and will bring mutual benefits.** This includes the involvement of not only provincial and local administrations but also NGOs, religious missions, or development partners with a strong presence in the off-grid communities. To that end, it is crucial to map these organizations and include them in the integrated planning process and in the subsequent tender documents, so that the future electricity suppliers can engage them in the early stages of project development.

4.6.5. Adopt a BOOT model for large-scale concessions

Vanuatu's existing large concessions have clauses requiring them to return assets to the Government after the concession contracts. We recommend that the new concession contracts contain the same clauses, for all assets including standalone solar, primarily for alignment with the existing framework.

The same approach should also be considered for assets operated under licenses. This will also allow for the easier comparison of tariffs between concessioned and licensed areas.

4.6.6. Allow specific mini-grid models in certain circumstances

For all communities not identified with large-scale concessions in the least-cost plan, rather than being actively solicited, prospective suppliers ("small-scale electricity suppliers") can apply to the URA to receive a license to supply electricity. Unless a small-scale electricity supplier proposes aggregating the identified communities, and the URA agrees, the licenses will cover single communities.

A BOOT mini-grid model is appropriate for sites outside the large concession areas. With little potential for public sector participation, mini-grid development will need to be led by the private sector. Requiring a transfer of assets

to the Government at the end of the license/concession period introduces competition and stimulates efficiencies and innovation.

A cooperative mini-grid model is appropriate for communities wishing to develop their own mini-grids, regardless of whether they are inside or outside a larger concession area. Communities will likely require support to manage the development and operation processes.

4.6.7. Allow specific standalone solar models in certain circumstances

A pay-as-you-go model will only be available to the official service provider under a technology-agnostic delivery model, under either a large-scale or smaller-scale concession/license, but to any supplier outside these areas. Private sale and leasing arrangements should be possible anywhere and not otherwise restricted

5. Electricity supplier procurement and approvals

This Chapter addresses the process for identifying electricity suppliers to apply for the right to supply electricity within a concession or license area, and the process for their approval. The previous chapter recommends four delivery models for which procurement and approval requirements are provided:

- Large-scale concessions
- Private BOOT mini-grids
- Community-owned cooperative mini-grids
- Standalone solar suppliers

5.1. Procurement approaches

For off-grid connections, including those within existing concession areas, the procurement approaches may be considered top-down or bottom-up, although hybrid approaches are also possible. Top-down procurement is a competitive procurement for a supplier to gain a right to supply electricity. Bottom-up procurement seeks to establish or enhance a competitive market for electricity suppliers, with multiple suppliers competing to supply electricity. The two approaches are summarised below:

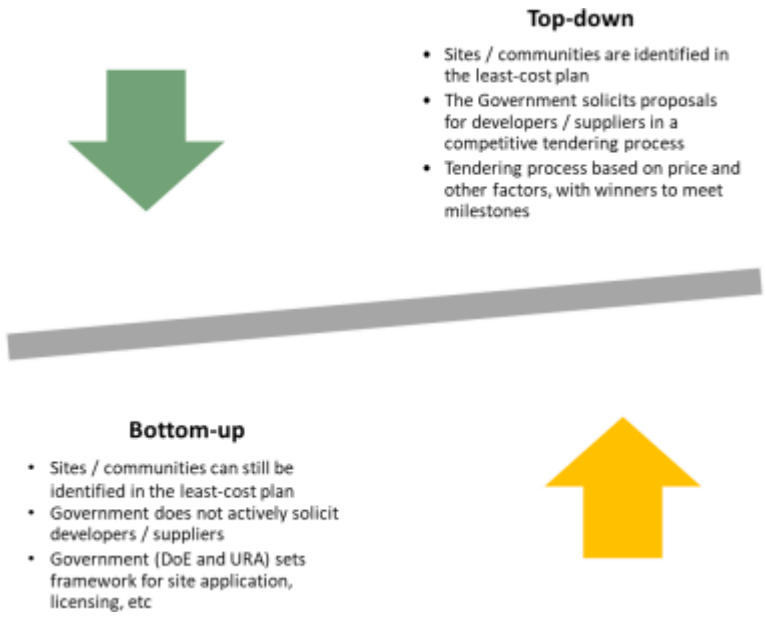


Figure 26. Key features of the proposed top-down and bottom-up procurement approaches. Source: ECA and TTA

Different procurement approaches can be chosen for each delivery model. However, this misses the potential for economies of scope in applying the same approach for both technologies, including the potential to competitively tender defined geographic areas and allow the winning bidder to choose which technology to use for each customer within the community.

Figure 27 presents the advantages and disadvantages of the top-down and bottom-up approaches for off-grid electricity supplier procurement.

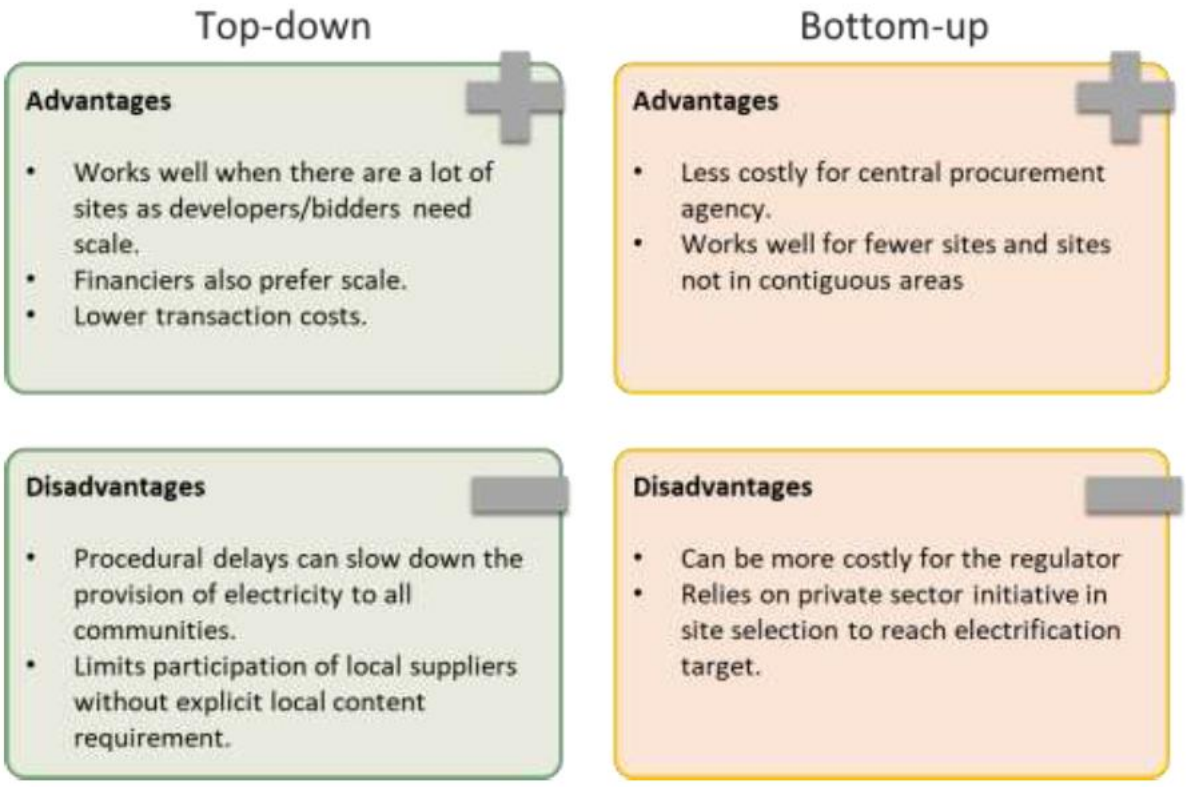


Figure 27 Selecting a procurement approach for mini-grid development. Source: ECA

Some of the details that will need to be considered and developed include:

- Determining how to arrange tendering lots. A strong option is to arrange them by Area Council (municipality). This has the benefit of aligning electrification with other initiatives at the Council level. It should also assist in ensuring there can be equity in how scarce resources are allocated across Vanuatu as the NEMP is implemented.
- Whether the approved right to supply is exclusive. While the natural monopoly nature of electricity grid supply suggests that only one mini-grid should be allowed in a given area, multiple standalone suppliers could supply the same area. Bidders compete for the right to supply under a top-down approach; exclusivity for standalone system supply eliminates competition under a bottom-up approach. As the technology-agnostic approach is based on electricity supply, if this approach is adopted, electricity *supply*, i.e., the sale of electricity, should be exclusive regardless of technology. However, the right to sell electricity *generation* need not be exclusive; companies should still be allowed to sell standalone systems to customers within a URA-approved supply area.
- The electrification objective and whether a bottom-up approach will achieve this within the objective's timeframe.
- The potential for mini-grids depends on whether they are 'pre-electrification', ie, should they expect to be interconnected with other mini-grids or a concessionaire's network (where applicable) or will they remain isolated.
- Rules governing coordination with concessionaires, concessionaire takeovers, or conversion of mini-grids to small private distribution entities should be considered part of the regulatory framework.
- The potential to attract international off-grid electricity suppliers through a tender where much of the due diligence is undertaken as part of the tendering process and shared across bidders, with other country establishment risks removed, ie, steps for establishing a local entity.
- The necessary size of concession areas to make them attractive to international off-grid electricity suppliers, typically based on the total investment requirement or number of customers. Determining this attractiveness threshold relies on market sounding that will be part of the NEMP implementation.

- Private sector participation also requires commitment from the Government of Vanuatu on tariffs that balance commercial viability, customer affordability/acceptability, and the accessibility of subsidies. Tariff options are discussed further in the following Chapter.

5.2. Top-down bidding for identified concession areas

Figure 28 summarises the steps involved in preparing and administering the top-down bidding process recommended for the clusters of sites identified for concession contracts. The first step of this process is part of the NEMP, with sites identified and bundled through the least-cost mapping exercise, generating the economies of scale identified.

Figure 28 Steps for administering a top-down procurement process

Following the open tender process, the preferred bidders will be invited to sign concession agreements negotiated with the DoE, with assistance from the URA.

Various factors can enhance the likelihood of a top-down competitive procurement's success, as summarised in Figure 29. We recommend that the DoE considers each step when designing the procurement process. We also recommend that the DoE considers engaging a technical consultant to design and administer the procurement process. The annexes provide an example ToR to facilitate the engagement of such a consultant.

Figure 29 Steps to enhance the likelihood of a successful procurement process

Scale and packaging of sites	• Tenders need to include a minimum number of customer connections to attract international developers. • A larger scale of projects packaged together attract larger, more experienced investor teams, and reduce transactions costs.
Partnerships between local and international companies	• Tendering procedures entail additional barriers for international developers, given size and evolving stage of the sector and risks for private companies. • Partnerships with local players mitigate this risk.
Investor forum	• Key requirement for successful implementation of a top-down procurement process is creating an interactive platform that allows investors to meet and coordinate with each other.
Facilitation of initial stages of site development	• The programme can undertake a lot of the site assessment and preparation, ie, demographic study, WTP, land access, E&S analysis etc.

The operating requirements for the concessions will be covered primarily through the concession contracts, which will be negotiated between the preferred suppliers in the bidding process and the DoE.

Under both concessions and licenses, the supplier will have certain rights and obligations:

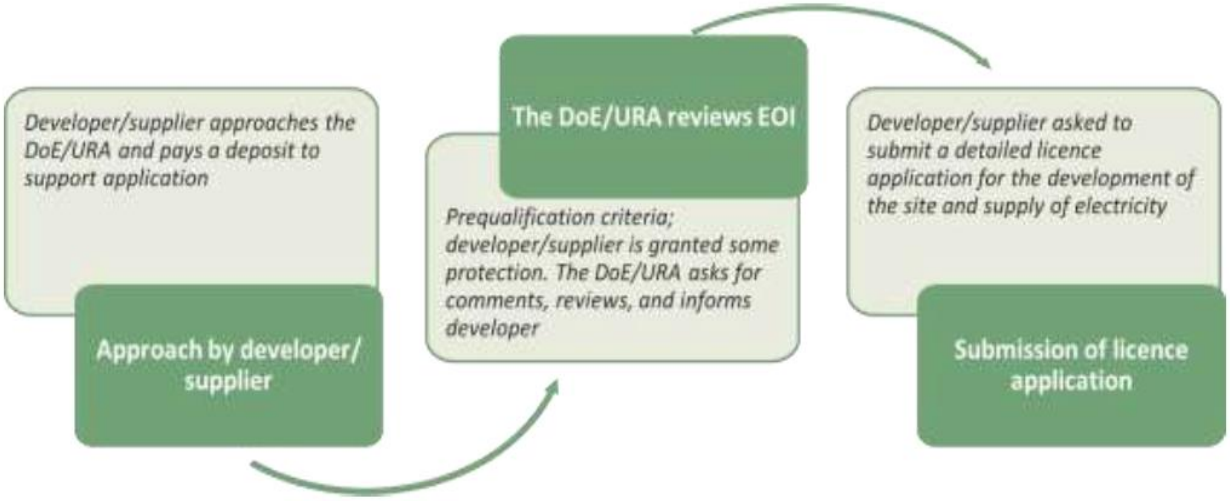
- An **obligation to connect all potential unconnected customers** within the area defined by their concession/license.
- They must offer an electricity supply that **meets the service quality requirements** as agreed with the DoE and URA under their concession/license terms. They will **not be required to use any given technology** to achieve this. Where the tariff is determined by the URA, it will consider all assets, regardless of technology, as part of the electricity supplier's regulated asset base.

- They will have **monopoly rights for electricity supply**, ie, where power is sold by the concessionaire to a customer. This includes any power sold from standalone solar. An exception will be prosumers (and anyone else) selling power to the supplier.
- They will not have **monopoly rights for the sale standalone solar units**, i.e., where a customer purchases their own generation source and locates it on their premises.

5.3. Bottom-up procurement through the URA

The URA should establish a clear process for any prospective suppliers to apply for a license through a bottom-up process. The suggested steps are summarised in Figure 30. Defining this process in more detail should be part of the scope of a technical consultant engaged to assist in developing a regulatory framework, with the ToR provided in the annexes.

Figure 30 Steps for a license application to the URA under the bottom-up approach



The operating requirements for small-scale electricity suppliers will be covered primarily through **a sector-wide regulation** to which the license will refer. Given the relatively simple terms of the license (compared with the concession), it will be easier to negotiate – most terms will be non-negotiable. There will be three types of license available, with the type determined between the supplier and the URA:

- A **community license**[15], applicable to sites (or aggregation of sites) developed by organisations with at least a majority of the ownership residing with its customers;
- A **light-handed license**[16], with fewer operating and reporting requirements than a full commercial license (below), applicable to all sites (or aggregations of sites) not with community licenses and with a voltage level entirely at or below a defined level; and
- A **full commercial license**[17], applicable to all other sites (or aggregations of sites) that do not fall under the other two categories identified above.

A small-scale electricity supplier can transfer their license from one type to another, provided they meet the requirements of the new license type and follow a process required by the URA. The regulations to be developed by the URA will define each license's operating terms and conditions, including the requirements for community ownership to qualify for a community license and the voltage level to qualify for a light-handed license. This report addresses the tariff and application/approval requirements of each license.

15 This can include the currently defined electricity cooperatives and community-owned electric systems.
16 This may be defined as a subset of the currently defined concessionaires under the Electricity Supply Act.
17 This can be defined as a subset of the currently defined concessionaires under the Electricity Supply Act.

5.4. Recommendations

5.4.1. A top-down approach for procuring off-grid electricity suppliers in larger (technology-agnostic) concessions will maximise the possibility of achieving the electrification objective

Vanuatu has set an objective of achieving 100% electrification. Considering the current electrification rate, this is more likely to be achieved through actively promoting electricity supply than by solely creating a conducive environment for private sector participation that will select which customers to serve. As the population currently without electricity access is among the poorest in Vanuatu, electricity connection affordability is a significant challenge, further challenging the models promoting wholly commercial solutions. Given this, **it is recommended that Vanuatu adopts top-down procurement approaches for identified larger concession areas**.

5.4.2. Ensure evaluation criteria in top-down tenders consider more than just price

In terms of evaluation criteria in the tenders, **the incorporation of weighted criteria in addition to the price should be considered** (in alignment with new World Bank procurement regulations[18]). Furthermore, it is recommended to give extra scoring for initiatives that incorporate PUE, or that include multi-sector approach (water, telecomunications, waste, e-mobility, etc).

5.4.3. Bottom-up procurement should be allowed for identifying mini-grid and technology-agnostic developers/suppliers

The DoE and URA will develop a procurement process for bottom-up approval of unsolicited mini-grid developers for areas outside the large concession areas. This activity could be incorporated into the same regulatory framework developed by the consultant engaged through the ToR provided in the annexes.

5.4.4. Bottom-up procurement should be allowed for identifying sellers of standalone systems

Vanuatu already has standalone solar suppliers with expertise in their products and their installation. These suppliers should continue their supply models alongside the top-down procurement. They will be entitled to sell standalone units, including with financing arrangements, but not be entitled to retain ownership of the systems and sell electricity within larger concession areas, as that will be the exclusive right of the concessionaire.

[18] https://www.worldbank.org/en/news/feature/2023/03/08/rated-criteria-a-game-changer-for-promoting-value-in-world-bank-procurement

6. Tariffs

6.1. Current framework

There are two primary pieces of legislation covering the activities addressed in this report:

- The Electricity Supply Act (the ESA), and
- The Utilities Regulatory Authority Act (the URA Act).

We are not aware of any specific guidance on tariffs or approvals in the ESA. However, the precedent of the concessionaires operating under current concessions is that tariffs are intended to be sufficient to allow suppliers to recover their costs of service.

The URA Act established the Utilities Regulatory Authority (URA) in 2007. It is mandated that utilities in Vanuatu be regulated. A utility, as defined by the URA Act, is a person who supplies electricity or water to a consumer for payment and includes any related entity. A utility can be a concessionaire, the Government, or a private company supplying electricity and water to customers.

When regulating electricity utilities, the URA must ensure that utilities provide a safe, reliable, and affordable service to consumers. It sets the maximum price of electricity and water that a utility can charge its customers. **Affordability** ensures that tariffs and charges determined by the URA for electricity utilities, customer connections, and other utility-related services directly linked to its responsibilities as an electricity utility are fair to customers and sufficient to sustain the utility service. While tariffs **within** the existing concession areas are determined through a tariff review process with the URA, following the URA's prescribed tariff methodology, there is currently no specific guidance for determining tariffs **outside** concession areas.

The Authority also acts as a mediator between utility customers and their utility to resolve any customer's dispute concerning an aspect of a regulated service (e.g. electricity billing, safety issues).

The URA does not have a dedicated framework for supporting mini-grid or independent electricity system (e.g. solar home systems) service delivery.

6.2. Policies and regulations

There are two main elements to tariff-setting for concessionaires and licensees: policies and regulations. The differences between them are presented in Figure 31, including how each should be addressed in Vanuatu.

Figure 31 Key aspects of and distinctions between tariff policies and tariff regulations

The first distinction is the entity responsible for each. Typically, it will be the policymaker (the DoE) who is responsible for determining tariff policies and the regulator (the URA) for determining regulations. However, DoE approval may be required to enact regulations. The second and most important policy decision is whether tariffs should be set at a cost-recovery level. The definitions and distinctions from the term 'cost-reflective' are important:

- A tariff is set at a **cost-recovery** level when the electricity supplier can recover all its allowed costs through charging the tariff.

- A tariff is **cost-reflective** when its structure, typically balanced between fixed and variable charges (although this may include other charges), reflects the structure of the underlying costs, ie, fixed and variable costs.

The approaches to tariff determination are discussed in the following section.

6.3. Approaches to Tariff Determination

The approaches to tariff determination consider the respective roles of the electricity supplier, its customers, and the regulator. As the regulator is a party to the process, it is helpful that another entity, i.e, the policymaker, determines its role.

Table 29 sets out the possible approaches for determining tariffs that may be considered for both concessions and licenses in Vanuatu.

Table 29 Approaches for determining tariffs

Option	Description
Willing buyer, willing seller	• Tariff set at a level and structure on which the supplier and its customers agree • Household disposable income sets a de facto tariff limit; if customers cannot afford the tariff, they will not pay • Customers may be able to protest to the URA
Individualised cost-based tariff limits	• Regulator sets limits on tariffs for each supplier, based on the full cost of service • Regulator may (but does not have to) review and approve proposed tariff structures
Bid tariffs	• Supplier obtains the right to serve an area by bidding the lowest tariff in a competitive tender • These tariffs are adopted as the tariffs for electricity supply for an initial control period • Following the initial control period, one of the other approaches should be applied
Uniform national tariff	• Tariffs are set equivalent to the national main grid tariff
Efficient new entrant price cap	• Regulator sets a single benchmark tariff for all electricity supply, based on the cost of service of an efficient new entrant in the market

Of the options proposed above, we recommend **not considering the uniform national tariff**, as Vanuatu does not have such a tariff. The closest approximation would be the tariffs set by each of the four current concessionaires, but as these differ from each other, there is no immediate consensus available. Applying the tariffs of any one of the current concessionaires would not be suitable for the same reasons.

We also recommend **not considering the efficient new entrant price cap** as this, by its nature, will be set for the cheapest electricity supplier, and, as the efficient costs of service provision will likely vary across the country, every site with higher (but still efficient) costs will be unable to recover its costs through tariffs. Similarly, if the tariff were based on an efficient operator at the most expensive site, customers would pay a higher tariff for every site across Vanuatu than the cost of service. However, this option hints at a methodology of benchmarking selected input costs at efficient levels, which should be followed wherever tariffs are assessed.

6.4. Recommendations

6.4.1. Proposed tariff approach

Table 30 proposes our recommendations for the approach to tariff determination for each of the service areas proposed in Chapter 2.

Table 30 Recommended tariff approach for each service area

Contract type	Tariff recommendation	Explanation
Top-down concession	Bid tariff	• Costs will vary across service areas, so a national benchmark will not be appropriate • The competitive bidding process for concessions should direct tariffs to cost-recovery levels • If there is inadequate competition in the bidding process, the individualized cost-based tariff limits may be considered • After the top-down concession has been operating for three years, individualized cost-based tariff limits will be applied, as approved by the URA
Community license	Willing buyer, willing seller	• As the customers of a community-owned supplier are also its owners, those same customers should be able to determine tariffs that allow cost recovery without exploiting themselves • Customers can approach URA for assistance in determining tariffs if there are any concerns
'Light-handed' license	Willing buyer, willing seller	• Allowing customers to agree on tariffs with the electricity supplier will assist with keeping costs (and therefore, tariffs) low • If there are many of these sites, this approach will minimize the cost burden on the URA • Customers can approach the URA for assistance in determining tariffs if there are any concerns
Full commercial license	Individualized cost-based tariff limits	• These sites are likely to be larger settlements where the costs of a tariff application and approval can more easily be shared across customers • We do not expect many sites to operate under a full commercial license, keeping the cost burden on the URA at a manageable level

The options for **tariff structures should be flexible for all operators**, i.e., there should be no restrictions on the balance between fixed, variable, time-of-use, and other charges.

For a BOOT model to be viable for the private operators who fund (at least partially) the assets, the tariffs charged should **either ensure full cost-recovery by the end of the concession** or **for the remaining value at that time to be paid to the operator as compensation for the assets acquired** (following an agreed valuation formula). Typically, asset costs should be recovered from customers over their useful lives, so compensation should be paid for assets with a useful life extending beyond the end of the concession, where the costs have not been fully recovered from customers.

We recommend continuing the current approach of **no tariff regulation for standalone solar suppliers** (effectively choosing the willing buyer, willing seller approach), except where these form part of a large-scale, technology-agnostic concession. In this case, the standalone solar will be considered part of the electricity supplier's regulatory asset base alongside any mini-grid assets and its costs recovered accordingly.

Draft the concession contract for concessions – as Vanuatu already has concessionaires operating under concession contracts, these contracts should be the basis for new concessions. To identify areas for enhancements, particularly for smaller systems than those currently operating, and to learn from international best practices, we recommend considering the concession contract template provided through the IFC scaling-mini-grids programme, albeit considering this is designed solely for mini-grids and not for a technology-agnostic service provision. In preparing the concession agreement and license templates, the DoE and URA (and any consultants supporting them) should consider underlying asset ownership and the treatment of assets after the concession contract/license.

Draft regulations for licensees – we recommend that URA engage a technical consultant to assist in preparing regulations for licensees, including the license template for each of the three licensees identified in this report. A sample ToR for a consultant is provided in the annexes. The scope of work should include reviewing the concession contract to ensure it aligns with the regulations where appropriate.

6.4.2. Tariff regulatory requirements

This section provides further details of regulatory requirements that the URA can apply to each electricity supplier. Determining the details of the points set out in this section will be part of URA's process for developing its regulations with the assistance of an external technical consultant; an example ToR for engaging a consultant on this basis is provided in the annexes.

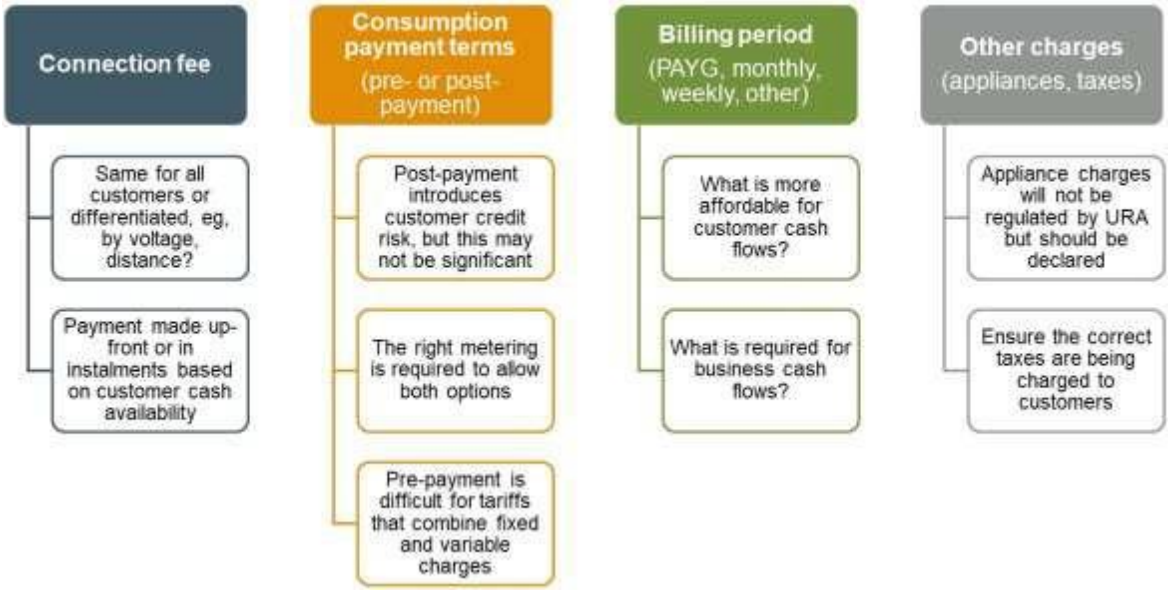
Table 31 summarises some key points the URA should consider when developing its tariff regulation.

Table 31 Selection of points for URA to consider when developing its tariff regulation

Regulatory action	Regulatory requirements to consider	Electricity suppliers this will apply to
Control period	• The time for which tariffs are set • Whether there should be a difference for early years as customers become familiar with electricity and 'steady state' when demand is more stable • Whether the length of the period should vary if there are cost pass-throughs, limiting the electricity suppliers (and ultimately the customers at the end of the period) to external price shocks	• All electricity suppliers
Tariff methodology	• Cost assessment approach, e.g. building blocks • Tariff determination approach, e.g. the marginal or average cost • The allocation of corporate overhead costs if there are multiple concessions/licenses under a single entity • Whether sites can be bundled into a single tariff application	• Full commercial licensees
Tariff model	• Whether to use a standardised tariff model • The level of operating detail included in the model	• Full commercial licensees • Could request bidders for concessions to use the same model as part of their bids
Cost benchmarking	• Identifying the cost items that can be benchmarked and applied across all electricity suppliers when assessing reasonable costs	• Full commercial licensees
Automatic adjustments / cost pass-throughs	• Whether any cost items should have automatic adjustments based on periodic changes in transparent external benchmarks	• Full commercial licensees
Right of appeal for willing buyer / willing seller	• The customers needed to trigger an enquiry, and whether this is based on the number or proportion of total consumption • The owners needed to trigger an enquiry, and whether this is based on the number or proportion of total ownership	• All electricity suppliers
Alternative electricity supply models, e.g. kiosks, e-vehicle charging	• Services should not be limited • Assume all will be provided on a willing buyer / willing seller basis unless URA determines otherwise	• All electricity suppliers
Non-electricity service provision, e.g. water	• Services should not be limited • Regulation will not be addressed by electricity regulation (even if URA is still the designated regulator, e.g. for water), but can be identified in the application process through a single application window	• All electricity suppliers

There is a range of other charges that may be applicable for any concessionaire/licensee that the URA should consider within the framework of the tariffs it reviews for fully commercial licensees, summarised in Figure 32. As with other aspects of the tariff regulation, it is not the role of this assignment to provide recommendations on this level of detail in the regulation. At the highest level, we recommend that URA offers guidance on these but ultimately lets the licensee determine these provided it is a) legal (for taxes) and b) not exceeding total revenue requirements (for fully commercial licensees).

Figure 32 Other customer charges the URA should consider for fully commercial licensees



7. Implementation costs and funding

7.1. Proposed implementation phases

This section provides a first attempt to define how the NEMP could be implemented in phases. These phases shall be discussed with the relevant sector stakeholders and refined before its implementation.

7.1.1. Key Principles

The following considerations have been observed in the definition of the proposed phases:

- **Phases**. The proposed implementation of the NEMP is structured in 4 phases, initiating construction activities in 2026, 2027, 2028, and 2029 respectively. The year 2025 would be left for all the program preparation activities in alignment with the action plan. These phases would allow reaching universal access by 2030 in alignment with the NERM.
- **Prioritization**. In general terms, the prioritization of municipalities in the proposed implementation phases is done based on scale (from larger to smaller) and complexity of the development (from easier to more complex). This strategy allows increasing the project complexity in parallel with the local market development (the most complex projects would be done once the local sector is more mature and has accumulated more experience through the previous phases).
- **Intervention to entire islands**. Except for the few largest islands, the proposed phases prioritize completing the electrification on entire islands before starting interventions on another nearby island. This facilitates logistics and reduces transactional and mobilization costs.

7.1.2. Shefa

The proposed approach is to start by completing the electrification of the entire Efate island, which primarily requires grid extension and standalone systems; continue electrifying the entire Epi island and finish electrifying the islands around.

Table 32. Proposed implementation phases for Shefa.

Phase	Area Council	CAPEX (low) [USD]	CAPEX (high) [USD]
SHEFA		**16,727,985**	**21,382,395**
-	Port Vila	3,627,799	4,705,062
-	Ifira		
-	Pango		
-	Mele		
PHASE 1	Erakor		
	Eratap		
	Eton		
	Malorua		
	North Efate		
PHASE 2	Vermali	6,866,291	8,774,634
	Vermaul		
	Varisu		
	South Epi		
PHASE 3	Nguna	2,678,923	3,381,403
	Emau		
PHASE 4	North Tongoa	3,554,972	4,521,296
	Tongariki		
	Makimae		

7.1.3. Sanma

The proposed approach is to first extend the electrification of Luganville to entire Canal-Fanafo; then expand the coverage towards northeast through grid extensions; then electrify South Santo, Malo island, and North, West and North-West in this order.

Table 33. Proposed implementation phases for Sanma.

Phase	Area Council	CAPEX (low) [USD]	CAPEX (high) [USD]
SANMA		**25,434,693**	**32,820,965**
-	Luganville	5,009,256	6,503,426
PHASE 1	Canal - Fanafo		
	South East Santo		
	East Santo		
PHASE 2	South Santo 1	7,484,858	9,593,012
	South Santo 2		
PHASE 3	West Malo	4,518,675	5,870,348
	East Malo		
PHASE 4	North West Santo	8,421,904	10,854,179
	Big Bay Coast		
	Big Bay Inland		
	West Santo		

7.1.4. Malampa

The proposed approach is to first complete the electrification of North-East Malekula around the existing concession. Then, extend the service to neighboring North West and Central Malekula, for which part of the settlements will be electrified through grid extension. Finally complete the electrification of Malekula and then focus on smaller islands (Ambrym and Paama).

Table 34. Proposed implementation phases for Malampa.

Phase	Area Council	CAPEX (low) [USD]	CAPEX (high) [USD]
MALAMPA		**27,196,452**	**34,711,224**
PHASE 1	North East Malekula	1,942,991	2,508,956
PHASE 2	North West Malekula	6,463,713	8,304,347
	Central Malekula		
PHASE 3	South West Malekula	8,596,108	10,946,623
	South East Malekula		
	South Malekula		
PHASE 4	North Ambrym	10,193,640	12,951,298
	West Ambrym		
	South East Ambrym		
	Paama		

7.1.5. Penama

The proposed approach is to electrify entire islands from large to small (Pentecost>Ambae>Maewo):

Table 35. Proposed implementation phases for Penama.

Phase	Area Council	CAPEX (low) [USD]	CAPEX (high) [USD]
PENEMA		**28,477,786**	**36,442,959**
PHASE 1	North Pentecost	16,788,854	21,410,846
	Central Pentecost 1		
	Central Pentecost 2		
	South Pentecost		
PHASE 2	West Ambae	8,158,105	10,533,945
	North Ambae		
	East Ambae		
	South Ambae		
PHASE 3	North Maewo	3,530,827	4,498,168
	South Maewo		

7.1.6. Tafea

The proposed approach is to electrify first West Tanna, then the entire Tanna, then entire islands from large (Erromonago) to small.

Table 36. Proposed implementation phases for Tafea.

Phase	Area Council	CAPEX (low) [USD]	CAPEX (high) [USD]
TAFEA		**26,912,525**	**34,577,756**
PHASE 1	West Tanna	2,120,948	2,776,660
PHASE 2	North Tanna	21,181,377	27,164,578
	Middle Bush Tanna		
	South West Tanna		
	Whitesands		
	South Tanna		
PHASE 3	North Erromango	1,553,824	1,993,608
	South Erromango		
PHASE 4	Aniwa	2,056,376	2,642,910
	Futuna		
	Aneityum		

7.1.7. Torba

The proposed approach: Electrify entire islands from large to small (Gaua>Vanua Lava>etc).

Table 37. Proposed implementation phases for Torba.

Phase	Area Council	CAPEX (low) [USD]	CAPEX (high) [USD]
TORBA		**8,885,392**	**11,421,980**
PHASE 1	Gaua	2,783,267	3,608,863
PHASE 2	Vanua Lava	1,921,146	2,489,507
PHASE 3	Torres	909,502	1,157,235
PHASE 4	Ureparapara	3,271,477	4,166,375
	Motalava		
	Mota		
	Merelava		

7.1.8. Summary Table

The following table provides a summary of the CAPEX needs for each phase as described in this section.

Table 38. Total CAPEX needs for the proposed implementation phases.

Phase	CAPEX (low)	CAPEX (high)
Phase 1	32,273,114	41,513,815
Phase 2	52,075,491	66,860,023
Phase 3	21,787,859	27,847,384
Phase 4	27,498,370	35,136,058
TOTAL	**133,634,834**	**171,357,280**

7.2. Sources of funding

Assorted options for funding new electricity connections are summarised below.

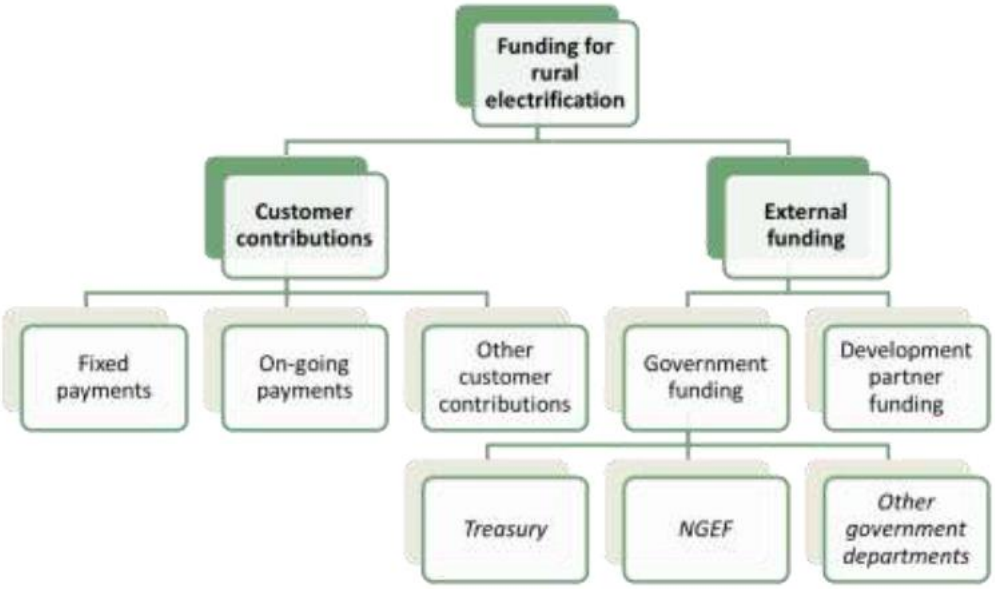


Figure 33. Options for financing rural electrification. Source: ECA

7.2.1. Customer contributions

The first and best option for financing rural electrification is through the customers who will benefit from the connection as it does not require additional funding. However, this is typically limited by those customers' ability to pay for connections[19] and the ongoing electricity supply, which is assumed to be low (and likely insufficient) for rural customers in Vanuatu.

The first two boxes under 'Customer contributions' in Figure 3 are payments by the connected customers, made in two possible ways:

- **Fixed payments**, e.g. one-off contributions towards the cost of a standalone system or connection cost of a mini-grid.
- **Ongoing payments**, where the capital costs are amortised over a given period, or the charges are recovered in instalments, e.g. monthly electricity bills for a mini-grid or monthly fees, or rental payments

[19] Customer affordability and willingness to pay impact the viability of connection programmes and the requirement for different funding mechanisms. This is particularly so for off-grid areas, as cost-recovery tariffs can be higher than affordability and willingness to pay. The government of Vanuatu entities do not have their own recent willingness to pay data to guide pricing and funding choices; such data will be assumed as part of this study.

for a standalone system. This approach can also be applied where a concessionaire/licensee owns the asset, with charges recovered through the monthly bill.

