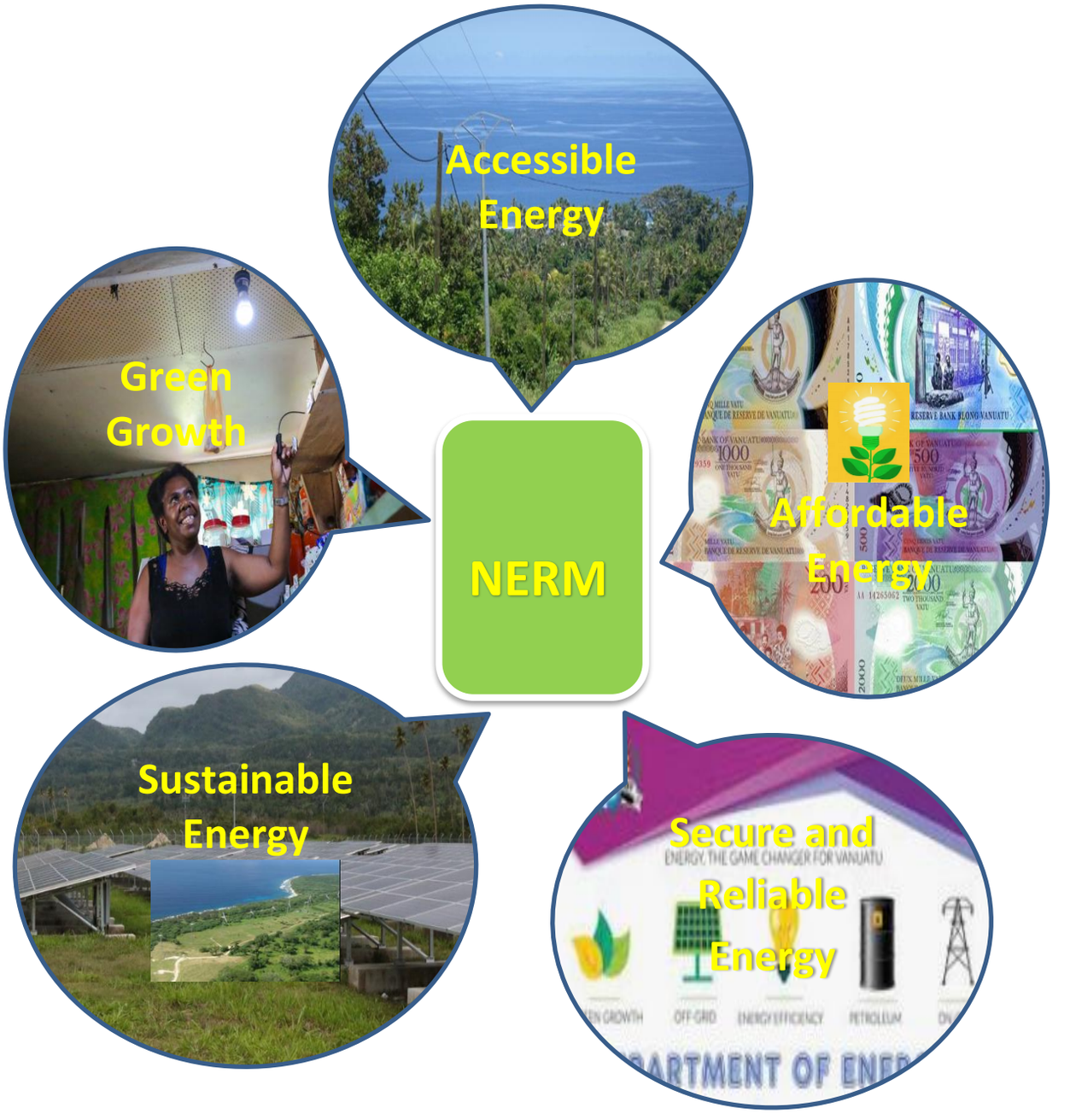
Vanuatu National Energy Road Map (2016 - 2030)

Implementation Plan

July 2019

Vanuatu National Energy Road Map (2016 - 2030) Implementation Plan (NERM-IP) and NERM Monitoring, Varification and Evaluation Plan

Priorities


Accessible Energy
Green Growth
NERM
Affordable Energy
Sustainable Energy
Secure and Reliable Energy
ENERGY, THE GAME CHANGER FOR VANUATU
OFF-GRID
ENERGY EFFICIENCY
PETROLEUM

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ACRONYMS

BRANTV	Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu
DoE	Department of Energy
GEF	Global Environment Facility
GGGI	Global Green Growth Institute
GPOBA	Global Partnership for Output-Based Aid (Grid Based Electricity Access Project)
GoV	Government of Vanuatu
IP	Implementation Plan
IPPs	Independent Power Producers
MoCC	Ministry of Climate Change and Natural Disasters
MRV	Measurement, Reporting and Verification
M&E	Monitoring and Evaluation
NERM	Vanuatu's National Energy Roadmap
NDC	Nationally Determined Contributions
NGEF	National Green Energy Fund
NERM-IP	Vanuatu's National Energy Roadmap – Implementation Plan
RE	Renewable Energy
ToR	Terms of Reference
VNSO	Vanuatu National Statistics Office
VREP	Vanuatu Rural Electrification Programme
UNDP	United Nations Development Programme

EXECUTIVE SUMMARY

The updated National Energy Road Map Implementation plan (NERM-IP) has been developed by the Department of Energy with technical support from the Global Green Growth Institute. It aims to update and prioritise the energy projects that will strategically contribute to achievement of the Vanuatu National Sustainable Development Plan (NSDP), Peoples Plan (2016-2030) goals and the National Energy Road Map (NERM) 2016-2030 targets. For this purpose, project prioritisation criteria were developed and approved by the Department of Energy which were used for the NERM-IP and will also help the Department staff to assess and prioritise future projects. The national energy targets as articulated in the NERM and the current and future project pipelines developed and approved using the agreed criteria in this document now forms the basis of the Government's negotiations for external development financial support.

While the Department of Energy noted past difficulties encountered in accessing domestic and external funding for energy projects, the recent approval and establishment of the National Green Energy Fund (NGEF) marked a milestone in Vanuatu's energy sector development, opening up a new financing stream for the sector. The Government is committed to the future of the NGEF and its potential to mobilize domestic and external sources of funding for development and implementation of sustainable energy projects and programs. The NGEF will contribute towards implementation of the NERM-IP and realisation of the NSDP and NERM targets.

The NERM-IP includes a total of 12 indicators to measure progress and has targets defined both for 2020 and 2030. In the priority Accessible Energy, there is excellent progress with the electrification of households and the 2020 targets have been or will be achieved. Electrification of public institutions is behind schedule. In the priority of affordable energy, the target efficiency of diesel generation will not be achieved in 2020. However, due to the ambitious target of 100% electricity from renewables, the validity of this target should be reconsidered.

In sustainable energy, the share of electricity generated from coconut oil has seen a sharp decline and was 0% in 2017 due to hike in coconut oil prices. However, there has been diversification of the renewable energy mix with solar generation added to the grid electricity mix from 2016 onwards. For the other indicators under this priority, further work on defining monitoring procedures is required. In the priority Green Growth, the share of coconut oil has been at 0% in 2017, but renewable energy (RE) use by rural tourism bungalows is above the target. The progress towards achieving these targets is summarized in Table 6.

Based on the progress up to now and the NERM targets defined for 2020 and 2030, existing and new additional measures required for achieving the targets were identified and discussed with stakeholders, both in workshops and bilateral meetings. These activities have been ranked by applying a set of prioritization criteria developed with and approved by a wide group of stakeholders. The activities (projects) were then included in the updated NERM-IP which can be found in Annex I.

In line with GoV's decentralization policy for supporting the development of all the 6 provinces and town municipalities, it is essential to decentralize the efforts of the NERM and to better integrate provincial governments and municipalities in the NERM-IP implementation.

Mainstreaming of the NERM-IP into Provincial Governments and Municipalities Development Strategies was also carried out as part of the NERM-IP review and updating. A sustainable energy strategy and action plan for the local administrative bodies (Provincial Governments and

Municipalities) has been developed (Section 4.5). Recommendations on the follow-up strategy by DoE to support the municipal and provincial stakeholders to implement the action plan is also included in the action plan.

The updated Vanuatu National Energy Road Map 2016-2030 defines a robust Monitoring, Verification, and Evaluation Plan (MRV) to monitor the status and progress for the NERM actions. The objectives, quantitative targets, and implementation plan under the NERM sets the framework for DoE to monitor and evaluate NERM implementation.

Based on the integrated MRV tool that has been developed for Vanuatu's NDC goal tracking, a standalone MRV tool has also been developed to monitor and track the progress of NERM priorities, goals, and indicators. The NERM-MRV tool allows DoE to remain up-to-date with implementation progress and gives more opportunity to address implementation challenges and issues encountered. A comprehensive capacity building and hands-on training program have been initiated for the stakeholders on the NERM- MRV tool.

The Department acknowledges the support of GGGI for developing this document and the BRANTV Project, funded by GEF and UNDP, for funding the NERM-IP validation workshop and contribution towards printing of this document.

1 INTRODUCTION

Vanuatu's National Energy Roadmap (NERM) 2013-2020[1] was published in 2013 and provided the vision *"To energise Vanuatu's growth and development through the provision of secure, affordable, widely accessible, high quality, clean energy services for an Educated, Healthy, and Wealthy nation."* The five energy sector priorities were access, petroleum supply, affordability, energy security, and climate change.

In 2015-2016 the GGGI, in collaboration with the World Bank, provided technical assistance to Vanuatu's Ministry of Climate Change (MoCC) to revise the NERM. The updated NERM 2016-2030[2] was completed and launched in 2016.

It has identified five strategic areas for policy intervention in the energy sector, which include:

- **Accessible energy,**
- **Affordable energy,**
- **Secure and reliable energy,**
- **Sustainable energy and**
- **Green Growth.**

The updated version of the NERM included the following aspects:

- **Priorities and objectives**: Re-frames the NERM priorities to reflect desired outcomes for Vanuatu's energy sector and to incorporate new areas of emphasis.
- **Progress**: Provides an update on how well Vanuatu is meeting the targets (and what progress might look like by 2020 and 2030).
- **Targets**: Sets 2030 targets for targets that previously only had targets for 2015 and 2020, and adds new targets to help catalyse faster progress in particular areas.
- **Implementation Plan**: Refines and adds actions needed to achieve the updated targets and objectives.

The Government of Vanuatu has requested GGGI to provide further assistance to the Department of Energy (DoE) in updating the NERM Implementation Plan (NERM-IP), which is a key component of the NERM 2016-2030 and is included in Annex B of the NERM.

The NERM-IP lists key activities aiming at achieving the targets of the NERM. The updated NERM-IP will be used by the Government, energy suppliers, and development agencies as it will serve as a guide for alignment of resources, programs and activities with national energy priorities.

[1] http://prdrse4all.spc.int/system/files/vanuatu_energy_roadmap_2013.pdf
[2] http://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/Updated%20Vanuatu%20National%20Energy%20Road%20Map%202016-2030_1.pdf

2 DEVELOPMENT OF NERM PRIORITIZATION CRITERIA

2.1 METHODOLOGY USED FOR PRIORITIZATION CRITERIA AND SCORING

The NERM-IP includes a long list of projects and activities contributing to achieving the various targets of Vanuatu's NERM. Based on discussions with key stakeholders, the list of projects was updated. Already implemented projects were separated, projects which are considered as not relevant were removed and new interventions were added (see chapter 3 for details).

As part of the preparation of the National Green Energy Fund (NGEF), a total of 21 prioritization criteria were identified for selecting relevant and financially viable projects. The criteria were split into two categories, non-financial and financial, with financial criteria playing an important role due to the aim of the fund to maintain its investment capital.

Table 1: Non-financial criteria NGEF

Gender impact*	Increased benefits for women	High score - mostly women benefit Low score - mostly men benefit
Productive purpose*	Productive use of energy rather than consumptive	High score - mostly productive Low score - mostly consumptive
Rural area*	Rural focus regions of higher priority than urban areas	High score - rural focus Low score - urban focus
Inclusiveness*	Increased benefits for the most vulnerable	High score - targets the vulnerable Low score - targets non-vulnerable
Innovative technology*	With demonstration and developmental impacts	High score - an innovative concept Low score - little innovation
Outer island*	Increased benefits for those living in outer islands	High score - targets outer islands Low score - targets Efate, Santo
Potential to scale*	High scale-up potential to reach many beneficiaries	High score - can reach many Low score - only serves a few
Priority industry*	For the promotion of certain industries or sectors	High score - helps target industry Low score - helps other industries
Priority technology*	For the promotion of certain types of technologies or projects	High score - helps target tech Low score - helps non-target tech
Environmental / social benefit*	For projects of high compliance with E&S safeguards	High score - high E&S compliance Low score - Low E&S compliance
Readiness to build	Time is taken to develop and construct the project	High score - can implement soon Low score - takes years to develop
Off-grid area	Increased access to energy in off-grid, not on-grid, areas	High score – off-grid project Low score - on-grid project
Low income	Focus on low-income populations	High score - low-income beneficiaries

Table 2: Financial criteria NGEF

Type of capital requested*	Debt, equity, grant finance requested, or a blend	Not included directly in scoring, but grants are of lower interest than debt or equity
Loan term, years	If not requested, estimated from the project simple payback period	Not included in scoring as already captured by simple payback period
Simple payback period, years	Calculated from estimated revenue and cost assumptions	High score - short payback Low score - long payback (grants = 0)
Pre-interest debt service coverage ratio	The ratio of net annual revenue to capital repayments on the loan	High score - high ratio Low score - low ratio
Value for money*	NGEF capital divided by total number of beneficiary households/businesses	High score - low USD per beneficiary Low score - high USD per beneficiary
Co-finance mobilization ratio	The ratio of non-NGEF funding mobilized as capital expenditure compared to NGEF funding	High score - high ratio Low score - low ratio or zero
Revenue mobilization ratio	The ratio of customer revenue funds mobilized compared to NGEF funding	High score - high ratio Low score - low ratio or zero

Consultations with the Department of Energy and country GGGI team clarified that a revised set of criteria should be applied for the NERM-IP. It was agreed to have a set of criteria that is more focused, realistic and implementable for the DoE considering its current capacity and experience in project delivery. The NGEF criteria are a good starting point, as there are linkages already with the NERM, National Sustainable Development Plan (NSDP) and other national policies, e.g. gender inclusion.

Based on the initial input received from DoE and discussions with GGGI, an initial list of criteria to be applied for prioritisation of interventions was prepared. The list included criteria, description and an argumentation why the criteria are relevant. The initial list included:

Table 3: Initial list of prioritization criteria

Criteria	Description	Argumentation
Scale/potential to scale	High scale-up potential to reach many beneficiaries	Important to reach scale in order to have a sizeable contribution to NERM target.
Potential for replication	High potential for replication	Successful interventions can be replicated, so proven concepts can be applied again, which reduces efforts for further activities.
Private sector involvement	Opportunities for private sector involvement	Business opportunities for the private sector, reduce the need for public funds, as the private sector has the interest to increase and expand its services in the energy sector.
Readiness to build / commercial maturity of the technology	Time is taken to develop and construct the project	Interventions with short preparation time are preferred, as results will be easier to achieve.
Social inclusion and gender impact	Increased benefits for women and the most vulnerable	Making sure women and vulnerable groups receive special attention.
Environmental safeguards	Compliance with environmental safeguards	Potential impacts on the environment and safeguards need to be taken into account.
Community/Beneficiary Involvement	Creating ownership among communities/beneficiaries	Ensuring long term sustainability of the intervention
Off-grid areas	Increased access to energy in off-grid areas	Increasing energy access in off-grid areas is a key target of the NERM.
Simple payback period	Calculated from estimated revenue and cost assumptions	As it is usually challenging to estimate revenues and costs, simple payback is sufficient for ranking of activities.

As for the weighting to be applied to the criteria, there is basically two types of weighting schemes which can be applied:

- **Balanced weighting**: each of the criteria receives same/similar weighting. This is a valid approach if the list of criteria has been reduced to key criteria and each criterion has the same importance as the other criteria.
- **Preferential weighting**: certain criteria are considered having higher importance, therefore receiving higher weighting. This can be used to give more relevance for example to impact (scale, gender, etc) or financial criteria.

The different scoring and ranking types were presented and discussed at a stakeholder's consultation workshop held in Port Vila (Melanesian Hotel Conference Room) on 19 February 2019.

2.2 ASSESSMENT OF CRITERIA AND WEIGHTING

During the workshop, an interactive session and group exercise was held on NERM Prioritization Criteria. As in input for the discussion and group work, the prioritization criteria used for NGEF projects were presented to the participants. The process of defining the initial list of suggested prioritization criteria together with argumentation for the criteria to be applied was explained to the stakeholders. Based on these inputs, stakeholders were invited to form groups by priorities of the NERM. The four groups were:

- **Accessible energy**
- **Affordable energy**
- **Sustainable energy**
- **Green growth**

There was no separate group for secure and reliable energy, as there is no specific indicator to be monitored and the topic is covered by the other priorities.

There were two key questions given to the Groups to brainstorm and discuss among themselves which included:

- What criteria should be applied to prioritize interventions under the NERM?
- How should the prioritization criteria be weighted?

After the group discussion, group leaders reported to the plenary, followed by a discussion by all participants.

The following inputs were given by stakeholders on the topic of criteria to be applied:

- **Sustainability**: The sustainability of interventions is a key criterion to achieve long-term targets such as the 2030 targets under the NERM. It is necessary to make sure interventions implemented are working and are sustainable over a long period of time (ideally 20 years),

this also includes considering maintenance (such as replacement of batteries in solar home systems). Therefore, the criterion of sustainability should be added.

- **Scale and replication**: These are very similar criteria and should be merged into a single criterion.
- **Readiness**: All technologies considered to be applied in Vanuatu are ready for implementation, therefore the criterion readiness is not relevant and should be deleted.
- **Off-grid**: as the target in the NERM is to provide 100% of electricity access in off-grid areas, there is no need to focus on off-grid. This criterion should be deleted.
- **Environmental safeguards**: All projects to be implemented need to be compliant with environmental safeguards both of the Government of Vanuatu and donors, which makes this criterion less relevant. However, it is important to mention compliance with environmental safeguards, therefore, this criterion will be kept.
- **Simple payback period**: This criterion should be expanded to make sure also the economic status/purchasing power of consumers to pay for and maintain technologies is considered.

The inputs were considered in the final list of criteria, which can be found in the following chapter. The following inputs were given by stakeholders on the topic of weighting to be applied:

- Overall, stakeholders saw the majority of criteria equally important. This suggests equal weighting for all criteria.
- Criteria, which were seen as less important or not important (e.g. focus on off-grid) were removed.
- Some stakeholders saw the financial criterion as the most important factor. However, this was not the view of all stakeholders.

As a result, it was decided that all criteria should receive equal weighting. With 7 criteria and 100 points, this would give 14.3 points for each criterion. To have whole numbers, all criteria were given 14 points, except the financial criterion, which received 16 points.

2.3 FINALISED CRITERIA AND WEIGHTING

The finalised criteria and weighting are as follows:

Table 4: Finalized criteria and weighting

Criteria	Description	Argumentation	Weighting in %
Sustainability	Interventions are working and are sustainable over a long period of time (ideally 20 years)	Interventions need to deliver contributions over long periods of time to be relevant for the NERM targets. The lifetime of technologies needs to be taken into account when applying this criterion. Batteries or cook stoves, for example, have a lifetime shorter than the envisaged 20 years and replacements will be necessary to achieve full sustainability.	**14**
Scale/potential for replication	High scale-up and replication potential	Important to reach scale or achieve replication in order to have a sizeable contribution to NERM target. renewable energy projects with more than 1 MW or electrification projects covering more than 1,000 people are considered sizeable and should get full points.	**14**
Private sector involvement	Opportunities for private sector involvement	Business opportunities for the private sector reduce the need for public funds, as the private sector has the interest to increase and expand its services in the energy sector. Projects with high involvement of the private sector should be given more points than projects with public/grant contributions.	**14**
Social inclusion and gender impact	Increased benefits for women and the most vulnerable	Making sure women and vulnerable groups receive special attention. This could be for example additional income generating activities provided as part of project implementation.	**14**
Environmental safeguards	Compliance with environmental safeguards	Potential impacts on the environment and safeguards need to be taken into account, based on requirements from financiers, donors and the Government of Vanuatu.	**14**
Community/ Beneficiary Involvement	Creating ownership among communities/beneficiaries	Ensuring long term sustainability of the intervention. Ownership is key for renewable energy projects, where access to resources or land is necessary, e.g. wind, solar or hydropower projects. Capacity building and training are key tools to increase ownership and create new work opportunities.	**14**
Simple payback period/ purchasing power	Simple payback calculated from estimated revenue and cost assumptions. Purchasing power defined by the ability of consumers to pay for and maintain	As it is usually challenging to estimate revenues and costs, simple payback is sufficient for ranking of activities. Purchasing power is a relevant criterion to make sure consumers can maintain technologies. Projects with less or no grant contribution are to be preferred.	**16**

	technologies is considered.		
Total			**100**

3 REVIEW OF NERM IMPLEMENTATION PLAN

The purpose of this chapter is to review the NERM 2016-2030 Implementation Plan, review of progress against targets and determine which additional efforts are necessary to achieve the NERM targets. As a first step, finalised activities are listed in chapter 3.1. These activities have been implemented over the last 3 years and have provided contributions to the NERM targets. This is followed by chapter 3.2, which reviews the progress towards targets for each of the 12 indicators defined in the NERM Monitoring Plan.

All other activities listed in the NERM-IP have been reviewed by the Project Team together with stakeholders during the workshop and bilaterally with the Department of Energy. Relevant activities, which have either been started or are necessary for achieving the NERM targets have been kept and new activities have been added to ensure achieving of the 2020 and 2030 targets. Chapter 3.3 describes the activities required for achieving the targets for each of the NERM priorities.

3.1 REVIEW AND UPDATE OF NERM-IP

The National Energy Road Map 2016-2030 includes in Annex B a list of activities and actions proposed to achieve the NERM targets. The activities are sorted by type of activity and ranked by priority. For each of the activities, the contribution to the five NERM priorities, costs, lead responsibilities, timing, and status are listed.

Over the last 3 years, various stakeholders have been working intensively on the preparation and implementation of a number of activities. The following table lists all activities, which have been finalised by the end of February 2019 and have provided contributions to the NERM targets.