The third box under 'Customer contributions' applies when other customers, i.e., not those being connected, contribute to national electrification by paying an explicit 'national electrification levy' on their monthly bills, paid into a ring-fenced 'national electricity access fund'. Levies are typically a small percentage of customer bills. Such funding sources are usually used after possible connected customer contributions have been exhausted. They should be sustainable as they rely on other customers' consumption, unlike external funding sources, which typically require periodic approval.

7.2.2. External funding sources

The right-hand side of the diagram considers two funding sources external to the sector, ie, not from customers. These sources are typically considered once funding options within the sector have been exhausted. Under Government funding, we present three options:

- **Treasury**—central Government funding, mainly from tax revenues. A government policy decision and a commitment to national electrification would guide this.
- **A dedicated electrification fund** – suggested above relating to the payments from other customers through a national electrification levy. This is a ring-fenced fund managed by the Government with the mandate to support the Government's electrification objectives. Its funding sources could include customer contributions through a levy (as noted above), Treasury, or development partners. As such, it is less a funding source than a funding vehicle. Box 1 summarises the NGEF, an example of a fund playing this role in Vanuatu.
- **Other Government Departments** may support electrification activities where support for activities such as the productive use of energy (PUE) could enhance the value of electricity connection investments. An example may be the Department of Agriculture's direct support for the electrification of agricultural activities or indirect support by funding PUE.

Box 1: Vanuatu National Green Energy Fund (*Source: ECA and TTA*)

The National Green Energy Fund (NGEF), the first national financing mechanism for the Vanuatu energy sector, is a corporate body/public entity established under the National Green Energy Fund Act No. 10 of 2018 [14]. The Act establishes the Fund, the functions of the Fund, the NGEF board, the Fund Manager, and their respective functions and states the purpose and objective of the fund is:

1. to support projects and activities aimed to achieve the objectives of the National Energy Road Map in providing accessible, affordable, secure, and reliable and sustainable energy and green growth and
2. to provide financial support and technical assistance to extend electricity access to a person using renewable energy sources and facilitate more efficient end-use of energy

Per the NGEF's website:

> *The aim of the NGEF is to facilitate capital investment opportunities to improve energy access for households and businesses in rural and peri-urban areas resulting in improved livelihoods, job creation and greater opportunities for income generation through implementation of renewable energy and energy efficiency.*
>
> *The Government of Vanuatu aims to create a sustainable fund, consolidating domestic resources and attracting international investment, as one of the tools for the implementation of the NERM which was launched in 2016. The NGEF will focus on rural electrification through renewables, energy efficiency and other renewable energy applications.*

NGEF has invested $1.5 million in energy projects, primarily standalone systems and small mini-grids supplying schools, cooperatives, or tourism operators. It has supported 130 projects with PV, including 43 schools and 30 cooperatives.

It is now collaborating with GGGI on a solar-water project for 12 sites through soft loans and grants. While it typically lends directly to institutions, it is considering lending through commercial banks.

In parallel, it is partnering with microfinance institutions in the field (cooperative finance). Typically, in their operations, repayment is made by the cooperatives on behalf of the users. Now they involve water cooperatives, for which there is potential for bundling with energy to avoid duplication of efforts and administrative structures.

The second of the external funding sources is development partner funding. Development partners may support electrification activities in different ways, e.g. directly (funding specific projects), through lending to the Treasury, financing of a ring-fenced fund, or through direct support to the private developers of connections. Examples of development partner support for electrification are presented in Table 27.

The options presented above are discussed further in the following sections. We note here that the private sector is not included unless it is willing to subsidise customer costs directly itself. They are essentially facilitators of other funding in that they collect money from their customers to cover the costs of investments.

7.3. Determining NEMP funding requirements

The financing requirement in section 7.1 can be further broken down by the type of financing required. This identifies the funding requirements of different stakeholders, notably development partners and the private sector. The calculations below are based only on the required capital expenditure, without consideration of costs for programme implementation, institutional support (including drafting new regulations and contracts), or critically, for supporting complementary rural development activities, i.e., productive uses of energy, social project funding.

7.3.1. Approach to identifying required funding types

As noted in Section 4.3, the NEMP seeks to achieve sustainable electrification across Vanuatu. Therefore, funding requirements must be determined by incorporating both the capital and operating expenditure for each connection type identified in the least-cost plan. The estimates are indicative of the NEMP's purposes; actual funding requirements will be determined through the implementation of the NEMP.

Capital costs in these calculations include replacing assets over a given horizon (set at 20 years). This only includes electricity supply and no complementary activities, e.g., productive use of energy assessment and promotion. Operating expenditure typically includes a variable component, so the determination also requires estimating future customer load for each connection. Given that all connections will be supplied with renewable energy with zero fuel cost, operating expenditure per kWh will be very low compared with retail tariffs currently observed in Vanuatu, which include significant capital cost recovery and fuel costs.

All capital and operating expenditures can be discounted to a value today that reflects the full cost of supplying electricity through that system over the given horizon. Customers will cover a proportion of this cost through their tariff. Without a regulated tariff, customers' willingness to pay is adopted as a proxy tariff. Multiplying this willingness to pay by the future customer load and discounting to a present value today gives the total value that customers are willing to pay for their electricity supply. The difference between the present values of all costs and what customers are willing to pay is the viability gap, or the subsidy required to ensure the electricity supply is sustainable.

The viability gap funding is in present value terms. To ease the funding process, it is assumed that this funding would cover only a proportion of capital expenditure; covering operating expenditure with subsidy funding is difficult as it relies on an ongoing funding source, which development partners and government budgets are typically unwilling to offer.

The remaining portion of capital expenditure is funded through commercial borrowing, and this part of the expenditure is recoverable from customers through tariffs.

7.3.2. Funding requirements by type, province, and phase

Figure 35 presents the viability gap and commercial funding profile by province and NEMP implementation phase. This breakdown presents potential funders with different ways of calculating funding options (this could also be done by technology, but this is discouraged given the impetus for technology-agnostic supply. The aggregate funding requirement is US$ 107 million over the four phases.

Figure 34 Viability gap funding requirements for the NEMP

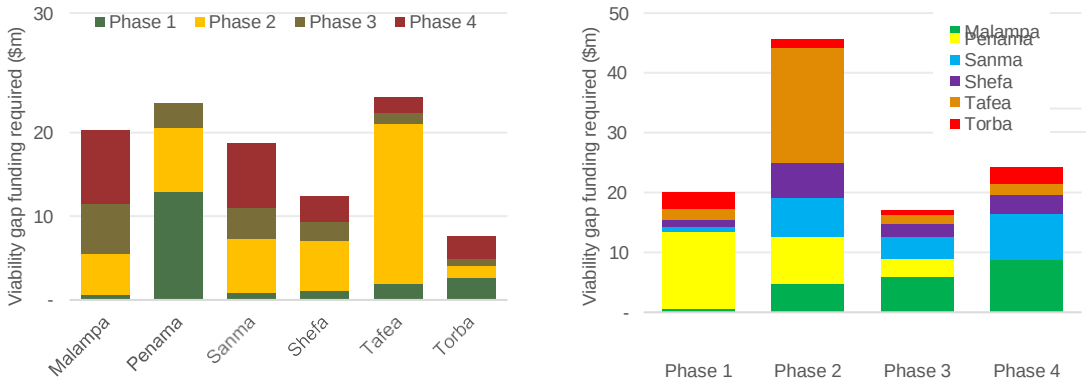
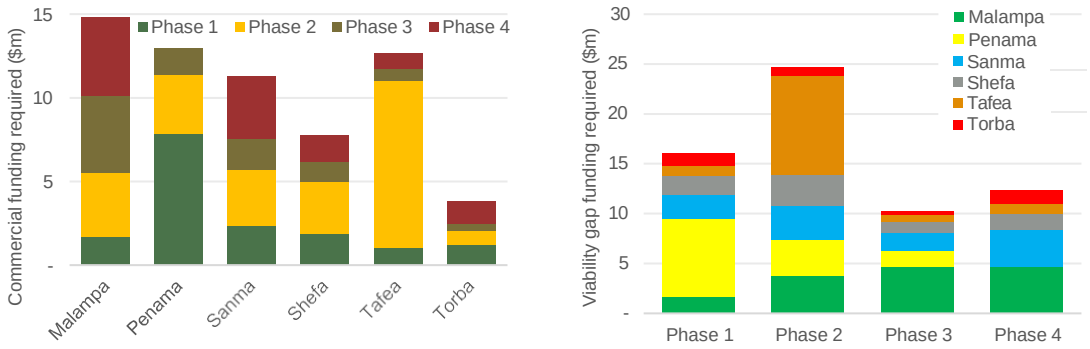


Figure 35 presents the commercial funding requirements for the NEMP. While private developers/suppliers will be expected to identify this funding themselves, the procurement process and development partner support can assist in identifying relevant and cost-effective commercial funding sources. The aggregate commercial funding requirement is US$ 63 million over the four phases.

Figure 35 Commercial funding requirements for the NEMP



7.4. Identifying appropriate funding instruments

As noted above, while the capital costs have been identified by technology, the preferred delivery model for large-scale concessions is technology-agnostic. This section outlines funding options for electrification, which are largely technology-based. Few funding instruments are technology-agnostic, and so this section identifies options by technology. Where possible, the NEMP's preferred funding sources will support the technology-agnostic delivery model with complementary funding instruments for both technologies.

7.4.1. Mini-grid funding options

7.4.1.1. Understanding the funding needs of private mini-grid developers

Mini-grid developers must finance pre-investment and initial capital costs. Some of these costs are detailed in Table 39.

Table 39 Mini-grid development costs. Source: ECA.

Pre-investment costs	Initial capital costs
• Includes site visits, feasibility studies, discussions with communities and government officials, and other elements of due diligence	• Generation, distribution, and connection infrastructure for an operating minigrid • Represent a large share of the total cost, especially for renewable energy minigrids with

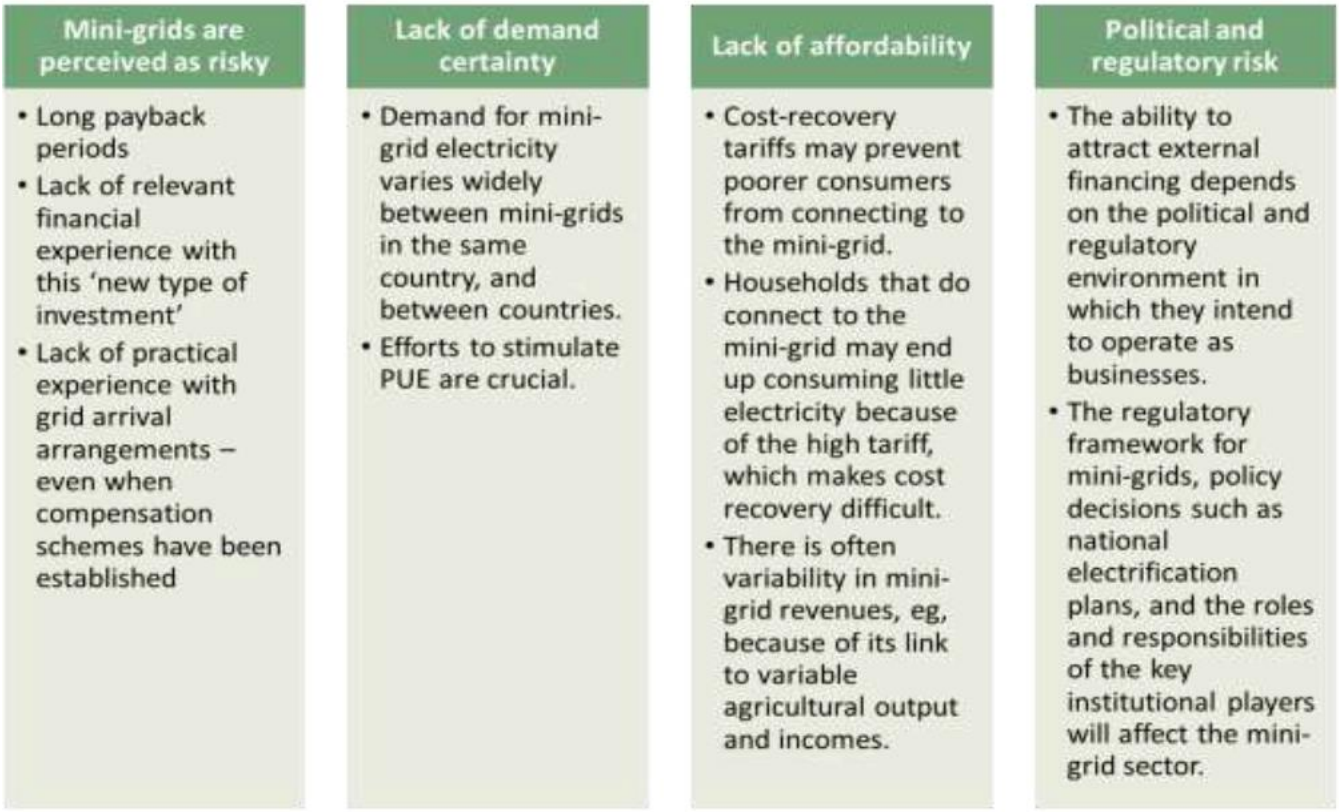
• This is particularly relevant for a bottom-up approach where a developer must bear all these costs itself; under a top-down approach, the procurement promoter may cover these costs	no significant fuel costs (only for the back-up diesel / coconut oil generation)

The payback period for mini-grids is long, as most generation and distribution assets have lives of 10–15 years and beyond. These developers must attract significant funding so that mini-grids are developed rapidly on a large enough scale. From a financial perspective, there are two broad categories of mini-grid developers:

- **Larger international developers**. Already have significant access to equity and, to a lesser extent, debt.
- **Smaller, primarily local, firms**. Limited access to commercial financing.

The financial needs of the two categories are different. Thus, the support package (consisting of debt, equity, subsidy, and risk-sharing mechanisms) will also differ. Gender mainstreaming is crucial, as women may face additional financial barriers. However, all sources of mini-grid commercial financing face barriers, as outlined in Figure 36. These barriers are common in established mini-grid markets, so with Vanuatu's nascent market, the barriers are particularly challenging to overcome.

Figure 36 Barriers in accessing commercial finance. Source: ESMAP. Mini-grids for half a billion people



7.4.1.2. Subsidy options to support mini-grid development

With barriers to commercial mini-grid financing, there is a clear requirement for subsidy funding to increase project viability. The options for subsidies are presented in Table 40. Many of these are not exclusive to mini-grids and could also be adopted for standalone systems.

Table 40 Subsidy approaches to enhance the viability of mini-grids. Source: ESMAP. Mini-grids for half a billion people.

Subsidy instrument	Description
Pre-investment subsidies	For costs incurred before the developers decide whether to build a mini-grid at the site being considered

Subsidy instrument	Description
Market and resource assessments, including geospatial planning	Governments can undertake these assessments for potential mini-grid sites and provide the relevant information to interested developers[20]
Prefeasibility and feasibility studies	The costs can be covered through subsidies or shared among firms shortlisted by the relevant government agency
Technical and financial information assistance	This can help local developers in the early years to develop bankable business plans
Marketing and related activities	Catalytic and marketing support can be provided as up-front grants, which serve as working capital
Capital subsidies	Can be preset as a share of "reasonable" capital costs in contexts where the tariff is not pre-defined or is based on lowest-subsidy bids in cases where the tariff is pre-defined
Results-based capital cost subsidies	Relying exclusively on final output makes it difficult for developers to finance the initial, up-front capital costs Thus, designing some "intermediate" results as a basis for some subsidy payments is important An example of an intermediate result is when goods arrive on site
Connection cost subsidies	For the costs of up-front connection and internal wiring costs. It is administratively easier to make a single subsidy payment to the developer, which covers the payment to the internal household wiring contractor.
Interest-free loan programmes	These can be made available to market low-income households to help them cover the costs of connecting to the mini-grid
Usage subsidies	Although mini-grid customers may initially agree to pay higher tariffs, they may later change their minds and ask to pay a lower tariff. This can threaten the financial viability of the mini-grid and deter future private investments. Thus, the government must be prepared to increase the subsidies provided to the private developers.
Subsidies for the most efficient appliances and end-use equipment	These can address the risk that usage subsidies may reduce incentives to limit energy consumption, leading to purchasing energy-inefficient appliances
Lifeline rates	Crucial for poorer households, regardless of the tariff scheme applied Such rates charge a low fee for the first few kilowatt-hours used per month

7.4.1.3. Selection of a subsidy option and recommendation

The options for funding these subsidies include funding from customers from the concessionaires (through an electrification levy, in the form of cross-subsidy) and external sources (the Government of Vanuatu and its development partners). We do not expect any mini-grids' wealthier customers to be a source of funding for its less well-off customers. Similarly, given Vanuatu's already high tariffs (by Pacific regional standards) we do not expect concessionaire customers to be a funding source. Therefore, external subsidies will likely play a significant role in Vanuatu's electrification. These subsidies can target consumers or producers and be recurrent or one-off expenses but are often difficult to administer and implement.

[20] This is partly being undertaken through this assignment.

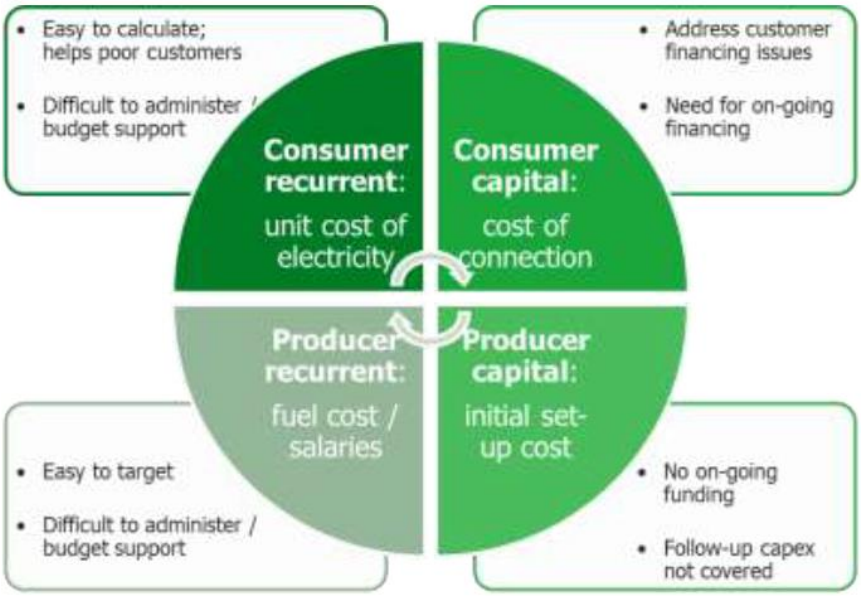


Figure 37 Approaches to subsidizing mini-grid costs to achieve viability. Source: ECA.

Our recommendations for subsidy approaches are summarized below:

- **Capital rather than recurrent subsidies**. Non-discriminatory, one-off grants to enable more mini-grid users to benefit from lower tariffs.
- **Subsidies to catalyse complementary financing**. Leverage capital contributions from project promoters to support more mini-grid projects.
- **Incentive-based subsidies**. Through competitive selection (number of connections or subsidy level) and results-based financing.
- **Subsidies for PUE**. Facilitate demand stimulation.

The Department of Energy will work with its development partners to identify this funding. The analysis presented in Section 7.1 indicated the quantum of subsidy funding that will be required to implement the NEMP.

7.4.2. Standalone solar financing options

The standalone solar sector in Vanuatu is still nascent, with few companies operating. Without a fully competitive market for standalone solar products and because of the NEMP objective, public support mechanisms, including supply- and demand-side mechanisms, will be necessary to attract private sector participation and provide solar products to those areas identified in the least-cost electrification plan. This applies to both top-down and bottom-up private sector procurement models. In this section, we discuss the various support mechanisms that could be adopted and recommend the most appropriate model for Vanuatu.

7.4.2.1. Supply-side mechanisms

Ideally, public funding programmes designed to increase the uptake of standalone solar products should encourage market competition and mobilise private capital. Several supply-side mechanisms can be tailored to achieve this goal:

- **Up-front grants** can be a suitable option for nascent markets where young and innovative companies exist but cannot attract investment due to their lack of operating history or where established companies must be incentivized to enter a new market due to high perceived risk.
- **Results-based financing** (RBF) can be used in markets where companies are already operating locally or regionally, but high costs and/or low incentives prevent them from entering a new geographical area, particularly in rural, remote areas. It can also scale up an existing standalone solar market and accelerate growth. This approach could be applicable as Vanuatu already has some standalone solar providers.

- **Tax exemptions** may be appropriate when affordability is a significant barrier to further market growth and support is needed to increase the share of quality-verified products. This mechanism requires the standalone solar sector to have widespread political support and market acceleration to be a priority, as tax exemptions need to be relied upon to remain in place or have a clear time-bound protocol[21].
- **Credit lines** can be helpful when companies require working capital and are close to meeting lender requirements (e.g. collateral, operating history), but the banking sector experiences liquidity issues. Related to this mechanism are the risk mitigation instruments that are suitable when lenders are unwilling or unable to take the full risk exposure of borrowers. This may be due to several factors, including the unfamiliarity of lenders with the off-grid sector and regulatory requirements that are not favorable for lending to standalone solar companies.

When sequenced appropriately, the above supply-side mechanisms can reinforce each other. In an ideal scenario, an up-front grant or RBF would be used initially to stimulate the development of a market, and then credit lines could be provided once the sector is more developed. If a focused top-down approach is recommended for Vanuatu, and a competitive market is not an objective, then only the first three support mechanisms may be considered.

7.4.2.2. Demand-side mechanisms

Demand-side subsidies should ideally complement supply-side mechanisms to close the affordability gap and attract more solar companies to the market. Demand-side subsidies could create market distortions, so they should only be provided parallel to other supply-side mechanisms to target vulnerable populations and those the commercial market cannot address. Table 41 provides an overview of the suitability of each public funding instrument to support a higher uptake of standalone solar products.

Table 41 Suitability of public funding mechanisms

Public funding mechanism	When is it suitable to use?
Supply-side mechanisms	
Up-front grants 	i. Nascent markets ii. Young and innovative companies iii. Companies do not yet have the operating history to attract investment iv. A need to incentivise established companies to enter a new market
RBF 	v. High costs and or low incentives are preventing companies from entering a new geographical area, particularly in rural, remote areas vi. Companies are already operating nearby (locally or regionally) vii. Incentives are needed to scale up a market and accelerate growth
Tax exemptions 	viii. The standalone solar sector has widespread political support, and market acceleration is a priority ix. Affordability is a significant barrier to further market growth x. Support is needed to increase the share of quality-verified products in the market xi. Customs departments at import points have the capacity and motivation to identify and approve quality products xii. Tax exemptions can be relied upon to remain in place or have a clear time-bound protocol xiii. Strong political support towards the standalone solar sector
Credit lines 	xiv. Companies require working capital and are close to being able to meet lender requirements (e.g. collateral, operating history) xv. The banking sector experiences liquidity issues xvi. Institutional set-up for providing commercial funding would be possible (not all markets have a developed financial sector or retail banks that would comply with the requirements of development institutions)

[21] Most solar products in Vanuatu are already exempt of duties.

Risk mitigation instruments 	xvii. When lenders are unwilling or unable to take the full risk exposure of borrowers. This may be due to several factors, including the unfamiliarity of lenders with the off-grid sector and regulatory requirements that are not favourable for lending to standalone solar companies.
Demand-side mechanisms	
Demand-side subsidies 	xviii. Despite other efforts to reduce the price of standalone solar products, some households or businesses cannot afford standalone solar products
Public procurement 	xix. Widely distributed populations are unable to purchase systems xx. Undeveloped private markets cannot reach rural markets xxi. The rural population does not have regular cash incomes to cover pay-as-you-go (PAYG) payments xxii. Rural communities have similar basic electricity needs

7.5. Recommendations

7.5.1. Assess affordability

Identifying the capacity (willingness and ability) of those customers being connected to pay for their connection and ongoing supply. This amount is currently proxied by the commercial funding required as set out in Section 0.

If there is a viability gap between this and the cost to serve (currently proxied by the viability gap funding required as set out in Section 7.3.2), consider support from other customers in the sector. A similar affordability assessment to that for those customers being connected should be undertaken to assess the maximum levy that could be added to customer bills; a priori, we expect this will be in the range of 1-3%. Given the developers and suppliers of electrification solutions may not be the current concessionaires, payments from those concessionaires' customers cannot be transferred directly to electrification customers but will need to be made through an electrification levy transferred through an external vehicle.

7.5.2. Assess and enhance the capacity of the NGEF to support electrification

The **NGEF** is already supporting national electrification initiatives. However, it has quite limited capacity, and few development partners have channeled financial support through it. It should be examined further, including through consultation with development partners, to establish whether it has the administrative and legal capacity to:

a. receive funds from concessionaire customers through an electrification levy;

b. receive funds from development partners;

c. distribute funds through various mechanisms, eg, financing prefeasibility studies, results-based finance, connection cost financing, lending for productive uses of energy; and

d. own assets on behalf of the Government of Vanuatu.

If the NGEF is unsuitable, the DoE should engage its development partners collectively to identify an alternative combined vehicle to support electrification.

If no alternative combined vehicle can be identified, the DoE should engage its development partners to provide bilateral support for different components of the electrification programme and its follow-on activities.

7.5.3. Determine the best subsidy instruments

A market assessment that considers the affordability of standalone solar across Vanuatu can show if there is a potential for market development. If so, a results-based framework approach to provide subsidies to companies supplying standalone solar to remote areas could apply to Vanuatu. Demand-side subsidies can also be considered as an additional component to address the lack of affordability that supply-side mechanisms alone cannot tackle. Implementation support should be provided to establish necessary frameworks and implement the NEMP. Complementary subsidies should be provided for the productive use of energy and social services.

7.5.4. Asses local capacity

Parallel to designing the rollout programme for standalone solar, Vanuatu's development partners may assess the capacity and skills of the Government and other market actors to ensure that any chosen public funding strategy can be feasibly implemented.

8. Technical Regulation

This chapter analyses the current technical framework of the electricity sector in Vanuatu with a specific focus on all those areas in the country that are yet to be electrified, identifies gaps and challenges within the existing regulations, and offers recommendations to contribute to the development of technical framework that ensures a quality and safe supply of electricity.

8.1. Current Framework

The current legal framework in Vanuatu covering technical aspects consists of:

1. **Electricity Supply Act 1972:**
    - It primarily focuses on regulating and managing electricity supply and related matters within the country. However, the Act is more concerned with establishing the legal framework surrounding electricity supply and management rather than providing technical regulations.
2. **Utilities Regulatory Authorities Act 2007:**
    - Establishes regulatory authorities responsible for overseeing utility services.
    - Does not explicitly address technical safety regulations related to electricity supply.
3. **Electricity Reliability Standards Notice no. 150 of 2018:**
    - Introduces standards for voltage and frequency quality of supply.
    - Specifies voltage tolerance levels for low- and high-voltage systems.
    - Mentions requirements for certified electricians but lacks clarity on certification procedures.
4. **Electricity Safety Standards and Rules Notice No 434 of 2014:**
    - Ensures the safety of individuals working and living near electricity grids.
    - Applicable nationwide, it sets forth requirements and guidelines to minimize risks associated with electricity infrastructure and operations.
5. **Solar PV Standards 2016:**
    - Establishes safety standards for photovoltaic (PV) installations, primarily for self-consumers.
    - Provides an overview of standards adopted for PV installations, covering aspects such as installation requirements, electrical wiring, and grid connection via inverters.
    - Adopts Australian/New Zealand standards with modifications for Vanuatu.
    - Mandates that PV installations must be performed by qualified and licensed electricians.
    - Includes standards for system design, installation, and structural requirements, considering factors such as wind actions and cyclone resistance.
6. **Existing concessions:**
    - Existing concession contracts (with UNELCO, VanPawa and VUI) por the power supply in defined geographic areas are also part of the existing legal and regulatory framework, given that many of the provisions to be followed are defined in these contracts (regulation by contract).

8.2. Gaps Identified

Given the existing legal framework as described in the previous section, the following gaps are identified:

1. **Lack of Adaptation for Emerging Technologies:** Even though there are technical regulations for grid-connected PV systems, the regulations are not adapted to technologies such as PV-hybrid mini-grids and

standalone PV systems, which are believed to be central to the national electrification plan. The regulations must be updated to include these technologies and ensure their integration into the regulatory framework.

2. **Unclear Certification Procedures:** The certification procedures for licensed electricity companies or electricians are not clearly outlined. This lack of clarity can lead to inconsistencies in the certification process and may hinder the quality assurance of electrical installations and services.
3. **Limited Applicability of Solar PV Regulations**: While the Solar PV regulation of 2016 addresses PV installation and wiring laws for self-consumers within specific concessions, it does not cover installations outside these concessions. Therefore, these do not offer nationwide coverage. Additionally, there is a need to adapt these regulations to cater to extra low, low and high voltage systems, ensuring comprehensive coverage across different voltage levels that can be applicable in off-grid locations.
4. **Inadequate Safety Standards for Low Voltages:** There is a need for the development of technical regulations and safety standards specifically tailored for low voltage systems. Enhancing safety standards for low voltage installations is crucial to mitigate potential hazards and ensure the reliability and safety of electricity supply.
5. **Dependency on Contractual Regulations:** Many technical regulations are currently embedded in contracts with concessionaires, limiting their applicability beyond specific contractual agreements. There is a necessity to develop more generalized technical regulations that can be applied to all electric systems in Vanuatu, irrespective of contractual arrangements or concessions, to ensure consistency and effectiveness in regulatory enforcement.

Addressing these identified gaps involves several key steps, including the formulation of updated and comprehensive technical regulations. Additionally, clarification of certification procedures is necessary. Furthermore, expanding regulatory coverage to include emerging technologies is crucial. Finally, the development of safety standards for low voltage systems will contribute to a more robust and inclusive regulatory framework for the electricity sector in Vanuatu. The following section describes in detail some recommendations to address the gaps identified above.

8.3. Recommendations

8.3.1. Electricity access definition

The Updated NERM 2016-2030 (published in June 2016) specifies the following:

> *The NERM's vision of electricity 'access' encompasses pico solar lighting products, solar home systems, micro-and mini-grid connections, and grid connections. The Government wants to see households and businesses having access to a higher quality electricity service than solar lanterns—and so does not consider that solar lanterns provide sufficient 'access' to meet the NERM's targets. However, small pico solar systems (even from 5 watts-peak upwards) can provide a valuable and improved service in rural Vanuatu, where many households currently rely on solar lanterns or kerosene. Such systems are assumed to constitute electricity 'access' under the NERM, as they provide the minimum functions of lighting, mobile phone charging, and a radio.*

In its turn, the NERM's Implementation Plan (published in July 2019) indicates:

> ***Indicator 2: Increase electricity access by households in off-grid areas***
>
> *[…]*
>
> *For this review, the definition of "electricity access by households in off-grid areas" includes the following households:*
>
> - *Households with own small-size (< 1,000 Watt) or medium-size (> 1,000 Watt) generator*
> - *Households with Pico (< 50 Watt), standard domestic (50-150 Watt) or commercial (> 150 Watt) Solar*
>
> *Home System Households with only solar or battery lamp are not considered as being electrified (The NERM does not define what service level needs to be provided to qualify a household or public institution as electrified. This definition needs to be added in a revised version of the NERM).*

In conversations with the major stakeholders, including the DoE and the URA, there seems to be a consensus that households with the lower tiers of service, as defined by ESMAP, should not be contemplated in the electricity access statistics. One of the main reasons behind this preference is the country's previous experience

with standalone solar PV systems, primarily solar lanterns and small solar plug-and-play systems. After a few years in operation, these systems tend to fail, often earlier than expected. Therefore, assuming that households owning these systems will have a guaranteed power supply in the long term is unrealistic. Unfortunately, this experience is not isolated; it is widespread globally.

As these systems' operation and maintenance (O&M) play a critical role, it is deemed essential to somehow integrate it into the definition of electricity access. While it is given for granted that a technician would look after the O&M of a mini-grid project, the same is not assumed for projects using standalone systems. It is strongly recommended that, in general terms, customers using the smaller sizes of standalone systems (falling under tiers 1, 2 and 3 for instance) are only considered electrified if a proper O&M model is ensured.

While it would be impractical and economically prohibitive for a standalone system supplier from Port Vila to offer O&M services to systems spread throughout the country, the definition of service areas in which a single Electricity supplier is responsible for the electrification services (regardless of the technology used—mini-grid or standalone) for a given period of time is essential to facilitate this task.

The possibility of incorporating standalone systems as part of the Service Areas is an effective way to ensure long-lasting standalone systems. Conventional PAYGO lease-to-own approaches facilitate the financing conditions for customers to purchase these systems but do not ensure long-lasting equipment. Even the use of high-quality certified products can't guarantee long-lasting equipment because the systems might not be sized according to the needs, due to customers' misuse, or because very often, these systems are not provided with after-sales support, so in case of failure, it is not easy to find spare parts or someone to fix the system. Alternatively, by including standalone systems as part of the service, the Electricity supplier is responsible for servicing these systems, repairing them when needed and ensuring the availability of spare parts.

Box 2. Proposed definition for Access to Electricity

Proposed definition:

For the purpose of official statistics related to access to electricity, households and institutions will have to satisfy one of the two following requirements to be considered electrified:

- The household/institution is connected to an operational **Collective Electrification System** (CES)
  OR
- The household/institution is connected to an **Individual Electrification Systems** (IES), AND:
  - The service Capacity falls under Tiers 4 or 5.
    OR
  - If the service Capacity falls under Tiers 1, 2 or 3, the IES is provided by the Electricity supplier of a given Service Area, with whom the customer holds a Customer Agreement that covers its maintenance.

Comments:

- The government might decide to move Tier 3 to the categories of IES that do not require the O&M of a Electricity supplier.
- The government might want to exclude lower Tiers from the definition. However, that would misalign with the definition considered for the United Nations Sustainable Development Goal 7 (affordable, reliable, sustainable and modern energy for all), which incorporates any service equivalent of Tier 1 and above.

8.3.2. Electrification Services definition

The box below provides a recommendation on how the electrification service can be defined to facilitate a technology-agnostic and holistic approach in alignment with Chapter 4.

Box 3. Proposed Electrification Service Definition

1. "Electrification Services" are those offered under the conditions defined in this section.
2. **Type of service**.
   a) The Electricity supplier can offer two types of Electrification Services:
      i. **Electricity Service** (Business as usual approach): Electricity is provided to the user at a certain Connection Point, usually the customer's meter. The service is typically charged by the energy units sold to the user.
      ii. **End-use Service**: The Electricity supplier includes appliances, indoor wiring and/or PUE equipment as part of the service. A fixed subscription charge is typically associated with the number of appliances and availability.
   b) The service can be delivered via three types of electrification approaches:
      i. **Collective Electrification Systems (CES)**, which provide a service to *multiple users using a single or multiple energy resource points.* Typically, they consist of three parts:
         - an electrical power production subsystem. This can consist of a centralised power production plant, small, decentralised power plants, or a combination. Depending on the generation technology, at least one of these plants shall include energy storage where appropriate.
         - a Distribution Network, and
         - a demand subsystem, including a Connection Point, the user installation, and (depending on the service offered) the electrical appliances.

         Another type of CES, sometimes referred to as a "solar kiosk," is based on providing services to multiple users through a battery charging station, multifunctional workshop or a collective call room.

      ii. **Individual Electrification Systems (IES),** which provide a service to one user (usually with a single energy resource point). They consist of two subsystems:
         - one electrical power production subsystem that may include energy storage, located close to the demand subsystem, and
         - a demand subsystem, including the Connection Point to the power production subsystem. The demand subsystem may include the user connection and/or the electrical appliances depending on the service offered.

      iii. **Single-Appliance Electrification Systems (SAES),** which provide an End-use Service to single or multiple users through a single type of Appliance. SAESs do not have a Connection Point between the power production subsystem and the demand subsystem where other appliances can be connected. Instead, the production and demand are integrated into a single system. An example can be a solar-powered water pump or a small PV generator that directly powers a DC fridge.
   c) IESs, CESs, SAESs, and/or a combination of these can simultaneously provide different services within the same service area.
3. **Renewable Energy Fraction.** The target in the Vanuatu National Energy Road Map is to increase the proportion of electricity generated from renewable sources to reach 100% of grid-based electricity from renewable sources by 2030. To align with this commitment, the Renewable Energy Fraction shall be at or above [XX]%; however, projects approved before these threshold years will not be required to retroactively upgrade the Renewable Energy Fraction when passing the threshold year.
4. **Technologies**
   a) Any Generation technology is accepted as long as the minimum Renewable Energy Fraction share is adhered to.
   b) Any energy storage technology is accepted (batteries, pumped hydro, compressed air, hydrogen, thermal storage, flywheels etc.).
   c) Both traditional Distribution Networks (aerial and underground) and swarm-based networks are accepted.
   d) Both DC- and AC- Distribution Networks are accepted.

8.3.3. Service Categorization

Globally, there is broad consensus on the need to categorize the electricity service for off-grid areas. According to ESMAP's multi-tier framework[22] *Improvement in energy access is not a single-step transition from lack of access to availability of access. Instead, it is a continuum of increasing levels of energy attributes. This forms the basis of a multi-tier conceptualization of energy access to reflect the continuum versus a binary conceptualization*.

Historically, electrification has been a binary answer (Yes/No) question. In the off-grid sector, it can be considered electrified the household that receives a power service that satisfies its needs, and this requires the incorporation of the tiers of service concept. Households in some regions might be satisfied with being able to charge a phone and have a light, whereas some other households might have the need to connect a washing machine. The tiers of service can accommodate these differences in needs that can occur even within the same community.

8.3.3.1. References

There are several internationally recognized references in the literature that deal with the attributes of Service categorization such as:

- **IEC TS 62257 (IEC TS)**. *Recommendations for small renewable energy and hybrid systems for rural electrification*. International Electrotechnical Commission (IEC) Technical Specification (TS).
- **Multi-Tier Framework (MTF)**: *Beyond Connections. Energy Access Redefined*. World Bank Energy Sector Management Assistance Program (ESMAP). The so-called *Multi-Tier Framework*;
- **Quality Assurance Framework (QAF)**. The National Renewable Energy Laboratory (NREL) and U.S. Department of Energy (DOE) Quality Assurance Framework for Mini-grids.

The provisions included in this section are inspired by the references above. It is hereby noted that these three references differ in the definition of the tiers. Nevertheless, the priority of the work presented herein is to embrace the idea of tiered attributes and make them relevant to the context of Vanuatu.

8.3.3.2. Attributes

The Regulation will require the categorization of services offered by the Electricity suppliers based on predefined set of tiered energy attributes. All electricity suppliers will use the same attributes to define the service they wish to offer, and they will be included as part of the contract agreements with communities and customers.

The attributes will be defined in the technical framework of the Regulation and will include:

- **Service Quality:**
  - **Capacity**: Amount of power made available to end users, either as maximum instant power (kW) or as a particular amount over a set period of time (kWh).
  - **Availability**: Existence and duration of the electricity service.
  - **Reliability**: Frequency of unplanned interruptions in supply.
- **Power Quality**: Determined by voltage, frequency, harmonic distortion, etc.

[22] *Beyond Connections. Energy Access Redefined*. World Bank Energy Sector Management Assistance Program (ESMAP).

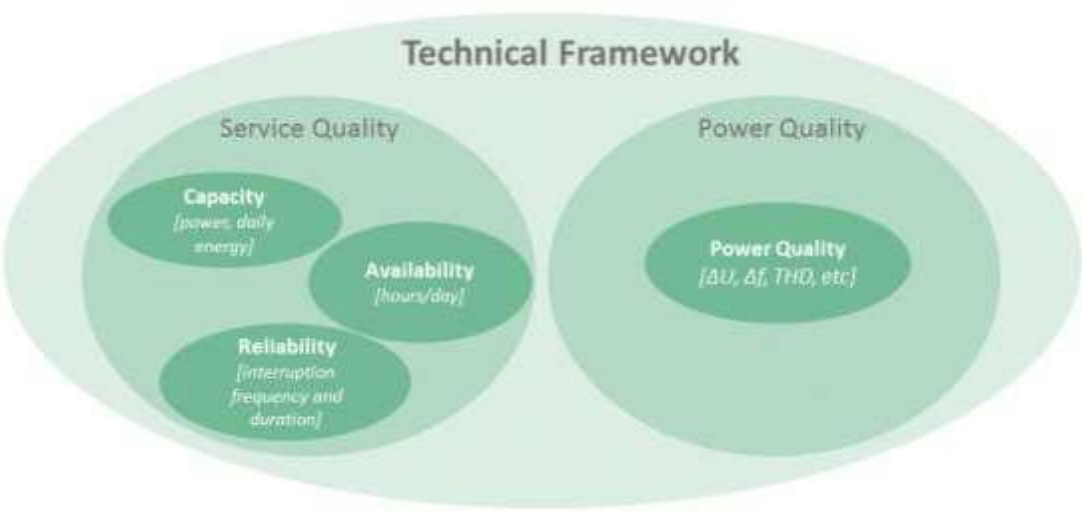


Figure 38: Attributes of the Service Categorization

It is recommended that the future technical regulation defines the energy attributes independently from one another. The MTF defines the tiers based on ranges for each of the attributes, whereas the IEC TS categorises each attribute independently. Therefore, the IEC TS would, for instance, allow for the definition of one system with low availability but very high power quality, whereas the Multi-Tier Framework would not allow for it. It is recommended that the future technical regulation follows the IEC TS approach and, therefore, uses a categorisation that maintains the definition of each attribute independently.

Table 42. Proposed categorisation of technical attributes

Capacity	Availability	Reliability	Power Quality
Tier 1	A		
Tier 2	B	1	I
Tier 3	C	2	II
Tier 4	D	3	III
Tier 5			

The table above introduces the proposed categorization of attributes to define the power supply service. Different levels are presented for each of the attributes, and they can be selected independently, as shown in the following example.

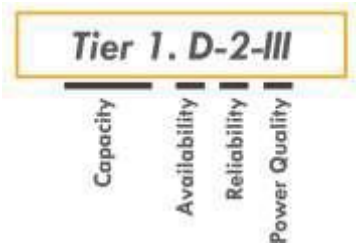


Figure 39. Example of a specific service categorization.

8.3.4. Service Quality

8.3.4.1. Capacity

The MTF tiers provide a structured framework to assess and categorize electricity capacities based on both power capacity ratings and daily energy consumption, enabling tailored energy solutions for various types of households or facilities. Furthermore, it is a reference globally recognized and accepted within the energy access sector. Therefore, it is recommended that **the future regulation provides Capacity tiers based on the MTF but**

adjusted (if needed) to the Vanuatu context. The next table provides an example of different capacities of power for each Tier as defined in the MTF.

Table 43. Tiers of Capacity of Electricity Supply from the Multi-Tier Framework. P=Power (W); E=Energy (kWh)

CAPACITY	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Power Capacity Ratings	3 W < P < 50 W 12 ≤ E < 200Wh/d	50 W ≤ P < 200 W 200 < E < 1 kWh/d	200 W ≤ P < 800 W 1 < E < 3.4 kWh/d	800 W ≤ P < 2kW 3.4 < E < 8.2 kWh/d	2 kW ≤ P E ≥ 8.2 kWh/d
Supported Appliances	**Very low-power appliances:** Task lighting AND Phone charging	**Low-power appliances:** General lighting AND Phone Charging AND Television AND Fan (if needed)	**Medium-power appliances**: Tier 2 AND Any medium-power appliances	**High-power appliances.** Tier 3 AND Any high-power appliances	**Very high-power appliances.** Tier 2 AND Any very high-power appliances
Typical Supply Technologies	Solar lantern	Rechargeable battery, SHS	Medium SHS, fossil fuel-based generator, mini-grid	Large SHS, fossil fuel-based generator, mini-grid, central grid	Large fossil fuel-based generator, central grid.

It is considered that **Tier 1 and 2 can be satisfied without the need for metering**. Electricity suppliers guaranteeing the energy uses considered for this specific Tier (i.e., task lighting, and phone charging) would qualify for Tier 1 or 2 without the need to include a meter for the customer. This is relevant for those services being provided through standalone systems, as the use of a meter for such applications would not be cost-effective.

8.3.4.2. Availability

It is recommended that the future regulation provides four (4) categories of Availability. These categories would range from D (lowest duration of service), to A (highest availability). Category D is envisioned for special applications (typically not households) in which high availability is not required. This can include examples such as small workshops, pumping stations, churches (which might only need power for just 1 service per week), etc.

Table 44. Proposed Availability categorization and requirements. *h/day = Minimum hours of service per day*

	D	C	B	A
AVAILABILITY	h/day < 8	8 ≤ h/day < 16	16 ≤ h/day < 23	23 ≤ h/day

8.3.4.3. Reliability

It is recommended that the future technical provides three (3) categories of Reliability. These categories would range from 3 (lowest service reliability), to 1 (highest availability). Each category includes a requirement in terms of % of time without service interruption. Such percentage shall account for the Availability of the service. For instance, if Availability subscribed offers a service of up to 8 h/day, then the Reliability indicator shall be calculated based on such Availability and not on a 24/7 service.

Category 3 is established for special applications in which the customer is willing to sacrifice reliability significantly. These applications can be beneficial both for the customer (as they could access to more attractive tariff arrangements) and the Electricity supplier (this would provide flexibility to use interruptability or load shedding as potential energy management strategies in case of need).

Table 45. Proposed Reliability categorization and requirements. % figures indicate % of time without service interruption

	3	2	1
RELIABILITY	>50%	>90%	>95%

8.3.5. Power Quality

It is recommended that the Regulation provides three (3) categories of Power Quality. These categories would range from III, the most basic category with lowest Power Quality, to I, the most demanding power quality.

Power quality refers to the compatibility of the voltage, frequency, and waveform of a power supply with the electrical loads, generation sources, and distribution networks involved. Bad power quality may cause malfunction or failure of electrical equipment, higher energy usage and costs, and higher maintenance costs. Historically, these standards were created to protect appliances that were highly sensitive to changes in voltage, frequency, or harmonics from the nominal value at which they were manufactured to operate. However, technological developments in the last decades have made these appliances more robust and sturdier in responding to these variations.

Within the same service area, there could be end-users belonging to different categories, as opposed to the classical approach, which conceives only one nationwide level of power quality for all users. Instead of checking that the appropriate power quality is delivered to each category, customers can be informed of the level of service they should expect and can appeal to the regulator if the service fails to meet their expectations.

Table 46. Proposed Power Quality categorization

PQ	III	II	I
Description	The most basic category: for those users that consume electricity mainly for lighting, appliance charging, and other similar low-consumption and high-tolerance devices, and therefore technical regulation is minimal. Frequency regulation is not restricted under this category.	This intermediate category provides tighter power technical requirements than the previous category, like surge protection for transients or frequency regulation that are not regulated in PQI.	The most demanding power quality category: for those users and appliances that require the least disturbances (i.e. have the least tolerance to disturbances) in the electricity supply
Examples	• Basic rural households consuming several lighting points and charging loads • Street lighting • Appliance charging stations (such as phones) • Dedicated source-to-power solutions (i.e. standalone systems)	• Basic commercial customers • Places of worship • Community centres • Health centres without sensitive equipment	• Health centre equipment, such as respirators • Electric motors • Light industries • Rural households with heavier consumptions • Telecom stations • Other critical loads

The next table provides the proposed power quality requirements adapted as per existing regulation of Vanuatu.

Table 47. Proposed Power Quality requirements.

POWER QUALITY	III	II	I
AC			
Voltage variation	NA	< ± 10%	< ± 10%
Voltage imbalance (only 3-phases)	NA	< 5 %	< 2 %
Frequency variations	Not Regulated	46 Hz < f < 54 Hz	48 Hz < f < 52 Hz
Harmonics	< 10%	< 5%	< 4%

POWER QUALITY	III	II	I
Transients	No protection	Surge Protection	Surge Protection
Short-duration voltage variations	< 5/day	< 1/day	< 1/week
Long-duration voltage variations	< 10/day	< 5/day	< 1/day
DC			
Voltage variation	≤±25%	≤±25%	≤±25%
Transients	No protection	Surge protection	Surge protection
DC ripple - switching noise	Unfiltered	Transient noise minimized	Ripple noise also minimized

In the case of Category III, any electricity supplier including the appliances as part of the service would automatically qualify for such category without having to meet the requirements. Power quality requirements are basically set to protect the customer's appliances, so if the electricity supplier offers them, the risk is basically transferred to the operator. In such a case, there is no need to make use of the requirements set in the table above because the appropriate Power Quality requirements will be such that allow the normal operation of the appliances being offered. This is of special importance for customers being served through standalone systems in which the appliances are included as part of the service.

The agency responsible for facilitating the technical regulatory framework should be required to undergo training so it can effectively monitor Power Quality using tools that are easy to use and understand.

8.3.6. Wiring and Safety Standards

Future technical regulations shall set wiring and safety requirements based on existing standards or local practices. The *AS/NZS 3000:2018, Electrical installations,* known as the *Wiring Rules*, are apparently the rules adopted by Vaunatu. Therefore, they would be the preferred candidate for the regulation. Nevertheless, the wiring and safety requirements shall be discussed in detail with the regulator (URA) for their validation. In this process, it shall be assessed which is the current practice in rural settings (e.g.: existings mini-grids), whether they manage to follow same standards than in urban areas, whether that would be feasible, etc.

There is already a Bill to enforce the AS/NZ wiring rules application and it is pending approval by parliament. The bill's coverage extends beyond the scope of any technical regulation on electricity; hence, it is important to pass the bill before any related regulation is set up.

Future regulations should establish power distribution requirements while facilitating electricity provision in remote areas. Electricity suppliers in the off-grid sector should be able to choose their preferred distribution approach (AC/DC, voltage levels, etc) as long as it adheres to safety standards like IEC 62257. Detailed discussions with regulators should take place to validate these distribution requirements.

It can be challenging to find licensed electricians in remote off-grid areas. This challenge can be partially reduced by stating that the need for licensed electricians should be based on the system's voltage level. If the voltage is within the Extra Low Voltage regime as per IEC (e.g., in a Solar Home System project with DC loads), certified electricians shall not be required. If the voltage is within the Low Voltage regime or higher, licensed electricians shall be required.

Concerns with licensed electricians should be addressed by the Electrical Safety Works Act. While it will be a challenge to promote safe electrical installations in a rural setting, it should be an initiative set up under DoE to promote this via provincial governments by ensuring that there are qualified DoE staff in the provinces that are able to pursue inspections of in house wirings. For established utilities, it should be mandatory that all customer connections are certified once the applicable law is passed in parliament.

8.3.7. Grid Interconnection

8.3.7.1. Interconnection Cases

Grid Interconnection can occur in two differentiated cases:

2. **Interconnected mini-grids.** This would be the case when two electricity suppliers decide on their own to interconnect their respective mini-grids. Under this scenario, the involved parties are the two Electricity suppliers and the respective communities.
3. **Interconnection to one of the existing grids in Vanuatu.** In this case, the interconnection is between a mini-grid and the main grid from the existing concessionaires. This situation can be motivated by either:
    1. Concessionaire, because of its own network expansion plans; or
    2. The Electricity supplier, because it is interested in reaching an agreement with the Concessionaire to purchase its power.

    In this case, the parties involved are one electricity supplier, the community and the concessionaire.

8.3.7.2. Key aspects to assess

In case of interconnection, there are two key aspects for which the Regulation shall respond:

1. **Technical Compatibility.** This has to do with how compatible the grids being interconnected are and relates to the *technical aspects* of the two grids involved.
2. **Business model.** This has to do with the impact of the interconnection into the business models of the previously independent two Electricity suppliers. This relates to the *legal and economic aspects* of the two Service Areas involved.

It should be noted that **Vanuatu is an archipelago composed of 83 relatively small islands, which drastically reduces the probability of grid encroachment**. Therefore, the recommendation is not to be very restrictive from a technical standards standpoint to facilitate the development of cost-effective projects in remote areas.

Mini-grid projects implemented close to the existing concessions would probably have to follow the same technical standards to facilitate compatibility. But out of the few islands with existing network assets, it is advisable to allow different voltage levels and even current types (e.g., in small communities, DC distributions might be a cost-effective solution).

8.3.7.3. Technical Compatibility

It is recommended that the future technical regulation (grid code) establishes Interconnection Readiness Levels (IRL) for mini-grids. Whereas in some cases it might be beneficial to require mini-grids to be grid-ready (adhere to technical requirements of an existing nearby grid), it is not needed for all the projects. In either (i) remote areas that have no prospect of interconnecting, or (ii) very small mini-grids, it would not be justified to require grid readiness as it would not be cost-effective. The IRL could set grid-readiness requirements depending on the proximity to one of the existing main grids of Vanuatu.

A grid code should be issued to address this matter.

Table 48. Proposed Interconnection Readiness Levels to categorize technical compatibility for grid interconnection

Interconnection Readiness Levels	IRL0	IRL1	IRL2
Conditions	✓ Projects located far from existing power infrastructure. AND ✓ Projects using Low Voltage	✓ Mini-grid projects near existing concessions.	✓ Large mini-grid projects OR ✓ Projects within the existing concession areas
Requirements	No need to comply with interconnection procedures	Lower compatibility requirements	Higher compatibility requirements

8.3.7.4. Business Model

The typical business model options for a mini-grid that is interconnected to the main grid are summarized in the following table. It should be noted that the same business models apply for the interconnection between two mini-grids.

Table 49. Business options for the interconnection between a mini-grid and the main grid[23].

Business Model	Description
Small power producer (SPP)	The mini-grid converts to a main grid–connected Small Power Producer (SPP), becoming another power plant on the grid. The mini-grid operator sells electricity to the grid while utility takes over the distribution to retail customers. Distribution assets can be scrapped, salvaged for use at a new location, or purchased by utility. Generation assets' ownership is not transferred.
Small power distributor (SPD)	The mini-grid converts to a Small Power Distributor (SPD) that buys its full supply at wholesale from the main grid and sells its purchased electricity to villagers at retail. The local generator is kept for use solely as backup for the local mini-grid when the main grid goes down. Distribution assets' ownership is not transferred. They are used by SPD to resell electricity purchased at wholesale. Generation assets can be scrapped, relocated, or maintained for use solely as backup for the local mini-grid when the main grid goes down.
SPP + SPD	The mini-grid continues to sell electricity to its retail customers with its own generated electricity, selling the electricity surplus to the main grid. It continues to sell electricity to retail customers, some of which may be purchased from the utility. Distribution and generation assets' ownership is not transferred.
Side-by-side but not interconnected	The mini-grid continues to serve customers even when the grid arrives, with no electrical interconnection between it and the main grid, even though both operate in the same village. They compete against each other in the same market. Distribution and generation assets' ownership is not transferred.
Compensation and exit	The mini-grid goes out of business, and the developer receives compensation for assets taken over by the main grid operator. Distribution and generation assets' ownership is transferred to the main grid operator.

The Regulation should not restrict the resulting business model from a voluntary interconnection between two electricity suppliers. In interconnections between two Electricity suppliers they will be open to define which is the business model that suits them better after the interconnection. In this case, the Regulation should not define any predetermined option. The specific requirements for interconnection would be agreed between the two parties and reflected in the Community Agreement.

8.3.8. Prosumers

The future technical regulation (grid code) for off-grid areas should allow prosumers. The current concession regulations do not facilitate customers with rooftop PV to feed their excess power into the grid. As long as they comply with certain requirements to be captured by the regulation, it is recommended to accept power injection as it can help in the energy and power balance of the mini-grid.

A grid code should be issued to address this matter.

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[23] Tenenbaum, Bernard, Chris Greacen, and Dipti Vaghela. 2018. *Mini Grids and the Arrival of the Main Grid: Lessons from Cambodia, Sri Lanka, and Indonesia*. Energy Sector Management Assistance Program (ESMAP) Technical Report 013/18. Washington, DC: World Bank.

8.3.9. Accountability and Performance Reporting

The accountability and performance reporting can be inspired by the QAF (NREL's Quality Assurance Framework). According to the QAF, the Accountability and Performance Reporting Framework aims to:

1. **Consumer accountability**. Focuses on the agreement between customer and Electricity supplier. Helps to ensure that the service expected is rendered through appropriate checks and balances, strengthening consumer confidence. Additionally, a defined project-specific process outlines recourse for customers who do not believe they are receiving the level of service expected.
2. **Electricity supplier accountability**. It focuses on the agreement between the electricity supplier and the regulator. The framework defines the process by which the regulator can validate the service being provided. Furthermore, it is the cornerstone of generating first-hand country specific information that can benefit all sector stakeholders by facilitating increased transparency, long-term performance tracking and forecasting, demonstrating a track record, improving risk assessment, and laying the foundation for aggregation and bundling of Service Areas.

8.3.9.1. Consumer accountability

Consumer accountability defines a process to provide customers with trusted information on the level of service they receive and a clear way to confirm that service. Without the ability to understand personal energy usage (or in an extreme case, the potential damage of appliances due to poor power quality), the value and willingness to pay for energy services will be reduced. To help maintain strong customer support, customers must understand that they are receiving the service that they pay for, and mechanisms must be in place to verify their power delivery.

The Regulation should provide a set indicators and monitoring requirements (energy consumption, hours of service, voltage, etc.) commensurate with the project scale. These attributes will give a sound indication of the Service Quality and Power Quality. Note that the level of service verification does not require that all elements are measured continuously, although it might be important to monitor these indicators at the customer level at least periodically and maintain a historical record over time. The use of smart meters facilitates the collection of robust real-time data across some or all these domains but may be cost-prohibitive for some off-grid infrastructure.

The Regulation should provide a template of Service Agreement that defines the expectation between the consumer and Electricity supplier. The service agreement must define the terms of service, including the details of the level of Service Quality and Power Quality to be delivered, tariffs and fees, payment processes, compliance with applicable standards and regulations, customer responsibilities, customer complaint procedures, and other relevant information.

For full transparency, the Service Agreement should also specify the type and frequency of service data that the Electricity supplier will provide to the customer, as well as clear processes for addressing customer concerns if the appropriate service is not provided.

8.3.9.2. Electricity supplier accountability

The accountability requirements for the Electricity supplier should be established in a Community Agreement. A template of the Community Agreement should be included in the technical Regulation.

The Electricity supplier Operator's accountability should be monitored through Key Performance Indicators (KPI). The KPI would cover aspects on technical, business, social, environmental, and Health & Safety. One of the issues that URA faces currently is the access to regular and authenticated data, especially when dealing with projects under community-based models or with standalone systems.

The complexity of the reporting requirements will be commensurate with the scale of the Service Areas being monitored. In this regard, the requirements for small, isolated areas, for instance, will allow manual readings by non-skilled personnel. The existing regulations state that parameters such SAIDI and SAIFI shall be reported. This reporting requirement can be excessive in small mini-grid projects, or it may just be unfeasible in Solar Home Systems projects. Therefore, a simplified reporting is recommended for smaller and simpler projects, such as the one presented in the section "Data records" in the annex.

8.3.10. Digital platform

It is recommended to digitize the entire application procedure, to facilitate the application from Developers, but also their processing by the Regulator. It is recommended that a website be habilitated for the purpose of Registering/Licensing Off-Grid Projects, in which the forms are digitized. Also, the same platform should facilitate electricity suppliers conveniently reporting their KPIs so that they can easily submit the information and URA can process it.

Furthermore, this platform can be used for market information dissemination. In the early stages of market development, access to information is essential. The sector can greatly benefit from the initial experiences of the country and can help expedite the sector's development. The regulator can play a critical role in providing relevant and reliable market information from its neutral position. Key information that could be disseminated would include but not be limited to:

- **# applications**. Number of applications received by the regulator. This will help see the volume and speed of the market's development.
- **Tariff benchmarking**. The experience built by early players will greatly help communities reach competitive tariffs in the agreements with developers and will help developers understand the market.
- **Main issues in the sector.** Information on the main challenges overcome by early players will help the sector to react accordingly and implement preventive measures.
- **New developments.** Case studies or new technologies seen in Vanuatu or regionally, policy or regulatory changes, etc.

This market information would allow stakeholders to identify market trends. The regulator can compile, edit, and publish the information periodically, for instance, through quarterly bulletins that are publicly available.

In order to have an effective Digital Platform there has to be a good communication strategy that enables remote monitoring via a robust and efficient data logging system that populates a data repository system that can enable more analysis and optimization of rural electrification initiatives.

9. Environmental and Social

This chapter supports the Objective 11 of the NERM ('*to minimise adverse environmental, social and health and safety impacts of energy infrastructure in Vanuatu*') by identifying the key risks associated with expanding electrification in Vanuatu and developing environmental and social safeguards (ESS) processes to prevent or mitigate harmful impacts. This involved:

- Screening for and identifying environmental and social issues surrounding a program at the scale and speed required to achieve universal connectivity by 2030, including dealing with 'greenfield' locations outside concession areas.
- Consulting with key stakeholder agencies regarding environmental and social risks and mitigation strategies.
- Recommending an environmental and social management and monitoring plan (ESMMP) which identifies the key issues, ways to address them and guidelines to facilitate rollout and
- Identifying mitigation strategies suitable for a national rollout and future maintenance for NEMP implementation.

9.1. Legal and Institutional Arrangements

9.1.1. International Commitments

The GoV has made a number of international commitments relevant to the energy sector, including endorsement of the Sustainable Development Goals (SDG). *SDG 7: Affordable and Clean Energy*, one of 17 SDGs established by the United Nations General Assembly in 2015, aims to 'ensure access to affordable, reliable, sustainable and modern energy for all' as an important pillar for the well-being of the people as well as for economic development and poverty alleviation. This goal has five targets to be achieved by 2030, all of which are relevant to the development of the Vanuatu National Electrification Master Plan.

9.1.2. Energy Legislation and Implementation

Key legislation relevant to environmental and social aspects includes the following:

9.1.2.1. The Electricity Supply Act 1972

The Electricity Supply Act 1972 (ESA) regulates Vanuatu's electricity distribution to entities inside and outside concessional areas, including off-grid communities. The ESA governs electricity transmission, distribution and supply. The Department of Energy within the Ministry of Climate Change Adaptation is the key government department to deploy and develop Vanuatu's energy policy.

9.1.2.2. The Utilities Regulatory Authority Act 2007

The Utilities Regulatory Authority Act 2007 provides for the Utilities Regulatory Authority (URA) to regulate both electricity and water to "(a) ensure the provision of safe, reliable, and affordable regulated services; and (b) maximise access to regulated services throughout Vanuatu".

In addition to the URA Act, the work of the Authority is guided by its Strategic and Action Plan 2022-2026. The Mission and Objectives of this Strategic Plan are:

Mission:

'To enhance quality of life and business growth in Vanuatu by ensuring sustainable, safe and reliable energy and water services at reasonable prices accessible to all who demand it."

To achieve its mission, the Authority is pursuing the following strategic objectives, all of which are relevant to the development of the NEMP. From an ESS perspective, objectives ii, iv, v and vi are especially important.

1. Improve the effectiveness and efficiency of our regulatory functions;
2. Strengthen and monitor price and safe provision of regulated services;
3. Promote reliability and enhance the quality of regulated services;
4. Identify means to enable regulated services to become more affordable;
5. Maximize access to regulated services;
6. Promote utility service resilience and environmental conservation objectives through regulation; and
7. Enhance regulatory capacity to regulate petroleum products.

9.1.2.3. Environmental Protection & Conservation Act

The Environmental Protection and Conservation Act and Environmental Assessment Regulations are administered by the Department of Environmental Protection and Conservation (DEPC). The Act requires that a Preliminary Environmental Assessment (PEA) is carried out by the Director for all developments other than residential buildings and *kastom* (custom) structures. The PEA also includes social risks such as:

- The need for temporary or permanent resettlement,
- Loss of assets, land, gardens and/or livelihoods,
- Health and safety,
- Unsustainable use of natural resources; and
- The ability of people to adapt to and mitigate the effects of climate change.

A PEA is required to determine whether the development is likely to cause significant environmental, social or *kastom* impacts, and if impacts are likely, a full Environmental (and Social) Impact Assessment (EIA/ESIA) will be needed.

The EIA Regulations also require public consultation and stakeholder engagement in the assessment process.

Application must be made to the Director in accordance with the Environmental Impact Assessment Regulations 2012[24] using the Application for Environmental Permit together with the required supporting information and plans. There are three potential outcomes from the PEA:

1. Environmental Impact Assessment (EIA) is required;
2. No EIA is required, but conditions are placed on the approval of the PEA; or
3. No EIA required and no conditions. DEPC can also require that a proponent prepare an ESMMP without an EIA. The DEPC statutory timeframe for undertaking the PEA is 21 business days.

Importantly, solar home systems and mini-grids supplying an existing residential dwelling (and 30m from a water body) are considered 'additions' and are not subject to an EIA and will not need a permit under the Act. Mini-grids supplying power to more than a single dwelling and/or public buildings do require a permit. All other forms of electricity generation, including hydroelectric, diesel, wind and geothermal energy, require an application for PEA.

An application to the Director of DEPC must be accompanied by a fee of VT 20,000. The application must include information on plans, specifications and other documentation the Director may require.

9.1.2.4. National Green Energy Fund (NGEF) Act

The Fund, headed by a Fund Manager and overseen by a seven-member Board with representatives from government agencies (including the Director of the Department of Women's Affairs) and civil society organisations, aims to ensure greater participation of women and other vulnerable groups in clean energy development in Vanuatu. The Fund developed an operational manual (in February 2019) that includes environmental and social safeguards procedures as well as gender policies and procedures that could have

[24] *Environmental Impact Assessment Regulations (Amendment)*, in *Environmental Protection and Conservation Act*. 2012. p. 6.

broader applications across sector development. To date, the NGEF has funded a total of 140 Projects in partnership with donor agencies.

The NGEF has recently initiated a pilot project (funded by UN WOMEN) in collaboration with Vanwoods Microfinance, a Vanuatu membership-based non-governmental organisation established in 1997 to provide small loans, business literacy/management training and saving facilities to women interested in starting their own businesses. The intention of this project is to provide a "solar loan package" to women entrepreneurs in Shefa and Tafea provinces (the worst-hit areas by the 2023 twin Category 4 cyclones, Judy on 1st March and Kevin on 3rd March), which includes lighting and either a freezer or sewing machine to support their existing micro-business. Women will be required to repay the loan within one year and will receive business development support services from Vanwoods during this time. This pilot project will provide valuable learning on effective strategies to support expanding access to energy while also supporting women's financial empowerment.

9.1.3. Waste Management Frameworks

In 2020, SPREP completed a review of waste management frameworks in Vanuatu[25]. They found that until the enactment of the Waste Management Act 2014 and Pollution Control Act 2013, solid waste management was regulated by the Environment and Conservation Act and the Public Health Act, and water pollution was regulated by the Water Resources Management Act and the Public Health Act. These older frameworks are still relevant for Environmental Impact Assessments, wastewater issues and public health matters arising from waste management.

Vanuatu has dedicated legislation for controlling particular waste streams, such as plastics, and there is scope for coverage of most waste streams, although there are some gaps with respect to e-waste, disaster waste, and wastewater.

9.1.3.1. The Waste Management Act (WMA) 2014

The Waste Management Act [16] does not specifically identify electrical and electronic waste (e-waste) but does cover e-waste as 'bulk', 'solid' or 'hazardous' wastes.

Bulk wastes include vehicle or marine batteries (or any of their component parts), refrigeration equipment, household or commercial appliances, construction or demolition waste, and 'any other item to be disposed of which cannot be effectively disposed of by regular waste collection services provided to residential or commercial premises'. Solid waste is also defined to include electronic waste (e-waste), industrial waste, in solid form, or any other matter or thing designated 'waste' under the Act. Hazardous wastes include any substances which are or have the potential to be toxic, poisonous or which may otherwise cause injury or damage to human health or the environment, including those covered by international conventions applicable to Vanuatu.

While disaster waste does not readily fall under the current legislative definition of 'solid waste' described above, new regulations could designate it as a waste covered by the WMA.

9.1.3.2. Pollution Control Act 2013

The Pollution Control Act defines a 'pollutant' as any solid or liquid substance, energy or organism which may cause environmental harm. This includes any gas, liquid or solid, energy, including noise, radioactivity and electromagnetic radiation, a hazardous substance (with the potential to be toxic or injurious to humans), a combination of pollutants or any other matter or thing deemed hazardous under international conventions applicable to Vanuatu.

9.1.3.3. National Waste Management Strategy (NWMS) 2011-2016

Although Vanuatu does not currently have a policy on e-waste, the National Waste Management Strategy (NWMS) (and Action Plan) covers solid waste from residential, commercial, institutional, and industrial sources,

[25] SPREP, *Assessment of Legislative Frameworks Governing Waste Management in Vanuatu*. 2020, EU, SPREP, PWP. p. 62.

and solid wastes from natural disasters, medical waste from hospitals and dispensaries, difficult waste such as used oil and scrap metal, quarantine waste, septic and sewage sludge wastes. The NWMS does NOT cover liquid wastes (such as raw sewage and other wastewaters), gaseous wastes, or hazardous wastes (such as Persistent Organic Pollutants, POPs), which will be addressed by the Stockholm Convention National Implementation Plan (NIP).

The NWMS has seven specific objectives to: 1. support solid waste management activities with practical, effective, enforceable legislation; 2. make solid waste management systems and programmes financially self-sustaining; 3. develop skilled and trained people in Vanuatu to manage solid waste management systems effectively; 4. reduce the amount of waste generated and landfilled; 5. disposed of waste that cannot be avoided, reused, recycled or composted in an environmentally sound manner; 6. upgraded waste collection systems to be well-managed, efficient, and self-sustaining; and 7. better coordinated national waste management activities.

Natural hazards most expected to impact waste management efforts include cyclones, volcanic eruptions, earthquakes and tsunamis.

The NWMS refers to, and is consistent with, the Priorities and Action Agenda (PAA) 2006-2015[26], Medium-Term Strategic Framework (MTSF), Waste Minimization and Management Strategy, Stockholm Convention on Persistent Organic Pollutants (POPs)[27], Noumea Convention for the Protection of the Natural Resources and Environment of the South Pacific Region[28], The Pacific Regional Solid Waste Management Strategy 2010-2015[29] and Pacific Islands Framework for Action on Climate Change (PIFACC)[30].

9.1.3.4. Vanuatu Waste Disposal and Recycling Audit (PacWastePlus)

The 2020 SPREP Waste Audit Reports for Vanuatu examined waste disposal, including assessments of landfills and stockpiles for recycling. PacWastePlus is a project funded by the EU and the Secretariat of the Pacific Regional Environment Programme (SPREP). Vanuatu is one of the fifteen Pacific island nations participating in the PacWastePlus programme. The program aims to enhance waste management practices across the islands, building the capacity of governments, industries, and communities to manage waste sustainably and cost-effectively while protecting human health and the environment.

In general, access to proper waste collection and disposal facilities in Vanuatu is limited, leading to environmental degradation and health risks. Waste management practices are inadequate, relying primarily on burying, burning, dumping, and landfilling methods. Four waste facilities in Vanuatu include the Bouffa landfill, the Luganville dumpsite, the Lenakel dumpsite, and Lakatoro.

There is a formal, managed landfill in Bouffa landfill (Efate) is a formal, managed landfill but dumpsites in Luganville (Espiritu Santo) and Lenakel (Tanna) unmanaged sites, with some collection services (also at Lakatoro, Malampa Province). Open dumpsites and informal stockpiles are found in the remaining provinces and rural areas. Backyard disposal, in which waste is burned and/or buried, still occurs throughout Vanuatu.

The three most common types of household waste are: 1) organic waste (37.21%); 2) hygiene products (28.30%); and 3) metals (11.54%). Overall, e-waste accounted for 3.1-4% (Efate and Espiritu Santo), and batteries were recorded in Efate as 0.3% of the landfill by weight. For most categories of e-waste, white goods, and batteries, large quantities are imported, and comparatively small amounts are disposed of, recovered or stockpiled. The only batteries collected are used lead-acid batteries (ULAB) in areas surrounding Port Vila and Luganville. There is no collection for these in other areas of the country.

RecycleCorp[31] is the only recycling aggregator in Vanuatu. Established in 2007, it focuses on exporting scrap metals, aluminium cans, glass, batteries, and some copper from e-waste for recycling. Stockpiles are located at RecycleCorp Yards in Port Vila and Luganville, awaiting sufficient volumes and suitable markets. There is no formal recycling done within Vanuatu. The company recovers 656 tons of waste annually.

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26 GoV, *Priorities and Action Agenda 2006-2015: An Educated, Healthy and Wealthy Vanuatu*. 2006, Department of Economic and Sector Planning, Ministry of Finance and Economic Management. p. 52.

27 https://chm.pops.int/

28 https://www.sprep.org/convention-secretariat/noumea-convention

29 SPREP, *Pacific Regional Solid Waste Management Strategy 2010-2015*. 2010, JICA. p. 48.

30 SPREP, *Pacific Islands Framework for Action on Climate Change (PIFACC) 2006-2015*. 2006. p. 26.

31 https://recyclevanuatu.com/

Only the Bouffa site at Port Vila has infrastructure that includes wastewater (leachate) collection, storage and treatment facilities, but they are not functional, according to the National Waste Audit Report 2023. None of the landfills in Vanuatu, including RecycleCorp, meet the standards for modern waste management according to the latest audit and are classified as 'unregulated'. This classification indicates that the facilities lack proper leachate management and do not use daily cover. The absence of leachate management poses significant environmental and health risks due to contamination and uncontrolled material flow. Additionally, the lack of daily cover at landfill sites makes them highly vulnerable to material displacement during climate-related events, such as cyclones.

9.1.4. Land Laws and Policies

A wide range of laws and policies govern the use, acquisition and leasing of land relevant to NEMP, including the Land Acquisition Act 2014, Land Reform Amendment Act 2013, Customary Land Management Act 2014, Land Leases Act 1983 and the Land Use Planning Policy 2013. The Land Acquisition Act gives the Minister for Lands and Natural Resources powers to acquire land for the project, including compensation, grievance and notice periods. The Land Leases Act 1984 deals with arrangements for the use of land under a lease agreement, which may be of relevance for NEMP. While there are no discriminatory laws regarding women's land ownership or access within Vanuatu's Constitution or subsequent national legislation, the "kastom" law can prevent or discourage the participation of women in decision-making processes pertaining to land management and tenure[32].

According to the 2020 Census, 73% of private households reported having customary land tenure agreements, and the National Sustainable Development Plan Baseline Survey found that male-headed households had greater access to customary land than female-headed households. However, the Vanuatu Land Registry does not collect sex-disaggregated data on land leases, and so the proportion of land leased by Ni-Vanuatu women is not known.

9.1.5. Energy Policies

The Vanuatu National Energy Policy Framework and the Updated National Energy Road Map (NERM) call for energy efficiency and the promotion of renewable energy sources. In particular, the NERM calls for accessible energy, affordable energy, secure and reliable energy, sustainable energy, and green growth. These five priorities will be used to choose sub-projects for NEMP where the technologies are proven and the benefits exceed the costs, particularly in regard to the provision of electrical power to rural and remote parts of the country.

From a social perspective, the NERM does not acknowledge GEDSI issues (other than a brief reference to the harmful effects of cooking by fire on women and children's health) or mainstream gender equity and social inclusion in the policy framework and implementation plan. This is a significant omission that needs to be addressed.

9.1.6. Climate and Disasters

Vanuatu has a range of legislation and policy documents aimed at ensuring developments increase the country's resilience through better planning, design, and coordination. This includes the Subnational Development Planning Framework, which mainstreams gender-sensitive disaster risk reduction and disaster risk management. The NEMP will necessarily follow these principles in the design and environmental and social management of the project.