Table 5: NERM projects finalized

Investment/action	Main outcome(s) it contributes to	Priority	Lead responsibility	Update
Undine Bay Solar PV System (510kW)	Access, sustainability, green growth	Immediate	UNELCO	Completed [2016]
GPOBA Grid Based Electricity Project	Access	Immediate	DoE, World Bank, UNELCO and VUI	Completed [2019]
The lighting of Luganville Town Streets	Access	Immediate	VUI	Completed

Investment/action	Main outcome(s) it contributes to	Priority	Lead responsibility	Update
North East Malekula Rural Electrification Project	Access	Immediate	GoV, EU, UNELCO	Completed [2017]
Kawene 1.5MW Grid-connected Solar Facility, Efate (Energy Facility 2)	Sustainability	Immediate	GoV, EU, UNELCO,	Completed [2018]
Loltong Hydro Project, North Pentecost	Access, sustainability, green growth	Immediate	Governments of New Zealand, Australia, and Vanuatu	Completed [2016]
Prepare a detailed design for, and establish, a National Green Energy Fund,	Access, sustainability, green growth	Immediate	DoE, MFEM, NGEF Taskforce, GGGI	Completed [Phase One: 2018]
Rural biogas project for Onesua Presbyterian College and Agriculture College	Access, sustainability, green growth	Medium	EU, GIZ DoE,	Completed [2019]
Pilot solar refrigeration for rural bungalows	Access, green growth	Immediate	Government of Germany (BMZ), GGGI, DoE, DoT, Skills Program	Completed [2017]
Introduce mandatory standards and labeling system (MEPS) for refrigerators, freezers, air conditioning, and lighting through Parliamentary approval of the Energy Efficiency of Electrical Appliances, Equipment and Lighting Products Bill	Sustainability, affordability	Immediate	DoE	Completed [2017]
Incorporate MEPS into Government procurement policies for appliances and vehicles	Sustainability, affordability	Immediate	DoE & Dept. of Finance and Treasury	Completed [2018]
Retender the Luganville concession agreement	Affordability, security, and reliability	Immediate	DoE	Completed [2019]
Develop an electrification plan for renewable energy in remote islands	Access, sustainability, green growth	Immediate	GIZ	Completed [2017]

Investment/action	Main outcome(s) it contributes to	Priority	Lead responsibility	Update
Undertake market demand assessment for the NGEF	Access, sustainability, green growth	Immediate	DoE, GGGI	Completed [2018]
Carry out joint planning sessions between different ministries to identify key energy sector activities that can contribute to objectives in other sectors (MoU with Ministry of Health)	Green growth	Highest	DoE and other government agencies	Completed
Develop a strategic and working partnership arrangement with the Department of Rural Water Supply so that it is coordinated and parallel rollout of both electricity and water projects throughout the country (MoU with Ministry of Lands)	Green growth	High	DoE and Dept. of Rural Water Supply	Completed
Support Department of Tourism and Agriculture to promote the use of solar technologies in these sectors	Green growth, access	Medium	DoE, DoA, Dept. of Tourism, GGGI	Completed

3.2 REVIEW OF PROGRESS AGAINST TARGETS

Appendix C of the NERM 2016-2030 includes the monitoring, verification and evaluation plan and describes how the various targets of the NERM will be monitored and evaluated. 12 quantitative targets have been defined for the NERM and specified indicators have been defined to measure progress against the baseline. Table C.1 in the NERM summarises the targets, indicators and data sources that will be used to track progress

This chapter provides a review of how each of the 12 indicators is performing compared to the targets set for 2020 and 2030. It also provides an outlook on further development and defines mitigating factors that could have an impact on the progress and also gives recommendation on how to improve monitoring in the future. The review of the target is grouped by NERM priorities.

Data availability is a key issue when analysing progress towards targets. As the review is carried out in early 2019, no data for 2018 has been available. The majority of data was collected for 2017, in some cases data for 2016 was used. For each of the factors, the reference year of data is indicated.

Progress towards targets is indicated by the following colour code:

2020 target already achieved
2020 target likely to be achieved
2020 target unlikely to be achieved

3.2.1 ACCESSIBLE ENERGY

Indicator 1: Increase electricity access by households in concession areas

Information on a number of households connected to the electricity grids has been collected from the latest mini-census. In 2017, a total of 16,014 households were connected to one of the four grids (Efate, Santo, Tanna, Malekula). The total number of households in concession areas was 22,338, which results in a connection rate of 71.7%. It is realistic that the target of 75% for 2020 will be achieved.

	Level 2017	Target 2020	Target 2030
Indicator 1	**71.7%**	**75%**	**100%**

Indicator 2: Increase electricity access by households in off-grid areas

To determine electricity access in off-grid areas, it is necessary to decide on how the number of households in off-grid areas is determined. The best data sources are the mini and major censuses, which are being carried out every few years (the next major census is due for 2019). The censuses provide the possibility to both determine the number of households and get information on the level of electricity access.

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.[3]

Out of the 41,296 rural households covered in the 2016 mini-census, 4,994 households are connected to the electricity main grid, which leaves 36,902 off-grid households. Of these, 14,187 households had

[3] 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.

either a generator or a solar home system, which translates into a national electrification rate of 38.4% in the year 2016.

The VREP (Vanuatu Rural Electrification Project) with its phases I and II is an important contributor to increasing access to electricity in rural areas. Since its launch in early 2016, VREP I have disseminated a total of 15,607 "Plug and Play" systems to households in rural Vanuatu (figure by end of May 2019). As the mini-census was carried out in November 2016, it is assumed that all "Plug and Play" systems disseminated by VREP in 2016 are covered by the mini-census. SHS disseminated in 2017 and May 2019 are contributing to the increase of rural electrification. Between January 2017 and May 2019, a total of 14,916 SHS were disseminated. This increases the number of households with access to electricity to 23,760 and the rate to 64.4%.

This is considerable progress compared to the 9% rural electrification rate reported at the end of 2015 based on the 2010 National Census Report. The target of 60% electrification by 2020 has been already achieved.

	Level 2018	Target 2020	Target 2030
Indicator 2	**64.4%**	**60%**	**100%**

Indicator 3: Increase electricity access by public institutions (on- and off-grid)

To calculate the electricity access by public institutions (on- and off-grid), the following facilities were taken into consideration:

- Primary schools
- Secondary schools
- Health Clinics
- Health Centres
- Dispensaries
- Aid posts

Early Childhood Education facilities were not considered. Data was provided by the Ministry of Education & Training as well as the Ministry of Health.

Out of a total of 555 schools (477 primary schools and 111 secondary schools), 215 schools have access to electricity (38.7%)[4] through grid connection, generators, and solar PV.

In the health sector, there are a total of 404 facilities, covering health centres, dispensaries, hospitals, clinic, and aid posts. Out of the 404 facilities, 331 are operational. Under VREP I, 185 aid posts out of a total of 243 aid posts have been electrified. All facilities in urban areas are electrified, these are 11 dispensaries, 4 clinics, and 37 health centres. Together with the electrified aid posts, this gives a level of electricity access of 71.6% for the public sector, which is behind the target of 80% for 2020. This excluded educational facilities due to lack of data.

[4] Based on preliminary figures provided by Ministry of Education, the figure will be updated after a current survey on secondary education is being completed.

	Level 2018	Target 2020	Target 2030
Indicator 3	**71.6%**	**80%**	**100%**

3.2.2 AFFORDABLE ENERGY

Indicator 4: Improve the efficiency of diesel generation

To calculate the improvement of efficiency of diesel generation, data from URA was used, which is based on technical reports from UNELCO and VUI. In the baseline year 2012[5], consumption of diesel was 216.1 grams per kWh of electricity generated. In 2017, this factor has gone up to 219.6 g/kWh, a deterioration of 1.6%, compared to a target of 20% improvement until 2020.

Based on data received from URA, also the factor for 2015 was calculated. On average, 218.0 g/kWh was used, which is a deterioration of 0.9% compared to the 2012 figure (the 2016 NERM reported an improvement of 2% compared to 2012).

The negative trend of efficiency in diesel generation is not surprising. Diesel generators not only have to cover the fluctuations in demand but due to the increasing contributions from wind and solar PV also need to cover fluctuations in supply. This decreases the efficiency of electricity generation with diesel. With the planned increase of renewable energy capacity, there is a tendency to further decrease in diesel generator efficiency.

The following figure compares the efficiency of diesel generation in the four different grids. Diesel generation efficiency in Efate, which provides around 92% of all diesel-based electricity in Vanuatu, is very high and further improvements are difficult to achieve. There is the potential for improvement in the other grids, however, these improvements will not have any sizeable contribution to the country average due to the small share in total electricity generation.

[5] There is a clarification necessary on the baseline data. NERM 2016 mentions: "The baseline average diesel efficiency is 253 g/kWh, based on the statement that a 17 percent improvement in efficiency would be 210 g/kWh (i.e. 210/0.83=253)". However, the NERM 2013 states: "existing fuel efficiency currently varying between 213.32g/kWh in Port Vila to 288.28g/kWh in Malekula". Taking into account that around 90% of diesel consumption for electricity generation is in Port Vila, an average of 253 g/kWh as a baseline figure seems to be a mistake.

Additionally, the NERM 2016-2030 is contradictory regarding the base year. Whereas the text (p. 56) mentions a base year of 2010, the progress towards targets table (p. 76) mentions a base year of 2012. It was assumed that 2012 is the correct base year.

Figure 1: Efficiency of diesel generation

	Level 2017	Target 2020	Target 2030
Indicator 4	**-1.6%**	**20%**	**20%**

Indicator 5: Reduce the cost of distributing petroleum costs in Vanuatu

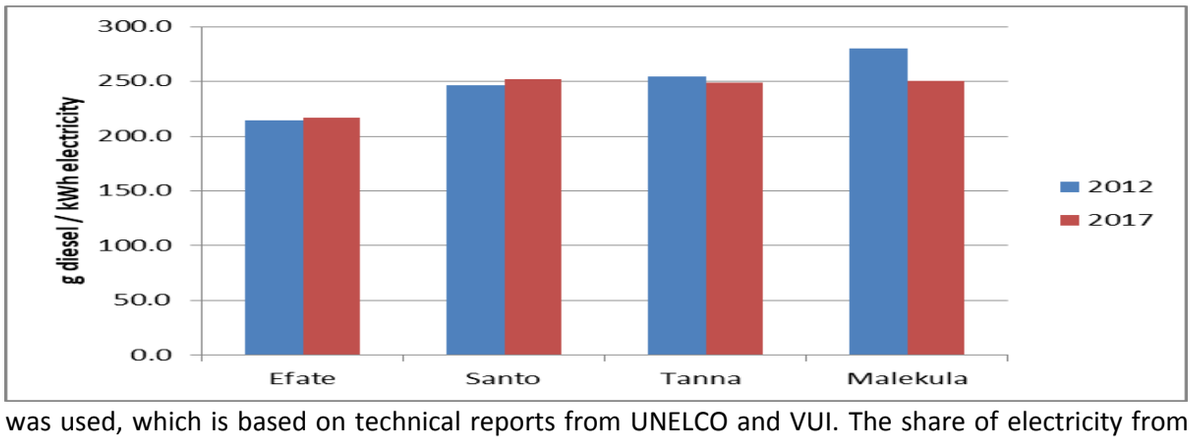
Indicator 5 aims at measuring the reduction of distribution costs of petroleum in Vanuatu. The main activity planned to contribute to this indicator was the investment into a barge to switch from delivery of fuel in drums to bulk deliveries. There are efforts from the private sector (such as Pacific Petroleum) to improve the delivery of fuel to islands by using safer equipment instead of drums for delivering fuel. Fuel storage facilities have been installed in Malekula and Tanna. The private sector in coordination with DoE and Ministry of climate change is committed to reducing the cost of distributing petroleum product by 15% in 2030. However, no concrete data could be collected to calculate the level of cost savings in the distribution of petroleum.

	Level 2018	Target 2020	Target 2030
Indicator 4	**n/a**	**-10%**	**-15%**

3.2.3 SUSTAINABLE ENERGY

Indicator 6: Increase the proportion of electricity generated from renewable energy sources

To calculate the proportion of electricity generated from renewable energy sources, data from URA

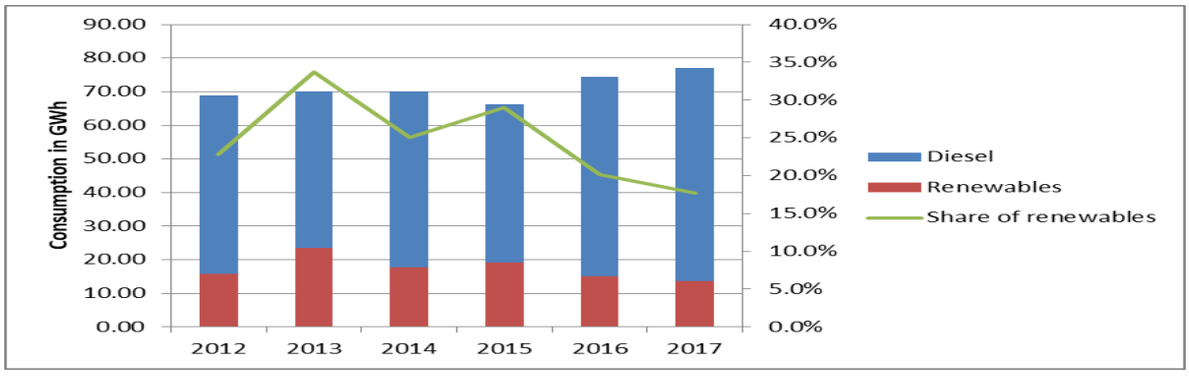


was used, which is based on technical reports from UNELCO and VUI. The share of electricity from renewables in 2017 was 18%, with contributions of 9% hydro, 6% wind and 3% solar. Due to high international market prices for copra, no coconut oil was used in 2017 for electricity generation. This also explains the reduction in the share from 29% in 2015, where coconut oil has been used in Efate and Malekula.