9.1.6.1. Disaster Risk Management (DRM) Act

One of the main objectives of this Act is to support a whole-of-government approach to disaster risk management, especially the integration of disaster risk reduction and climate change adaptation across the different sectors and through all levels of Government, through information-sharing, cooperation and joint planning. Through the National Disaster Management Office (NDMO), the Act seeks to ensure that disaster risk

32 http://asiapacific.unwomen.org/sites/default/files/2022-12/UN_WOMEN_VANUATU.pdf

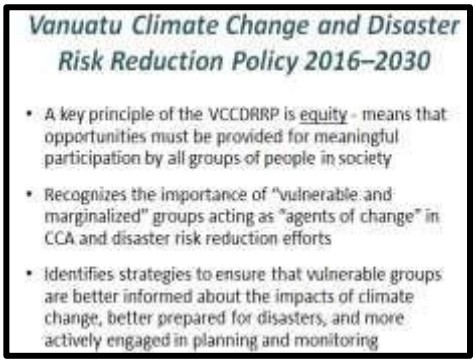
management and climate change adaptation measures are gender-responsive, sensitive to indigenous knowledge systems, and respectful of human rights. Further, Provincial Disaster and Climate Change Committees (PDCCCs) are tasked with coordinating disaster risk reduction and climate change adaptation programs, activities and initiatives with communities.

9.1.6.2. Climate Change Disaster Risk Reduction CCDRR Policy 2016-2030

The vision of this Climate Change and Disaster Risk Reduction Policy is for Vanuatu to be a nation whose communities, environment and economy are resilient to the impacts of climate change and disaster risks. The policy provides a framework through which risks can be identified, assessed, reduced and managed. This policy recognises the varying perspectives, needs, and capacities of under-represented groups such as women and persons with disabilities, and advocates for the meaningful involvement of under-represented groups in planning and implementing climate and disaster programmes.

9.1.7. Gender Equality, Disability and Social Inclusion

The Government of Vanuatu has established a strong GEDSI policy environment as shown through the endorsement of numerous global and regional human rights agreements, including the United Nations Sustainable Development Goals (SDGs)[33], the Beijing Platform for Action[34], and the Pacific Platform for Action on Gender Equality and Human Rights 2018–2030[35].



In addition to women, disability and youth-specific policies, the GoV has mainstreamed equality and inclusion in fundamental domestic documents, including the Constitution, the National Sustainable Development Plan 2016-2030 (NSDP) and the National Climate Change and Disaster Risk Reduction Policy 2016-2030.

The GoV has also mainstreamed gender, inclusion and community engagement in sector documents. For instance, the Water Resource Management Act was updated in 2016 to require a minimum 40% representation of women on rural water committees.

The Vanuatu National Disability Inclusive Development Policy (NDIDP) 2018-2025 focuses on mainstreaming disability in disaster risk reduction and ensuring people with disabilities (PWD) are included in climate resilience planning. Women and girls with disabilities are cited as a strategic priority given their even greater vulnerability to gender-based violence including sexual exploitation, abuse and harassment (SEAH). The NDIDP is managed by the Ministry of Justice and Community Services (MJCS) Disability Desk.

The Department of Women, under the MJCS is responsible for coordinating implementation of the *National Gender Equality Policy* (NGEP) 2020-2030. The purpose of the NGEP is to provide a unifying strategic framework for government, civil society and development partners to coordinate actions to advance gender equality and the well-being of women and girls in Vanuatu. Among other priorities, the NGEP strives to enhance women's economic empowerment and skills development, foster gender-responsive and community-driven solutions to climate and disaster resilience, and advance women's leadership opportunities and abilities. These objectives will be supported through the development of a pro-poor, gender-responsive and socially inclusive national electrification master plan.

33 https://www.undp.org/sustainable-development-goals

34 https://www.unwomen.org/en/digital-library/publications/2015/01/beijing-declaration

35 SPC, *Pacific Platform for Action on gender equality and women's human rights 2018-2030*, in *Endorsed by the Ministers for Women's on 5th October 2017*. 2017, SPC. p. 19.

The Family Protection Act of 2008 was passed to address the high level of violence against women and children by criminalising domestic violence in recognition that many perpetrators were family members. However, the legal framework does not protect unmarried women or domestic workers.

With respect to the energy sector, the National Gender Equality Policy (NGEP) 2020-2030 states that there is inadequate attention to gender issues and strategies in the National Energy Road Map 2016-2030 and calls for women-led initiatives that contribute towards energy development and low carbon growth and adaptation in line with SDG 7.

9.2. Stakeholder Consultations

A series of agency-level ESS consultations were conducted in December 2023 and January 2024 with state and non-government organisations (NGOs) active in the energy sector. The meetings included the Customary Land Management Office (CLMO), Department of Climate Change (DCC), Department of Environmental Protection and Conservation (DEPC), Department of Energy (DOE), National Green Energy Fund (NGEF), Utilities Regulatory Authority (URA), Vanwoods and Oxfam. During these meetings, the following environmental and social risk management issues were identified.

9.2.1. Environmental Factors

9.2.1.1. Department of Environmental Protection and Conservation (DEPC)

The main issue raised by the Director of DEPC, Mrs Touasi Tiwok, is concerned with the end-of-life (EOL) e-wastes for the project. The main concerns are how the wastes are managed and how communities understand their part in this process. This concern includes that there is already little land available for the disposal of wastes and that the provinces have been slow to respond to waste management, with some having only dump sites and others more formal landfills and some form of waste separation. Some of the provinces expect that one day, the waste will be shipped off their land. It was strongly suggested that NEMP would have to deal with this aspect, especially regarding waste storage areas

The Director also highlighted that there is not enough awareness in the community, an issue that has been repeatedly raised by SPREP in the regional context[36][37]. People are not clear on what to do with all the e-waste now being generated by their access to power and their use of electrical and electronic equipment.

Underlining her concerns, the Director of Environment recommended that NEMP establish an environmental management system for any community of over 3,000 persons, including waste sites and collections.

The Department of Environment is planning to discuss waste management with UNELCO and VUI. She suggested there may be other private sector partners who might be able to work on these issues through recycling or investing in projects (such as the Vanuatu Provident Fund).

9.2.1.2. Department of Climate Change (DCC)

The Department of Climate Change is mostly concerned with promoting the use of renewable energy and with reductions in greenhouse gas (GHG) emissions. The person contacted was Mr. Nelson Kalo, Senior Mitigation Officer.

Some islands have hydroelectric schemes, the largest on Espiritu Santo and Malekula, but also smaller ones on Pentecost and Maewo. There are also studies being done on geothermal energy, and there may be an opportunity in North Efate.

Mr. Kalo stressed the need to identify regulatory environmental and social frameworks for rural electrification projects for customers and businesses currently without access inside and outside concession areas. The projects must be feasible and work under Vanuatu conditions.

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36 SPREP, *PacWastePlus Programme A Guide to Developing Project Engagement Plans: Stakeholder Education and Awareness*. 2021. p. 43.

37 SPREP, *PacWastePlus Programme Model Regional Education and Awareness Plan*. 2021. p. 39.

The main environmental and social issues identified were:

- There is a need for better regulations for importing equipment for the energy sector.
- There are risks with disasters, mainly cyclones, and there is a real need to take into account Category 4 and 5 cyclones. UNDP is working in Vanuatu on "Risk-informed Development".
- There are risks associated with the disposal of e-waste, especially batteries, and this should be a focus of the NEMP. These issues have been overlooked until now. Also, waste-to-energy projects are being discussed.
- Interactions between the project and climate change need to be better understood; and
- The need for specific guidelines to effectively manage gender, inclusion and E&S issues in rural electrification.

9.2.2. Social Factors

Community-level consultations were undertaken during the preparation of the Environmental and Social Management Framework (ESMF) for the Vanuatu Rural Electrification Project (VREP II) in 2016[38]. During these meetings participants described the following social benefits accruing from the provision of electricity provided under the project:

- Cost savings from eliminating kerosene use in hurricane lamps, the previous light source.
- Refrigeration allows local shops to stock perishable goods and avoids the need for residents to pay for transport to town to procure these goods.
- Access to modern technology, including computers for school-age children and more reliable lighting to allow studying.
- Access to knowledge and the "modern world" through internet connection.
- Access to entertainment such as television and music.
- The ability for women to access labour–saving devices such as sewing machines, washing machines and rice cookers, and
- Street lighting and community facility lighting allow for community gatherings.

Community members also noted, however, that the use of higher energy-demand devices such as rice cookers resulted in higher tariff charges, and hence, there was a trade-off between convenience and extra power costs. Fundamentally, however, it was the provision of more reliable and cost-effective lighting that was the greatest benefit.

This ESMF also stated that sub-projects could have minor adverse social impacts on local communities and households, which need to be addressed through effective remediation. These risks included:

- Impacts during construction activities such as loss of assets such as trees and standing crops.
- Social exclusion is based on an inability to afford access to the expanded electricity services.
- Vulnerable individuals could include widows, single mothers, orphans, disabled persons, and women more generally, and
- Indebtedness, in particular, due to the high energy cost via self-reliant electricity systems.

The expected social benefits arising from improved energy noted in the ESMF included:

- Create opportunities to employ local businesses and workers in subproject construction, operations, and maintenance activities, as well as the provision of training and skills development opportunities for communities (including women, unemployed youth, and PLWD).
- The provision of electricity to social infrastructure within communities, such as health clinics and schools, leads to improved health and education outcomes.
- Improved community safety through better lighting, particularly for women and children, and
- Increased production of food crops leads to better nutrition and market sales.

[38] VREP, *Environmental and Social Management Framework for the VREP Stage II*. 2016. p. 49

Additional insight into the impacts of improved energy can be found in case studies conducted by the National Green Energy Fund[39]. For instance, the Hoghabour Secondary School in East Santo Island applied for a concessional loan from the NGEF to install a solar PV system in 2020. Following a load assessment, a locally registered energy vendor installed a 21.5 kWh/day Solar PV system for the school with about 330 students and 15 teachers. A recent case study revealed significant academic and economic impacts as outlined below:

- Students study time increased due to the consistent supply of electricity compared to diesel generators running for only 3 to 4 hours per day;
- Online classes improved student learning;
- Teachers performed well;
- Noise pollution caused by diesel generators was reduced;
- Diesel generator fuel costs were reduced by VUV1,600,000 per year;
- Transportation costs to access fuel in Luganville town were reduced by VUV10,000 per trip;
- Additional savings were used by the school to build new classrooms; and
- The school now offers free charging services to students plus surrounding communities.

9.2.3. Main Issues Identified by Stakeholders

9.2.3.1. Land Disputes

The DOE, NGEF, CLMO and the URA reported that land disputes continue to be an issue for energy developers and operators, often due to contention over the identity of the rightful owner(s). In some cases, landowners have agreed to lease their land for energy infrastructure, and these agreements are later disputed by the landowning group. A current dispute in Santo involves landowners requesting free power in exchange for the use of the land. As such, the URA emphasised the importance of the GoV determining if land acquisition is a better alternative than leasing, at least in some situations. Further, regardless of whether land is legally acquired or leased, early (and ongoing) communication and engagement with landowners and local communities is considered essential for sustainability.

9.2.3.2. Capacity Constraints

Experience has shown that area, local and community-based energy management arrangements are weak, which leads to supply, maintenance and sustainability issues. As such, stakeholders emphasized the need to build the capacity of management committees to effectively oversight operations, and to significantly increase the number of qualified solar technicians available to service equipment, especially in rural areas. It was suggested that a customised training program be developed and fast-tracked to ensure the supply of technicians is commensurate with the supply of new solar systems. In this regard, it was suggested that the NERP include arrangements for partnering with national and/or regional technical and vocational education and training (TVET) providers to upskill electrical engineers.

9.2.3.3. E-Waste

Agency-level stakeholders indicated strong concern about e-waste generated by the transition to renewable energy and the negative impacts this is having on communities. Abandoned generators, solar batteries, and panels are being used for non-intended purposes, creating environmental and safety issues. An initiative by the Ministry of Health to transport e-waste to Santo and Port Vila using their motor vessel (MV Helper) on return trips from the outer islands is a strongly supported initiative. Stakeholders stressed the need for the NEMP to identify sustainable e-waste solutions.

9.2.3.4. Public perception

Stakeholders consulted believe that communities often do not have a good understanding of how solar systems operate and have unrealistic expectations regarding supply levels and costs. As such, it is important that the public has ready access to user-friendly information about power supply options and costs and that load

[39] NGEF, *Successful Achievement for Hoghabour Secondary-School*. 2023, National Green Energy Fund, Vanuatu. p. 3.

assessment information is widely shared. The use of a simple tiered supply system which illustrates what can be supported under each tier (i.e., # of lights, refrigeration, fans etc.) was recommended as the basis for public awareness campaigns

9.2.3.5. Lack of Data

The DoE and the URA stressed that the lack of available up-to-date data on the location of working solar systems is an impediment to effective sector planning. As there, it was suggested that the NEMP highlight the need for improved data on existing and planning energy developments and that management committees receive training on collecting and reporting usage data.

9.2.3.6. Need for Staged Approach

Stakeholders emphasized the need for a more planned and sequenced approach to achieving national electrification. They said there is currently little coordination between donors, and the DOE is not always aware of planned initiatives or consulted on priority focus areas. As a result, systems are often under or oversized or inadequate quality for the intended use. The need to prioritize essential public services was frequently mentioned.

9.3. Social Analysis

Energy services are vital to the provision of adequate food, shelter, water, sanitation, medical care, schooling, transportation and access to information and markets. Energy also fuels productive activities, including agriculture, forestry, commerce, manufacturing, industry, and mining, which drive the economy. As such, universal access to affordable and reliable energy is essential to achieving development outcomes and alleviating poverty, as indicated in SDG 7.

The energy dimension of poverty, or 'energy poverty', has been defined as 'the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development' [40].

This analysis provides a brief overview of the relationship between energy, gender, social inclusion, and poverty in Vanuatu and summarizes key social factors that need to be addressed from a social perspective.

The 2020 National Census indicated that Vanuatu's total population was 300,019, of which 49.5% are women. About 22.2% of the population live in the urban areas of Port Vila and Luganville and 77.7% of females live in rural areas. The national labour force participation rate was 42.1% for women and 51.5% for men and the unemployment rate was 9.4% for women and 6.7% for men over the age of 15 in 2019-2020. As of March 2022, there were no female members of Parliament, and there have only been five women in Parliament in the country's history. In terms of local governance, 26% of municipal councillors elected for the 2018-2021 term were women as were 7% of provincial councillors elected for the 2018-2021 term. Women are also under-represented as board members of organisations in Vanuatu; an analysis conducted by the Pacific Private Sector Development Initiative (PSDI)[41] estimated that 18% of Directors were women in 2021.

Customary laws form the basis of the relationship between people and land and there are no discriminatory laws regarding land ownership or access within Vanuatu's Constitution or national legislation. While the 2013 Custom Land Management Act allows for the participation of women in customary institutions which are involved in decision-making regarding land matters, *'Kastom'* laws and practises can prevent or discourage the participation of women in decision-making processes pertaining to land management and tenure.

The national prevalence rate of disability is between 3% and 12%, depending on the definition used to measure disability. People with disabilities are more likely to be living in the lowest wealth quintile than those without disabilities. Women and children with disabilities face additional stigma and social exclusion and are highly susceptible to abuse and exploitation. More than one in five women (21%) who have been injured as a result of intimate partner violence have sustained a permanent disability.

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40 Women, U., *Gender Equality Brief for Vanuatu*. 2022. p. 20.

41 https://www.pacificpsdi.org/

Currently, only about 30% of all Vanuatu households and public institutions have access to electricity via connections to a grid network (in 4 of 6 provinces), and there is a severe imbalance in access between urban and rural areas. According to the Vanuatu 2020 census, 83% of the urban population is connected to the grid for lighting, while lighting is mostly provided by solar panels/lamps/batteries in rural areas (82%). For cooking, about 16% of urban households use electricity, and the remainder use bottled gas and open fires, while less than 3% of rural households use electricity to cook, while the remainder mostly use open fires (86%).

Biomass resources used for cooking (i.e., firewood and crop residue) are being degraded. In a single generation, the time and effort required to meet minimum household energy needs have increased significantly[42]. The negative impacts of climate change on crop outputs and fisheries stocks have further contributed to women's time and work burdens. In addition, the health impacts on women and children of exposure to high concentrations of particulate matter, carbon monoxide and other pollutants emitted when biomass fuels are burned are becoming more apparent. According to the UN Environment SDG 7 Issue Brief, close to 4 million people annually die prematurely from exposure to household air pollution caused by inefficient cooking practices[43].

The 2016 Global Green Growth Institute (GGGI) study on energy demand projections in Vanuatu states that in the absence of changes in household behaviour and technologies used for cooking and drying, the national biomass consumption is likely to increase in line with population and GDP growth over the coming 15 years. This research also states that the demand for biomass is driven by cooking and crop drying in rural households and businesses. With an expected annual growth in biomass usage of 3% in the next 5 years, and 4% between 2020–2030, the required volume of fuelwood and coconut residues being burnt is estimated to increase by 78% between now and 2030. If this scenario does eventuate, it could lead to the following impacts: (1) increased deforestation around areas with high population density; (2) increased time spent collecting biomass; and (3) continued negative impacts on health, caused by exposure to smoke. These impacts will have a disproportionate impact on women, who are largely responsible for cooking tasks.

9.3.1. Energy is not gender neutral

Women suffer heavily from energy poverty given they are primarily responsible for household tasks including food preparation, child and elder care, laundry, cleaning etc. and for generating income through market sales, all of which is considerably more labour intensive without power. They also lack access to assets, finance, markets, infrastructure and skills required to secure more efficient energy sources. In addition, women are generally not empowered to contribute to infrastructure planning at community, district, provincial or national level because this is still considered men's domain. The lack of women involved in energy sector work enables this situation to continue.

A study on women and energy carried out by Oxfam in 2017[44] found that many energy access projects fail to generate the intended beneficial impacts for women for two main reasons: (1) households engage in "fuel stacking"—that is, using traditional energy sources to save costs or to meet their preferences even when they have access to improved sources, and (2) women lack decision-making power within households. This means that energy access projects need to fully understand the barriers to using improved energy even when it is accessible.

9.3.1.1. Gender-based Violence (GbV) is pervasive in Vanuatu

According to the 2009 survey conducted by the Vanuatu Women's Centre and the National Statistics Office[45], 60% of women have been in a relationship where they experienced either physical and/or sexual violence by a husband/intimate partner. Emotional and punitive violence are also prevalent in the home as more than two in

[42] Johnson, O.W., et al., *Intersectionality and energy transitions: A review of gender, social equity and low-carbon energy.* Energy Research & Social Science, 2020.

[43] UNEP, *Issue brief SDG 7: Ensuring Access to Affordable, Reliable, Sustainable and Modern Energy for All*. 2022. p. 2.

[44] https://www.oxfamamerica.org/explore/research-publications/energy-women-girls/

[45] Hunt, J., *Vanuatu National Survey on Women's Lives and Family Relationships*. 2011: Vanuatu Women's Centre (VWC).

three women have experienced emotional violence, and more than 80 per cent of children have experienced some form of violent discipline[46].

Given this situation, it is imperative that electrification planning in Vanuatu take GbV into account. For example, this means recognizing that improved lighting plays an important role in keeping women and girls safe in public places and on transport routes. The UN Women's "Safe Cities and Safe Public Spaces" report indicates that investing in urban infrastructures, like better public lighting, is one of the keys to ensuring safer and more inclusive spaces for women, especially in developing countries. Initiatives carried out in cities around the world, including Port Moresby, Papua New Guinea, demonstrated that improving public lighting systems in certain areas was one of the factors that raised the feeling of security in these spaces and generated a decrease in violence against women.

9.3.1.2. Women's Voice

According to a 2020 review of papers on gender, social equity and low-carbon energy, factors contributing to the equitable social impacts of developing low-carbon systems include the necessity of community engagement, including a participatory framework that integrates the voices and concerns of all stakeholders[47]. The research also found that in addition to social and environmental impact assessments, programs should conduct gender impact assessments that consider 'gender injustices' in the transition to new energy sources. These analyses would address what resources women would need to aid in their transition to new systems, the development of more holistic compensation plans in the event of land or livelihood loss and developing jointly titled land claims in case of resettlement.

In developing the national electrification master plan, it is critical to fully consider the different energy needs and priorities of women and men, and to ensure that women have a strong voice in planning and decision-making processes. As stated in the National Gender Equality Policy, women face many barriers to participating in decision making from national to community level and are largely left out of the chiefly system of informal governance. For these reasons, the Water Resource Management Act was updated in 2016 to require a minimum 40% representation of women on rural water committees, and the EIA Regulations also require public consultation and stakeholder engagement in environmental and social assessment processes.

9.3.1.3. Equity and Inclusion

Global experience has shown the wide range of benefits that can accrue for women and children when household access to reliable energy is provided. This can include a decline in women/child health issues resulting from smoke inhalation, reduced work burdens allowing women more time for childcare and productive activities, improved education outcomes and an increase in entrepreneurialism. The same type of benefits can accrue when power is provided/improved at rural health centers, schools and marketplaces.

However, the existing power imbalances related to energy access and resource distribution can easily be replicated and transferred to new energy systems if care is not taken to address structural inequalities. This includes the financial impacts of new electrification and renewable technologies on low-income households. In response, the review highlights the benefits of collaborations between multiple sectors (for instance, the energy and public sectors) in developing more inclusive energy policies, programs and subsidy schemes.

Researchers warn against the temptation to assume that a commitment to 'greening' energy systems will necessarily render them more inclusive. To avoid the risk of perpetuating unequal access to energy resources, the authors recommend that all stakeholders be consulted, that a gender assessment is crucial in the understanding of the energy needs of women, and that careful consideration be given to social, political, economic, and cultural dynamics that impact current gender inequities.

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[46] Arabi, A., et al., *Enabling Women's and Feminist Movements to End Violence Against Women and Girls: Experiences from Vanuatu*, in *Development Futures Series*. 2022, UNDP. p. 10.

[47] Johnson, O.W., et al., *Intersectionality and energy transitions: A review of gender, social equity and low-carbon energy.* Energy Research & Social Science, 2020

9.3.2. Energy Justice

Energy justice calls for equitable decision making for all members of society in order to 'balance' the aims of different interest groups such as energy financiers, developers, operators, regulators, and communities[48].

While energy justice principles form the foundation of social and environmental safeguard policies, there an opportunity to move towards a more inclusive approach and improve engagement with local communities in the planning, development, implementation, and governance of energy projects in rural community locations.

Energy justice recognizes the vital role that regulatory and policy frameworks play in preventing injustices associated with energy systems and transitions. As such, it is important to review energy laws and policies in Vanuatu to ensure the rights and duties of stakeholders and communities are clear and just.

9.4. Environmental and Social Safeguards (ESS) Screening

9.4.1. Approach to ESS Screening and Identification of Significant Impacts

The final types and sizes of interventions resulting from the NEMP are not yet known and will be determined during implementation. Furthermore, the Government of Vanuatu (GoV), and possibly also the private sector, will identify potential locations for the interventions. Therefore, the purpose of this screening and the following ESMMP is to guide the implementing agency, the DoE, on the environmental and social screening and subsequent environmental and social assessment of sub-projects during project implementation.

The environmental and social factors discussed here only refer to environmental and social impacts within Vanuatu, not those experienced at the overseas sites of manufacture of fuel-based or renewable energy equipment, nor freight to bring the equipment to Vanuatu.

Regarding technology, this environmental screening focuses mainly on micro- and mini-grid PV systems as the most likely to yield economic, social and environmental benefits. However, small hydroelectric systems and backup diesel generators may also be required. Most projects are expected to include solar arrays, batteries, a battery house and power distribution lines to convey energy to households in nearby areas. The distribution system may involve power poles or buried lines, and electricity meters. As additional types of power generation are added to the system, the NEMP ESMMP will need to be updated.

Using SPREP's Environmental and Social Safeguards (ESS) framework as a guide, potential project activities are screened for inherent environmental and social risks before applying mitigation or management measures. Screening for potential adverse environmental and social risks and impacts includes all activities with potential direct and indirect risks and impacts across the project's area of influence. The main protections covered in this framework include human rights (in this case, energy justice), gender equality and social inclusion, child protection, climate change, biodiversity and ecosystem services and waste management.

9.4.2. Potential Social and Environmental Impacts and Mitigation

9.4.2.1. Pre-construction Phase – Impacts due to Design

Environmental and Social Assessments

The Preliminary Environment Assessment (PEA), in association with any required Environmental (and Social) Impact Assessment (EIA) and Environmental and Social Management & Monitoring Plan (ESMMP), are required by Vanuatu Law and are central to identifying issues and mitigation before any part of the NEMP project begins. All required environmental and social assessments for NEMP implementation will be carried out according to relevant policies and procedures.

[48] Taylor, M. and S. Taylor, *Applying energy justice principles: a case study of solar energy in Vanuatu.* The Journal of World Energy Law & Business, 2022. **15**(3): p. 193-211.

Resettlement

E&S assessments will include an analysis of resettlement requirements, both temporarily and permanently, associated with each development. Investigation of this matter will be guided by World Bank ESS Standard 5: Restrictions on Land Use and Involuntary Resettlement which aligns with international standards. The key tenants of this standard are:

- To avoid or minimize impacts by exploring alternatives.
- To mitigate adverse impacts through timely compensation and assistance to restore livelihoods and living standards.
- To improve living conditions of physically displaced poor or vulnerable persons.
- To conceive and execute resettlement activities as sustainable development programs.
- To ensure that resettlement activities are planned and implemented with appropriate disclosure of information, meaningful consultation, and the informed participation of those affected.

Land use impacts

Depending on their location and size, small-scale and utility-scale solar facilities can raise concerns about land degradation and habitat loss, with land area requirements ranging from 3.5 to 10 acres per megawatt[49]. Unlike wind facilities, there is less opportunity for solar projects to share land with agricultural uses (except see ESMMP below, which suggests the use of some animals for keeping PVs clear of the rapidly growing vegetation in Vanuatu.

Utility-scale solar systems can be seated at locations previously impacted by other developments (abandoned mining land or existing transportation and transmission corridors) to minimize land impacts. Smaller-scale solar PV arrays, which can be built on top of homes or commercial buildings, have minimal land use impact. These determinations will be made as part of the project's environmental and social assessments.

An important part of E&S land use screening will be assessing potential loss of livelihoods, either temporarily or permanently, due to land use impacts associated with the construction and maintenance of new energy infrastructure. Compensation for such losses needs to be reviewed and made clear to affected parties prior to the commencement of any works.

Natural hazards

As one of the most disaster-exposed countries on Earth, Vanuatu carries the extra burden on its developments in any cost-benefit calculations. To ensure NEMP is efficient, provides value for money, and reaches 100% electrification, it will be necessary to ensure project components are built to suitable standards. This burden means the costs of NEMP will be higher than in other countries (Tonga is a close second), adding to the costs of high dispersion of the population. Steps will need to be taken in the project to ensure buildings can withstand cyclones and earthquakes and that distribution lines are buried wherever possible.

9.4.2.2. Construction Phase Impacts

A range of impacts associated with the construction facilities resulting from the NEMP can be addressed through effective stakeholder engagement and by using best practice industry standards at all development sites. These include impacts on air quality (including dust generation during dry periods), noise nuisance, as well as soil erosion and sedimentation during excavations and building. There may be short-term disruptions to roads and access to property during the construction of distribution systems and installation of household meters. It is expected that relatively inert wastes will be generated during construction. There are also pollution risks from using machinery, such as fuel and oil spills.

From a social perspective, design and construction risks will be mitigated through meaningful stakeholder communication and engagement, early identification of land use sensitivities, attention to community and

[49] https://www.ucsusa.org/resources/environmental-impacts-solar-power

worker health and safety, robust prevention of gender-based violence (GbV), including sexual exploitation, abuse and harassment (SEAH) and effective grievance management.

The best environmental and social practices during civil construction include:

- undertaking prior consultation with local leaders, landowners and affected communities to provide comprehensive information about the works;
- identifying and addressing all land or cultural sensitivities before the commencement of any works;
- gaining permission to access specific sites during specific times and maintaining regular communication with community representatives throughout the works;
- ensuring all workers and affected communities are aware of the behavioural standards of workers, including sexual exploitation, abuse and harassment;
- ensuring workers sign a community code of practice;
- providing safety training and personal protective equipment (PPE) for all workers;
- ensuring community members are aware of the grievance redress mechanism (GRM) available to them;
- ensuring all construction sites are fully fenced to minimise public risk, especially of children;
- limiting work to standard work hours to minimise disruption;
- limiting the area of land under excavation at any one time and ensuring proper drainage around work areas and stockpiles;
- ensuring proper maintenance of all machinery;
- ensuring proper storage and disposal of wastes;
- providing portable toilets and wash facilities at each construction site;
- ensuring use of spill response kits and proper bunding for oil and fuel stores; and
- ensuring 'chance find' procedures are in place to protect cultural heritage.

An Environmental Code of Practice for Health and Safety and Land Permission was developed by DoE as part of the VREP[50], which will serve as a guide for the NEMP. It is recommended that a Worker Code of Conduct or Community Code of Practice also be adopted that commits workers to professional behaviour while working at the community level, including not engaging in sexual exploitation, abuse and harassment. This Code will also address child protection issues to ensure that children are not exposed harmful situations.

9.4.2.3. Impacts during Operations Phase

The main ongoing impacts during operations involve security and aesthetics of the installations (including distribution systems), fuel use for generators, proper maintenance of electricity infrastructure and the impacts of natural disasters.

The PV generators and power rooms will be enclosed in a locked fenced area to prevent the public, especially children, from gaining access and being exposed to dangers. These areas need to be maintained to ensure their security and aesthetics in the community. The power companies will incorporate regular inspections into a permanent management plan.

The PV array areas would be best kept as grassy lands (rather than concrete or compacted earth) to minimise water run-off. To reduce the need for regular mowing (requiring more equipment and fuels), it might be best to establish small herds of sheep (but not goats) to be owned by local farmers to maintain each site, as occurs in North Efate. One informant said this approach suffered in existing PVs because the sheep were not properly cared for. He suggested that the sheep be given adequate watering facilities and be enclosed in a fenced area larger than required just for the PV so they can escape the heat effect around the panels, and they be sheared and wormed as necessary. Smallholder farmers may be able to run a fixed number of sheep as part of larger holdings.

50 GoV, *Environmental Code of Practice for Solar Home Systems and Solar Micro-Grid Systems (Used Battery Disposal, Health and Safety and Land Permission) for Vanuatu Rural Electrification Project*, in *VREP*. 2017. p. 20.

The distribution of power to households and businesses carries the risk of localized disruptions for maintenance and risks to communities if power is conveyed on poles and cyclones damage them. Systems are already in place to deal with cyclones, but the project should consider underground power distribution to limit risks.

Where applicable, generators and other equipment used for backup power will require regular maintenance to minimise the risk of spills and disruptions to services. The new draw on fuel supplies resulting from operating generators must be incorporated into fuel planning to ensure supplies are reliable and other uses (for vehicles, fishing etc.) are not disrupted. Risks to the environment from the use of fuels, such as spills to land and waterways during transport and storage are to be mitigated by the same mechanisms that now operate throughout the country, including by the power companies that will operate NEMP sub-projects. Biodiesel or other fuels shown to be better for the environment should be used if and when possible.

Throughout operations, emphasis will be placed on worker and community health and safety and ensuring that risks are minimized through E&S-approved and monitored standard operating procedures (SOPs). The power company managing the supply in each area of the project should establish all of these mitigation measures. It is important that system operators (concessionaires) be required to regularly report against customized ESS key performance indicators (KPIs) to the regulator.

9.4.2.4. Hazardous materials and e-Waste

E-waste refers to discarded electrical and electronic equipment that is at the end of its life or is no longer suitable for use in its current form, consistent with the classification of hazardous waste under the Basel and Waigani Conventions[51] [52] [53]. This includes a wide range of technological wastes such as computers, printers, photocopy machines, television sets, washing machines, fridges, vehicles, radios, mobile phones and toys, which are made of sophisticated blends of plastics, metals, and other materials. E-waste also includes wastes generated by renewable energy systems such as solar and wind systems and any batteries they may include.

There is now a constant and strong demand for newer technology, and the lifespan of electrical and electronic products is progressively decreasing. Older and obsolete items are being discarded in large quantities and at increasing rates around the world (increasing at 4% per year), including the Pacific Island Countries (PICs) where the problem is only recently being documented and addressed.

End-of-life (EOL) electrical and electronic items contain contaminants that can damage the environment, as well as those that are potentially recoverable and valuable components such as copper, steel, and gold, which may be recycled[54]. The presence of hazardous substances including heavy metals (such as mercury, cadmium, lead) and flame-retardants. If improperly managed, these may pose significant environmental and human health risks. In this regard, new research from the World Health Organization (WHO) has shown that human exposure to e-waste, especially by pregnant women and children, is linked with impaired neurodevelopment and behaviour, negative birth outcomes, impaired lung function and respiratory effects including coughing, wheezing and asthma; weakened immune system functions that lead to increased vulnerability to common infections like hepatitis B, greater susceptibility to allergies and autoimmune diseases and reduced response to immunization[55].

Management and disposal of e-waste in Vanuatu is important for the maintenance of long-term community and environmental health.

In many developing countries, some recycling is occurring in the informal sector, which consists of simple recovery techniques targeting a few valuable substances. There is generally no protection of the workers or the environment. Most wastes are subjected to open burning and open dumping . According to SPREP, e-waste is, however, likely to pose little risk to human health until the time that their constituent metals and alloys are

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51 UNEP, *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.* 1992: p. 46.

52 SPREP, *Waigani Convention: The Convention to Ban the importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement of Hazardous wastes within the South Pacific Region.* 2001: p. 46.

53 Lundgren, K., *The Global Impact of e-Waste: Addressing the Challenge*. 2012, ILO: Geneva. p. 72.

54 Haynes, D. and E. Richards, *Management of e-Waste in the Pacific: A Regional Strategy and Action Plan*. 2011, SPREP. p. 31.

55 World Health Organization, 2021. Children and digital dumpsites: e-waste exposure and child health

extracted and recycled. This idea may be changing as we see cases worldwide of Li-ion batteries exploding without apparent cause.

Efforts to effectively manage e-waste in the Pacific face many challenges due to access to disposal points, recycling markets and the high cost in transporting e-waste out of the region.

Table 50: The negative impacts of informal recycling are well documented[56].

Aspect	Impacts
Workplace and environmental pollution	• Extremely high concentrations of e-waste related chemicals. • Chemicals detected are those incorporated into EEE (e.g., metals, PBDEs) or generated through processing of e-waste (PXDDs/Fs). • Process chemicals used for metals leaching are simply discarded.
Human exposure	• High levels of chemicals observed in e-waste recycling workers and people living close to recycling sites. • Toxic effects (chromosome aberrations, oxidative stress, etc.) observed in affected populations.

Table 51: Hazards of incineration and landfilling of e-Waste.

Situation	Hazards	Details
Incineration	Emission of metals into flue gas and ash	Low melting point metals (incl. Cd and Pb) easily form fumes.
	Emission of mixed chlorinated /brominated dibenzo-p-dioxins and dibenzofurans (PXDD/Fs)	If feedstock contains PVC or plastics flame-retarded with BFRs and incinerator temperature is not sufficiently high, Mixed halogenated dioxins/furans PXDD/Fs are formed. In the process, Cu may act as a catalyst.
Landfilling	Leaching of heavy metals and BFRs	Pb was shown to leach from CRTs and PCBs, BFRs were detected in landfill leachate.
	Evaporation of toxic substances	Methylmercury was detected in landfill gas.
	Formation of more toxic substances due to microbial activity or fires	Hg → methylmercury BFRs, PVC → PXDD/Fs

So far, experience in the Pacific has suggested that there is or will be a net cost to environmentally sustainable e-waste recycling in the region, with an e-waste collection in the Cook Islands in 2010 costing over $NZ 70,000 to collect and export waste components to New Zealand.

Probably the greatest environmental and social risk for the NEMP project will, therefore, be a large increase in the amount of e-waste generated over the next decade as a result. With e-waste currently at 3.1-4% of landfill (by weight) in Efate and Espiritu Santo, the amount to be disposed of can be expected to jump significantly. This will include a greater flow of batteries, solar panels, controller systems, meters, and cabling, as well as whitegoods and a wide range of electric and electronic equipment that will be enabled by the project. The chemical impacts of e-waste are summarised in Table 50.

With none of the landfills in the country being considered 'modern' and adequate to the task, and only limited recycling, this represents a significant impact and challenge. It will take around a decade for the full force of waste generation to be felt, given the time it will take for the project and the time it will take for components to become EOL. This gives Vanuatu an opportunity to build better systems to handle e-waste before there is a large supply. One approach would be to pursue waste-to-energy projects because they will free up landfills and dispose of wastes that need high-temperature burning to bypass dioxin formation. Waste-to-energy projects could also feed into the energy grid in some areas.

[56] Tsydenova, O. and M. Bengtsson. *E-waste: Chemical Hazards and Policy suggestions for Safer Management*. in *International Workshop on Hazardous Substances within the Lifecycle of Electrical and Electronic products*. 2011. 29 - 31 March 2011, Vienna: Institute for Global Environmental Strategies (IGES).

In the interim, an Environmental Code of Practice for used battery disposal and the disposal of household solar systems was developed by DoE for the VREP project and will serve well for the NEMP project.

The project should also collaborate with the Ministry of Health to raise public awareness about the health risks of e-waste for children, pregnant and lactating women, and other vulnerable groups and how to prevent harmful impacts.