Work on the NDC Implementation Roadmap is focusing on the increase of the share of renewables in electricity generation in order to achieve the NDC target of “close to 100% renewable energy in the electricity sector by 2030”. Taking into account additional capacities which were added in 2018 (1 MW Kawene solar PV plant) and assuming average annual generation of all renewable energy installations,

the share of renewables is expected to increase to 24.3% in 2020, which is considerably behind the 2020 target of 65%.

Figure 2: Share of renewables 2012-2017



	Level 2017	Target 2020	Target 2030
Indicator 6	**18%**	**65%**	**100%**

Indicators 7, 8 and 9

The importance of energy efficiency to Vanuatu was highlighted in the original NERM (2013-2020), but a lack of data at that time on energy usage made it difficult to define any meaningful policy targets. When working on the update of the NERM, an effort has been undertaken to gather additional data to allow more explicit objectives and targets in this area to be incorporated into the revised NERM. This led to indicator 7 (electricity end-use efficiency), indicator 8 (transport – land and marine – energy efficiency) and indicator 9 (biomass end-use efficiency) being included in the monitoring plan.

Despite the definition of indicators, little efforts have been undertaken to operationalise these indicators and clearly define which data has to be collected in order to be able to calculate contributions towards the targets. In the 2015 review, all 3 indicators were evaluated as "not available". Since then, there was an only marginal effort on interpreting the indicators and data to be collected. As a result, no review of the progress could be made.

Further work is necessary to define data to be collected and methods to be applied to allow the calculation of contributions towards targets for indicators 7, 8 and 9. Initial inputs can be found below.

Indicator 7: Improve electricity sector end-use efficiency

End-use efficiency is related to electrical appliances in buildings, to provide services such as lighting, cooling, entertainment, and communications. Energy savings through the improved energy efficiency of buildings and appliances (including lighting) are often a cost-effective first option before installing new electricity generation capacity.

Monitoring improvements in end-use efficiency is a challenge for various reasons, such as:

- There are various electric appliances, like lamps, fans, air conditioners, coolers, freezers, etc. which need to be included.

- To calculate effects for the entire country, representative samples need to be taken for each of the appliances.
- Direct measurement of the reduction in consumption is in many cases challenging as user behaviour has a considerable impact on the consumption level and needs to be considered in any survey.

As a result, it will be challenging to directly monitor improvements in end-use energy efficiency. Potential ways to indirectly monitor improvements are for example:

- The penetration of the country with energy efficient equipment: for different groups of appliances (lamps, AC, coolers,) the number of devices imported into Vanuatu in a specific year can be taken as an indicator on the uptake of technology improvements. Additional information on baseline technologies and assumptions on time required for disseminating/implementing imported devices need to be made.
- Surveys: representative surveys can be taken to investigate the penetration of efficient technologies.

Indicator 8: Improve transport (land and marine) energy efficiency

The main challenge in transport energy efficiency is – as in most countries – the availability of relevant data. In most cases, only the number of registered vehicles and the total fuel consumption (without any split by users, such as private vehicles, trucks or marine) is available. Therefore, as a first step, data collection is key to have a basis for discussion and deciding on interventions. This can be accompanied by pilot projects, for example, the introduction of electric or hybrid vehicles for government.

To calculate baseline emissions for the transport sector, various approaches and models are existing. A rather simple model, which has been applied by UNDP in other SIDS, is the GHG Emission Inventory Tool provided by GIZ-IFEU. This is an open source tool and focuses on calculating fuel consumption and related emissions in a country.[6] The tool is excel based and provides a lot of standard factors (e.g. emission factors, fuel consumption, etc.). To start to work with the model, only a limited set of data is required. Once more detailed data is available, this can be added to the model.

The tool requires the following main inputs:

- Number of vehicles, average mileage and average fuel consumption by vehicle category: number of vehicles is usually available from vehicle registration. Information on mileage usually needs to be collected through surveys. For average fuel consumption government vehicles are usually a good source of data.
- Main vehicle categories are passenger cars, buses, trucks, and motorbikes: usually available from vehicle registration.

[6] https://www.changing-transport.org/tool/trigger/

- Vehicle categories are broken down into sub-categories, differentiated by engine size/weight, fuel type, and emission standard: usually available from vehicle registration

Indicator 9: Improve biomass end use (cooking and drying) efficiency

Nationwide information on the share of improved cook stoves is not available. In order to collect this data, the mini and major censuses can be used. Households are being asked what their choice of energy source for cooking is. In case the answer is firewood or charcoal, a question could be added whether they are using an improved cook stove. This would give a high-quality data set, which would allow monitoring the penetration of improved cook stoves and also would help understanding differences in penetration rates on various islands.

Indicator 10: Ensure all energy infrastructure projects comply with government and donor environmental and social safeguard requirements

"To be sustainable, and to achieve the overall NERM vision, Vanuatu's energy supply and energy infrastructure must be safe for humans and the environment. They must also promote Vanuatu's broader social and environmental objectives as set out in the NSDP (National Sustainable Development Plan). This specifically relates to the following goals and policy objectives in the NSDP 206-2030:

- SOC4 – Social Inclusion
- ENV2 – Blue-Green Economic Growth
- ECO2 – Improve Infrastructure
- ECO3 – Strengthen Rural Communities

The vast majority of energy projects in Vanuatu are financed or co-financed by international financiers or donor organisations, such as the World Bank, the EU or various national governments under bilateral development aid programs. All these institutions have stringent environmental and social safeguard requirements. As a consequence, it can be assumed that this target will be achieved in 2020. Further monitoring is required to make sure the target for this indicator is met.

	Level 2018	Target 2020	Target 2030
Indicator 6	**100%**	**100%**	**100%**

3.2.4 GREEN GROWTH

Indicator 11: Increase the proportion of electricity generated from biofuels

Biofuels (coconut oil) have been used for electricity generation in Vanuatu for a number of years. Diesel generators in the Efate and Malekula grids have been converted by the operator (UNELCO) to be able to both use coconut oil and conventional diesel. The use of coconut oil had its peak in 2013 when world market prices for coconut oil/copra were low and operators could purchase coconut oil at competitive prices. Due to price increases for coconut oil on the national markets, there was a

decline in consumption and in 2017 no coconut oil was used for electricity generation. The following figures show the historical data on coconut oil consumption as well as price development of coconut oil and diesel oil.

Figure 3: Fuel inputs for electricity generation

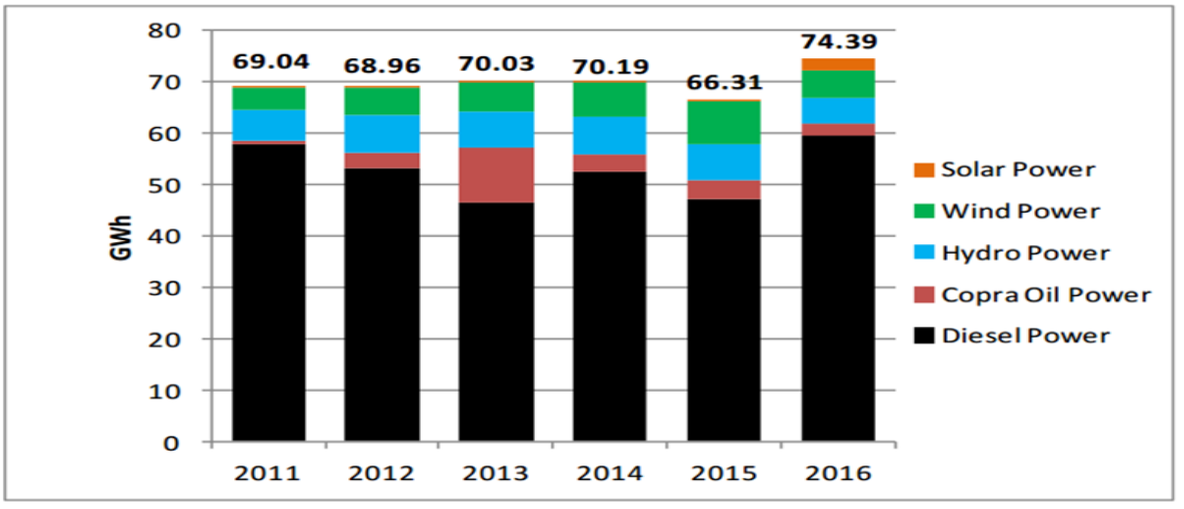
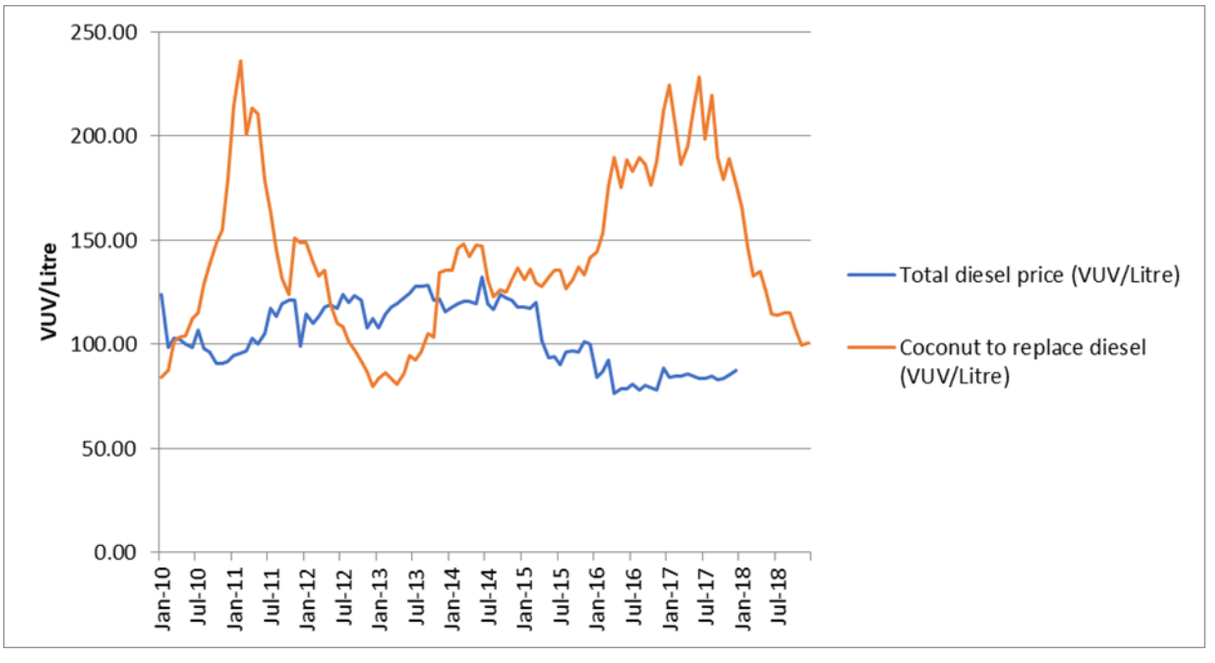


Figure 4: Coconut oil prices 2008-2018 in USD per ton



	Level 2017	Target 2020	Target 2030
Indicator 11	**0%**	**10%**	**14%**

Indicator 12: Increase renewable electricity use by rural tourism bungalows

In 2016, a study was carried out for GGGI investigating the status of renewable energies for rural, off-grid tourism bungalows. The study also looked at technical solutions and business models for increasing use of renewables for lighting, charging/ventilation and freezing.

A survey carried out during the study revealed that 45% of the 91 off-grid bungalows have a solar system with a panel. This is seen as sufficient to meet the requirements of the indicator. The study also mentions that site visits to various bungalows showed some system problems, such as failing batteries and damage from cyclone Pam. This indicates that the current level of achievement might not be sustainable and repair/maintenance or replacement of components will be necessary to keep the current level of 45%. Bungalows have to declare their sources of energy each time they apply for their tourism license with the Department of Tourism, which is helping to monitor the level of renewable electricity.

	Level 2016	Target 2020	Target 2030
Indicator 12	**45%**	**25%**	**65%**

Summary

The following table summarizes the progress towards the NERM's quantitative targets:

Table 6: Progress towards NERM's targets

Priority /Objective		Indicator	2015 level	Year level	Current Level	Source	2020 Target	2030 Target
Accessible energy	Increase electricity access by households in and near concession areas	% with access	62%	2017	71.7%	Mini census	75%	100%
	Increase electricity access by households in off- grid areas	% with access	9%	2016	64.4%	VNSO, 2016 Mini Census Report, table 3.9, VREP	100%	100%
	Increase electricity access by public institutions (on- and off-grid)	% with access	54%	2018	71.6%	Ministry of Health, Ministry of Education & Training	80%	100%
Affordable energy	Improve the efficiency of diesel generation	Grams of diesel fuel per kWh of electricity	2% improvement from 2012	2017	-1.6%	URA, Electricity Fact Sheet 2012 – 2017	20% improvement from 2012	20% improvement from 2012
	Reduce the cost of distributing petroleum costs in Vanuatu	Distribution cost in Vatu per litre	n/a	2018	0%	Pacific Petroleum	10% reduction	15% reduction
Sustainable energy	Increase the proportion of electricity generated from renewable energy sources	% of grid-based electricity from renewable sources	29%	2017	18%	URA, Electricity Fact Sheet 2012 – 2017	65%	100%
	Improve electricity sector end-use efficiency	% saving on BAU projection	n/a	n/a	n/a	n/a	5%	13%
	Improve transport (land and marine) energy efficiency	% saving on BAU projection	n/a	n/a	n/a	n/a	2%	10%
	Improve biomass end use (cooking and drying) efficiency	% saving on BAU projection	n/a	n/a	n/a	n/a	5%	14%
	Ensure all energy infrastructure projects comply with government and donor environmental and social safeguard requirements	% of projects complying	n/a	2017	100%	Various reports	100%	100%
Green Growth	Increase the proportion of electricity generated from biofuels	% of electricity generated from biofuels	5%	2017	0%	URA, Electricity Fact Sheet 2012 – 2017	10%	14%
	Increase renewable electricity use by rural tourism bungalows	% of bungalows using renewable energy sources for electricity supply	n/a	2016	45%	Vanuatu: Tourism and Renewables Market Assessment and Business Model Development	25%	65%

n/a….data not available

3.3 INTERVENTIONS REQUIRED TO ACHIEVE TARGETS

This chapter builds on the progress against the target as described in chapter 3.2 and defines for each of the NERM priorities the activities necessary to achieve the targets defined for the various indicators.

The NERM has defined five priorities:

- Accessible Energy
- Affordable Energy
- Secure and Reliable Energy
- Sustainable Energy
- Green Growth

Indicators have been defined for all priorities except for Secure and Reliable Energy, which is seen as a cross-sectoral priority. The objectives defined under this priority are well covered by indicators in other priorities:

- **Objective 1**: Achieve a greater diversity of energy sources – covered by Indicator 6 (Increase the proportion of electricity generated from renewable energy sources) and Indicator 11 (Increase the proportion of electricity generated from biofuels)
- **Objective 2**: Reduce the likelihood, and impact on consumers, of volatility in the prices of imported petroleum products – covered by Indicator 4 (Improve the efficiency of diesel generation) and Indicator 5 (Reduce the cost of distributing petroleum costs in Vanuatu)
- **Objective 3**: Facilitate the development of energy infrastructure and energy supply chains that are resilient to natural disasters – covered by Indicator 6 (Increase the proportion of electricity generated from renewable energy sources)

3.3.1 ACCESSIBLE ENERGY

Vanuatu is making good progress with increasing access to electricity. Electricity access by households in and near concession areas is at 71.7%, thereby close to achieving the 2020 target of 75% and getting close to reaching the 2030 target of 100%. Electricity access by off-grid households has increased considerably over the last years to more than 50%. Achieving the 2020 target of 60% is likely and the country is on a good track of achieving the 2030 target.

Currently, ongoing activities (such as VREP II) would provide 16,635 off-grid households with access to electricity (assuming 6,000 households under an extension of VREP I and no households under GPOBA). According to the data provided, a total of 17,400 off-grid households are currently without access to electricity, which leaves a gap of around 800 households to be electrified. As the implementation of VREP-I has been very successful and the continuation under VREP II looks promising, it is suggested to extend VREP I+II to provide electricity access to these 800 additional households.

For grid-connected households, the gap is around 1,000, these should be covered by an extension of the successful GPOBA program.

In the public sector, there is a considerable gap to reach the target of 100% electricity access. 373 schools are lacking access to electricity. In the health sector, a total of 113 dispensaries, 78 aid posts and 48 health centres need to be electrified. Aid posts will be provided with lighting only, dispensaries will receive a 0.5 kW system. All other systems will be provided with 1.1 kW systems (based on the VREP I+II catalogue).

As a result, the following activities are suggested for the priority Accessible Energy:

Table 7: Activities suggested under Accessible Energy (NGEF pipeline projects in italic)

Activity	Description
Extension of VREP I	According to the latest Project update as of May 2019, USD 0.43 hasn't been used up to now. VREP I is currently requesting restructure to move funds from project management component of into the subsidy component and to include VREP I products to be covered by the VREP II subsidy component at 33% rather than 50%.
VREP II	Under VREP II, microgrids will be installed and Solar Home Systems will be disseminated to off-grid households. Until 2022, a total of 8,400 households will be electrified. The project is fully financed and operational.
Extension of GPOBA	The GPOBA provided one-off subsidies to assist low-income households to connect to the existing electricity grid in concession areas in Port Vila, Tanna, Malekula and Luganville. A continuation of the project is suggested, funding has not been secured. A minimum of additional 1,000 households needs to receive electricity access to achieve the NERM targets.
BRANTV	2,000 households will gain access to village-scale power systems or to family compound-scale Nano-grids installed in all compounds in a village. Project is fully financed and activities started. Work will end in 2022. It is important to note that there will be 20 hydro sites, equating to (approx. 50 HH*20 villages) households which will have access onto the mini-grid, while the other 1000 will have access to community-based or Nano/compound-based solar systems in terms or incremental or productive use, but no house connections.
Wintua/Lorlow mini-grid	Under the Wintua/Lorlow mini-grid funded through NAMA facility, around 75 households and 14 public buildings will be electrified. The project is fully financed and construction is about to start.
Ambrym mini-grid	Erection of 2 solar PV mini-grids on Ambrym island, connecting around 160 households to the grid. The concept will be handed in at GCF SAP proposal go be submitted to GCF in 2019.
Distributed Energy Generation	DoE is interested to explore the option of using the "Distributed Energy Generation" by installing micro/mini-grids in concession areas (Efate, Santo, Malekula & Tanna) in locations where grid extension is hard to reach or very expensive. Once the grid penetration is achieved eventually the micro/mini-grids could be integrated on to the main grid.

Electrification of all Educational and Health Centres by 2022	DoE is keen to launch a program similar to VREP focusing on electrification of all education and health centres in Vanuatu by 2022. The idea is to have a targeted approach to electrify on one of the key sub-sectors (Schools & Health centres) and replicate the approach across other sub-sectors. DoE is of the view that this kind of approach could assist in efficient utilization of resources and fast track achieving the NERM targets. DoE intends to explore potential subsidy options under NGEF, VREP and GCF submissions.
Extension of VREP I+II	A minimum of an additional 800 households needs to receive electricity access to achieve the NERM targets.
NGEF pipeline projects	
Teachers Solar - Targeted at solar home systems for teachers in off-grid villages/schools, delivered through the Vanuatu Teachers Union Co-operative	*Could be part of VREP 1 or 2 subsidies. Include estimates there are 1000 teachers in off-grid areas and require an average of 50W each costing $500 each. 50% of the capital required will be financed through NGEF, the balance from VREP 1 and 2.*
Schools Solar - Targeted at the basic needs of schools (not teachers) such as printer/copier/ scanner, projector, computer power, classroom lights, fan, refrigerator, etc.	*Could be part of the VREP-2 subsidy. Include estimates there are 50 schools in off-grid areas and require an average of 1kW each costing $10,000 each. Assuming an average of 300 students per school for 60,000 students, it is estimated there are 200 schools in Vanuatu (which agrees with GIS data from Lands, but not cross-checked with Dept of Education), and it is assumed 25% of schools may currently lack power. It is unlikely the Dept of Education or others will invest in these projects, but some VREP2 subsidy may help. NGEF will support through co-financing arrangements directly with schools, with Ministry of Education's support.*

3.3.2 AFFORDABLE ENERGY

As explained in chapter 3.2.2, increasing shares of renewable energy for electricity generation led to a deterioration of electricity generation from diesel. Taking further into account that the target for grid-connected electricity generation is to achieve 100% share of renewables (as per the NERM, the NDC defines the target as "close to 100%), focusing on a target for diesel generation efficiency seems meaningless. As a consequence, Indicator 4 should not be considered and finally be removed from the NERM.

As there is a strong tendency towards using coconut oil for electricity generation, it would be more helpful to make sure that coconut oil can be used in concession areas. Up to now, diesel generators in Efate and Malekula have been converted for the use of coconut oil. Analysis of the Santo concession area shows that conversion of diesel generators to be able to burn coconut oil doesn't make sense for a number of reasons:

- Santo already has a very high share of renewables in electricity generation based on the hydropower projects currently in operation (share of renewables is on average between 70% and 80%).

- Further capacity additions of hydropower are planned, which will increase the share of renewables further.
- Due to the type of diesel generators used in Santo, a full replacement would be necessary to burn coconut oil.

As a consequence, the use of coconut oil in Santo is not recommended.

The equipment used on Tanna is similar to the equipment on Malekula, which has been converted to use coconut oil. It is recommended that the same step is taken on Tanna.

No information has been provided regarding the costs of distributing petroleum. From discussions with the Department of Energy, it was understood that the activity originally included in the NERM IP (investment into a barge) would be an important step in reducing distribution costs. As a result, this activity is kept in the NERM IP:

The following activities are suggested for the priority Affordable Energy:

Table 8: Activities suggested under Affordable Energy

Activity	Description
Conversion of diesel generators on Tanna	Existing diesel generators should be converted to make sure coconut oil can be used for electricity generation.
Investment in Barge	Invest in a barge to improve the efficiency and reliability of fuel distribution within Vanuatu by shifting away from deliveries of fuel in drums and towards the use of regular bulk deliveries to outer islands.

3.3.3 SUSTAINABLE ENERGY

Vanuatu is behind target on the share of renewables for electricity generation. New solar PV capacities have been added over the last years, but the decline in the use of coconut oil (due to a price increase for coconut oil, which made it non-competitive to diesel) had negative results on the share of renewables. With a current share of 18%, reaching the 2020 target of 65% is not feasible.

The government has launched the NDC Implementation Roadmap in April 2019. The roadmap elaborates which combination of measures is necessary to reach the NDC (and thereby also the NERM target) of 100% renewable energy in electricity generation by 2030 and the interventions suggested are listed below.

For electricity sector end-use efficiency, the planned national energy efficiency strategy and action plan would be an important starting point to define the status quo, baseline, and interventions necessary to improve efficiency. The study should also provide a detailed MRV framework to follow improvements in energy efficiency. This work should recommend reform of import duties, tariffs and VAT to encourage imports of energy efficient and renewable energy equipment.

For the transport sector, the first step should be to develop a GHG Emission Inventory Tool to get some understanding of emissions in the transport sector. This should be followed by pilot projects on

hybrid/electric vehicles, ideally commencing with government vehicles. Government buildings would be ideal for charging, as solar panels right next to the buildings and electricity could be used directly.