9.4.3. Summary Table

The following is a list of significant issues identified for the project, mitigations and monitoring and evaluation (M&E)

Table 52: ESS screening and framework for ESMMP for NEMP

Safeguard Requirements	Potential E&S Issues	Prevention and Mitigation	M&E: (what/when/how much/etc.)
1: Assessment and Management of Environmental and Social Risks and Impacts **Initial Environmental Assessment (EA), followed by full EIA/ESIA if required)**	PEA/EIA/ESIA process is not followed for utility-scale projects	MOUs to be signed with all participating communities, UNELCO/VUI and the Department of Environment for a PEA for each sub-project. Funding identified, including for audit.	The project has a PEA/EIA/ESIA report with ESMMP. The ESMMP is audited during works as a monthly ESMMP Report to cover all sub-projects. EIA/ESIA and ESMMP Reports for all sub-projects are publicly disclosed and made available on the project website. An ESS Officer is appointed for the project to ensure all mitigations are followed, coordinate ESMMP reporting (with PDCCCs) and ensure information is available on the website and social media.
	Wastes generated by the project are not properly disposed of	Use of Environmental Code of Practice for Solar Home Systems and Solar Mini-grid Systems (Used Battery Disposal, Health and Safety and Land Permission) for Vanuatu Rural Electrification Project (VREP) and Environmental Code of Practice (Used Battery Disposal) For Rural Electrification Project Vanuatu .	An e-Waste policy is in the pipeline for the country. In the interim, the codes of practice developed by DoE for VREP will be used and updated as necessary for NEMP with information posted on the project website. Any updates to the policy will be reported as part of an ESMMP Report at inception. Quarterly visits to disposal and recycling sites will be carried out as part of the ESMMP from the beginning of Year 2 of the project.
		RecycleCorp and other potential recyclers are approached to include NEMP waste streams. MOU signed with Department of Environment. Funding needed for yearly audit throughout the project.	MOU signed and waste recovery audit shows e-waste is being recovered or stockpiled according to agreements.
		Controlled stockpiles are developed for temporary storage of recyclable wastes until such time they can be exported or used locally	Report on each stockpile developed, using best practices and posted on project website in ESMMP Reports.
	Wastes generated by the increase in electricity supply are not disposed of properly	Public awareness campaigns are developed so that people know where and how to dispose of all wastes arising in response to the project (individual e-wastes).	Radio shows, website and other materials developed showing in graphical format how materials should be disposed of in each area.

Safeguard Requirements	Potential E&S Issues	Prevention and Mitigation	M&E: (what/when/how much/etc.)
		Penalties are imposed for uncontrolled dumping. Planning and policies for e-wastes and the possible roles of waste-to-energy projects are accelerated with SPREP. Concessionaires develop systems for local storage of e-wastes and work with recycling facilities for proper disposal. Recycling facilities are upgraded through RecycleCorp and/or others to accommodate the new waste that will come online in the next decade.	Regional mechanisms on e-waste and waste-to-energy are actively pursued by Vanuatu and options for both examined in relation to the country's development plans as a priority.
	Forests and other wildlands are damaged by the establishment of solar arrays and other renewables.	EA will seek to locate all facilities in areas already impacted by past developments.	EA will show the potential losses to natural habitats, biodiversity and resources of each sub-project. To be posted on project website.
2: Public Participation and Information Disclosure	Land needed for the project is acquired without the correct/formal procedures for land acquisition, resulting in disputes.	Proper consultations and multi-stakeholder processes are used to acquire land to be used for the project. These are to be included as part of environmental and social assessments and public consultations. Due diligence reports on leases and land use MOUs will be completed by the ESS Officer. Funding for full and proper compensation, including purchase or rents, will be identified as part of the project. Resettlement plans are developed if required as part of the project. Project GRM is well-known and accessible to relevant stakeholders.	There are no grievances recorded over land issues, including no court cases resulting from NEMP. The Ministry of Lands and Natural Resources, Ministry of Internal Affairs and relevant Provincial and Municipal Councils are informed of the plans for land acquisition. A 3-month period for objections is given for each sub-project.
	The energy needs and priorities of women and other vulnerable groups, including people living with disabilities, are not adequately identified and/or addressed.	Stakeholder Engagement and Communication Action Plans will identify strategies to ensure meaningful engagement of people of all genders, ages, abilities and incomes in each project area.	Records of consultation meetings identify issues/solutions identified by women and men and summarized in ESMMP Reports. Consultation attendance records disaggregated by gender.
	The public is not suitably aware of the NEMP project and its activities	A public awareness campaign will use radio, social media and the project website to inform all	Project website, Facebook page / other social media, Radio shows.

Safeguard Requirements	Potential E&S Issues	Prevention and Mitigation	M&E: (what/when/how much/etc.)
	leading to delays, grievances and confusion.	stakeholders of the plans and progress against the project targets. A stakeholder engagement and communication action plan (SECAP) is developed and implemented for each sub-project. A grievance mechanism is established.	The grievance mechanism shows all issues are followed up till resolution and are reported in Monthly ESMMP Reports
	Communities are not adequately aware of the interventions in their area.	Chiefs and community representatives (male and female) will be consulted for each sub-project, and issues will be identified and addressed, if any.	Records of meetings in ESMMP Reports
3: Accountability, Grievance and Conflict Resolution	People negatively affected by any part of the NEMP work have no way of communicating their distress and no mechanism for redress.	A grievance mechanism is established which includes a pathway for dealing with sensitive issues such as sexual exploitation abuse and harassment (SEAH) and is well known to project affected parties.	A well-maintained project website is established. All complaints are catalogued and addressed, with full records available for examination by DoE and DEPC. ESMMP Reports.
4: Labour and Working Conditions	Workers dealing with NEMP installations, maintenance and waste disposal could be negatively affected in the workplace.	NEMP project will develop specific worker policies for selecting workers and provide toilet/washroom and protective equipment for workers as part of project designs	Policies and workers scheme developed and implemented for NEMP. Information on these to be publicly available on the project website. ESMMP Reports cover worker conditions.
		A workers compensation scheme will be established as part of the project	
		Standard working hours are used, including Sunday as a day of rest to minimise noise and impacts on communities and family life. Any work outside of standard hours by negotiation with communities	
5: Resource Efficiency and Pollution Prevention	NEMP installations could negatively impact fuel, existing electricity supplies and ecosystems	NEMP projects will seek to utilise the best technologies and best practices from planning through to implementation and maintenance. Special care will be taken to identify best systems for waste disposal / recycling	NEMP project design will show feasibility and cost-benefit calculations that show best solution in each project area.
	Poorly maintained equipment used for the project results in oil and fuel leakage and delays in works	All project machinery is kept maintained, including during operations phase by the power company responsible.	Maintenance records are kept as part of this ESMMP for construction phase.
	Fuels, oils and other chemicals used by the project are spilled, or accessed by the public	Fuels, oils and other chemicals are kept in a locked, bunded area at each project site and wastes are disposed of at proper facilities.	ESMMP reports show good storage of all chemicals.

Safeguard Requirements	Potential E&S Issues	Prevention and Mitigation	M&E: (what/when/how much/etc.)
	Land surrounding each project site is polluted by presence of larger than usual number of workers	Portable toilet and wash areas provided at each work site.	ESMMP Reports.
	Spills occur and are not adequately addressed leading to pollution of land and waterways	Spill kits available for all sub-projects.	ESMMP Reports.
6: Community Health, Safety and Security	The public and staff working on the project may be harmed by coming into contact with sub-projects, or during maintenance or waste disposal.	Workers will be supplied with machinery and personal protective equipment (PPE) as appropriate to their job. An incident reporting mechanism is established which includes notification of near misses. Proper e-waste storage facilities capable of handling explosive Li-ion batteries are provided by the Concessionaires who will work with recyclers when possible to remove waste.	Few if any complaints are received on the project website. Incident reporting is kept up to date and all incidents are resolved within 3 months. ESMMP Reports Development plans show design and location of safe e-waste storage
	Power distribution from mini/mini-grids to households and businesses is on poles which are vulnerable to natural disasters with risks to humans and supply disruptions.	NEMP establishes underground distribution systems wherever possible.	NEMP Policy includes use of underground power distribution wherever possible.
	Power generation and distribution systems are subject to damage and become safety issues due to cyclones, tsunamis and earthquakes.	All facilities are built to withstand Category 5 cyclones and at least ML 7 earthquakes and are elevated at least 20m from mean sea level.	NEMP Policy ensures these conditions are met.
	Local water supplies may be affected by excavations causing run-off into waterways.	Area of land excavated to be limited in area and duration. Bunding and drainage to be used as part of the work to ensure no damage to local ecosystem services. Re-planting of plants and trees undertaken as part of site rehabilitation.	Complaints of sedimentation and tainted water supply are near zero and if they occur are addressed immediately.
7: Involuntary Resettlement	Individuals and land-owner groups are alienated from their land due to the need to balance development with owner rights.	Involuntary resettlement will be avoided where possible. In the event of no workable alternatives, a resettlement plan is developed in cases where land is not currently controlled by government will be acquired for the project.	Grievance mechanisms will show all cases resolved properly. Grievances must be 100% resolved within 3 months. A period for public objection of at least 3 months will be applied to all land acquisitions

Safeguard Requirements	Potential E&S Issues	Prevention and Mitigation	M&E: (what/when/how much/etc.)
		Full compensation will be offered, and the project will ensure landowners are treated fairly and equitably.	
8: Biodiversity Conservation and Sustainable Management of Living Natural Resources	The project causes damage to areas with great biodiversity or resource values.	PEA/EIA/SEIA processes will identify protected areas, and areas of biodiversity or resource significance, avoiding them if possible, or severely limiting impacts.	PEA/EIA/SEIA will show that the project design has avoided areas of significance.
9: Cultural Heritage	The project causes damage to areas of cultural significance. 'Chance finds' of articles of national and cultural significance are damaged or lost.	PEA/EIA/ESIA process will ensure no areas of cultural significance are impacted by the project. This will include public consultations. In the event of any chance finds, the project will immediately inform relevant authorities.	The PEA/EIA/ESIA and grievance mechanisms will show no encroachment on areas of cultural significance. Any chance finds are recorded, along with information on the fate of the materials.

9.5. Preliminary Environmental and Social Management Plan (ESMMP)

The procedures outlined in the ESMMP serve to ensure that potential adverse environmental and social impacts that may result from NEMP sub-projects are identified and appropriate safeguards are prepared prior to implementation. The ESMMP seeks to avoid, minimise, mitigate and, in cases where there are residual impacts, offset or minimize adverse environmental and social impacts. The ESMMP also contains guidance on safeguard instruments that may be triggered by certain activities, such as additional mitigation measures.

There is a range of potential solutions for reaching the electrification targets of NEMP, including solar photovoltaics (PV) with or without storage, with biofuel/diesel backup, small hydroelectric and geothermal systems and waste-to-energy systems. This ESMMP will focus mostly on PV systems. It is expected that the installations will be modular and scalable with demand growth and will allow for other systems to be connected in future. If other kinds of systems, such as hydroelectric power, are proposed, the ESMMP will need to be updated and PEA/EIA/SEIA processes followed.

The following is a summary of the main elements of the ESMMP for the overall NEMP. For some subprojects, these may need to be adapted to specific site conditions.

9.5.1. Environmental Assessments

The respective developer will apply to the Department of Environmental Protection and Conservation (DEPC) with the appropriate fee (VUV 20,000) to seek a Preliminary Environmental Assessment (PEA) from the Director. The application will follow the guidelines referenced in the Environmental Protection and Conservation Act. The Director will determine whether an EIA/SEIA will be required for the overall project or sub-projects, to be accompanied by an ESMMP.

9.5.2. Appointment of ESS Officer and Monthly ESMMP Reports

It is recommended that the DoE work with provincial governments to appoint an ESS Officer who will be responsible for ensuring ESMMPs are properly implemented and reported on for all NEMP projects in the province. This could be a rotational or shared position between provinces. The ESS Officer will coordinate and edit a monthly report on mitigation measures and environmental and social impacts of the project. All grievance submissions will be recorded and resolved transparently. The ESS Officer will report anonymously on all submissions received and their resolution.

A comprehensive ESMMP Report will be delivered at the NEMP project's inception, followed by monthly reports during the project's life. This report will detail the monitoring and evaluation (M&E) for all environmental and social management plan elements. Broadly, the ESMMP Report will quantify the progress of the NEMP and its sub-projects and evaluate adherence to all mitigation measures. A simple 5-star system is suggested where qualitative measures are used, documents are referenced where permissions are needed, and numerical measures are used where possible. An annual ESMMP Report should be produced to summarise progress during each year.

9.5.3. Public Consultations and Information

9.5.3.1. Stakeholder Communications and Action Plan (SECAP)

The ESS Officer will develop a stakeholder engagement and communication action plan for each project. SECAPs will provide details on the consultation's time, location, purpose and expected outcomes. Meeting summaries and attendance records (disaggregated by gender and age) shall be maintained. SECAPs will be made available on the project website and social media.

9.5.3.2. Consultations

The project will consult with traditional and local government representatives, as needed, to ensure uncontested access to sites, identification of any land or cultural-related sensitivities, and provision of local workers.

9.5.3.3. Project Website, Radio, Social Media

As part of public disclosure, the project should set up a website, Facebook page and perhaps radio shows to allow for grievance mechanisms and issue identification. The website should allow for downloading of project documents and reports and include a system for collecting comments about the project and requests for redress. Regular updates on the project's progress will serve to build public interest in the project. A website is also a good place to carry out public awareness programmes in tandem with social media.

9.5.3.4. Gender-based Violence (GbV) and Sexual Exploitation and Harassment (SEAH)

The ESS Officer will: (1) inform communities in all sub-project areas of the behavioural requirements of workers and sub-contractors while working in their area; (2) ensure that all project workers receive an orientation on gender-based violence; and (3) sign a Community Code of Practise which includes sexual abuse, exploitation and harassment provisions. The ESS Officer will also oversee the grievance redress mechanism and ensure it is clearly explained to the community. In the case of school-based projects, the ESS Officer will also meet with school management to discuss SEAH prevention and ensure that an appropriate reporting mechanism is established for students.

9.5.4. Codes of Practice

9.5.4.1. Code of Practice for Waste Management

Codes of practice on disposal of solar panels, batteries, health and safety and land issues developed during VREP should be adopted by NEMP and improved as necessary. The ESMMP Report will document these policies, which will be made available on the project website. Periodic inspections of recycling stockpiles and disposal sites will be carried out by the PCC and NEMP project ESS Officer to ensure policies are being implemented effectively.

9.5.4.2. Code of Practice for Construction, Health & Safety and Land Permission

An overall Code of Practice for the construction phase of NEMP sub-projects will cover all best practices, including ensuring good public information at all sub-project sites through community meetings, media and signage. The Code of Practice will specifically include policies for:

1. Early consultation with traditional and local government representatives, as needed, to ensure uncontested access to sites, identification of any land or cultural-related sensitivities, and provision of local workers. This will include consultations with Chiefs as may be necessary for access to sites and the provision of workers.
2. Providing accurate, user-friendly information about the works to the local population through community meetings, media and other established networks *prior* to any construction.
3. Use of signage and temporary fencing to minimise public risk at construction sites, especially of children.
4. Workers on the project will be made aware of behavioural standards regarding gender-based violence (GbV), including sexual exploitation, abuse, and harassment (SEAH), and have signed a Code of Conduct with GbV provisions.
5. Providing safety training and proper personal protective equipment (PPE) for all workers. To this would be added the VREP Code of Conduct for Health and Safety and Land Permission to form one consolidated Code.

6. Ensuring community members are aware of the SEAH policies that workers and contractors must follow and the Grievance Redress Mechanism (GRM) available to them.
7. Ensuring all construction sites are fully fenced to minimise public risk especially of children.
8. Limiting work to standard work hours unless agreed with a community and avoiding Sundays.
9. Limiting the area of land under excavation at any one time and ensuring proper drainage around work areas and stockpiles.
10. Maintaining all machinery in good condition to limit the risk of spills and work disruptions; Proper storage in bins and for construction wastes in stockpiles, and disposal to approved landfills of all wastes associated with construction.
11. Ensuring proper storage in bins and for construction wastes in stockpiles and disposal to approved landfills of all wastes associated with construction.
12. Provision of portable toilets and wash facilities at each construction site.
13. Spill response kits and proper bunding are used for oil and fuel stores. Oil and fuel drums to be locked in secure areas, and
14. Ensuring 'Chance Find' procedures are in place to protect cultural heritage, requiring any finds of materials of potential archaeological significance are reported to relevant authorities.

9.5.5. Grievance Mechanism

A formal grievance redress mechanism (GRM) will be developed by the ESS Officer. This mechanism will allow people to register complaints on the project website by filling in a form or via a grievance box in the Project Management Office. Grievances can be made anonymously. All grievances will be entered into a database, and the ESS Officer will be responsible for raising concerns with project management and the appropriate authorities to develop acceptable solutions. All grievances will be followed until they are 100% resolved over a period ideally no longer than 3 months.

Given the high prevalence of gender-based violence in Vanuatu, it is essential that the GRM incorporate a specific pathway for addressing complaints concerning sexual exploitation, abuse and harassment (SEAH). A survivor-centred approach will be adopted, and all project workers will be trained in dealing with GbV issues and required to sign a Code of Conduct with GbV provisions.

9.5.6. Memorandum of Understanding (MOUs)

Memorandum of Understanding (MOUs) are used, particularly with communities in non-concession areas, to ensure that all stakeholders agree with the approach to be taken on local sub-projects, laying out responsibilities and arrangements for all aspects of the project.

9.5.6.1. E-waste recycling and disposal

The MOU should include regular check-list inspections of disposal facilities, which will be conveyed with photographs to the ESS Officer for the Project. The officer will, in turn, report on waste management and other aspects of the ESMMP. All MOUs signed will be recorded with their date in the ESMMP Reports.

9.5.6.2. MOU for workers

An agreement is to be signed as a Code of Conduct for all individual workers to ensure they agree to safety training and using PPE in their work where needed. A particular focus will be on behavioural standards regarding gender-based violence (GbV), including Sexual exploitation abuse and harassment (SEAH).

9.5.6.3. Development of e-Waste stockpiles and Recycling

Local landfills and recycling stockpiles will be developed for every island or province as part of the project. These will be in MOUs of each sub-project to ensure e-wastes are appropriately handled throughout the project and beyond.

9.6. Future Solutions to the Waste Problem

9.6.1. Recovery of e-Wastes

When collected in sufficient volume and brought into a material recovery industry, end-of-life electrical and electronic equipment are a useful source of copper, tin and steel, gold, silver and palladium, among others. Cathode ray tube (CRT) glass recovery is also possible. Recycling engineered plastics from electrical and electronic equipment is also technically feasible, especially when plastics are carefully separated by type. Plastic is sometimes not recovered because of brominated flame retardants unless the brominated compounds can be removed or the recovered plastic has continued uses that require flame retardant properties.

Even when solar panels are recycled, recyclers typically remove the frame holding the panel together, strip the copper wiring off the back, and shred the panel, creating a 'solar hash' sold as crushed glass. Those three products — aluminium, copper, and crushed glass — might fetch a recycler $3 per panel. Companies say it costs up to $25 to recycle a panel after decommissioning and transit costs[57]. At least one company has developed technology to recover 100 per cent of the silver, tin, copper, and lead in solar cells; conditions may change in the future.

Even if recycling e-waste is technically feasible but difficult across the world, the challenge for Vanuatu has always been the high cost of freight (even as back freight) and the high dispersion of the country. For now, developing safe, securely controlled stockpiles away from settlements may be the only option until better mechanisms for recycling are available. Initially, the responsibility for safe storage of e-waste will be the responsibility of the Concessionaire, who will work with recyclers when possible to dispose of proper waste. At least for now, the Concessionaires will be required to ensure the community's safety by keeping potentially explosive Li-ion batteries in controlled areas.

The Pacific E-waste management strategy[58] describes an integrated framework to progressively collect, store and dispose of E-waste in the region. It is supported by an action plan with a five-year timeframe for improving regional e-waste management. This should be used as part of the Code of Practice for storing and disposing of e-waste in Vanuatu.

9.6.2. Waste to Energy

Waste-to-energy (WtE) projects are still in the early stages of discussion and feasibility work in the Pacific region. Although they are not directly beneficial for disposing of non-combustible e-wastes or generating power from end-of-life (EOL) renewables, they can limit the amount of land required for all waste storage and may contribute to energy generation.

The Pacific Community's (SPC) Geoscience, Energy and Maritime (GEM) Division has a project in partnership with SPREP on the Pacific Adoption of Waste to Energy Solutions (PAWES)[59]. The project is working with Samoa, Tuvalu, the Republic of Marshall Islands, Solomon Islands and Papua New Guinea to complete their feasibility studies on Waste to Energy (WtE) technology by September 2023. The feasibility study will provide available options, costings, suppliers, the necessary environmental standards, and support for WtE solutions in the countries. Unfortunately, Vanuatu was not included in this study.

9.6.3. Estimation of e-waste generated by the NEMP

This section aims to provide an understanding of the magnitude of e-waste that will be generated during the NEMP's implementation.

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57 https://www.theverge.com/2021/12/29/22857157/solar-recycling-new-better-method

58 Haynes, D. and E. Richards, *Management of e-Waste in the Pacific: A Regional Strategy and Action Plan*. 2011, SPREP. p. 31.

59 https://gem.spc.int/projects/pacific-adoption-of-waste-to-energy-solutions

9.6.3.1. Methodology

The lifespan of the system components is projected under the assumption of proper usage, sufficient maintenance, and effective e-waste management. The calculation focuses solely on mini-grids and standalone systems. Future estimations could include grid extensions and existing grids, but these are not considered in the estimate provided in this section. The breakdown of recyclable valuable metals from PV panels and batteries is also considered. Overall, the e-waste estimation follows three key steps:

- The conversion of capacity (MW) to mass in tons for two types of connections (mini-grid and standalone);
- A high-level estimate of potentially recoverable metals from the amount of end-of-life PV and batteries generated (waste associated with the power is not included in the computation);
- Assumptions of the number of appliances used over a period of 20 years by households and the respective generation of e-waste.

9.6.3.2. Conversion of generation capacity (MW) into e-waste (tons)

The e-waste calculation includes solar PV panels, batteries, battery inverters, and charge controllers. The capacity of the PV panels and batteries is derived from the least-cost analysis. The total battery inverters and charge controllers is estimated based on rules of thumb for simplicity.

The replacements of battery inverters, batteries, and charge controllers are factored into the total computation. A concession with a 20-year period is assumed as base-case, while a 10-year lifespan is considered for standalone systems and mini-grid batteries.

Table 53. Total generation capacity autonomous systems

Type	Components	Capacity (MW)
Mini-grid	PV	14.98
	Battery	28.29
	Battery inverter	4.07
	Charge controller	5.99
Standalone	PV	7.53
	Battery	14.23
	Battery inverter	2.05
	Charge controller	3.01
TOTAL	PV	**22.51**
	Battery	**42.52**
	Battery inverter	**6.12**
	Charge controller	**9.00**

The total capacities for standalone and mini-grid systems are then convereted into tons of waste based on the following conversion factors.

Table 54. E-waste conversion factors

Year	PV (ton/MW)[60]	Battery	Battery inverter (ton/MW)	Charge controller (ton/MW)
2030	60.00	140.00	1.80	1.17

Table 55. Total e-waste generated

Type	Components	E-waste (Tons)
Mini-grid	PV	898.6
	Battery	404.2
	Battery inverter	14.7
	Charge controller	14.0

[60] IRENA and IEA-PVPS (2016), "End-of-Life Management: Solar Photovoltaic Panels," International Renewable Energy Agency and International Energy Agency Photovoltaic Power Systems.

Standalone	PV	452.1
	Battery	203.3
	Battery inverter	7.4
	Charge controller	7.1
TOTAL	PV	**1,351**
	Battery	**607**
	Battery inverter	**22**
	Charge controller	**21**
TOTAL E-WASTE GENERATED		**2,001**

The projected e-waste generated over 20 years from mini-grids and standalone systems, assuming overnight nationwide electrification, is 2,000 tons. This equates to 80 kg of e-waste per household, based on a total of 28,427 households for mini-grid and standalone systems.

9.6.3.3. Computation of recoverable metal waste from solar PV and batteries

Valuable metal wastes can be recycled from solar PV and batteries. The following breakdown provides an approximation of the presence of these materials:

Table 56. Breakdown of valuable metal waste – Solar PV

Components	Weight (kg)
Glass	0.8
Aluminium	0.1
Copper	0.01
Polymers	0.09

Table 57. Breakdown of valuable metal waste – Batteries

Components	Weight (kg)
Lithium	0.0276
Cobalt	0.145
Nickle	0.0586
Manganese	0.0417
Copper	0.0355
Aluminium	0.0526
Iron	0.00575

Based on the total e-waste generated from the solar PV panels and batteries, the following valuable metals could potentially be recovered:

Table 58. Total recoverable metal waste - Solar PV and batteries

Components PV	Weight (tons)
Glass	**1,081**
Aluminium	**135**
Copper	**14**
Polymers	**122**

Components Battery	Weight (tons)
Lithium	**17**
Cobalt	**88**
Nickle	**36**
Manganese	**25**
Copper	**22**
Aluminium	**32**
Iron	**3**

9.6.3.4. Computation of quantity of appliances potentially owned

In addition to the e-waste associated with the power generation assets (be it centralized in the case of a mini-grid or individualized in the case of standalone systems), the NEMP projects will also foster the demand for appliances in off-grid areas. This will result in an additional stream of e-waste that is indirectly generated by the NEMP.

As indicated in the following table, different frequencies of ownership have been assumed for four basic appliances (lights, TV, fan, and fridge).

Table 59. Appliances ownerships hypothesis

	Lights	TV	Fan	Fridge
Average number of items purchased in year 1	**5**	**0.8**	**0.9**	**0.25**
Appliance lifespan (years)	**5**	**10**	**10**	**18**
Estimated number of replacements over 20 years	**5**	**2**	**2**	**1**

The following number of appliances is obtained using the previous ratios for all households covered by the electrification plan (including mini-grid, standalone systems and grid extension).

Table 60. Total forecasted appliances

	Lights	TV	Fan	Fridge
Mini-grid	343 440	27 722	31 170	4 907
Standalone	225 100	19 198	21 462	3 797
Grid-extension	104 140	8580	9 622	1591
TOTAL APPLIANCES	672 680	55 500	62 254	10 295

In addition to the 2,000 tons of e-waste generated directly by the mini-grid and standalone systems generation assets, more than 800,000 appliances are expected to be added to the e-waste generation over the next 20 years.

These computations offer a preliminary estimate of the e-waste likely to be generated over 20 years across Vanuatu due to the NEMP. In addition to the existing waste challenges, Vanuatu must invest in infrastructure, implement data-driven decision-making processes, and increase public awareness of e-waste management to manage the anticipated e-waste effectively.

9.7. Recommendations

To ensure the National Energy Master Plan results in minimal environmental and social impacts, the following general recommendations are proposed as an important part of the NEMP:

9.7.1. Social and Environmental Management

1. Engage an ESS Officer who will have primary responsibility for implementing the Environmental and Social Monitoring & Management Plan (ESMMP) and upholding the E&S-related guiding principles.
2. Ensure preliminary environmental assessments (PEAs) and environmental impact assessment (EIA/SEIAs) for all initiatives under the National Electrification Master Plan incorporate key social issues, including poverty, gender equality and inclusion.
3. Assess the risks of damage to e-waste facilities by natural disasters and climate change and mitigate those risks for each location.

9.7.2. Gender equality, disability and social inclusion (GEDSI)

4. Adopt a human rights (energy justice) approach that results in a pro-poor, gender-responsive and socially inclusive national electrification master plan.
5. Prioritise electrification of essential services to ensure that households/communities without power have improved local services. This includes all elementary and secondary schools, health clinics, area council offices, cooperatives, banks and evacuation centres.
6. Conduct a comprehensive gender equality, disability and social inclusion (GEDSI) assessment of the energy sector in Vanuatu to address the lack of gender-segregated information and analysis in the National Energy Road Map 2016-2030. Without this analysis, there is no assurance that the energy needs and priorities of women and other underrepresented, marginalized or vulnerable groups will be addressed. This is especially important given the strong connection between gender and poverty reduction and the limited representation of women in the energy sector.
7. Recognize the need to consider gender-based violence (GbV) in electrification planning given the important role that lighting plays in keeping women and girls safe in public places and on transport routes.
8. Ensure that women have a strong voice in planning and decision-making processes regarding energy planning and implementation at all levels and that energy interventions are based on a comprehensive understanding of whole community energy needs and aspirations.

9.7.3. Consultations, Communications and Grievance

9. A Stakeholder Engagement and Communication Action Plan (SECAP) should be developed for each activity and approved by the ESS Officer.
10. Inform Vanuatu's communities and improve their knowledge of the relative risks posed by E-waste. This means public awareness campaigns, such as those shown in PacWastePlus's Model Regional Education and Awareness Plan are needed.
11. Incorporate a specific pathway for addressing complaints related to sexual exploitation, abuse and harassment in the Grievance Redress Mechanism and adopt a survivor-centred approach when addressing GbV issues.

9.7.4. Health and Safety

12. Adopt a Community Code of Practice that commits workers to professional behaviour while working at the community level, including not engaging in sexual exploitation, abuse and harassment. This Code will also address child protection issues to ensure children are not exposed to harmful situations.
13. Develop an up-to-date Code of Practice for Health and Safety (from VREP) and enforce it throughout NEMP to minimise emerging health risks to workers in contact with e-waste. This will include personal protective equipment (PPE) and training for workers, as discussed in the PacWastePlus programme.

9.7.5. Waste and Recycling

14. Develop a national E-waste Management Policy to cover the country's NEMP and other e-waste needs. The draft model in SPREP's "Management of e-Waste in the Pacific: A Regional Strategy and Action Plan" may serve as a starting point. This policy will need to include coordination, public awareness, and capacity-building for handling NEMP wastes.
15. As it is unlikely that the economic conditions exist in Vanuatu for the removal and/or recycling of all NEMP wastes, concessionaires will need to set up collection and storage systems to isolate e-waste and protect the public until the materials can be exported for reprocessing. This will be a requirement in every major center, plus at least one waste station for each island close to the

main town center. Therefore it will be necessary to develop best practices on e-waste management for developers/constructors and local actors.

16. Assembling a national inventory of what constitutes e-waste and publishing it on the web, in brochures and other means, along with the best practices for disposal.
17. Prepare a detailed forecast for over 20 years of e-waste generation and establish a methodology for computing the generated e-waste. This will help standardize data collection and monitoring among developers/constructors and local actors.
18. Conduct an audit replicating PacWastePlus's methodology for Data Collection, Monitoring and Reporting (DCMR) framework, focusing on Vanuatu's e-waste and waste disposal facilities. The study on waste disposal facilities should include a proposal for upgrading existing unregulated facilities that align with best practices for e-waste management.
19. In collaboration with the existing working group on Product Stewardship Scheme [61](PSS), consider an advance and recovery fee deposit [62](ARFD) for e-waste in Vanuatu for re-possessing as much e-waste as possible. Best practices from the other fifteen countries involved in the PacWastePlus program, those related to ARFD models, can be adapted and replicated in Vanuatu.

9.7.6. Capacity Building

15. Enhance the capacity of local mechanisms/committees to provide effective management oversight of energy systems, including collecting and reporting usage data and equipment maintenance needs.
16. Design training to raise public awareness and capacity building about e-waste management for the Vanuatu local actors and communities.
17. Develop a strategy to significantly increase the number of qualified solar technicians available to service equipment, especially in rural areas. It will be important to ensure that equal numbers of men and women are trained in this area.
18. In line with the NGEF Operational Manual, the NEMP should give special attention to the capacity-building needs of women by focusing on:
    - Dissemination of knowledge about sustainable energy technologies for access to energy and energy efficiency in households, especially for lighting, cooking and household appliances.
    - Transfer of know-how in using sustainable energy for income-generating activities, including agriculture, handicrafts, tourism, and other services, financial literacy, modern payment systems, and access to finance.

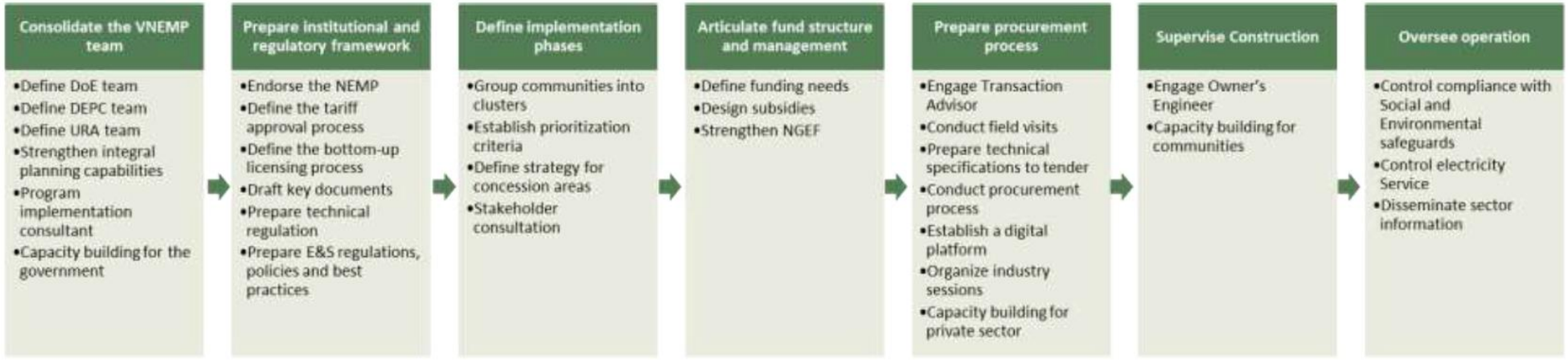
61 https://pacwasteplus.org/wp-content/uploads/2023/08/PWP-MTE-Vanuatu-brief.pdf
62 https://pacwasteplus.org/regional-project/advance-recovery-fees-and-deposits/

10. Implementation action plan

This last chapter provides a roadmap for the Vanuatu's National Electrification Master Plan. It builds on the previous chapters' recommendations and organizes them chronologically to facilitate their implementation.

The flowchart in Figure 40 summarizes the implementation actions involved. Each point is discussed further in the sections that follow.

Figure 40. Implementation action plan flowchart.



10.1. Consolidate the NEMP team

10.1.1. Define DoE team

- **Strengthen the off-grid team**. The Department of Energy (DoE) shall increase its human resources and technical assistance specifically dedicated to implementing the NEMP.
- **Secure budget for fieldwork**. The implementation of the NEMP will require extensive travelling across the country. These needs shall be anticipated and budgeted accordingly.
- **Other resources.** In addition to human resources and budget for field work, DoE will require:
    - Equipment: Personal protective equipment (PPE), data collection devices, etc.
    - Software: Design tools (e.g. AutoCAD or HOMER Pro), GIS tools (e.g. VIDA license), etc.

10.1.2. Define DEPC team

- **DEPC to hire an ESS Officer**. The Department of Environmental Protection and Conservation (DEPC) shall engage an ESS Officer who will have primary responsibility for implementing the Environmental and Social Monitoring & Management Plan (ESMMP) and upholding the E&S-related guiding principles. The ESS Officer will also be involved in coordinating the preparation of (through external support):
    - Stakeholder Engagement and Communication Action Plan (SECAP) .
    - Grievance Redress Mechanism.
    - Community Code of Practice.
    - Code of Practice for Health and Safety.
    - National E-waste Management Policy to cover the country's NEMP and other e-waste needs.

10.1.3. Define URA team

- **URA to identify a focal point for NEMP**. The Utilities Regulatory Authority (URA) shall identify a focal point who will be responsible for coordinating:
    - the development of appropriate regulations for off-grid projects,
    - granting licenses and concessions, and later
    - overseeing the operation of the future service areas.

10.1.4. Strengthen integral planning capabilities

- **Promote the Vanuatu Joint Energy Sector Working Group**. This Working Group shall work towards:
    - Providing the **overall vision** for implementing the NEMP
    - Coordinating international support around the NEMP
    - Avoiding duplication, addressing gaps, facilitating requests
    - Combining efforts to achieve more than the sum of the parts
- **Promote inter-ministerial coordination**.
    - Coordinate Government of Vanuatu support for rural development across the country
    - Facilitated by an independent secretariat
    - An essential aspect of promoting **a meaningful positive impact on rural communities** to be electrified
- **Consolidate integrated planning tool**. The VIDA tool shall be used as a unified platform integrating planning information from different departments to help make informed decisions.

10.1.5. Program Implementation Consultant

- **DoE to engage a Program Implementation Consultant**. An external specialised firm shall provide overall program management support and coordination to the DoE.

  - The consultant will work with other stakeholders, including the URA, DEPC, and the Joint Energy Sector Working Group
  - It will provide technical advice and ensure timely completion of the action points
  - It may facilitate the engagement of other support, including capacity building.

10.1.6. Capacity building for government

- **Capacity building for DoE, URA, and DEPC**.
  - For these three key stakeholders to be ready, a strong component for capacity building shall be envisioned.
  - This can be integrated and delivered within the scope of the Program Implementation Consultant, which can offer on-the-job and dedicated training.
  - Aspects may include project management, technical planning, procurement, contract negotiations, financing, pricing, monitoring & evaluation.

10.2. Prepare institutional and regulatory framework

10.2.1. Endorse the Vanuatu National Electrification Master Plan

- **Update the NEMP with the government format**.
  - Remove the Consultant's format from this document and use the DoE corporate format
  - Remove references to the consultant, the assignment, and the process, leaving only the sections relevant to implementation.
- **Undertake formal approval of the document.** Approve the document through the official Government process.
- **Establish a program to implement the NEMP**.
  - Adopt a name for the program to strengthen its entity
  - Give the implementation team ownership and autonomy
- **Disseminate the NEMP**.
  - Engage key stakeholders directly, including the Government, private sector, NGO, and development partners.
  - Distribute across Vanuatu.
  - Through the web and social media.

10.2.2. Define the tariff approval process

- **Establish the tariff approval process for the top-down site procurement**.
  - Competitive bidding.
  - Reviewed by URA after three years.
- **Establish the tariff approval process for bottom-up site procurement**.
  - Willing buyer – willing seller
  - Right of appeal to URA
- **Approval process overseen by DoE and URA**
  - Standardise the tariff methodology, aligned with current URA practices for existing concessions
  - Standardise the tariff model to facilitate analysis and comparison.
  - Benchmark prices to guide assessment.

10.2.3. Define the bottom-up licensing process

- **Design process.** A 'light-handed' approach can be used for smaller systems. The differentiation criteria should be based on the voltage level (lighter approaches only for projects using low-voltage or extra-low-voltage projects). The process must sit alongside the top-down process and shall define the application period (bottom-up site identification shall not be possible once that area is defined for top-down procurement).