The following activities are suggested for the priority Sustainable Energy:

Table 9: Activities suggested under Sustainable Energy (NGEF pipeline projects in italic)

Activity	Description
Brenwe 400 kW Hydro Power Project	The Brenwe Hydro Power project is a 400kW run-of-river hydropower plant on the island of Malekula. Funding is secured and the project will be financed through an ADB loan and contributions from the Government of Vanuatu. Completion is expected in 2022.
Sarakata 800 kW Hydro Power Extension Project	Preparation of the project is underway, currently, the feasibility study is being carried out. Funding through Japanese Grant for Projects envisaged, the project will also receive a contribution from the Government of Vanuatu. Commissioning is expected for 2023.
Vanuatu Rural Electrification Project (VREP) Phase II (micro-grids)	VREP II will finance around 4.5 MW installed capacity of solar PV with battery backup, generating around 2.7 GWh annually of solar-based power. The project has received approval and implementation has started. It is expected that the installations of SHS and microgrids are finalised by 2022, therefore 2023 will be the first year of full operation of these systems.
Talise 75 kW Micro Hydro Power Project	This project is implemented through IUCN (International Union for Conservation of Nature) and funded by the Government of Austria and Italy with co-financing from the Government of Australia and Government of Vanuatu which has completed phase 1 & 2 and awaiting funding support for phase 3 implementation (transmission & distribution network).
Revision of Electricity Supply Act and Coconut for Fuel Strategy	Revision of the Electricity Supply Act is necessary to allow Independent Power Producers (IPPs) to erect grid-connected renewable energy projects. The Coconut for Fuel Strategy is a key component of the NDC Implementation Roadmap to secure a well-established agreement among all relevant stakeholders to provide coconut oil for electricity generation.
Batteries (Efate grid)	Due to the planned expansion of renewable energy capacities (solar PV and wind), batteries are a key component for the functioning of the grid. Surplus electricity will be stored and will then be consumed at times when renewables do not provide sufficient contribution.
Expansion of solar PV	Solar PV will be expanded by 7.6 MW on Efate to achieve the total installed capacity of 10 MW, in combination with storage capacity.
Expansion wind	Addition of 5.1 MW (Option 1) or 2.6 MW (Option 2) on Efate, in combination with storage capacity.
Coconut oil	Usage in Efate grid up to a maximum of 12.5 million litres (Option 1) or 6 million litres (Option 2) in 2030. Agreements between key stakeholders based on Coconut for Fuel Strategy.

Geothermal	The first stage of 4 MW in Takara, providing a base load to the Efate grid. Batteries will need to be added to the grid to balance the fluctuations in the production of electricity from wind and solar.
Mini geothermal	A potential project in Takara under investigation, using 50°C warm source without deep drilling. A draft business proposal submitted to DoE.
Solar for hydrogen	An Australian company is interested to develop a 1MW solar farm to produce hydrogen (to be used in pilot fuel cell cars) and feed excess to the grid. The company is currently negotiating land for the project. DoE has received a draft proposal.
Bauerfield Airport solar farm	Airports Vanuatu Limited (AVL) has expressed interest to implement 1 or 2 MW solar farm as part of the airport upgrade project. It's still not clear whether it would be a grid-connected or a stand-alone initiative.
BRANTV	12,000 households will be provided with energy efficient cook stoves under the program
National energy efficiency strategy and action plan	Development of a national energy efficiency strategy and action plan. The DoE, through the NDA, is in the process of applying for GCF Readiness funding to undertake this task.
Iimport duties, tariffs, and VAT reform	Reform import duties, tariffs and VAT to encourage imports of energy efficient and renewable energy equipment: ▪ Energy efficient products for use in buildings—in particular, efficient electrical appliances and lights ▪ Spare parts for vehicles and marine vessels ▪ Energy efficient vehicles ▪ Improved cook stoves and crop dryers Renewable energy systems (solar PV, wind, biomass) and spare parts
GHG Emission Inventory Tool	Develop GHG Emission Inventory for the transport sector based on GIZ-IFEO tool or another suitable tool.
Pilot projects hybrid/electric vehicles	Develop a pilot project for hybrid/electric vehicles for government.
Strategy for energy efficiency in the transport sector (including in tourism uses) and development of action plan for cost-effective implementation	Development of a strategy to improve efficiency in the transport sector.
NGEF pipeline projects	
Improved copra/cocoa dryers sold for cash to Dept of Agriculture	*Solar/biomass hybrid system (100W fan with 250W solar with 0.5 kWh battery for up to 10 hours drying) for smoke-free high-quality drying of coconut for copra or grated coconut for oil production, and can also be used for cassava flour drying and fruit/meat dehydrating. As per Gilbert*

	Gibson prototype developed for VIA. Cost estimate of $1000 each, deploy 100.
Solar coconut/cassava graters sold for cash to Dept of Ag	*The solar grating machine of 250W / 250Wp solar for 4 hours operation per day to make 100 kg of grated cassava or coconut that could yield 50 L/day of oil. 12 already ordered by Dept of Ag from VIA, more expected. Cost estimate of $2000 each, deploy 100.*
Solar refrigerators for meat, milk and some vegetables/fruit sold for cash to Dept of Ag	*Inland villages with cows may need refrigeration, as may small-medium businesses. Small quantity expected, maybe 20, at $5000 each for 500L capacity, 1000Wp, 5kWh battery.*
Solar meat grinders for beef sold for cash to Dept of Ag	*Solar meat/kava grinding machine of 1000W / 1000Wp solar for 1 hour's operation per day already ordered by Dept of Ag from VIA, more expected. Cost estimate of $3000 each, deploy 50.*
Dept of Industry can assist to help roll out other value-adding infrastructure for other sectors not covered in EU grant, like kava grinders, coffee pulpers, and cocoa dryers.	*Solar powered kava grinders, coffee pulpers and cocoa dryers (already mentioned above in coconut section) can also be of interest for lending as per VIA 3-5-year lending model, but unlikely to get EU grant support (could qualify for 20% grant from VREP 2, so 80% maximum finance is required, which could possibly come from NGEF). Assume an average of $2000 each, a total of 250 in near future (600 manual pulpers are estimated to exist and hundreds of villages produce cocoa and kava, so potential is there for 1000)*
Solar refrigerators/freezers for rural businesses, communities and fishermen.	*Huge demand exists for solar refrigeration for fishermen around the country. VIA has a waiting list of 70 already without excessive marketing. Could be part-financed by VREP 2 (if all VREP 2 funds financed only these, could fund 8,000 for 40,000 off-grid households). Estimated demand of 500 over 3 years or 150/year, needs lending capital to be affordable. $2000 each at scale. 20% deposit or equity required, 80% from NGEF. Census stats note 4% of 57,000 urban people and 21% of 177,000 rural households engage in fishing, so a total of 40,000 people or 8000 around households. Assuming 50% could benefit from a solar fridge/freezer costing $2000-3000 each, the market potential is up to $8-12 million.*
Anelcauhat village microgrid on Aneityum, for 231 households.	*160 kW 800 kWh microgrid for daily demand of 246 kWh/day with 30kW peak load. Aiming to use Tesla batteries. No generator backup included forecast reliability of 99%. Cost of Vt 160 million including VAT; revenue estimated at Vt 120/kWh Vt 13.4 million/year (Vt 4834/house/month average). 5-year additional service contract + 20% risks charges applied for Vt 238 million total of which Vt 106 million is sought (other funding from cruise ship companies and VREP 2). Cost is $6500-9800/household.*

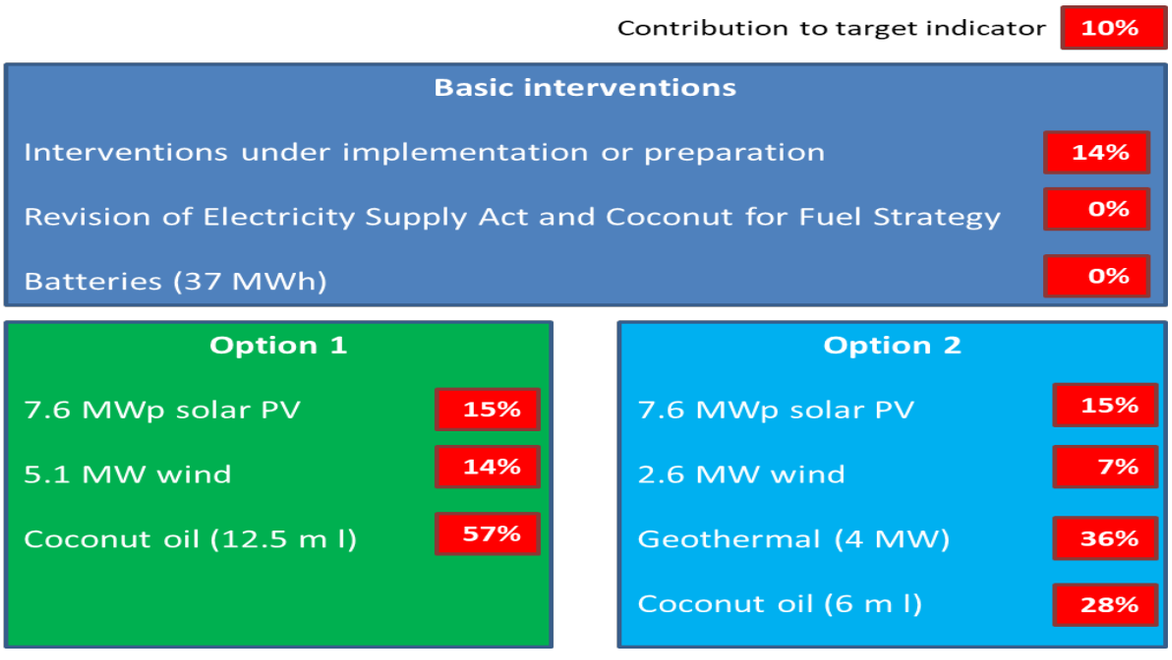
Facilitating the development of run-of-the-river hydro mini-grids for rural electrification - 1) 17kW Epilmail Waterfall, Tanna ***2) 58kW Miru Waterfall, Erromango*** ***3) 42kW Ranwadi, Pentecost*** ***4) 106kW Panbo, Pentecost***	*Detailed feasibility studies are planned to be conducted.*
Rehabilitation and extension of Tanna pico-hydro project by UNSW	*A pico-hydro project was installed in south-east Tanna Island for the main buildings but not surrounding households which is currently not operational. But calculations suggested that 50-100 nearby households could be served by it for basic lighting and phone charging services, either via a grid or battery charging or both.*
Demonstration of Solar Pico-grid Pilot for Rural Vanuatu using low voltage DC (<60V) distribution and 20-100W per household.	*$200-500/household target plus project administration costs to connect 5-15 buildings (probably best suited to a tourist bungalow) for a total cost of US$15,000. Possible to serve up to 50 households nearby too via grid or battery charging services. A hybrid 1-2kW system with back generator to give >99% reliability. Income is likely to be Vt 1000-3000 ($10-30)/house or bungalow per month or $1500-3000/year for the whole project.*

There are a number of projects, which are currently under implementation or preparation. These are the following:

- **Brenwe 400 kW Hydro Power Project**
- **Sarakata 800 kW Hydro Power Extension Project**
- **Vanuatu Rural Electrification Project (VREP) Phase II (micro-grids)**
- **Talise 75 kW Micro Hydro Power Project**
- **NGEF capitalisation funding to co-finance current and pipeline RE projects to increase number of beneficiaries.**

These projects are expected to be implemented until 2022 and are expected to increase the share of renewables to 34% in 2023. For achieving the NDC target of close to 100% of renewables in 2030, 2 different options have been elaborated in the NDC Implementation Roadmap defining additional measures required. The following figure summarizes the interventions included in each of the options.

Figure 5: Contributions to NDC target



First of all, there are basic interventions, which are recommended to be implemented in any case:

- Interventions under implementation or preparation: a project under implementation such as VREP II or the Talise Hydro Power Project bring good contributions towards the target and should be finalised as planned. The focus should be on implementations under preparation to secure funding and push for implementation.
- Coconut for Fuel Strategy: this is the key element in providing a sizeable contribution to achieving the NDC target and is the first implementation step to be carried out.
- Revision of the Electricity Supply Act: this is a key step for stronger involvement of the private sector and should allow attracting private capital for the investment into renewable energy projects. Batteries: a total of 37 MWh of battery storage capacity are necessary to secure a well-functioning grid, where overproduction can be stored for later consumption.

In addition to these basic interventions, 2 options are suggested for achieving the NDC target.