10.2.4. Draft key documents

- **Draft contract models.** Three contract models shall be drafted:
    - Concession/License: To be signed between the electricity supplier and the DoE. Some terms of the concession contracts for top-down procurement might be negotiable. Fewer license terms should be open to negotiation. The future contracts should include specific clauses to integrate e-waste responsibilities for the future electricity suppliers (even if these are just to offer a safe place for e-waste stockpiling).
    - Community Agreement: To be signed between the electricity supplier and the community. It shall be standardized. Ideally, it should consider the possibility of having prosumers. The service categorization shall be based on the recommendations in sections 8.3.3, 8.3.4 and 8.3.5.
    - Customer supply contract: To be signed between the electricity supplier and the customer. The service categorization shall be based on the recommendations in sections 8.3.3, 8.3.4 and 8.3.5.

  As much of the application process as possible should be online with digital application forms

10.2.5. Prepare technical regulation

- **Define electricity access**. The NERM-IP recommends adding the definition of electrification in a revised version of the NERM. The DoE shall consider the recommendations provided in this report.
- **Define electrification service**. To facilitate the adoption of Energy as a Service (EaaS) models, the technical regulation shall contemplate two approaches for Electricity suppliers to electrify a customer:
    - Electricity Service (Business as usual approach): Electricity is provided to the user at a certain Connection Point, usually the customer's meter. The service is typically charged by the energy units sold to the user.
    - End-use Service: The Electricity supplier includes appliances, indoor wiring and/or PUE equipment as part of the service. A fixed subscription charge is typically associated with the number of appliances and availability.
- **Define wiring and safety standards for off-grid projects**. Adopt the *AS/NZS 3000:2018, Electrical installations*.
- **Define interconnection compatibility**. Expand the technical requirements for projects in terms of compatibility based on the Interconnection Readiness Levels (IRL).
- **Establish monitoring requirements**. The URA shall detail the reporting requirements for future Electricity suppliers based on this report's recommendations. An initial list of potential indicators is included in the annexes.

10.2.6. Prepare E&S regulations, policies, and best practices

- **Preliminary environmental assessments (PEAs)**. Ensure PEAs and environmental impact assessments (EIAs) are prepared for all initiatives under the National Electrification Master Plan and incorporate key social issues, including poverty, gender equality, and inclusion.
- **Mitigate for natural disasters.** Require systems capable of withstanding Earthquake ML 7 and Cyclone Cat 5.
- **Conduct a comprehensive gender equality, disability, and social inclusion (GEDSI) assessment** of the energy sector in Vanuatu to address the lack of gender-segregated information and analysis in the National Energy Road Map 2016-2030. Without this analysis, there is no assurance that the energy needs and priorities of women and other underrepresented, marginalized, or vulnerable groups will be addressed.
- **Recognize the need to consider gender-based violence (GbV)** in electrification planning, given the important role that lighting plays in keeping women and girls safe in public places and on transport routes.

- **Prepare best practice guidelines** for the site selection process, community engagement, and e-waste management.
- **Codes of Practice** – to allow for quick start – waste and safety
- **MOUs**: On e-waste recycling and disposal, for workers, stockpiles and recycling
- **Prepare policies and best practice guidelines** for the site selection process, community engagement, and e-waste management (Is stockpiling until recycling possible? Is a buy-back scheme possible?).

10.3. Define implementation phases

10.3.1. Group communities into clusters

- **Establish the Area Councils (municipalities) as Service Areas**. The NEMP requires defining geographical areas where the future Electricity supplier will operate. Vanuatu's Area Councils (or municipalities) shall be used as the standard boundaries for future Service Areas established under a top-down approach. This municipal perspective aligns with the development strategy presented in the NERM-IP.
- **Define clusters of area councils with a balanced scale (not too big, not too small).** Economies of scale can help reduce future electricity tariffs, thus benefiting customers in remote areas. On the other hand, developments that are too big can be technically complex to manage and can discourage participation from developers due to the risks involved and the high financial requirements. Furthermore, very large developments tend to favour international partners and limit participation by local Vanuatu companies. Multiple area councils shall be grouped into clusters in a way that promotes: (i) reaching economies of scale, (ii) manageable project portfolios (technically and financially), and (iii) participation of local companies.
- **Define how to integrate existing mini-grids**. The definition of Service Areas will require dealing with communities that have already been electrified (e.g. communities in south Malekula benefiting from the VREP project, Loltong, Wintua, etc). It shall be defined how to accommodate these communities within the proposed Service Areas. Similarly, there will be a need to define how the communities electrified through unsolicited projects are coordinated smoothly with the surrounding service areas planned following a top-down approach.

10.3.2. Establish the prioritization criteria

- **Define a seamless integration of top-down and bottom-up electrification planning approaches.** The NEMP shall offer a top-down structured strategy to connect the country's unelectrified households, businesses, and institutions. In parallel, unsolicited project proposals shall be accommodated for those communities that decide to develop a project independently (cooperative model) or in collaboration with a private sector developer. A community shall be allowed to develop its own electrification project, but if it does not succeed or does not have the interest or capacity to do it, there shall be an alternative top-down strategy from the government to electrify it.
- **Define the prioritization criteria.** The Vanuatu NERM-IP establishes a set of revised prioritization criteria that can be used as a basis for this exercise.
- **Equity across regions.** The prioritization criteria might want to consider a balanced development across the country. In this regard, ensuring a parallel implementation of projects in the six provinces might be a good strategy to decentralize the regional benefits. This provincial approach aligns with the NERM-IP.
- **Phased approach.** The NEMP implementation shall be planned in phases. Tendering out all the projects simultaneously would benefit reaching very large economies of scale but would not be technically or financially bearable. A phased approach facilitates a progressive strengthening of the local private sector and thus increases the local impact of the electrification program. Furthermore, a phased approach allows building on the experience of the previous phases, improving the process successively in each phase.

10.3.3. Define strategy for concession areas

- **Engage concessionnaires**. Engage the existing concessionnaires (UNELCO, VanPawa, VUI).
- **Define network expansion plans to fully electrify the existing concessions.** With the existing concessionaires, define the plans to expand electricity service within the concession boundaries.
- **Plan additional generation capacity**. Assess the additional generation capacity to satisfy the increased demand in the existing networks due to their extension.

10.3.4. Stakeholder consultation

- **Stakeholder Engagement and Communications and Action Plan (SECAP).** Including project Website, Radio, Social Media. Consultations. Grievance mechanism
- **Engage provincial governments.** Consult the provincial governments and share the proposed implementation phases to promote decentralization and ownership at the provincial level. The exercise can be presented as a continuation or an update of the consultation process and resulting provincial Sustainable Energy Action Plans conducted under the NERM-IP.
- **Engage other government departments.** Consult other government entities, including those in charge of water, telecommunications, agriculture, cooperatives, education, fisheries, health, industry, tourism, women, and statistics. Promote an inter-ministerial integrative planning approach.
- **Engage entities with a presence in off-grid areas:** NGOs, microfinance organizations, religious organizations, etc.

10.4. Articulate fund structure and management model

10.4.1. Define funding needs

- **Define sources of funding.** Include both customer contributions and external funding sources (from government and development partners).
- **Assess funding requirements.** Define the commercial funding and viability gap for each phase.

10.4.2. Design Subsidies

- **Design subsidies.** Shall contemplate:
    - Project development subsidies:
        - Capital subsidies to address the viability gap.
        - Results-based financing by connection type, against milestones.
        - Limited pre-financing to support cash flow.
    - Rural development support subsidies. To stimulate demand and support
        - Productive use of energy.
        - Healthcare, education, and other social services.
    - Pre-investment support subsidies:
        - Program Implementation Consultant.
        - Supporting frameworks.
        - Capacity building.

10.4.3. Strengthen NGEF

- **Define roles and responsibilities**.
    - Formalize responsibility within the NEMP
    - Agree on funding sources and potential disbursements
- **Define governance and accountability.**
    - Align with international best practices

  - Consult with potential funding partners
- **Capacity building for NGEF**.
  - Capacity should align with the scale of support NGEF will provide
  - Financial management, project development, M&E

10.5. Prepare procurement process

10.5.1. Engage Transaction Advisor

- **Secure technical assistance**. The government shall seek external support to ensure a smooth procurement process. The technical support should cover technical, legal, economic, social, and environmental expertise. The support in these different areas can be either outsourced individually or as an integrated consultancy assignment. Alternatively, this can also be integrated into the scope of the Program Implementation Consultant.

10.5.2. Conduct field visits

- **Plan fieldwork**. Field visits to the targeted communities are essential to ensure a successful procurement process. The government and its respective advisors are in the best position to characterize each Area Council's situation and needs in detail (as opposed to the future bidders, who will have limited time and resources to prepare their bids). This will reduce the due diligence and preparatory costs of the future bidders and will, therefore, result in better proposals and prices that are more competitive. The fieldwork shall be done in alignment with the established phases.
- **Characterize demand**. Assess the energy needs of the communities, identifying major anchor loads and potential growth.
- **Identify productive uses of energy**. Map the presence (or potential for development) of energy-intensive activities (commerce, industry, agriculture, or tourism).
- **Map existing social services**. Identify and characterize existing and planned social service facilities such as schools or health centers.
- **Promote a multi-sector approach**. During the field visits, the focus shall go beyond the electricity needs and characterize the potential synergies with other public infrastructures, such as water and telecommunications.
- **Assess affordability.** During field visits, basic socioeconomic indicators, including customer willingness and ability to pay, shall be gathered, which will inform later decisions related to tariffs in each specific region. It is essential to characterize the existing energy expenditures (how much they spend now on fuel for gensets, candles, etc.).
- **Identify local capabilities**. Assess the presence of local governance structures such as cooperatives, religious missions or any sort of organized entity that can potentially play a role in the electrification process (e.g. support the operation of the assets). It will also be relevant to identify if there is any person in the village with technical skills.
- **Social and Environmental safeguards**. Conduct a social and environmental screening of the communities, identifying major risks and appropriate mitigation measures.
- **Undertake GIS mapping**. To the extent possible, the data collected shall be in a geospatial format and later integrated into the VIDA platform.

10.5.3. Prepare technical specifications to tender

- **Use output-based requirements.** The technical specifications shall be output-based. Hence, the effort shall not be on providing the final sizing of the future facilities (though it can be given as a reference) but on characterizing the local context in detail so that bidders can make informed decisions.
- **Use technology-agnostic requirements.** The technical specifications shall be output-based, specifying the service requirements but not the technologies to facilitate them, which shall be the decision of the future bidders. The specifications shall allow seamless integration of:

  - **Collective Electrification Systems (CES).** CES provide service to multiple users using a single or multiple energy resource points. Examples of CES include mini-grids, swarm grids, solar kiosks, or battery-swapping facilities.
  - **Individual Electrification Systems (IES)**. IES provide service to one single user. Examples include solar home systems or solar kits.
  - **Single-Appliance Electrification Systems (SAES)**. SAES provide an End-use Service to single or multiple users through a single type of appliance. They are an end-use system with embedded generation. Examples include solar pumps.
- **Map public services and PUE.** The specifications shall map and characterize existing and planned energy uses for public services (health, education, religious centers, etc) and for productive uses. This information is essential to assess the viability of the projects by the future bidders. Electricity suppliers should be incentivized to offer end-use services beyond the electricity provision (e.g. cold storage, water pump for irrigation, food processing equipment, etc). The tender shall incorporate weighted evaluation criteria, offering extra points to bidders who incorporate these services.
- **Integrate indoor wiring.** Service, lines, meters, and indoor wiring for households shall be incorporated as part of the intervention. This is essential to ensure safe installations in the context of communities using traditional construction methods.
- **Support the integration of appliances**. Bidders should be encouraged to incorporate appliances as end-use services in the Service Areas. The benefits of incorporating include:
  - Facilitate access to electrical equipment, which might be challenging in remote locations because of a lack of financial means or simply because they are unavailable in the local market.
  - Promote the use of quality-certified and energy-efficient appliances.
  - Incentivize circular economy. The Electricity supplier can oversee the waste management of the appliances at the end of their life cycle.
- **Promote a holistic service approach.** Where feasibile, bundle energy supply with other services, such as water, telecommunications or local electric mobility. This can make the business case more attractive for Electricity suppliers and help address community cross-cutting issues (health, education, communications, transportation, etc.).

10.5.4. Conduct procurement process

- **Prepare tender documents**. Prepare the tender documents incorporating the technical specifications and all the administrative requirements, including the qualification and evaluation criteria (preferably weighted criteria as opposed to the traditional pass/fail technical evaluation followed by a financial evaluation on the basis of least cost), documentation requirements, etc.
- **Implement the procurement process in stages**. Given the complexity of the tenders, it is recommended to conduct procurement processes with more than one stage, so that only strongly qualified and informed bidders are invited to prepare detailed proposals.
- **Evaluate proposals**. Evaluate proposals received.
- **Negotiate contracts**. Negotiate contracts with the preferred bidders.
- **Evaluate the process**. Assess what worked and what didn't, compile feedback from the private sector and other stakeholders and adjust the documents for the following Phase.

10.5.5. Establish a digital platform

- **Design and implement a digital platform.** DoE shall establish a platform to digitize the entire application procedure, thus facilitating the application from Developers, but also their processing by DoE and other related government entities (such as URA or DEPC). The same platform should facilitate Electricity suppliers reporting their KPIs in a convenient way so that they can easily submit the information and the government can process it. Furthermore, this platform shall be used for market information dissemination. In the early stages of market development, access to information is essential. The sector can greatly benefit from the country's initial experiences, which can help expedite the sector's development.

10.5.6. Organize industry sessions

- **Organize informative sessions with the private sector**. The government shall diseminate the long-term vision and the implementation details. This will allow the private sector (both local and international) to anticipate business opportunities and prepare for them under a long-term plan, giving stability and predictability to the sector. The sessions shall also be used to gather feedback, suggestions, and concerns from the private sector. This information is essential to maximize participation in the tenders.

10.5.7. Capacity building for the private sector

- **Offer training for the local private sector.** Building local capacity is essential to fostering the development of the off-grid sector. The government should offer training to local firms' staff so that private firms do not bear all the costs of capacity building.
- **Engage universities and vocational training schools.** In the medium term, the country will require skilled personnel to operate the future systems. Engaging educational centers is important to ensure the availability of skilled labour in the future. Develop a strategy to significantly increase the number of qualified solar technicians available to service equipment, especially in rural areas. It will be important to ensure that equal numbers of men and women are trained in this area.

10.6. Supervise construction

10.6.1. Engage owner's engineer

- **Engage an Owner's Engineer.** The Owner's engineer shall supervise the construction activities on behalf of the government. This work can be sourced independently or included in the scope of the Program Implementation Consultant.

10.6.2. Capacity building for communities

- **Offer capacity building to the beneficiary communities**. Communities shall be trained in:
    - Energy efficiency and use of appliances. Information campaigns like "Turn off your lights" and learning about energy efficiency ratings to purchase the most efficient low-running-cost appliances
    - Transfer of know-how in using sustainable energy for income-generating activities, including agriculture, handicrafts, tourism, and other services, financial literacy, modern payment systems, and access to finance.
    - Health and Safety. Electrical risks, etc.
    - Social safeguard: Grievance mechanisms, etc.

10.7. Oversee operation

10.7.1. Control compliance with Social and Environmental Safeguards

- **Pre-construction (due to Design):** PEA/EIA, Resettlement, land use, natural hazards, plan for wastes.
- **Construction Phase:** EMMP, monitoring, air, soil, noise, erosion/sedimentation, disruptions to roads and services, wastes, spills, biodiversity, resources, e-waste, prevention of SEAH.
- **Operations Phase (ongoing use of facilities):** EMMP, monitoring, security, aesthetics, fuel use, spills, run-off minimization, cyclone/earthquake/tsunami damage, maintenance, disposal/recycling of e-waste (including HH white goods and electronics enabled by the project), hazardous materials.

10.7.2. Control electricity service

- **KPI (for DoE and URA).** Collect data on Service Quality and Power Quality. The Indicators to be collected should facilitate integration with the Monitoring Reporting and Verification (MRV) Plan from the NERM-IP. It is noted that the NERM-IP developed an MRV tool.

10.7.3. Disseminate sector information

- **Share information**. Key information that shall be disseminated will include but not be limited to:
    - **# applications**. Number of applications received by the regulator. This will help see the volume and speed of the market's development.
    - **Tariff benchmarking**. The experience built by early players will greatly help communities reach competitive tariffs in the agreements with developers and help developers understand the market.
    - **Main issues in the sector.** Information on the main challenges overcome by early players will help the sector to react accordingly and implement preventive measures.
    - **New developments.** Case studies or new technologies seen in Vanuatu or regionally, policy or regulatory changes, etc.
    - **Publications.** This market information would allow stakeholders to identify market trends. The information can be compiled, edited, and published periodically by the regulator, for instance, through publicly available quarterly bulletins.

ANNEX 1: Mini-grid shortlist

Introduction

At the request of the Department of Energy, the Consultant prepared this Annex, which lists the stronger project site candidates for the development of mini-grids according to the results of the least-cost electrification analysis. The list contains all the mini-grid sites identified in the VIDA platform with a high certainty level and a number of connections above 50.

This Annex provides the mini-grid candidate sites by province, first showing their location on a map and then providing the main parameters of the proposed mini-grid on a table.

Important note about the use of this shortlist

The consultant strongly discourages DoE from using the list provided in this annexe in isolation from the rest of the recommendations provided in the Master Plan. Among many other aspects, the master plan recommends the development of projects following the boundaries of area councils using technology-agnostic tenders. While DoE might be tempted to use this list to prioritize the first projects to implement using mini-grids, as they are probably going to be most cost-effective, it must be noted that this approach entails some drawbacks, as summarized in the following table.

Table 61. Advantages and disadvantages of planning the VNEMP based on the best mini-grid candidate locations (as provided in this annex) or using area councils as proposed in the Master Plan.

	Develop projects prioritizing the list of best candidates for mini-grids *[business-as-usual approach]*	Develop projects following a structured and phased approach using area councils *[approach proposed for VNEMP]*
PROS (+)	• **Low-hanging fruits.** The mini-grids presented in this annexed are the most financially attractive, so they are probably the most viable electrification projects to implement in the country. • **Highest short-term impact**. As these are the financially most attractive projects, their implementation first would ensure that the highest impact is reached in the short term with a cost-effective approach. • **Attractive to donors**. Given the two advantages above, the projects identified in this list are probably the sites that attract the highest interest from development partners or the private sector.	• **Economies of scale**. The use of entire area councils, as opposed to single communities that could potentially be electrified by a mini-grid, offers the operator a larger geographical area to service. Consequently, it allows for reaching a scale that justifies having staff locally, facilitates O&M tasks and logistics, etc. This ultimately benefits customers as tariffs can be more competitive and the service better managed. • **Only possible approach to ensure universal access**. Using a planning approach by area councils ensures that the entire country can be electrified (reach universal electrification, which is the objective of the VNEMP) in the long term, leaving no one behind, as the entire country's geography will be covered. • **Truly least-cost electrification**. Using technology-agnostic tenders, the operator is allowed to choose the most cost-effective technology (solar kiosks, standalone, swarm-grids, DC or AC mini-grids, etc.) to electrify every customer, offering the most competitive tariffs and thus facilitating affordability. • **Limits ad-hoc developments**. Once the area councils to be electrified are defined by phases, the country's vision is clearly stated, which facilitates donors and the private sector aligning their interventions to it, thus reducing ad-hoc developments (reportedly one of the issues DoE faces today). • **Alignment with Vanuatu's administrative divisions.** Structuring the implementation in area councils facilitates the definition of concessions aligning with the country's administrative divisions. That can facilitate coordination with the local governments.

	Develop projects prioritizing the list of best candidates for mini-grids *[business-as-usual approach]*	Develop projects following a structured and phased approach using area councils *[approach proposed for VNEMP]*
CONS (-)	• **Limited geographical coverage.** Not all area councils have high-priority mini-grids, so some would be excluded from this approach. Furthermore, developing a mini-grid does not offer a solution for all the population within the area council, so some populations (typically the most remote) would again be excluded from this approach. • **Technology restrictive.** Using the list of best candidate locations in this annexe will presumably lead to tenders narrowing the technical solution to mini-grids. This does not facilitate the incorporation of other technologies wich can be more cost-effective and can offer equal quality of service. • **Hindering the viability of remote locations.** If the country were to develop the best mini-grid candidate locations first, that would leave the less commercially attractive populations for the end, thus jeopardizing their viability. • **Limited potential for economies of scale.** Developing projects in selected spots of different area councils do not allow the future operator to gain the full benefits of economies of scale. Even if the same entity operates multiple sites, if they are not in the same area, that does not facilitate the operation and maintenance tasks. This eventually would result in higher costs (and therefore tariffs).	• **Need for planning**. Structuring the implementation of the VNEMP based on area councils requires strong planning and long-term vision. • **Political will**. Defining the area councils to be included in each phase of the VNEMP entails a difficult political decision that generally tends to slow down the selection process. It must be noted, though, that selecting any project, be it using area councils or using the best mini-grid candidates, requires prioritization, which needs difficult political decisions anyway.

Malampa

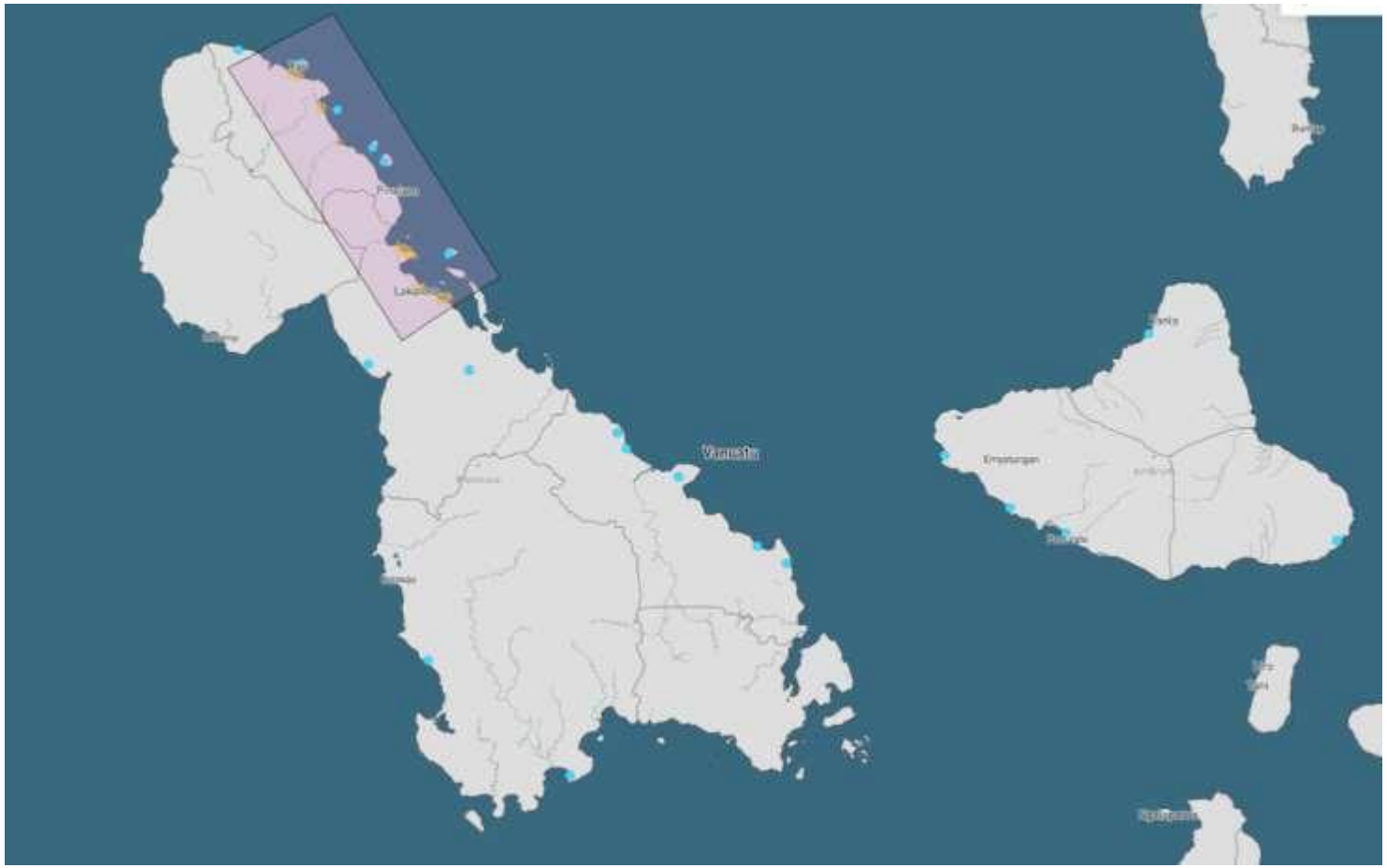


Figure 41. Location of shortlisted mini-grids in Malampa

Table 62. Main parameters of shortlisted mini-grids in Malampa

Settlement name	Province	Telecommunication towers	Health care facilities (total)	Primary schools	Secondary schools	Education facilities (unknown type)	Within concession?	Has NGEF standalone?	Total connections	Basic distribution layout length [km]	Total demand [kWh/day]	Average demand per connection [kWh/day]	Battery size (kWh)	PV size (kWp)	Investment required - Low - (USD) [USD]	Investment required - High - (USD) [USD]	Average cost per connection [USD]
Penapo (#672)	Malampa	0	1	1	-	-	no	no	117	3.5	130	1.1	154	82	449,827	564,024	4,333
Ranon (#746)	Malampa	1	-	1	1	-	no	no	118	2.7	191	1.6	227	120	547,565	685,797	5,226
Sésivi (#797)	Malampa	0	-	1	1	-	no	yes	93	2.1	114	1.2	135	71	364,136	456,206	4,410
Lolonwei (#798)	Malampa	0	1	-	-	2	no	no	102	2.4	120	1.2	143	76	389,199	487,660	4,298
Craig Cove (Fali) (#829)	Malampa	0	-	2	-	-	no	yes	101	2.6	115	1.1	137	72	386,303	484,160	4,309
Settlement #847	Malampa	0	1	1	-	-	no	no	93	3.2	104	1.1	124	66	378,346	474,492	4,585
Settlement #848	Malampa	0	1	-	-	-	no	no	91	2.1	105	1.1	124	66	346,363	433,981	4,288
Settlement #882	Malampa	0	1	1	-	-	no	yes	102	1.1	112	1.1	134	71	336,859	421,599	3,718
Settlement #895	Malampa	0	1	-	-	-	no	no	95	2.6	103	1.1	123	65	359,823	451,034	4,268
Settlement #901	Malampa	0	1	1	-	-	no	no	110	3.6	128	1.1	152	81	444,220	557,033	4,551
Settlement #907	Malampa	0	-	-	-	-	no	no	104	3.3	112	1.1	134	71	402,526	504,758	4,362
Matanvat SDA Station, Matanvat Village (#2099)	Malampa	0	1	1	-	-	no	no	91	3.1	102	1.1	122	64	372,455	467,107	4,613
Vao (#2135)	Malampa	0	2	1	-	-	yes	no	179	5.0	201	1.1	239	126	670,380	840,444	4,220
Tautu (#2171)	Malampa	0	2	1	-	1	yes	yes	112	2.5	132	1.1	157	83	419,812	525,984	4,222
Settlement #2182	Malampa	0	1	1	-	-	no	no	104	3.2	114	1.1	136	72	403,797	506,311	4,376
Larevet (#2193)	Malampa	1	-	-	-	-	no	no	101	1.9	161	1.6	191	101	458,859	574,523	5,116

Settlement name	Province	Telecommunication towers	Health care facilities (total)	Primary schools	Secondary schools	Education facilities (unknown type)	Within concession?	Has NGEF standalone?	Total connections	Basic distribution layout length [km]	Total demand [kWh/day]	Average demand per connection [kWh/day]	Battery size (kWh)	PV size (kWp)	Investment required - Low - (USD) [USD]	Investment required - High - (USD) [USD]	Average cost per connection [USD]
Lawa (#2212)	Malampa	0	1	1	-	-	no	no	123	2.8	135	1.1	161	85	441,617	553,396	4,045
Atchin (#2131)	Malampa	0	1	3	-	-	yes	no	136	3.8	156	1.1	185	98	90,072	116,045	758
Rano (#2136)	Malampa	0	-	-	-	-	yes	no	81	2.5	88	1.1	105	55	58,189	76,384	831
Serser Village (#2138)	Malampa	0	1	-	-	-	yes	no	70	1.9	77	1.1	91	48	55,971	75,105	936

Penama

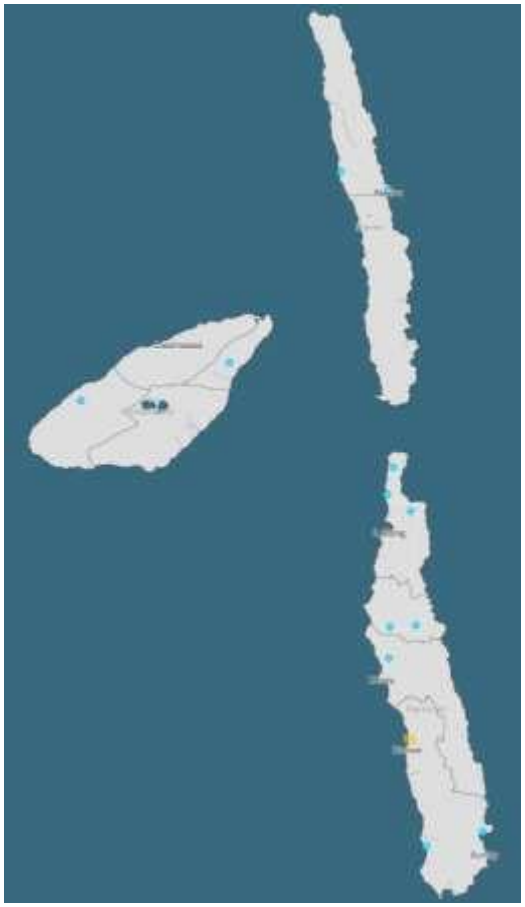


Figure 42. Location of shortlisted mini-grids in Penama

Table 63. Main parameters of shortlisted mini-grids in Penama

Settlement name	Province	Telecommunication towers	Health care facilities (total)	Primary schools	Secondary schools	Education facilities (unknown type)	Within concession?	Has NGEF standalone?	Total connections	Basic distribution layout length [km]	Total demand [kWh/day]	Average demand per connection [kWh/day]	Battery size (kWh)	PV size (kWp)	Investment required - Low - (USD) [USD]	Investment required - High - (USD) [USD]	Average cost per connection [USD]
Abwatuntora (#1209)	Penama	0	2	1	-	2	no	no	142	4.8	167	1.2	199	105	578,888	725,950	4,595
Atabulu (#1059)	Penama	1	3	2	1	3	no	yes	397	15.0	499	1.3	593	314	1,659,725	2,077,073	4,706
Hubiku (#1126)	Penama	0	2	2	-	2	no	no	263	13.4	294	1.1	350	185	1,139,240	1,430,661	4,886
Naviso (#1058)	Penama	0	1	1	-	-	no	no	111	2.9	129	1.1	153	81	426,599	534,675	4,330
Lolsarivuana (#1064)	Penama	0	1	2	1	3	no	no	236	9.9	280	1.2	333	176	994,988	1,248,641	4,753
Ena (#1130)	Penama	2	1	-	1	3	no	yes	186	9.0	325	1.5	387	205	1,029,962	1,284,414	6,242
Ena (#1131)	Penama	1	2	2	-	-	no	no	217	9.9	296	1.3	352	186	1,011,791	1,269,640	5,257
Ranon (#693)	Penama	0	1	1	-	1	no	yes	87	1.8	103	1.2	123	65	331,413	415,132	4,290
Pangi (#723)	Penama	0	1	-	1	1	no	yes	84	2.9	108	1.9	128	68	371,914	466,323	4,990
Natalu (#724)	Penama	1	4	3	1	6	no	no	320	22.9	432	1.3	513	272	1,717,329	2,150,525	6,055
Lolomatui (#1113)	Penama	0	1	-	1	-	no	no	147	7.2	172	1.2	204	108	663,651	833,126	5,091
Ngwatiakwoli (#1063)	Penama	0	1	1	1	1	no	yes	170	5.8	203	1.3	241	128	690,668	866,170	4,579

Sanma

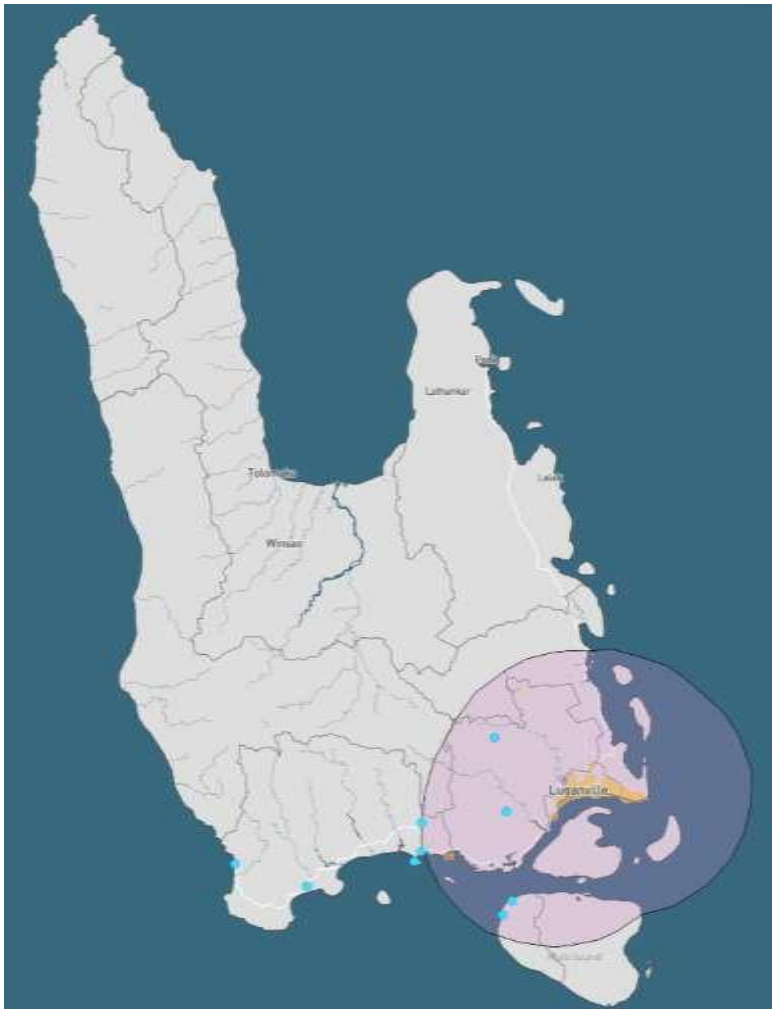


Figure 43. Location of shortlisted mini-grids in Sanma

Table 64. Main parameters of shortlisted mini-grids in Sanma

Settlement name	Province	Telecommunication towers	Health care facilities (total)	Primary schools	Secondary schools	Education facilities (unknown type)	Within concession?	Has NGEF standalone?	Total connections	Basic distribution layout length [km]	Total demand [kWh/day]	Average demand per connection [kWh/day]	Battery size (kWh)	PV size (kWp)	Investment required - Low - (USD) [USD]	Investment required - High - (USD) [USD]	Average cost per connection [USD]
Tasiriki (#1501)	Sanma	0	1	-	1	1	no	no	98	1.9	123	1.3	146	77	375,600	470,407	4,316
Ipayato (#1523)	Sanma	0	1	1	-	-	no	yes	152	4.0	168	1.1	200	106	563,822	706,726	4,179
Venabisu (#1584)	Sanma	0	1	-	-	-	no	no	97	1.6	105	1.1	125	66	335,114	419,660	3,891
Venabisu (#1586)	Sanma	0	1	1	1	1	yes	no	113	3.9	142	1.2	169	90	480,775	602,880	4,795
Narango (#1588)	Sanma	0	-	1	-	-	yes	no	103	2.4	114	1.1	136	72	380,173	476,401	4,158
Mavunlevu (#1963)	Sanma	0	-	1	-	-	yes	no	89	2.9	101	1.1	120	64	361,326	453,061	4,575
Nambauk (#1997)	Sanma	0	-	1	-	-	yes	no	97	0.9	109	1.1	129	68	321,701	402,564	3,733
Settlement #2012	Sanma	0	-	1	-	1	yes	yes	104	3.8	118	1.1	140	74	427,256	535,921	4,631
Settlement #2033	Sanma	0	1	1	-	1	yes	no	179	6.5	206	1.2	245	130	722,056	905,751	4,547

Shefa

Figure 44. Location of shortlisted mini-grids in Shefa.

Table 65. Main parameters of shortlisted mini-grids in Shefa

Settlement name	Province	Telecommunication towers	Healthcare facilities (total)	Primary schools	Secondary schools	Education facilities (unknown type)	Within concession?	Has NGEF standalone?	Total connections	Basic distribution layout length [km]	Total demand [kWh/day]	Average demand per connection [kWh/day]	Battery size (kWh)	PV size (kWp)	Investment required - Low - (USD) [USD]	Investment required - High - (USD) [USD]	Average cost per connection [USD]
Marou (#544)	Shefa	0	1	-	1	-	no	no	98	2.3	120	1.2	142	75	383,623	480,649	4,410
Ngaloparua (#815)	Shefa	2	-	1	-	-	no	no	114	3.0	229	1.5	273	144	623,576	780,954	6,160
Moriu (#825)	Shefa	0	1	-	1	-	no	yes	147	3.9	166	1.1	198	105	554,150	694,580	4,247
Lamen Bay (#627)	Shefa	0	1	-	2	-	no	yes	116	5.0	143	1.2	170	90	518,342	650,406	5,038
Taloa (#2280)	Shefa	0	1	-	1	-	yes	yes	183	6.1	206	1.1	245	130	713,302	894,609	4,393
Natapao (#2331)	Shefa	0	1	1	-	-	yes	no	105	2.7	120	1.1	143	76	400,333	501,730	4,296

Tafea

Figure 45. Location of shortlisted mini-grids in Tafea.

Table 66. Main parameters of shortlisted mini-grids in Tafea

Settlement name	Province	Telecommunication towers	Health care facilities (total)	Primary schools	Secondary schools	Education facilities (unknown type)	Within concession?	Has NGEF standalone?	Total connections	Basic distribution layout length [km]	Total demand [kWh/day]	Average demand per connection [kWh/day]	Battery size (kWh)	PV size (kWp)	Investment required - Low - (USD) [USD]	Investment required - High - (USD) [USD]	Average cost per connection [USD]
Antap (#21)	Tafea	0	1	1	1	-	no	yes	112	4.5	139	1.2	165	87	491,220	616,229	4,944
Ifangawe (#37)	Tafea	0	1	1	-	-	no	yes	130	2.8	150	1.1	178	94	471,916	591,257	4,089
Lounapkau Langis (#63)	Tafea	1	1	1	-	-	no	yes	253	8.8	326	1.4	387	205	1,062,725	1,325,234	4,734
Lapangnagen Kupa (#64)	Tafea	0	3	6	2	1	no	yes	626	24.5	720	1.2	856	453	2,479,648	3,106,664	4,462
Green Hill (#117)	Tafea	1	1	2	-	1	no	no	242	11.0	326	1.4	387	205	1,123,872	1,402,787	5,236
Yaneumakel (#139)	Tafea	1	1	2	2	-	no	yes	204	7.3	300	1.5	357	189	934,024	1,171,134	5,160
Yenhup (#166)	Tafea	0	1	-	-	-	no	no	181	7.2	201	1.1	239	126	738,062	926,155	4,597
Yapkeusep (#167)	Tafea	0	1	-	-	-	no	no	165	5.9	183	1.1	217	115	655,694	822,528	4,479
Unpongor (#408)	Tafea	0	1	1	-	-	no	no	95	1.6	111	1.2	132	70	344,053	430,822	4,078
Lounimapen (#431)	Tafea	0	1	3	-	-	no	yes	109	4.0	124	1.2	148	78	450,738	565,417	4,661
Ihlareng (#138)	Tafea	0	1	1	-	-	no	no	120	4.2	132	1.1	157	83	477,367	598,794	4,484

Torba

Figure 46. Location of shortlisted mini-grids in Torba

Table 67. Main parameters of shortlisted mini-grids in Torba

Settlement name	Province	Telecommunication towers	Health care facilities (total)	Primary schools	Secondary schools	Education facilities (unknown type)	Within concession?	Has NGEF standalone?	Total connections	Basic distribution layout length [km]	Total demand [kWh/day]	Average demand per connection [kWh/day]	Battery size (kWh)	PV size (kWp)	Investment required - Low - (USD) [USD]	Investment required - High - (USD) [USD]	Average cost per connection [USD]
Aplow (#1295)	Torba	0	1	2	-	2	no	yes	273	7.9	311	1.2	370	196	1,011,238	1,267,920	4,174
Vétuboso (#1358)	Torba	0	1	-	1	-	no	yes	104	3.9	125	1.2	149	79	445,920	559,331	4,833
Lesus (#1083)	Torba	0	1	1	1	-	no	yes	245	11.3	283	1.1	336	178	1,045,095	1,311,951	4,810

ANNEX 2: ToR for Program Implementation Consultant

TERMS OF REFERENCE

Vanuatu: Owner's Engineering services for the supervision of off-grid electrification projects

[Note: The scope of this consultancy can be integrated partially or fully under the scope of the Program Implementation Consultant]

1. Background

Vanuatu National Electrification Master Plan (NEMP)

The National Energy Road Map (NERM) 2016-2030 and the Implementation Plan (NERM IP) form the overall policy framework for developing the energy sector in Vanuatu. NERM has five priority policy objectives targeting energy that is accessible, affordable, secure and reliable, and sustainable, with green growth. By 2030 it is planned that all households in Vanuatu will have access to an electricity supply. In order to reach this target, the Government of Vanuatu (GoV) has developed the National Electrification Master Plan (NEMP), which will guide improvements and accelerate electrification to achieve universal access for the entire population.

[…]

2. Objective of the assignment

The overall objective of this assignment is to provide end-to-end engineering support to the Department of Energy (DoE) in implementing the NEMP. The Consultant shall have a permanent presence in Port Vila throughout the assignment.

3. Scope of Services

The consultancy firm will undertake the following activities:

Task 1. Project inception

Within two weeks of signing the contract, the consultant will have an inception meeting with the DoE. This meeting will allow the consultant to confirm the experts to be engaged in the assignment, the timeline and content of all deliverables, the approach for undertaking the assignment's tasks, and project management aspects, including regular engagement with the DoE. Within two weeks of the meeting the consultant will submit an Inception Report addressing all topics covered in the inception meeting. The inception report shall cover, at least:

- Project Team
- Scope: Definition of scope
- Time schedule: Preparing the work plan and identifying tools or templates to be used for stakeholders to follow the construction schedules.
- Quality: Define a quality assurance and control plan.
- Risks: Identification of risks and proposed mitigation measures
- Communication: Description of communication preferences (meeting periodicities, communication platforms
- Stakeholders: Preparation of the stakeholder engagement plan, including government, private sector, donors and NGOs, local authorities and representatives of the communities.

Task 2: International benchmarking

The consultant will map major comparable off-grid programs internationally, identifying status, approach and level of success. As part of this task, the Consultant will try to arrange meetings with the implementing agencies of some of these relevant programs. Examples include, but are not limited, to programs that had

an important private sector component (such as in the NEMP) like the Nigeria National Electrification Program, Myanmar National Electrification Project, Cambodia electrification, and programs in small island developing states (SIDS).

Task 3: Prepare institutional and regulatory framework *[This can potentially be an independent consultancy]*

This task aims to support the URA in developing and making its policy and regulatory framework fit for small-scale electricity suppliers. The Consultant shall provide the necessary support to the URA in preparing any formal documents, including drafting them.

The Consultant will work with the URA to develop the key outputs for this assignment. These are a suite of formal documents, adapted for Vanuatu, with formal approval by the DoE and the URA through a consultation process with key counterparts and stakeholders from within Vanuatu's Government and the electrification and rural development sectors. These outputs will include the following:

- Guidance on critical electrification policy decisions;
- A stakeholder map of key institutions, their roles and responsibilities, including the identification of a sector 'champion' (both an organisation and an individual within it), and their capacity-building requirements;
- A formal regulatory document and associated templates for regulatory implementation; and
- A small-scale electricity supplier tariff tool, accompanying methodology, and approvals process documentation.

The engagement between the Consultant and the URA will be long-term to ensure that the URA and its approval processes are fully engaged in the framework's development and that complementary rural development activities are incorporated and aligned with the framework. In addition, aspects of the assignment are conditional on the results of these complementary activities, and the Consultant's workplan should remain flexible to accommodate this.

The Consultant shall use the current electricity concession contracts and reference other relevant applicable international best practices, e.g. the templates produced by the IFC Scaling Mini-grids programme, as the basis for the regulatory document and modify it as appropriate for Vanuatu's preferences.

The regulatory aspects that the Consultant should address both through the training pack and further discussions include, but may not be limited to:

- How 'light-handed' the regulatory framework should be;
- Licensing requirements, including voltage thresholds (not capacity-based) at which different licensing requirements apply;
- The licensing application and approvals process, including the timing of various stages, roles of different stakeholders, and the use of an online platform;
- License template and conditions, including duration, recourse, political risk, enforcement, and penalties;
- Other necessary template agreements;
- Possible business models and how the regulations treat them;
- Technical design standards, including for future interconnection;
- Technical service quality standards, including alignment with electrification policies;
- Reporting requirements and monitoring, including via an online platform;
- Arrangements for larger grid interconnection: business models, the timing of notification and responses, responsibilities for different parties, valuation of assets transferred, payment for assets transferred, arbitration in the event of disputes; and
- The regulatory treatment of PUE activities, e.g. any regulation of revenues from leasing appliances and treatment of such complementary business activities if the small-scale electricity supplier assets are transferred.

Tariffs are a critical aspect of the regulations. The Consultant's activities will include tariff determination and support for the review framework. If Vanuatu does not already use its own tariff model, the consultant shall develop a small-scale electricity supplier tariff tool for tariff determination.

The tariff aspects that the Consultant should address both through the training pack and further discussions to be implemented in the tariff model and methodology include, but may not be limited to:

- The methodology to be applied when determining tariffs, including
    - cost determination and benchmarking;
    - tariff structures and the balance of fixed, variable, connection, and other charges;
    - the length of the control period(s) (the period for which a tariff applies before it is reviewed);
    - automatic within-period adjustments for variation in uncontrollable factors; and
    - the allocation of risks between different parties;
- The design of the tariff model and its application;
- Whether the URA approves a small-scale electricity supplier's tariff application or determines the tariff for the applicant and
- Rights for the small-scale electricity supplier to challenge the tariff determination.

The small-scale electricity supplier tariff tool should be adopted by the URA together with a tariff methodology that explains both the tariff tool and the methodological aspects raised above. This output should be in Vanuatu's name and approved by the two decision-making bodies.

Task 4: Define implementation phases

This task's objective is to detail and refine the implementation process described in the NEMP. This process should be based, in general terms, on the phases provided in the NEMP and should be defined in close collaboration with the DoE.

- **Group communities into clusters.**
    - Establish the Area Councils (municipalities) as Service Areas. The NEMP requires defining geographical areas where the future Electricity supplier will operate. Vanuatu's Area Councils (or municipalities) shall be used as the standard boundaries for future Service Areas established under a top-down approach. This municipal perspective aligns with the development strategy presented in the NERM-IP.
    - Define clusters of area councils with a balanced scale (not too big, not too small). Economies of scale can help reduce future electricity tariffs, thus benefiting customers in remote areas. On the other hand, developments that are too big can be technically complex to manage and can discourage participation from developers due to the risks involved and the high financial requirements. Furthermore, very large developments would tend to favour international partners and leave out local Vanuatu companies. Multiple area councils shall be grouped into clusters in a way that promotes: (i) reaching economies of scale, (ii) manageable project portfolios (technically and financially), and (iii) participation of local companies.
    - Define how to integrate existing mini-grids. The definition of Service Areas will require dealing with communities that have already been electrified (e.g. communities in south Malekula benefiting from the VREP project, Loltong, Wintua, etc). It shall be defined how to integrate or not these communities into the proposed Service Areas. Similarly, there will be a need to define how the communities electrified through unsolicited projects are coordinated smoothly with the surrounding service areas planned following a top-down approach.
- **Establish the prioritization criteria**
    - Define a seamless integration of top-down and bottom-up electrification planning approaches. The NEMP shall offer a top-down structured strategy to connect all unelectrified households, businesses and institutions in the country. In parallel, unsolicited project proposals shall be accommodated for those communities that decide to develop a project on their own (cooperative model) or in collaboration with a private sector developer. If a community ventures to develop its own electrification project it shall be allowed to do it, but if it does not succeed or does not have the interest or capacity to do it, there shall be an alternative top-down strategy from the government to electrify it.
    - Define the prioritization criteria. The Vanuatu NERM-IP establishes a set or revised prioritization criteria that can be used as a basis for this exercise.

  - Equity across regions. The prioritization criteria might want to consider a balanced development across the country. In this regard, ensuring a parallel implementation of projects in the six provinces might be a good strategy to decentralize the regional benefits. This provincial approach aligns with the NERM-IP.
  - Phased approach. The NEMP implementation shall be planned in phases. Tendering out all the projects at once would benefit reaching very large economies of scale but would not be technically or financially bearable. A phased approach facilitates a progressive strengthening of the local private sector and thus increases the local impact of the electrification program. Furthermore, a phased approach allows building on the experience of the previous phases, improving the process successively in each phase.
- **Define strategy for concession areas**
  - Engage concessionaires. Engage the existing concessionaires (UNELCO, VanPawa, VUI).
  - Define network expansion plans to electrify the existing concessions fully. Together with the existing concessionaires, define the plans to expand electricity service within the concession boundaries.
  - Plan additional generation capacity. Assess the additional generation capacity to satisfy the increased demand in the existing networks due to their extension.

The output of this task shall clearly identify the proposed implementation phases and the list of selected municipalities included in each phase.

Task 5: Articulate fund structure and management model

The Consultant will work closely with the DoE and NGEF to design a funding program for the NEMP. The Consultant will determine required subsidies and concessional instruments , and how much private capital is to be leveraged. Funding options may include, but are not limited to, grants, concessional debt, and equity.

The tasks shall include:

- **Strengthen NGEF**
  - Define roles and responsibilities. Formalise responsibility within the NEMP and agree on funding sources and potential disbursements.
  - Define governance and accountability. Align with international best practices and consult with potential funding partners.
  - Capacity building for NGEF. Offer capacity building aligned with the scale of support NGEF will provide, covering financial management, project development, M&E
- **Identification of best-suited financial instruments.** The Consultant will identify the best-suited financing package given the market conditions, considering:
  - innovations in equity investments and debt financing;
  - different types of subsidies that might be required;
  - risk-mitigation instruments;
  - different combinations of equity, debt, subsidy, and risk-sharing mechanisms; and
  - gender mainstreaming, given that female-led enterprises and project developers may require an expanded support package.
- **Development of funding programme.** The Consultant shall develop a funding programme for NEMP that could mobilise private capital and interest in Vanuatu's off-grid market. The programme should identify the key components of the selected approach, including:
  - the preferred combination of financial instruments;
  - realistic financing terms identified from the stakeholder engagement;
  - documentation required (eg, Terms of Reference);
  - eligibility criteria;
  - selection criteria;
  - disbursement criteria; and
  - in the case of an RBF programme, an effective verification mechanism.
- **Fundraising activities.** Based on the expressed interest from stakeholder consultations, the Consultant will facilitate negotiations with donors and any other identified parties to mobilise additional funds for the NEMP, emphasising the importance of collaboration and coordination

among stakeholders. As part of the negotiations, a common approach should be selected when it comes to the following key aspects:

- Terms: Specify the format of proposals, the criteria for evaluating and prioritising proposals, and the milestones and mechanism(s) for payment disbursement.
- Monitoring and reporting: Define uniform reporting requirements, including the frequency and format of progress reports to be shared with, and approved by, all stakeholders/donors.
- Collaboration and coordination: Identify mechanisms for information sharing and coordination meetings to maximise the impact of the additional funds raised.

Task 5: Propose a tendering platform that supports the procurement process control and management

The Consultant will review the NEMP tendering needs and propose options for an online tendering platform for undertaking and managing the procurement tendering process. The following aspects need to be considered for the platform:

- The Consultant will first assess the digital tools with which the Government of Vanuatu is familiar and will see if any of them is suitable for the purpose through an expansion if needed.
- The Consultant and DoE will define a consensus view of the criteria that the platform should meet, such as:
  - The platform should help the DoE, URA, and DEPC to monitor and evaluate the bidding proposals, including technical and financial performance and later on monitor and evaluate development and O&M activities of the Service Areas;
  - The platform should provide clear key indicators for monitoring and evaluating the proposals;
  - Stakeholders (private sector, authorities, regulators, investors, individual users) should be able to find projects of their interest;
- The Consultant will prepare technical specifications for the procurement of the platform.
- The Consultant might be requested to participate in the dialogue with the service provider.

Task 6: Promote productive uses of energy *[This can potentially be an independent consultancy]*

The objective of the task is to guide the DoE and development partners on the opportunity and framework for setting up the most appropriate financing and non-financing tools to stimulate the development of potential Income-Generating Activities (IGAs) of interest that may support the sustainability of off-grid market acceleration.

The types of activities that may be identified can include:

- Mechanisation of agricultural activities, including irrigation, post-harvest processing, and cold storage;
- E-mobility;
- Small business (retail, services, etc.)
- Mining and logging; and
- Social services such as street lighting, education, and healthcare (ie, lighting buildings, cold storage for medicines).

The Consultant shall coordinate with:

- Department of Industry. Promotes economic activities on islands. They support value-adding activities. The Department is taking decentralisation seriously. To that end, they are carrying out mapping exercises in each province, where activities are based, value addition, etc, starting with Malampa province and will move to Sanma next.
- Department of Cooperatives. Supports rural development with value-added activities from the primary sector. They promote management systems, accounts, etc. They have identified and mapped the 50 financially stronger cooperatives across Vanuatu. They are supporting some electrical cooperatives such as Lorlow and Wintua. They are working on financial cooperatives,

essential to offer access to credit in rural areas but which require electricity access to monitor the activities. The most common cooperatives are the ones related to fishermen and retailers for consumer goods. There are more than 300 cooperatives, half of which relate to consumer and retail activities.

- Department of Tourism. In the rural tourist facilities, electricity is needed to secure minimum standards for accommodation, to satisfy needs in cold storage, lighting, bookkeeping systems, marketing (Facebook, etc), etc. Most tourist infrastructure has already benefited from programmes offering small-scale solar photovoltaic (PV) systems, but larger systems are often required. Mini-grids might be challenging as tourist bungalows and resorts tend to be in remote and isolated locations far from the towns' economic centres.
- Department of Agriculture. Their work is typically complemented by the Department of Cooperatives or Department of Industry for any activity beyond growing crops. Agriculture in Vanuatu is generally done for subsistence, so establishing cooperatives helps scaling up. Market access is often the main problem. Irrigation is not common, so they do not have that energy need very often.
- Fisheries Department. The body charged with the implementation and enforcement of fisheries management laws, policies, regulations and principles under the Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB). Its mission is "to ensure sustainable management, development and conservation of fish resources in order to achieve maximum social and economic benefits to Vanuatu for the present and future generations".
- Ministry of Health and Ministry of Education and Training. The bodies with responsibility for health and health services provision, and education and training, across Vanuatu. With decentralised health and education services, including in areas without reliable electricity connections, they are a key stakeholder in electrification planning.
- Provincial and municipal governments. As the key decentralised interface for public service provision, local governments represent cross-sectoral interests. Therefore, they are critical in ensuring the alignment of electricity service provision with the uses of electricity, both social and productive.

The Consultant is expected to quantify each opportunity's economic potential, highlight key risks and barriers to the success of these concepts in Vanuatu, and identify possible financial and non-financial support measures or technical assistance that could help overcome such barriers and contribute to the sustainable development of economic activity that a new or enhanced electricity supply offers the project areas.

The assignment will also provide recommendations to future concessionaires for capitalising on the potential demand of IGAs through offerings complementary to their core electricity supply business. It will estimate the impact of the opportunities on the demand for and price of electricity. The recommendations of both sets of measures will benefit from supporting analysis from economic modelling assessing the costs and benefits of the proposed measures.

The task shall include:

- **Productive activities mapping per location**. The Consultant will map existing and potential productive IGAs in the economic value chain for each Service Area, following the NEMP phases. In doing this, the Consultant will capitalise on the actions undertaken by the NGOs and other entities present on site, if applicable to identify and analyse the potential economic activities that deserve to be supported or developed for the benefit of the local communities and profitability of the concession.

  The Consultant will classify the number of sites by the type of activity identified. To do this, they must identify, among other things:
  - the productive activities that already exist in each site and their potential for growth/ acceleration;
  - the productive activities that have the potential to be expanded in each site and their potential for growth and development; and

  - potential synergies with actions already undertaken or planned by the Bank or other relevant entities, including NGOs operating in the same geographic areas, particularly in the [relevant] sector(s)

- **Productive activities expansion plans per location.** Formulation of a productive use expansion plan for all sites to assess the development potential of IGAs and the stimulating measures that could accompany the electrification programme, eg, the provision of specific financing instruments or agriculture extension services. The activities should be aligned and harmonised as much as possible across sites with no more than five forms of assistance, eg, agriculture extension service for a specific value chain, small manufacturing business advisory, logistics coordination, and equipment financing. The business plan shall cover all sites and comprise generic and site-specific recommendations.

  The business plan will identify existing and planned complementary support programmes (technical assistance, financing, and other programmes), supported by donors, NGOs, and other entities that can be utilised. It will provide details of the programmes' scope, instruments, capacity, and key contacts.

  The expansion plan will be accompanied by clear recommendations for implementing the recommended instrument(s) and detail of all accompanying measures, particularly those addressing the needs of female entrepreneurship. The Consultant will define the potential role that the concessionaires, any specialised PUE supporting entity, and any microfinance institutions could play locally and nationally.

  The Consultant will provide recommendations for informing the different sub-groups of the local population about the project, particularly women entrepreneurs in rural areas, for their participation in the choices and the implementation of the measures and the establishment of a grievance mechanism.

- **Business plan for utilising electricity demand for PUE.** From the identification and expansion planning of the IGAs, the Consultant will propose a business plan which will make it possible to satisfy the existing and potential demand for electricity from IGAs at all sites. The business plan will guide developers' electricity connection and supply activities to support the demand for electricity from IGAs. It will focus only on technical assistance activities and financing directly related to electricity consumption, eg, appliance purchases, time-of-use consumption, and energy efficiency, and consolidate recommendations with no more than five forms of assistance. As with the business plan for technical assistance, the electricity demand business plan shall cover all sites and comprise both generic and site-specific recommendations, as appropriate, and identify the relevant complementary support programmes.

- **Cost identification and impact assessment.** The Consultant will present the economic and retail structure for the level of technical assistance and concessional funding necessary for developing potential IGAs. The plan should not identify specific IGAs but categorise them broadly into no more than seven categories.

  The Consultant will characterise and assess the following:
  - the positive and negative, direct and indirect, immediate and deferred impacts of the development of each activity on the [location of sites] in the mini-grid construction phase and the mini-grid operating phase for a minimum of 20 years; and
  - the impacts of the different measures on employment, income, and local living conditions, in particular, those targeting women and women's cooperatives, assessing the political and social acceptability of the project, and characterising the problems that need to be solved to implement solutions acceptable to the populations and in line with the jurisdiction in the field.

- **Develop an economic model of the costs and benefits of the recommended assistance.** For this activity, the Consultant will develop an economic model to assess the viability of the measures, separately and collectively, quantifying their costs and benefits to assist the development partners investment decision. The inputs should be generic across all sites but be based on the information

gathered in first sub-task. Calculations should be applied for each site using the generic inputs. The model should consider, but not be limited to:

- International and national cost benchmark research for mini-grids in Vanuatu, including capex and opex.
- Calculation of the investment cost of the PUE support programme for each instrument.
- Detailed analysis of operating and renewal costs (opex).
- Development of a financial/economic model in Microsoft Excel incorporating all recommended measures, with a sensitivity analysis of the funding required to achieve a financial IRR of [x%] and an economic IRR of [x%].
- Detailed analysis of the investment contribution capacity of private, NGO, and other operators present in these localities and estimate of the investment and subsidy requirements of the specific projects and the programme as a whole.
- Assessment of the profitability and financial viability of each site and the project as a whole, and sensitivity analyses of each of the measures to test their viability from a country perspective (economic viability) and private developer/operator (financial viability), considering rural industrialisation and price elasticity in mini-grids (based on information collected in sub-task 1, and available secondary willingness to pay or similar data; assumptions should be made where data are not readily available). Viability metrics should include (but not necessarily be limited to) NPV and IRR. In addition, the economic analysis should identify the costs and benefits by stakeholder.
- Analysis of risks for the project's sustainability and respective mitigation plans, including the electricity market in Vanuatu, operational, technological, environmental, social, macro-economic, and political risks.
- Define the envisaged implementation plan for the PUE support programme in the selected areas, which can be presented to donors and potential financiers.

4. Deliverables:

The Consultant will deliver the following outputs:

[TBD depending on the final secope]

5. Qualifications and Experience:

The Consultant will be required to mobilise a team of experts with diversified technical competencies, demonstrating experience:

- Managing competitive procurement processes for private suppliers of mini-grids or other energy projects;
- Drawing up and negotiating contracts for the construction of energy assets and supply of energy, including PPP contracts;
- Arranging finance for energy projects;

The Consultant team should include at least the following Key Experts:

Team leader

The Team Leader will coordinate the overall work, ensure the coherence and quality of the services provided, and lead the delivery of the assignment content. The expert is expected to have the following qualifications:

- Advanced university degree (MSc or higher) in energy engineering, law, energy economics, politics, finance, or a related field;
- At least 10 years of experience in the energy sector;

- Proven track record of delivering similar services in developing countries, preferably in the Pacific.
- Previous experience in Vanuatu's energy sector is essential.

Off-grid technical expert

- Advanced university degree (MSc or higher) in engineering or another energy-related field;
- At least 5 years of experience in electrical engineering for rural electrification projects.
- Experience working on at least 3 assignments providing independent advice on small-scale electricity or mini-grid project designs in the Pacific.
- Previous experience in Vanuatu will be an added advantage

Regulatory expert

- Advanced university degree (MSc or higher);
- At least 10 years of professional experience advising regulatory frameworks for mini-grids and distributed renewable energies.
- Experience in organising and participating in investor / stakeholder roadshows;
- Advised at least 5 similar transaction processes in the past 10 years and have demonstrable experience with small-scale electricity supply in developing countries.

Financial expert

- Advanced university degree (MSc or higher) in finance, economics, or business;
- At least 10 years of experience with financial analysis of small-scale electricity supply projects;
- At least three assignments involving capital raising or financial negotiation for mini-grid, solar home systems, or renewable energy projects.

Each of the Key Experts must have the following:

- Good communication skills, full proficiency in English;
- Experience in Vanuatu's rural development sector is desirable.

Ideally, the Consultant should include local experts as well. Additional staff may include more junior team members to support data collection, select analytical tasks, implement projects, etc.

6. Reporting:

The Consultancy firm will report to the DOE's NEMP Project Manager.

ANNEX 3: ToR for ESS Officer

TERMS OF REFERENCE

Vanuatu: Environmental and Social Safeguards (ESS) Officer in the Department of Environmental Protection & Conservation (DEPC)

Full-time individual consultant position

1. Background

Policy framework

The National Energy Road Map (NERM) 2016-2030 and the Implementation Plan (NERM IP) form the overall policy framework for developing the energy sector in Vanuatu. NERM has five priority policy objectives targeting energy that is accessible, affordable, secure and reliable, and sustainable, with green growth. By 2030 it is planned that all households in Vanuatu will have access to an electricity supply. In order to reach this target, the Government of Vanuatu (GoV) has developed the National Electrification Master Plan (NEMP), which will guide improvements and accelerate electrification to achieve universal access for the entire population.

According to the Vanuatu 2020 National Population and Housing Census, about 78% percent of the population lives in rural areas, and more than 70% of the rural population has little or no access to secure and reliable energy services. Projections indicate that energy consumption in Vanuatu is expected to double by 2030, which has major implications for the economy, the environment and people's welfare. Energy is a central issue in the Vanuatu National Sustainable Development Plan (NSDP), which at the same time has important goals in social and environmental aspects of development. This directly includes goals in health care, quality education, social inclusion, strong institutions, food and nutrition security, blue/green economic growth, climate and disaster resilience and natural resource management.

Guiding Principles for the NEMP

Underpinning the development of the NEMP, are several guiding principles identified by government officials and other stakeholders. These principles include the need to use a holistic planning approach to foster cross cutting benefits and support localisation and to ensure that tariffs are affordable for all consumers despite greater costs and lower incomes in underserviced areas. The GoV is also concerned about the impacts of increased electronic waste (e-waste) on people and the environment resulting from electrification and has stressed the need for improved waste management practices.

Results of the Preliminary Environmental Assessment (PEA) and Environmental & Social Management & Monitoring Plan (ESMMP) for NEMP

As part of the NEMP, a PEA was prepared with the aim to minimise adverse environmental, social and health and safety impacts of energy infrastructure in Vanuatu by identifying the key risks associated with expanding electrification in Vanuatu and developing environmental and social (ESS) processes to prevent or mitigate harmful impacts. The PEA focused on:

- Screening for and identifying environmental and social issues surrounding a program at the scale and speed required to achieve universal connectivity by 2030 including dealing with 'greenfield' locations outside concession areas.
- Consulting with key stakeholder agencies regarding environmental and social risks and mitigation strategies.
- Recommending an environmental and social management and monitoring plan (ESMMP) which identifies the key issues, ways to address them and guidelines to facilitate rollout, and
- Identifying mitigation strategies suitable for a national rollout and future maintenance for NEMP implementation.

The ESMMP developed as part of the PEA recommended the following procedures to ensure that potential adverse environmental and social impacts of the NEMP sub-projects are avoided, minimised, mitigated or offset during the roll out:

- Ensure the completion of Preliminary Environmental Assessments (PEAs) or Environmental Impact Assessments (EIAs) of sub-projects as may be required (depending on the scope of the project) by Section 14(2) of the Environmental Protection and Conservation Act [CAP 283] for approval before works can begin;

- **Appointment of an ESS Officer** who will be responsible for implementation of the ESMMP, monthly reporting and monitoring of environmental compliance by the contractor for sub-projects;
- Public consultations and information (see full ESMMP for details);
- Codes of Practice to guide waste management, construction, health and safety and land permissions;
- Grievance Mechanism; and
- Use of Memoranda of Understanding (MOUs) to ensure agreement among stakeholders.

2. Purpose of the ESS Officer

The primary purpose of this position is to ensure that all aspects of the Environmental and Social Management and Monitoring Plan for NEMP are carried out for the NEMP as a whole and for all sub-projects as the programme rolls out. The ESS Officer will be responsible for monitoring the ESS aspects and writing simple monthly reports on progress, issues, and lessons learned.

3. Scope of Services

The ESS Officer will undertake the following tasks:

- Attend NEMP Steering Committee Meetings, reporting on findings, lessons learned, and helping the committee to address issues as they arise to ensure the best project outcomes for all stakeholders.
- Oversee the production of a Preliminary Environmental Assessment (PEA) reports by the Contractor in each sub-project and ensure it is submitted to the Department of Environmental Protection & Conservation (DEPC) along with a Contractor's ESMMP which is based on the one created for NEMP. This will be carried out by working with each proponent to include:
    - Ensuring that each PEA for the sub-projects considers the risks of natural disasters on facilities and e-waste during construction and operations.
    - Ensure all sub-projects adopt a human rights (energy justice) approach that results in a pro-poor, gender-responsive and socially inclusive national electrification roll out.
    - The ESS Officer will ensure that all initiatives have a suitable stakeholder engagement plan.
    - Ensure all sub-projects include plans for the storage, removal or recycling of wastes associated with electrification (including end of life white goods).
    - Ensure the contractor for each sub-project monitors and reports on their ESMMP on a monthly basis during construction. This will include random inspections from time to time by the ESS Officer.
- Work with DOE to ensure that the NEMP rollout prioritizes electrification of essential services to ensure that households/communities without power have improved local services. This includes all elementary and secondary schools, health clinics, area council offices, cooperatives, banks and evacuation centres. This should include ensuring lighting in public places as well as initiatives that can address gender-based violence (GbV).
- Develop community engagement guidelines for use by the contractors and by the ESS Officer to work with communities on siting of sub-projects, land considerations, tariffs and conflict resolution. Special consideration will be made for engaging communities on e-waste management.
- Carry out consultations and communications with stakeholders in support of the NEMP. This will require the development of a stakeholder engagement and action plan (SECAP) and will include:
    - Ensuring women, people living with disabilities, the aged and youth have a voice in planning and decision-making around energy planning and implementation by carrying out focus group meetings and reporting findings back to DOE Steering Committee;
    - Conduct community meetings in at least 20 communities over the life of the project to gather information on whole of community's aspirations and needs regarding energy;
    - Carry out awareness campaigns and capacity-building for communities through talks, radio shows and pamphlets on what e-wastes are and how to properly handle and dispose of them.
    - Establish a Grievance Redress Mechanism, including complaints boxes, and selected community persons to gather complaints. This must include a mechanism to ensure issues are raised to NEMP management and must be resolved within a period of 2 months.
- Develop a Community Code of practice that commits NEMP workers to professional behaviour while working at the community level, including not engaging in sexual exploitation, abuse and harassment.

This Code will also address child protection issues to ensure that children are not exposed harmful situations.
- Update the VREP Code of Practice for Health and Safety to cover all aspects of electrification work. This must also include health risk to workers in contact with e-waste, use of personal protective equipment (PPE) (see PacWastePlus Programme).
- Assist DOE in developing a national E-waste Management Policy to cover NEMP and other e-waste needs in the country. The draft model in SPREP's "Management of e-Waste in the Pacific: A Regional Strategy and Action Plan" may serve as a starting point. Carry out quarterly visits to disposal and recycling sites from beginning of Year 2 of the project to monitor progress and guide corrective actions as may be needed.
- Carry out capacity-building for communities through talks, radio shows and pamphlets on what e-wastes are and how to properly handle and dispose of them.

4. Deliverables:

The ESS Officer will deliver the following outputs:

Ref	Key Deliverables	Timing
1	Inception Report with a work and implementation plan	Month 1
2	Design and establishment of grievance redress mechanism	Month 2
3	Stakeholder engagement and action plan (SECAP)	Month 2
4	Codes of practice for Communities and Health & Safety	Month 3
5	Monthly reports on significant issues and lessons learned among the sub-projects	All months
6	Annual reports	Annually

5. Qualifications and Experience:

The candidate should possess the following qualifications and experience:

- A degree in environmental science, social sciences, geography or similar.
- Experience in environmental impact assessment, community consultations or related fields.
- Proficiency in relevant software for report production and data and information management (such as Microsoft Word, Excel, PowerPoint). Experience in developing information materials is an advantage.
- Familiarity with the principles of environmental management and mitigation.
- Strong analytical and problem-solving skills, with the ability to translate complex requirements into practical solutions.
- Knowledge of Vanuatu's islands and communities. Willingness to travel to outlying areas.
- Excellent communication and training skills to effectively engage with diverse stakeholders.
- Excellent writing skills, attention to detail and ability to work under pressure and to deadlines.

6. Reporting:

The ESS Officer will report to the EIA Officer of DEPC and the NEMP Project Manager of DOE.

7. Application Procedure:

Interested candidates should submit the following documents:

- Curriculum Vitae (CV) highlighting relevant qualifications and experience.

- Cover letter outlining the candidate's suitability for the position and proposed approach to the programme in each of the areas highlighted in the Scope of Services and Qualifications and Experience.

The DOE and DEPC are committed to diversity and inclusion and encourages applications from qualified individuals, regardless of gender, age, race, ethnicity and religion.

ANNEX 4: ToR for procurement process transaction advisor

TERMS OF REFERENCE

Vanuatu: Owner's Engineering services for the supervision of off-grid electrification projects

[Note: The scope of this consultancy can be integrated partially or fully under the scope of the Program Implementation Consultant]

1. Background

Vanuatu National Electrification Master Plan (NEMP)

The National Energy Road Map (NERM) 2016-2030 and the Implementation Plan (NERM IP) form the overall policy framework for developing the energy sector in Vanuatu. NERM has five priority policy objectives targeting energy that is accessible, affordable, secure and reliable, and sustainable, with green growth. By 2030 it is planned that all households in Vanuatu will have access to an electricity supply. In order to reach this target, the Government of Vanuatu (GoV) has developed the National Electrification Master Plan (NEMP), which will guide improvements and accelerate electrification to achieve universal access for the entire population.

Program Implementation Consultant

[Describe here the scope of the Program Implementation Consultant and its role in relation to the Owner's Engineer to clarify boundaries and ensure smooth coordination]

2. Objective of the assignment

The overall objective of this assignment is to support the Department of Energy (DoE) in implementing the procurement plan of Phase [*X*] of the NEMP and during the negotiations and contract award process with prospective bidders. This includes preparing the concept designs and technical specifications for tender, drafting the concession contracts and bidding documents, reviewing and assisting during evaluation and contract award, and coordinating stakeholder workshops across Vanuatu.

3. Scope of Services

The consultancy firm will undertake the following activities:

Task 1. Inception Report

The inception report shall cover, at least:

- Project Team
- Scope: Definition of scope
- Time schedule: Preparing the work plan and identifying tools or templates to be used for stakeholders to follow the construction schedules.
- Quality: Define a quality assurance and control plan.
- Risks: Identification of risks and proposed mitigation measures
- Communication: Description of communication preferences (meeting periodicities, communication platforms
- Stakeholders: Preparation of the stakeholder engagement plan, including government, private sector, donors and NGOs, local authorities and representatives of the communities.

Task 2: Field work and project sites contextualization

The objective of the task is to collect all relevant information about the project sites relevant for future project developers in the preparation of their proposals. This will reduce the due diligence and preparatory costs of the proposals and will, therefore, result in better proposals and prices that are more competitive.

The task shall include:

- **Characterize energy demand**. Assess the communities' energy needs, identifying major anchor loads and potential growth.
- **Identify productive uses of energy**. Map the presence (or potential for development) and characterize energy-intensive activities (including but not limited to commerce, industry, agriculture or tourism).
- **Map existing social services**. Identify and characterize existing and planned social service facilities such as schools or health centers.
- **Promote a multi-sector approach**. During the field visits, the focus shall go beyond the electricity needs and characterize the potential synergies with other public infrastructures, such as water and telecommunications.
- **Assess affordability**. During site visits, basic socioeconomic indicators shall be gathered, including willingness to pay and ability to pay, which will inform later on the decisions related to tariffs in each specific region. It is essential to characterise the existing energy expenditures (how much people spend now on fuel for gensets, candles, etc.).
- **Identify local capabilities**. Assess the presence of local governance structures such as cooperatives, religious missions or any sort of organized entity that can potentially play a role in the electrification process (e.g. support the operation of the assets). Also relevant to identify if there is any person in the village with technical skills.
- **Social and Environmental safeguards**. Conduct a social and environmental screening of the communities, identifying major risks and appropriate mitigation measures.
- **Undertake GIS mapping**. To the extent possible, the data collected shall be in a geospatial format and later integrated into the VIDA platform.