Option 1 includes the installation of 7.6 MW solar PV and 5.1 MW wind, which together can contribute around 30% to the target. The majority of the contribution towards the target (57%) will come from the use of coconut oil (12.5 million litres per year).

Option 2 includes the installation of 7.6 MW solar PV, which is seen as the renewable energy source with the lowest generation costs. The main contribution in Option 2 will come from geothermal (36%), which requires successful drilling and considerable investment for the implementation. The remaining gap will be covered by coconut oil (6 million liters) and a total of around 6 million litres will be required to achieve the target.

On biomass end-use efficiency, the BRANTV project will disseminate efficient cook stoves. Out of the 55,285 households in Vanuatu (mini-census 2016), 6,499 households are using gas and 1,187 household's electricity. This leaves 47,599 which either use firewood or charcoal for cooking. By

replacing three-stone fires with an energy efficient stove, the efficiency can be improved from 10% (three-stone fire) to at least 20%. The dissemination of 12,000 cook stoves would increase efficiency from 10% (assuming all households used three-stone fires) to around 12.5%. This is an increase of 25% and therefore exceeds the 2030 target of improvement of 14%.

3.3.4 GREEN GROWTH

With the share of biofuels in electricity generation of currently zero percent, there is considerable room for improvement. The development of the NDC has shown that coconut oil is a major component in achieving the NDC target of close to 100% electricity from renewable energies. In contrast to solar PV and wind, there is no need to store electricity as diesel generators fire with coconut oil would operate based on demand. In Option 2, which projects the use of around 6 million litres of coconut oil in 2030, the share of coconut oil in electricity generation would reach more than 20%, thus over-achieving the NERM target of 14%.

For renewable electricity in bungalows, there is good progress and the 2020 target has been already achieved. Further efforts should be made for increasing the share and reaching the 2030 target of 65%. The easiest approach would be to encourage tourism operators to further access VREP I and VREP II, as the systems approved for these programs are well-suited for tourism bungalows. There is only a small number of additional electrifications required (around 20 bungalows remaining for achieving the 65% target), so this should be feasible.

The following activities are suggested for the priority Green Growth:

Table 10: Activities suggested under Green Growth (NGEF pipeline projects in italic)

Activity	Description
Coconut for Fuel Strategy	The Coconut for Fuel Strategy is a key component of the NDC Implementation Roadmap to secure a well-established agreement among all relevant stakeholders to provide coconut oil for electricity generation.
Coconut oil	Usage in Efate grid up to a maximum of 12.5 million litres (Option 1) or 6 million litres (Option 2) in 2030. Agreements between key stakeholders based on Coconut for Fuel Strategy.
Expansion of VREP I and VREP II for bungalows	Use the existing structure in the VREP program to supply equipment to remaining bungalows.
NGEF pipeline projects	
Solar system for small tourism operators	*It is estimated 43 off grid bungalows of 1-2-star rating require 0.4-1kW systems, of which 50% may take up an offer. This would total approximately 12kW of demand or $120,000 worth at $10,000/kW. NGEF may provide 80% debt to 20% other finance from the owner or developer.*
Solar system for medium tourism operators	*It is estimated 31 off grid bungalows of 3-star rating require 5kW systems, of which 50% may take up an offer. This would total approximately 76kW of demand or $608,000 worth at $8,000/kW. NGEF may provide 80% debt to 20% other finance from the owner or developer.*

Solar system for large tourism operators	*It is estimated 25 off grid bungalows of 4-5-star rating require 25-125kW systems, of which 50% may take up an offer. This would total approximately 306kW of demand or $1.8 million worth at $6,000/kW. NGEF may provide 80% debt to 20% other finance from the owner or developer.*

3.4 UPDATED NERM IMPLEMENTATION PLAN

Based on the information in the previous chapters, the NERM Implementation Plan has been updated and can be found in Annex II. The NERM IP includes the name of the activity, a description, estimated costs, lead responsibility, current status and year of planned implementation.

The NERM IP also includes the priority (high or medium) of each intervention. This is based on the prioritization criteria described in chapter 2.3. The application of the prioritization criteria can be found in Annex III.[7]

3.5 INSTITUTIONAL CAPACITY

The Department of Energy (DoE) is the main responsible institution for the implementation of the NERM-IP. As indicated in the original NERM-IP under the column lead responsibility, the DoE cooperates with various ministries, government institutions, development organisations, and private sectors participants.

For each of the activities to be implemented under the NERM-IP, a project team is being set up in close coordination or under the guidance of the lead organisation/donor. Each project manager is reporting directly to the Director of the DoE.

Whereas this structure has proven successful over the years for the management of activities, there has been a lack of monitoring progress on the implementation of the entire NERM IP. Project managers are focusing on their project work, but don't deliver the information required for monitoring progress on each of the 12 NERM indicators.

As a consequence, the new position of a Monitoring Officer is suggested for the DoE. The task of the Monitoring Officer is to collect on project information a regular basis relevant for monitoring progress of the 12 NERM indicators. The Monitoring Officer reports directly to the Director of the DoE.

[7] Due to the low number of activities required for Affordable Energy and Green Growth, no prioritization was applied.

3.6 RECOMMENDATIONS TOWARDS REVISION OF THE NERM

Work under this assignment is focused on revising the NERM Implementation Plan. Whereas revision of the NERM itself was not part of the work, a number of points were raised in discussions with stakeholders, which are recommended to be taken up in the next revision of the NERM. These recommendations are the following:

- 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.
- Data collection proved to be a major challenge in investigating progress towards targets. The mini and major censuses have been an excellent data source and it should be investigated how the censuses can be further integrating into collecting data for the NERM.
- 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.
- Indicator 4 (*Improve the efficiency of diesel generation*) should be removed from the NERM as it is contradictory to Indicator 6 (*Increase the proportion of electricity generated from renewable energy sources*). Increasing the proportion of electricity generated from renewables is one of the overarching targets of the NERM. It is also the key focus of the NDC (Nationally Determined Contribution) and its Implementation Roadmap. By increasing the share of renewables and adding sources with fluctuating supply (e.g. solar PV and wind), diesel generators have the task to balance demand which cannot be covered by renewables. As this demand is constantly being reduced, diesel generation is bound to be less efficient.
- 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%).

It is recommended that the NERM to be revised and updated in the near future to incorporate these relevant changes. The review should be limited to the main inconsistencies identified in this report as well as strengthening the monitoring framework.

4 MAINSTREAMING VANUATU'S NATIONAL ENERGY ROAD MAP (NERM-2016-2030) IMPLEMENTATION INTO PROVINCIAL GOVERNMENTS AND MUNICIPALITIES DEVELOPMENT STRATEGIES

4.1 BACKGROUND

Vanuatu is composed of six provinces: namely Sanma, Shefa, Tafea, Torba, Malampa, and Penama. Each province is administered by a provincial council and three municipalities for the city of Port Vila (Shefa Province), Luganville (Sanma Province) and Lenakel (Tafea Province).

Provincial councils, whose areas of responsibilities are mainly in the rural parts of the country promote regional autonomy. Municipal councils of Port Vila, Luganville, and Lenakel are virtually independent of provincial councils in terms of governance and administration The Department of Local Authorities (DLA), within the Ministry of Internal Affairs, is responsible for overseeing provincial and local government (area councils) and provincial planning while services ranging from education to health rest with the national government; however, the representatives of custom chiefs are consulted by the councils on customary laws and traditional issues. At the provincial level, Government of Vanuatu is embarking on a decentralisation policy through the DLA with an ultimate objective of enhancing development focus at the municipal area and provincial levels (broadly classified as urban and rural areas respectively). Several sectoral initiatives have been implemented by various government agencies to support this policy.

The National Energy Roadmap (NERM):2016-2030 and National Determined Contribution (NDC*) roadmap for* Vanuatu has an ambitious target to provide affordable, secure, reliable and sustainable energy access and generate close to 100% electricity from renewable sources. One of the key priorities of the NERM is to extend electricity access in off-grid areas, which is a key component for sustainable development. Despite the importance of this target, there was little progress achieved with off-grid areas having access to electricity. As of 2017, about 71% of Vanuatu's over 270,000 people lacked access to grid electricity[8]. Over 80% of the population cooks over the open-hearth fire. Of the off-grid population, over half have no other access to power aside from a solar lantern.

Multiple approaches have been adopted in the past to improve energy access in rural areas via renewable energy (RE) interventions and limited efforts to promote energy efficient (EE) cook stoves. However, the results show underperformance to achieve the targets. Particularly, it is widely agreed that sustainability of off-grid RE power systems is poor, insufficient and inefficient. Mainly due to (even when systems are installed for free) lack of funds for operation and maintenance and lack of local access to spare parts and services repeatedly resulted in broken down systems in the long-run. For village-scale RE power systems, in-country capabilities are extremely limited, so that the few systems

[8] Mini Census 2016

NERM priority and implementation plan. However not all provinces have developed or updated the strategic and corporate plans, some have been developed a while ago and needs to be reviewed. Some of the plans have energy focused activities but these are not necessarily aligned to the NERM targets, NERM-IP or the NDC and no concrete implementation plan or strategy to achieve the said goals.

The key objective of this activity is to consult with the Department of Local Authorities including municipal and provincial authorities and develop a **"Sustainable Energy Action plan"** for mainstreaming of national energy targets and strategies into their respective corporate (or similar strategic) plans.

4.2 APPROACH AND METHODOLOGY

The key steps in achieving the objective involve:

Consultations with relevant stakeholders: The approach adopted for this activity includes a review of the existing documents followed by the extensive consultations with the key stakeholders including the government departments, local body (provincial and municipal councils). One on one meetings were held with the SHEFA, SANMA & MALAMPA provincial council officials. A briefing Note and a brief presentation for Department of Local Authorities and Secretary Generals (SGs) of Provincial Government Councils on mainstreaming of energy strategies into their respective corporate (or similar) plans were circulated.

Review and analysis of project documents, strategic and corporate plans, etc.: Where available, the provincial and municipal strategic action plans, other relevant documents were collected. The review and analysis of available documents and consultation focused on the identification and assessing the current and planned energy priorities and plans for the municipal and provincial authorities. This also included exploring opportunities to align the energy priorities and plans for the municipal and provincial authorities in line with NERM and NDC roadmap.

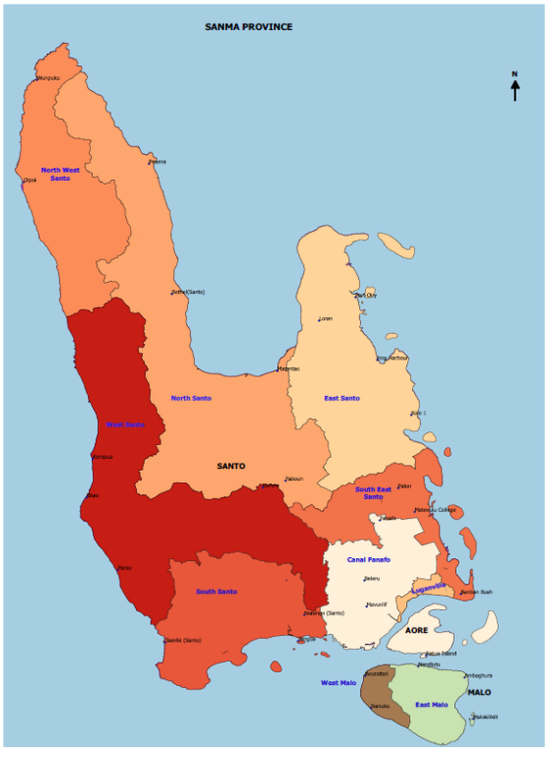
4.3 OUTCOME

The result of this exercise was a "Sustainable Energy Action plan" for the municipal and provincial authorities. The action plan provides recommendations to the DLA and Department of Tourism and other relevant departments such as SMEs-Industries, Forestry, Agriculture and Livestock for mainstreaming and integration of energy access and sustainable energy priorities into municipal council and provincial authorities and provincial area councils' strategic action plans. This also includes the recommendations on the follow-up strategy by DoE to support the municipal & provincial stakeholders to implement the action plan.