Task 3: Concept Designs and technical specifications

The consultant will prepare a concept design and technical specifications to be included in the tender documents, considering the following requirements:

- **Use output-based requirements.** The technical specifications shall be output-based. The facility sizing shall be given as a reference. Technical information shall be provided in a way that allows bidders to make informed decisions and propose alternative designs if applicable.
- **Use technology-agnostic requirements.** The technical specifications shall be output-based, with a stronger focus on the service requirements rather than on the technology to satisfy them. The specifications shall allow seamless integration of:
    - **Collective Electrification Systems (CES).** CES provide service to multiple users using a single or multiple energy resource points. Examples of CES include mini-grids, swarm grids, solar kiosks, or battery-swapping facilities.
    - **Individual Electrification Systems (IES)**. IES provide service to one single user. Examples include solar home systems, or solar kits.
    - **Single-Appliance Electrification Systems (SAES)**. SAES provide an End-use Service to single or multiple users through a single type of appliance. They are an end-use system with embedded generation. Examples include solar pumps.
- **Map public services and PUE.** The specifications shall map and characterize existing and planned energy uses for public services (health, education, religious centers, etc) and for productive uses. This information is essential to assess the viability of the projects by the future bidders. Electricity suppliers should be incentivized to offer end-use services beyond the electricity provision (e.g. cold storage, water pump for irrigation, food processing equipment, etc). The tender shall incorporate weighted evaluation criteria that offer extra points to bidders incorporating these types of services.
- **Integrate indoor wiring.** Service, lines, meters and indoor wiring for households shall be incorporated as part of the intervention. This is essential to ensure safe installations in the context of communities using traditional construction methods.
- **Support the integration of appliances**. Bidders should be encouraged to incorporate appliances as end-use services in the Service Areas. The benefits of incorporating include:
    - Facilitate access to electrical equipment, which might be challenging in remote locations either because of a lack of financial means or simply because they are not available in the local market.
    - Promote the use of quality-certified and energy-efficient appliances.

    - Incentivize circular economy. The Electricity supplier can oversee the waste management of the appliances at the end of their life cycle.
- **Promote a holistic service approach.** Where feasibile, bundle energy supply with other services, such as water, telecommunications or local electric mobility. This can make the business case more attractive for Electricity suppliers and help address community cross-cutting issues (health, education, communications, transportation, etc.).
- **Provide geotechnical information for pre-selected generation sites.**

Task 4: Preparation of bid documents including bid evaluation criteria, tender & technical evaluation

The Consultant will work on and prepare the following documents:

- Prepare bid documents for concessioning electricity supply at the selected sites per the [funder] and the Government's procurement regulations. Bidding documents will include instructions to bidders, technical specifications, and bidding conditions.
- Develop and set out the bid weighted evaluation criteria that promote projects that minimise Government contribution, maximise service levels, [is within the maximum tariff (and tariff path)], and are consistent with the design considerations. Evaluation criteria will include technical and financial criteria. The technical criteria should consist of adherence to the technical specifications and the aspects indicted above. In addition, they may include others such as the developer's relevant prior experience and key personnel in the Vanuatu, the quality of feasibility studies and business plan, innovation, including energy efficiency, productive uses, social inclusion and gender (e.g. integration of women as employees), compliance with environmental and social safeguards, and potential for scalability and knowledge transfer (if an international company). The financial criteria will include the [grant / subsidies].

Evaluation criteria should ensure that only viable proposals are awarded while minimising costs to the Government and users. Developers may be allowed to submit proposals for multiple sites (clustering).

Task 5: Preparation of contract documents

The Consultant will leverage existing Vanuatu documents (existing concession contracts) and international best practices (e.g. World Bank Scaling Mini-Grid – SMG- templates [63]) and adapt them as appropriate. The set of documents to prepare shall include the following:

- Consumer supply contract;
- Community contract;
- Consumer service charter;
- Concession agreement;
- Financing agreements (e.g., grant agreement).

Task 6: Coordinate and support the implementation of a stakeholder roadshow

The Consultant will assist the DoE in designing a programme promotion plan and coordinating its implementation. This includes promoting the programme transaction and organising and participating in workshops with potential developers and authorities (both local and international). This will allow the private sector to anticipate business opportunities and prepare for them under a long-term plan, giving stability and predictability to the sector. The sessions shall also be used to gather feedback from the private sector, as well as suggestions and concerns. This information is essential to maximize participation in the tenders.

Within this task, the Consultant will also perform an investor and stakeholder analysis providing a database (with contact details) of interested parties in the investment opportunity (financiers, operators, EPC contractors, Independent Engineers, etc.).

[63] See International Finance Corporation (IFC)'s website: https://www.ifc.org/en/what-we-do/sector-expertise/infrastructure/energy/scaling-mini-grid/scaling-mini-grid-templates#templates

Task 7: Capacity Building for the private sector

Building local capacity is essential to fostering the development of the off-grid sector. The Consultant will design a training program for the local firms, with the objective of:

- Presenting the long-term vision of the government in detail,
- Help build capacity for their staff in the different phases of project implementation (design, construction and operation),
- Helping the firms be ready for the procurement, explaining the application procedure and anticipating the expectations regarding the quality of the proposals and requirements.

Task 8: Support during the receipt and review of proposals, including final concession negotiations and contract award

The Consultant will support the DoE during the reception and evaluation of proposals according to the following factors:

- Evaluate tenders for the supply of electricity and prepare a bid evaluation report per the [Funder] procurement regulations for no objection review.
- Negotiate concession contract(s) for the supply of electricity with the successful tenderer. The concession should include a performance bond and sanctions/penalties for non-performance on any aspect of the concession. The DoE will administer the concession agreement.
- Assist the DoE with the contract award, ensure that all the relevant documentation (performance security, insurance, etc.) is received before signing the contract, and ensure compliance with technical specifications, environmental and social regulations, other safeguard instruments, and national legislation.
- Ensure the concession contract is signed in consultation with the DoE and consolidate the revisions into a proposals evaluation report, including revisions and negotiations agreements and compliance with the defined criteria.

4. Deliverables:

The Consultant will deliver the following outputs:

Ref	Key Deliverables	Timing (months after contract signing)
1	Inception Report	0.5
2	Project sites report	3
3	Concept Design	5
4	Tender documents	6
6	Stakeholder roadshow report	6
7	Capacity building materials	7
8	Evaluation report	11
9	Concession contracts signed	12

5. Qualifications and Experience:

The Consultant will be required to mobilise a team of experts with diversified technical competencies, demonstrating experience:

- Managing competitive procurement processes for private suppliers of mini-grids or other energy projects;
- Drawing up and negotiating contracts for the construction of energy assets and supply of energy, including PPP contracts;

- Arranging finance for energy projects;

The Consultant team should include at least the following Key Experts:

Team leader

The Team Leader will coordinate the overall work, ensure the coherence and quality of the services provided, and lead the delivery of the assignment content. The expert is expected to have the following qualifications:

- Advanced university degree (MSc or higher) in energy engineering, law, energy economics, politics, finance, or a related field;
- At least 10 years of experience in the energy sector;
- Proven track record of delivering similar services in developing countries, preferably in the Pacific.
- Previous experience in Vanuatu's energy sector is essential.

Electrical Engineer

- Advanced university degree (MSc or higher) in engineering or another energy-related field;
- At least 5 years of experience in electrical engineering for rural electrification projects.
- Experience working on at least 3 assignments providing independent advice on small-scale electricity or mini-grid project designs in the Pacific.
- Previous experience in Vanuatu will be an added advantage

Civil Engineer

- Advanced university degree (MSc or higher) in engineering or another energy-related field;
- At least 5 years of experience in civil engineering for rural electrification projects.
- Experience working on at least 3 assignments providing independent advice on small-scale electricity or mini-grid project designs in the Pacific.
- Previous experience in Vanuatu will be an added advantage

Legal expert in energy transactions

- Advanced university degree (MSc or higher) in law;
- At least 10 years of professional experience advising transactions to procure private operators of service supply infrastructure through different contractual arrangements, e.g. PPP, concession, etc;
- Experience in organising and participating in investor / stakeholder roadshows;
- Advised at least 5 similar transaction processes in the past 10 years and have demonstrable experience with small-scale electricity supply in developing countries.

Financial expert

- Advanced university degree (MSc or higher) in finance, economics, or business;
- At least 10 years of experience with financial analysis of small-scale electricity supply projects;
- At least three assignments involving capital raising or financial negotiation for mini-grid, solar home systems, or renewable energy projects.

Each of the Key Experts must have the following:

- Good communication skills, full proficiency in English;
- Experience in Vanuatu's rural development sector is desirable.

Ideally, the Consultant should include local experts as well. Additional staff may include more junior team members to support data collection, select analytical tasks, implement projects, etc.

6. Reporting:

The Consultancy firm will report to the DOE's NEMP Project Manager.

ANNEX 5: ToR for Owner's Engineer

TERMS OF REFERENCE

Vanuatu: Owner's Engineering services for the supervision of off-grid electrification projects

[Note: The scope of this consultancy can be integrated partially or fully under the scope of the Program Implementation Consultant]

1. Background

Vanuatu National Electrification Master Plan (NEMP)

The National Energy Road Map (NERM) 2016-2030 and the Implementation Plan (NERM IP) form the overall policy framework for developing the energy sector in Vanuatu. NERM has five priority policy objectives targeting energy that is accessible, affordable, secure and reliable, and sustainable, with green growth. By 2030 it is planned that all households in Vanuatu will have access to an electricity supply. In order to reach this target, the Government of Vanuatu (GoV) has developed the National Electrification Master Plan (NEMP), which will guide improvements and accelerate electrification to achieve universal access for the entire population.

Program Implementation Consultant

[Describe here the scope of the Program Implementation Consultant and its role in relation to the Owner's Engineer to clarify boundaries and ensure smooth coordination]

Procurement process transaction advisor

[Describe here the scope of the transaction advisor and its role in relation to the Owner's Engineer to clarify boundaries and ensure smooth coordination]

Developers under the NEMP

[To describe here the implementation approach, the role of the developers as contractors and future operators under a concession contract]

Context about the selected Service areas

[to be defined here which Service Areas shall be covered as part of the scope of this assignment. It is understood that the NEMP will be implemented in phases and not all the projects art once, so multiple contracts, and therefore also TOR, might be required. Describe the selected projects]

2. Objective of the assignment

The objectives of the consulting services shall be to ensure that the developers awarded for the selected service areas implement the construction projects with a high standard of workmanship and quality, on schedule, and within the budget, in accordance with the specifications and drawings of the contracts, to acceptable environmental and social standards and in accordance with the DoE, URA and DEPC requirements.

The selected Service Areas are:

[…]

3. Scope of Services

The consultancy firm will undertake the following activities:

Task 1. Inception Report

The inception report shall cover, at least:

- Project Team
- Scope: Definition of scope
- Time schedule: Preparing the work plan and identifying tools or templates to be used for stakeholders to follow the construction schedules.

- Quality: Define a quality assurance and control plan.
- Risks: Identification of risks and proposed mitigation measures
- Communication: Description of communication preferences (meeting periodicities, communication platforms
- Stakeholders: Preparation of the stakeholder engagement plan, including government, private sector, donors and NGOs, local authorities and representatives of the communities.

Task 2. Review of designs and specifications prepared by the developer

The Owner's Engineer (OE) shall review the design drawings, Equipment drawings, technical specifications, acceptance test proposals and quality assurance program prepared by the developer, which form the basis of the construction and equipment contract documents, and draft the responses of approval or amendment of the documents for DoE's decision. The OE shall prepare and draft appropriate variation orders of the construction and equipment contracts to incorporate such changes.

The construction drawings shall be reviewed in accordance with contractual conditions. The construction drawings shall clearly impart the final design of the works and shall be revised and supplemented to meet field conditions as the works progress. The OE shall also review layouts and details of temporary facilities to be constructed by the developer. The OE shall draft the responses to approval or revision of the drawings.

Task 3: Construction Supervision, quality control, testing and commissioning and acceptance tests in accordance with the contract documents.

The OE shall assume full responsibility for the contract management and construction supervision of the works performed by the developer. Some of the important functions are:

- Review EPC Contractor's Programs of Work and any changes made thereto during construction for DoE's approval.
- Scrutinize major items of equipment, plant, materials, etc. to be incorporated in the works for DoE's approval.
- Perform tests on materials as and, when required, to confirm the suitability of materials for use in the works.
- Review and confirm the delivery of material to the site
- Supervise the installation of the electrical and mechanical equipment in a satisfactory and safe manner in accordance with the specifications and contract requirements
- Monitor and supervise on site testing and commissioning of all equipment
- Review and confirm the acceptance test proposals made by the developer and conduct the acceptance test including supervision of resolution of possible defects found during acceptance tests to ensure that they meet the requirements and specifications.
- Providing additional technical support to DoE as needed for successful implementation of the EPC Contract.

Task 4: Progress monitoring and contracts management of construction contract

This scope of the OE will include overall monitoring of progress and contracts management of the construction contract. The activities will include but not limited to the following:

- Hold regular meetings with the developer to review and monitor progress, technical issues, and measures to achieve the targeted cost, quality and schedule control of the contracts.
- Monitor the manufacturing and delivery of equipment to ensure smooth and timely completion of the contracts.
- Manage safety, social, and environmental related issues during the construction cooperating with DoE and DEPC.
- Prescribe the format for subsidy payment certificates to the developer.
- Measurement, verification and confirmation of quantity and quality of works completed, which would serve as certification of the progress.
- Prepare, process and issue variation orders with DoE's approval as required.
- Issue stop orders of work with prior approval of the DoE.
- Make recommendations to and draft responses for the DoE to settle claims from the developer.

- Update the procurement and cost of contract works every month
- Prepare a "Completion Report" for the works under the contract, including a summary of final costs.

4. Deliverables:

The Consultant will deliver the following outputs:

Ref	Key Deliverables	Timing
1	Inception Report	2 weeks after the contract signature
2	Monthly Reports	Monthly
3	Technical Reports	As required
4	Final report	1 month after commissioning

5. Qualifications and Experience:

The consultancy firm should possess the following qualifications and experience:

- Experience in design and supervision of construction projects in the Pacific.
- Experience in electrification projects using Solar PV and Batteries.
- Previous experience in Vanuatu

The team requirements are as follows:

Ref	Key Positions
1	Project Manager
2	Electrical Engineer
3	Civil Engineer

Project Manager

The focal point of the project organization is the Project Manager, the principal contact and communication channel with the DoE. He/She shall be a solar expert with international experience. The Project Manager shall have total project responsibility for the work and for providing the requisite leadership, direction, and supervision. The Project Manager shall provide overall technical direction and coordination of the Services. He/She shall be accountable to the DoE for day-to-day performance of the project team including the civil and electrical engineers and shall be vested with sufficient authority to act. He/She shall exercise all standard management functions including planning, scheduling, directing, organizing, and controlling; and shall be involved in key technical activities; and assigned to specific technical tasks to achieve maximum efficiency and benefit to the implementation of EPC contracts lot 1 and lot 2.

The Project Manager shall be a Solar Engineer with 10 years of general experience and 5 years of experience in solar power construction projects in the Pacific. He should be able to communicate fluently in English Language and must be physically fit to carry-out the rigors of the contract in a challenging environment.

The Project Manager shall be based in Port Vila, Vanuatu.

Civil and Electrical Engineer

The Civil & Electrical Engineers shall possess at least 7 years of general experience and 3 years of experience in photovoltaic projects. They will work in close coordination with the Project Manager and shall be responsible for the design and supervision works as required, and shall be responsible for their related fields individually. They must be physically fit to carry-out the rigors of construction supervision in a challenging environment.

6. Reporting:

The Consultancy firm will report to the DOE's NEMP Project Manager.

ANNEX 6: ToR for e-waste management plan

Vanuatu: Consultancy services for the definition of an e-waste management strategy for the Vanuatu National Electrification Master Plan

1. Background

Vanuatu policy framework for electrification

The National Energy Road Map (NERM) 2016-2030 and the Implementation Plan (NERM IP) form the overall policy framework for developing the energy sector in Vanuatu. NERM has five priority policy objectives targeting energy that is accessible, affordable, secure and reliable, and sustainable, with green growth. By 2030 it is planned that all households in Vanuatu will have access to an electricity supply. In order to reach this target, the Government of Vanuatu (GoV) has developed the National Electrification Master Plan (NEMP), which will guide improvements and accelerate electrification to achieve universal access for the entire population.

According to the Vanuatu 2020 National Population and Housing Census, about 78% percent of the population lives in rural areas, and more than 70% of the rural population has little or no access to secure and reliable energy services. Projections indicate that energy consumption in Vanuatu is expected to double by 2030, which has major implications for the economy, the environment, and people's welfare. Energy is a central issue in the Vanuatu National Sustainable Development Plan (NSDP), which at the same time has important goals in social and environmental aspects of development. This directly includes goals in health care, quality education, social inclusion, strong institutions, food and nutrition security, blue/green economic growth, climate and disaster resilience, and natural resource management.

Guiding Principles for the NEMP

Several guiding principles identified by government officials and other stakeholders underpin the development of the NEMP. These principles include the need to use a holistic planning approach to foster cross-cutting benefits, support localization, and ensure that tariffs are affordable for all consumers despite greater costs and lower incomes in under-serviced areas.

One of the major environmental and social risks identified for the NEMP is a large increase in the amount of e-waste generated by renewable energy systems and electric equipment to be purchased over the next decade by households and businesses as electricity is made available in rural areas. This will include a greater flow of used batteries, solar panels, controller systems, meters, and cabling, as well as a wide range of electric and electronic equipment that will be enabled by the NEMP. The GoV is concerned about the impacts of increased electronic waste (e-waste) on people and the environment resulting from electrification and has stressed the need for improved waste management practices.

As part of the NEMP, a Preliminary Environmental Assessment (PEA) has been prepared to minimise adverse environmental, social health and safety impacts of energy infrastructure in Vanuatu. This identifies the key risks associated with expanding electrification in Vanuatu and proposes processes to prevent or mitigate harmful impacts. The Environmental & Social Management & Monitoring Plan (ESMMP) is to be developed as part of the recommended PEA procedures to ensure that potential adverse environmental and social impacts of the NEMP sub-projects are avoided, minimized, mitigated, or offset during the rollout. An Environmental and Social Safeguards (ESS) officer will be appointed under the supervision of the Department of Environmental Protection & Conservation (DEPC) to ensure that ESMMP is carried out for NEMP as a whole and for all sub-projects as the program rolls out.

Vanuatu´s waste management

In general, access to proper waste collection and disposal facilities in Vanuatu is limited, leading to environmental degradation and health risks. Waste management practices in the country are inadequate, relying primarily on burying, burning, dumping, and landfilling methods. As of the latest Vanuatu waste disposal and recycling audit, e-waste represents less than 5% of total municipal solid waste (which refers to waste from the public, typically managed by local governments and excluding commercial/business waste). E-waste management regulations are being developed by the Government of Vanuatu.

At the time of the latest audit report in August 2023, there were four waste facilities, and RecycleCorp was the only recycling aggregator in Vanuatu. The company recovers 656 tonnes of waste annually, targeting materials such as aluminium, copper, nonferrous metals, glass, e-waste, and used lead-acid batteries.

However, none of the four facilities, including RecycleCorp, meet the standards for modern waste management facilities and are classified as 'unregulated'. This classification indicates that the facilities lack proper leachate management and do not use daily cover, posing significant environmental and health risks due to contamination and uncontrolled material flow. Additionally, the lack of daily cover at landfill sites makes them highly vulnerable to material displacement during climate-related events, such as cyclones.

Pacific region policy framework

PacWastePlus is a project funded by the European Union (EU) and the Secretariat of the Pacific Regional Environment Programme (SPREP). Vanuatu is one of fifteen Pacific Island nations participating in the PacWastePlus Programme. The program aims to enhance waste management practices across the islands, building the capacity of governments, industries, and communities to manage waste sustainably and cost-effectively while protecting human health and the environment. This assignment shall align with SPREP initiatives in the region.

2. Objective of the assignment

The primary purpose of this assignment is to provide a strategy and tools to improve e-waste management practices in Vanuatu. This project will be done in parallel with implementing the NEMP to mitigate the long-term environmental and social risks of renewable energy systems as well as electric equipment (white goods) to be purchased. The purpose is also to equip the appointed ESS officer with the methodology and tools to support the implementation of the ESMMP regarding e-waste management.

3. Scope of Services

The consultancy firm is expected to address recommendations and guidelines at four stakeholder levels involved in e-waste management: 1) Government agencies with policy advice, 2) Private actors to be involved in the NEMP implementation, 3) Waste facilities, and 4) Local actors/communities. Indeed, in addition to the existing waste management challenges, Vanuatu might need to invest in infrastructures, implement data-driven decision-making, and increase public awareness of e-waste management to manage the anticipated e-waste from NEMP effectively.

The consultancy firm will undertake the following activities:

Inception Report

- Definition of scope
- Preparation of the work plan
- Preparation of the stakeholder engagement plan including government, private sector, donors and NGOs and local authorities/communities

Output: Should contain a stakeholder engagement plan with and work and implementation plan

Desktop review and gap identification

- Review existing policies and procedures at the national level and regional level
- Review existing waste audits at the national level
- Review existing business models and initiatives at the regional level, particularly those related to advance and recovery fee deposit models, to see if they can be adapted and replicated in Vanuatu specifically for e-waste.
- Mapping of the existing waste facilities in Vanuatu and at the regional level. Provide a case study on the most advanced waste facility in Vanuatu including challenges identified in handling e-waste management in the country.

Output: Report characterizing the starting point, identifying findings and major gaps among the existing policy and regulatory framework, existing facilities, and ongoing projects in Vanuatu, and present best practices from abroad (preferably from the Pacific region) that could be applicable to Vanuatu.

E-waste management framework

- Assist GoV and ESS Officer in developing a national E-waste Management Policy to cover NEMP and other e-waste needs in the country. The draft model in SPREP's "Management of e-Waste in the Pacific: A Regional Strategy and Action Plan" may serve as a starting point.

- Assist DOE and ESS Officer in updating the VREP Code of Practice for Health and Safety to cover all aspects of electrification work. This must also include health risks to workers in contact with e-waste and, use of personal protective equipment (PPE) (see PacWastePlus Programme).
- Suggest clauses to be integrated into concession and license contact templates to be used by the future private operators/developers that ensure:
    - Developers/contractors will follow the best e-waste monitoring and management practices established in the Code of Conduct.
    - Private actors/developers will consider the risks associated to e-waste generation during construction and operations.
    - Private actors/developers will include plans for the storage, removal or recycling of wastes associated with electrification (including end-of-life white goods).
- Propose business models and financial mechanisms such as advance and recovery fee deposits for e-waste management in Vanuatu.
- Provide recommendations on how to upgrade existing unregulated facilities to align best practices and present investment opportunities.

Outputs: Address gaps in the existing policies and procedures and provide advice on policies, business models and infrastructure adaptation plans to ensure that NEMP will be implemented with a framework that includes e-waste management.

E-waste projections in Vanuatu and monitoring tools

- Conduct an audit on e-waste and waste disposal facilities in Vanuatu, following PacWastePlus's methodology (Data Collection Monitoring and Reporting Framework).
- Provide detailed forecasts for e-waste generated over the span of 20 years, specifically for e-waste to be generated by the NEMP implementation (renewable energy systems and white goods).
- Design methodology to standardize e-waste computation, assessment, and monitoring for developers/contractors' part of the NEMP.
- Integrate data collection and monitoring standardized tools into ESMMP

Output: Provide a full picture of the e-waste situation and waste management capacity in Vanuatu, as well as a detailed projection of e-waste to be generated by the NEMP.

Final report: Recommendations and guidelines on e-waste management strategy

- Recommendations and guidelines are expected on:
    - E-waste computation, data collection, projections, monitoring and reporting in Vanuatu
    - Policy and regulations
    - Business models and financial mechanism
    - Capacity building and training to raise public awareness about e-waste management for the Vanuatu local actors and communities

Outputs: Consolidate recommendations and guidelines at the different level of actions to structure the e-waste management strategy in Vanuatu. Provide capacity building to DEPC, DOE and ESS officer.

4. Deliverables:

The Consultant will deliver the following outputs:

Ref	Key Deliverables	Timing
1	Inception Report	Month 1
2	Desktop review and gaps identification	Month 2
3	E-waste management framework	Month 5
4	E-waste projections in Vanuatu and monitoring tools	Month 6
5	Final report: Recommendations and guidelines for e-waste management strategy	Month 7

5. Qualifications and Experience:

The consultancy firm should possess the following qualifications and experience:

- Expertise in waste management practices, and financial mechanisms, particularly in electronic waste, is mandatory.
- At least one team member with a degree in environmental science, social sciences, geography, or similar is mandatory.
- Experience in projects in the Pacific islands, island context, and/or developing countries
- Familiarity with recycling processes and environmental impacts of e-waste.
- Experience in environmental impact assessment, community consultations or related fields
- Experience in developing or advising on environmental policies, particularly related to e-waste management and recycling.
- Proficiency in relevant software for report production and data and information management (such as Microsoft Word, Excel, PowerPoint). Experience in developing information materials is an advantage.

6. Reporting:

The Consultancy firm will report to the DEPC EIA Officer and consult the DOE's NEMP Project Manager.

ANNEX 7: PEA CHECKLIST

[This annex proposes a template to be used by DEPC as checklist for the Preliminary Environmental Assessment Report]

PRELIMINARY ENVIRONMENTAL ASSESSMENT REPORT

This report is prepared for the purpose of section 14(2) of the *Environmental Protection and Conservation Act* [CAP 283]

1. Background information

DEPC REFERENCE NUMBER:

APPLICANT:

PROJECT NAME:

LOCATION:

PROVINCE:

PROPERTY OWNERSHIP: ☐ Lease ☐ Custom ☐ In the process of acquiring land

TYPE AND PURPOSE OF PROJECT:

2. The current environment

Y—Impacts may occur / **N—**Not present or no significant impacts would occur **/ N/A—**Not applicable

CURRENT ENVIRONMENT	Y/N/NA	DOES THE APPLICATION ADEQUATELY DESCRIBE THIS? IF NO, HAVE YOU REQUESTED ADDITIONAL INFORMATION? IF YOU'RE NOT SURE, HAVE YOU CONSULTED OTHER AGENCIES FOR ASSISTANCE?
Sensitive or fragile habitat Is the project site located on or close to the sea? Is the project site located on or close to a river, stream or wetland? Is the project site located in, close to or include a conservation area or water protection zone? Does the project involve a dam or hydroelectric development?		
Existing vegetation Is the local vegetation mainly: Mangroves? Swamp or coastal vegetation or forest? Established forest/ dark bush? Modified or agricultural land? If project is coastal, are there colonies of coral or reef, seagrass beds?		

CURRENT ENVIRONMENT	Y/N/NA	DOES THE APPLICATION ADEQUATELY DESCRIBE THIS? IF NO, HAVE YOU REQUESTED ADDITIONAL INFORMATION? IF YOU'RE NOT SURE, HAVE YOU CONSULTED OTHER AGENCIES FOR ASSISTANCE?
Existing fauna What animal and bird species use, are present on or close to the project site (e.g. megapode nesting sites, flying fox roost)? What fish and marine species are present on or close to the project site (e.g. turtle nesting sites)? Are there important or endangered species in the area of the project?		
Existing land uses What is the current land use of the site? What are the neighbouring land uses? Will any fishers (including women and gleaning) be affected by the project?		
Existing settlement and social environment Are there existing homes, settlements or other activities present on or adjacent to the project site? Is the area culturally or archaeologically sensitive?		
Existing cultural environment Is the area culturally, traditionally or archaeologically sensitive? Is there a taboo ples on or close to the project site? Is there a natural heritage site on or close to the project site?		
Stakeholder engagement plan Is there a stakeholder engagement plan for the entire project?		
Gender equality, disability and social inclusion (GEDSI) How are the needs of women and people with disabilities being considered in project design? Were they involved in the design? Have women's and other groups been consulted on the project? What were their concerns? Has a grievance mechanism been established as part of the project? What kind iof stakeholder engagement plan is in place?		

3. Environmental, social and cultural impacts of the project during construction and operation

IMPACTS OF PROJECT CONSTRUCTION	Y/N/NA	DOES THE APPLICATION MANAGE PROJECT CONSTRUCTION TO MINIMISE IMPACTS? ANY ADDITIONAL REQUIREMENTS?
Ecosystem functions and services Will construction involve working in a conservation area or water protection zone? Will construction involve clearing vegetation, including mangroves? Will construction affect animals and birds, including important or endangered species? Will construction involve introducing or removing foreign organisms or species?		
Siltation, erosion, pollution or other damage Will construction involve discharges to freshwater, wetlands or coastal waters? Will construction involve extraction of materials from rivers or disturbance of the near-shore area? Will there be stockpiles of project materials on site during construction? Will dumping of spoil or removal of timber and vegetation, rock or soils affect land stability? Will the immediate or downstream effects of construction affect marine species, fisheries resources or marine habitat? Will the immediate or downstream effects of construction impact on coastal areas (beaches, seabed, coral reefs, and sea grass beds) rivers, streams, wetlands or drinking water sources? Will the immediate or downstream effects of construction change or modify the existing habitats?		*Consideration must also be given to the potential for amplification of minor impacts by storms or tidal effects.*
Waste management Will waste products be treated / disposed of onsite? Will any waste products be treated or disposed of offsite?		
Hazardous materials Will construction involve any hazardous substances (including pesticides, fertilizers, petrol, oils, tar, paints or industrial chemicals) to be used or stored on site?		
Noise Will construction require the use of heavy or noisy machinery or equipment?		
Dust, smoke or odours Will the project construction cause dust?		

IMPACTS OF PROJECT CONSTRUCTION	Y/N/NA	DOES THE APPLICATION MANAGE PROJECT CONSTRUCTION TO MINIMISE IMPACTS? ANY ADDITIONAL REQUIREMENTS?
Will there be any burning of materials on site during construction?		
Traffic What are impacts on local traffic from construction? Will workers be accommodated on the site?		
People and livelihoods Will construction require people to move out of their houses or businesses? Will construction affect people's gardens or access to their land, homes or work? Will construction affect any fishing or gleaning operations? Are local authorities being consulted for the use of local workers on the project? Is there a Health and Safety Plan for workers and the public?		
Other Will there be other impacts from project construction? Will there be a need to repair environmental damage following completion of construction (include expected costs)?		

IMPACTS OF PROJECT OPERATIONS	Y/N/NA	DOES THE APPLICATION MANAGE PROJECT OPERATIONS TO MINIMISE IMPACTS? ANY ADDITIONAL REQUIREMENTS?
Ecosystem functions and services Will operations involve ongoing activities in a conservation area or water protection zone? Will operations affect animals and birds, including important or endangered species? Will operations involve introducing or removing foreign organisms or species?		
Waste products Will operations generate: sewerage, solid wastes, rock or soil wastes, chemically contaminated waste or hazardous materials? Will operations involve discharges to freshwater, wetlands or coastal waters?		
Waste treatment Will waste products be treated / disposed of onsite? Will any waste products be treated or disposed of offsite? Will the project or waste treatment and disposal affect the quality of local streams		

IMPACTS OF PROJECT OPERATIONS	Y/N/NA	DOES THE APPLICATION MANAGE PROJECT OPERATIONS TO MINIMISE IMPACTS? ANY ADDITIONAL REQUIREMENTS?
or ground water through sedimentation, erosion or contamination?		
Hazardous materials Will any hazardous substances (including pesticides, fertilizers, petrol, oils, tar, paints or industrial chemicals) be used or stored in the project area?		
eWastes Will the project generate the need for a storage location for e-Wastes? Is there an eWastes and whitegoods storage and recycling facility established for this project? Details. Has a public awareness programme been designed to educate people on how to handle eWastes and other hazardous wastes?		Has a storage site been located? Where? Is there a management plan for handling the wastes, protecting people and recycling?
Noise Will there be ongoing noise from operations?		
Dust, smoke or odours Will operations create any dust, smoke or odour? Will there be any other emissions from the operations?		
Traffic Will operations result in increased vehicle movements? Has there been provision for parking and supply loading and unloading?		
Environmental risks Is the project likely to be affected by a rise in sea level, earthquake or landslip, cyclones or severe storms, floods or droughts? What ratings for earthquakes and cyclones is the construction designed to withstand?		
Environmental monitoring What steps will be required to ensure that operations are not impacting the environment?		

4. Consultation

CONSULTATION	
Who has been consulted as part of this PEA?: ☐ Lands ☐ Geology and Mines ☐ Water ☐ Forestry ☐ Fisheries ☐ Public Works ☐ Maritime Regulator ☐ Tourism ☐ Environmental Health ☐ Internal Affairs (Physical Planning Unit) ☐ NDMO ☐ Biosecurity Vanuatu ☐ Agriculture/Livestock ☐ Municipality ☐ Provincial Government ☐ Local community ☐ Other	*Can be by DEPC or the applicant*
Are there any other interested persons (e.g. custom landowners, public) that should be consulted? **Note:** Consultation should occur before any approval is given for the project.	
When did you visit the site? Who accompanied you?	

5. Alternatives considered (e.g. alternative sites):

6. Magnitude and significance of potential impacts:

☐ LOW ☐ MEDIUM ☐ HIGH

(NB: This takes mitigation and conditions into account)

7. Any other relevant information for assessment: *Include additional information requested and provided.*

8. Recommendation (tick one):

☐ **Grant permit**, no EIA report required but the following conditions should be attached to the permit:

1.

☐ **EIA report required** (draft TOR attached)

- ☐ **Permit refused**, for the following reasons:

PEA report prepared by: Name: Signature:	**Date**:

Section below to be completed by Director of the Department of Environmental Protection and Conservation only

9. Recommendation:

☐ Accepted

☐ Not accepted

If recommendation is not accepted, provide reasons why:

(E.g. further information or study required by applicant; the project is located within a declared water protection zone that probibits this type of project; the project is inconsistent with a community conservation area management plan etc.)

Name: _____ **Signature:** _____

ANNEX 8: Reporting template

[This annex provides an example of how the Reporting Template from the Electricity supplier to the regulator can be structured. Ideally, the reporting procedure should be channelled through a digital form that facilitates both the reporting process by the Electricity supplier and the data postprocessing by the regulator]

APPLICANT DETAILS

Electricity supplier details:

Name: _____

Contact Person:

Name: _____
Position: _____
ID: _____
E-mail: _____
Address: _____
Telephone: _____

SERVICE AREA

The Service Area cover the following community/ies.

Province: _____
Village/s: _____

REPORTING PERIOD

The information contained in this report covers the period from

Initial date: Day: _____ Month: _____ Year: _____

End date: Day: _____ Month: _____ Year: _____

KEY PERFORMANCE INDICATORS

Electricity suppliers offering Electricity Service. This section shall be filled only by those Electricity suppliers offering Electricity Service. The information shall be extracted from the Electricity supplier's monthly performance reports.

#	Key Performance Indicator	Unit	Frequency	Month												TOTAL
				1	2	3	4	5	6	7	8	9	10	11	12	
ELECTRICITY SERVICE - GENERAL																
1	**Generation.** Total electricity generation (only for CES)	kWh	Monthly													
2	**RE Generation.** Electricity generation from renewable sources (only for CES)	kWh	Monthly													
3	**Renewable Fraction**. Renewable share of total electricity generation (only for CES)	%	Monthly													
4	**Connectivity Potential**. Total number of potential customers within the Service Area (including households, businesses and institutions).	Unit	Quarterly													
5	**Complaints.** Total number of customer complaints (If any, please provide details in following section).	Unit	Monthly													
6	**Unsolved Complaints.** Total number of unsolved customer complaints	Unit	Monthly													
7	**Health and Safety incidents** (If any, please provide details in following section).	Unit	Monthly													
8	**ARPU.** Average Revenue Per User. Total yearly revenues / customers	PGK	Yearly													
9	**Customer Bill Collection Rate**. Revenues collected / Total Services billed	%	Yearly													
ELECTRICITY SERVICE - PARTICULAR*																
X.1	**Customers.** Number of customers at the beginning of quarter	Unit	Quarterly													
X.2	**Reliability.** Number of days of service for each client	days/month	Monthly													
X.3	**Complaints.** Number of user complaints	Unit	Monthly													

(*) These indicators shall be provided for each type of electricity service offered (1 table for each). An electricity service is defined by the Capacity package, availability level, reliability level and power quality level (example: Electricity service 1 with Package 2 + Availability C + Reliability 2 + Power quality II).

Electricity suppliers offering End-Use Service. This section shall be filled only by those Electricity suppliers offering End-Use Service. The information shall be extracted from the Electricity supplier's monthly performance reports.

#	Key Performance Indicator	Unit	Frequency	Month												TOTAL
				1	2	3	4	5	6	7	8	9	10	11	12	
END-USE SERVICE - GENERAL																
1	**Generation.** Total electricity generation (only for CES)	kWh	Monthly													
2	**RE Generation.** Electricity generation from renewable sources (only for CES)	kWh	Monthly													
3	**Renewable Fraction**. Renewable share of total electricity generation (only for CES)	%	Monthly													
4	**Connectivity Potential**. Total number of potential customers within the Service Area (including households, businesses and institutions).	Unit	Quarterly													
5	**Complaints.** Total number of customer complaints (If any, please provide details in following section).	Unit	Monthly													
6	**Unsolved Complaints.** Total number of unsolved customer complaints	Unit	Monthly													
7	**Health and Safety incidents** (If any, please provide details in following section).	Unit	Monthly													
8	**ARPU.** Average Revenue Per User. Total yearly revenues / customers	PGK	Yearly													
9	**Customer Bill Collection Rate**. Revenues collected / Total Services billed	%	Yearly													
END-USE SERVICE - PARTICULAR**																
X.1	**Customers.** Number of Customers served with the appliance	Unit	Quarterly													
X.2	**Appliances.** Number of appliances at the beginning of quarter	Unit	Quarterly													
X.3	**Complaints.** Number of customer complaints	Unit	Quarterly													
X.4	**Inspections.** Number of inspections	Unit	Quarterly													
X.5	**Replacement.** Number of replaced appliances	Unit	Quarterly													

(**) These indicators shall be provided for each type of appliance and service offered (1 table for each). Example 1: LED lights.

COMMENTS

Customer complaints. Please provide further details on the nature and status of Complaints during the reporting period.

Health and Safety incidents. Please provide further details fo major incidents occurred during reporting period.

Service interruptions. Please provide further details on any major service interruptions during the reporting period.

Tariffs. Please provide details on any changes to the tariffs during the reporting period.

Unforeseen Hardship. Please provide details on any impact to the Electricity supplier due to unforeseeable events such as extreme weather events, vandalism, theft, etc.

Others. Please indicate below any information you would like the Regulator to be aware of.

CHANGES THE IN BOUNDARIES OF LICENSED SERVICE AREA [If applicable]

The Electricity supplier intends to extend/constrain the extension of the Service Area.

☐ Yes ☐ No

Any request from the Electricity supplier to the Regulator to propose a change to the geographical boundaries of the Service Area shall enclose an accurate depiction of the previous and the proposed new boundaries.

Justification:

_____

_____

_____

_____