4.4 PROVINCIAL OVERVIEW

4.4.1 SANMA PROVINCE

(Area councils: West Santo, North Santo, South Santo, East Malo, West Malo, Canal – Fanafo, East Santo, South East Santo, and North West Santo; Municipal Council: Luganville)



The Sanma province includes twelve area councils and the Luganville Municipal Council (LMC). The Luganville municipal council has four wards. The total population of the Sanma province is 52,145; which is 19.6% of the total population of Vanuatu (as per 2016 mini-census[9]). The majority of the Sanma population are from Luganville area council i.e. over 15,000 people (30%) and the least population from North West Santo with the population less than 2,000 people (3%). Luganville City, the second largest city in Vanuatu, is in the south-eastern coastal area of Santo island. Sanma province's area council has a total of 10,792 Households including 10,704 Private Households, 79 Institutions (e.g. schools, hospitals, hotels, apartments, and other lodging houses) and 9 Mobile households Including vessels, and construction camps. Average household size is 5 people/HH and households earn income through household sales, wages, and salary, own business and through remittances.

The source of energy/lighting in Sanma council area households are mainly off-grid Solar (7,130 HH, 67%), grid-connected electricity (3,097HH, 29%) i.e. mainly in an urban area (Luganville), Battery lamp (218HH, 2%) and Generator Set (177HH, 2%). Over 94% of households use firewood as cooking fuel and 6% HH main in the urban area uses other sources like LPG, electricity, charcoal, kerosene, etc. [10]

The Sanma Provincial Council and Luganville Municipal Council Strategic Development Plan for 2017 to 2026 was developed and launched in January-2017. The Sanma and Luganville Strategic Plan revolves around three fundamental Pillars; Economic, Social, and Environment. Further, for the energy sector, the plan mentions promoting renewable energy initiatives. However, specific initiatives or targets such as energy access progress, electrification rate and a number of electrified households are not part of the plan. However, the promotion of rural electrification mainly utilizing renewable energy is stated as a goal. "Establish hydropower and windmill plants" and "Establish and extend rural

[9] https://vnso.gov.vu/index.php/2-uncategorised/153-mini-census

10 Sanma Province Mini Census - 2016

electrification projects in Sanma and Luganville" are included under the Strategy Framework for the objective of "Promote renewable energy initiative".[11]

The electricity demand annual growth rate and actual electricity consumption in the Luganville concession area for the period from 1996 to 2016 is 4.4% on average, which is roughly the same as mentioned in the NERM. Further, the peak demand and overall electricity consumption are expected to increase in Luganville due to rapid growth as people from rural areas migrate to the town along with increased tourism and commercial activity. There is a growing need for immediate development and expansion of energy infrastructure for more densely populated districts in and around the Luganville town. [12]

The activities planned/proposed under the National Energy Roadmap (NERM) and Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu (BRANTV) for Sanma province council area (mainly Santo and Luganville) are as follows: [13]

- Grid Extension, East Cost Santo (Matevulu to Shark Bay, Port Olry, Stone Hill and Palekula)
- Sarakata Hydro Power Extension Project (600KW), Santo
- Low Voltage and Medium Voltage Extensions, Santo
- The lighting of Luganville Town Streets
- 1,512 Energy efficient cook stove to be sold in Luganville and Santo
- Assessment of Renewable Energy Sources: Proposed *Incremental pico- and small micro-hydro demo sites (all 5-kW capacity): Falambil; Vussvongo and Pesena on Santo.*
- Village-scale Community Solar PV demonstration projects (all 5-kW capacity): Lelek, Sara, Kole, Lathi communities on Santo
- Family-Scale PV-Nano-grids (all of 300 W): Saufeli Youth centre on Malo

4.4.2 SHEFA PROVINCE

(Islands: Efate Outer Islands, Efate, Epi, Sheperd Islands; Area Councils: South Epi, Tongariki, Eratap, Eton, Malorua, Makimae, Varisu, Erakor, Eemau, Nguna, North Efate, Vermaul, Mele, North tongoa, Pango, Ifira, and Vermali; Municipal Council: Port Vila)

The Shefa province includes four islands, seventeen area councils along with the Port Vila municipal council. The total population of the Shefa province is 97,602; which is 35.8% of the total population of Vanuatu (as per 2016 mini census). In Shefa province, Efate is the most populated island with about 83,989 people compared to other islands within the province, followed by Epi (6278), Sheperd islands (3,725) and Efate outer islands (2,413).

This includes an urban population of Port Vila (50,944) and rural population (46,658) of area council's - South Epi, Tongariki, Eratap, Eton, Malorua, Makimae, Varisu, Erakor, Emau, Nguna, North Efate, Vermaul, Mele, North Tongoa, Pango, Ifir, and Vermali. The capital city of Prot Vila on the island of Efate is the largest city of Vanuatu and having the municipal council and also is the economic and commercial center of Vanuatu.

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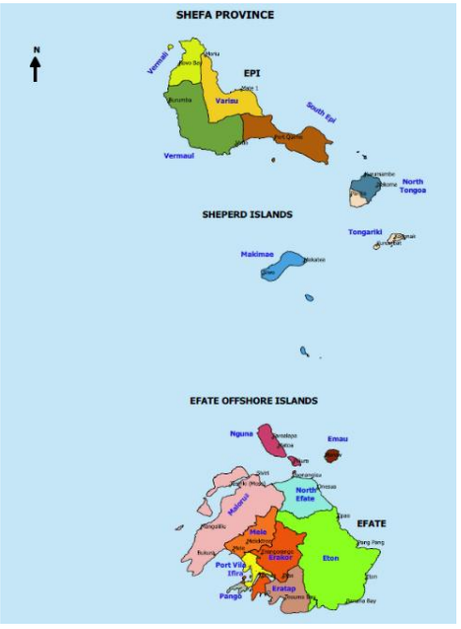
11 Sanma Provincial Council and Luganville Municipal Council Strategic Development Plan -2017-2026

12 Data Collection Survey on Power Sector in Espiritu Santo in Republic of Vanutau-2017 http://open_jicareport.jica.go.jp/pdf/12288635.pdf and Vanuatu Energy Demand Projections: Business As Usual Scenariohttp://gggi.org/site/assets/uploads/2016/12/BAU-Energy-Projection-for-Vanuatu-GGGI-2016.pdf

13 National Energy Roard Map Implementation Plan-2016-2030, Project document - Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu (BRANTV)

Shefa province's area council have total 19,962 Household (HH) including 19,913 Private Households (mainly Urban HH in Port Vila about 10,965 and remaining 8,948 rural HH), 38 Institutions (e.g. schools, hospitals, hotels, rooming houses, and other lodging houses) and 11 Mobile households Including vessels, and construction camps. Average household size 5 person/HH. The main income of Shefa province with 71% (14,060) of households earning income through wages and salary, 34% (6,735) through Household sales, 23% (4,578) from own businesses and households that earned income through remittances and other sources are at 9% (1,723) and 8% (1,577) respectively.



More than half (60%) of the households in Shefa are dependent on grid electricity as their main source of lighting. Over 33% of Shefa households, however, use Solar as their main source for lighting. While Battery lamp (1%) and Generator Set (6%); which is the lowest percent in Shefa Area councils. The grid-connected electricity available in the Port Vila, Erakor, Eratap, Mele, Eton, North Efate, Malorua, Pango, Vermali, North Tongoa, Tongariki, and Ifira area councils; however, grid connection and availability varies among the area councils. Over 77% of Households in Shefa had stated that Firewood is their preferred choice of cooking energy. Nine out of ten rural households prefer firewood compared to Urban households.[14]

The SHEFA province corporate plan (2014-2018) which is currently being reviewed has some energy sector activities listed which includes:

- Establish power supply for Burumba Dispensary
- Identify potential power sources to all Area Councils offices
- Expand power supply to increase the accessibility of Shefa residents
- Re-negotiate Geothermal power plant at Takara

The strategic plan has some energy focused activities but no concrete implementation plan is available.

The key energy initiatives proposed and planned for the Shefa province under the National Energy Roadmap (NERM) and Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu (BRANTV) programs include:

- Village-scale community PV demos to demonstrate off-grid renewable energy systems.
    - 5 kW Village-scale Community PV Demo on Sara, Epi Island, Utanlangi village on Nguna Island, Pele on Tongoa Island and Finonge/Nofo on Emae Island.

14 Shefa Province Mini Census - 2016

- Distributing EE cook stove production beyond Port Vila/ Efate to allow lower cost and more effective distribution of the cook stoves; specifically, in northern Efate, the capital of Port Vila and the two mainland sites of Epau and Lelepa, and the offshore island of Nguna, with a target of 530 EE stoves to be sold.
- Crop drying technology based on an energy efficient stove model combined with a solar-powered fan to be developed demonstrated and deployed.
- Relocation of two new 5 million liter petroleum storage tanks in Port Vila, Efate
- Reduction in petroleum distribution costs by 10%-15% (primarily by using a barge to supply outer islands and developing wharves in Port Vila and outer islands).

4.4.3 TAFEA PROVINCE

(Islands: Tanna, Aniwa, Futuna, and Erromango; Area Councils: Middle Bush Tanna, South Tanna, West Tanna, Whitesands, South West Tanna, North Tanna, Aneityum, North Erromango, Futuna, South Erromango, Aniwa; Municipal Council-Lenakel)

Tafea province includes four islands, eleven area councils and one municipal town-Lenakel located on the west coast of the island near the administrative capital of Isangel which serves as a major port of entry.

The total population of the Taefa province is 36,799; which is 13.81% of the total population of Vanuatu (as per 2016 mini-census). Tafea province has a youthful population with 46% of the population under the age of 15 years of age. About a quarter of Tafea population is between the age of 15-29 years and the percentage keeps decreasing as the age increases.

In Tafea province, Tanna is the most populated island with about 8,545 people in west Tanna council area compared to other council areas within the province, followed by Whitesands (6,733), Middle Bush Tanna (5,994), South West Tanna (5,593), North Tanna (4,165), North Erromango (1,466), Aneityum (1,402), South Tanna (1,205), South Erromango (618), Futuna (613) and Aniwa (420). Tafea province's area council have total 6,867 Household[15] (HH); which is 12.4% of total households Vanuatu. The Tafea province's total households include 6,853 Private Households, 13 Institutions (e.g. schools, hospitals, hotels, apartments, and other lodging houses) and 1 Mobile household (e.g. vessels, and construction camps).

The average household size in Tafea is 5 person per household. The main income of Tafea province with 82% (5,611) of the household earn income through Household Sales (fish, crops, and handicrafts); 20% of the household (1,401) earn income through

15 The statistical definition of a household (HH) in a census is "a family that live together and share the cost and work of preparing a meal".

Wages and Salary. Households receiving remittance and owing a business share 16% (1,070) of the household income and Others make up the remaining 6% (426).

The lighting and cooking are the two major energy consuming area in Tafea province; 86% of Tafea households use Solar Systems as their main source for lighting (5,936 HH). The grid electricity available for 10% of Households (670 HH) mainly in West Tanna Area council in Lenakel Town (upgraded as a municipal town and commercial hub of Tanna). The other sources of energy include Generator (62 HH), Battery lamp (45HH) and Others (2%; 145 HH). 100% of Households in South Erromango (108HH) and Aniwa (100HH) uses renewable (Solar) energy for lighting purposes.

Nearly all (99%) of Households in Tafea had stated that Firewood is their preferred choice source of energy for cooking. [16]

The key energy initiatives proposed and planned for the Tafea province under the National Energy Roadmap (NERM) and Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu (BRANTV) programs include:

- Extension of access to energy in all Area Councils (ACs)
- Whitesands Solar PV Micro-grid inTanna
- UNELCO Grid extension in Tanna
- Extension of off-grid electricity access under Rural Electrification program in Tanna and Aniwa.
- Improving diesel generation efficiency (g/kWh)
- Distributing EE cook stove in all Area Councils (ACs)
- Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos on Tanna: Labang Nuying Middle Bush (7.5kW);.
- Village-scale Community PV Demos on Tanna (all 5kW capacity): Unpongkor Dillons Bay Erromango, Ipak North Tanna and Lapangtawat East Tanna and Isahvani on Aniwa Island.
- Family-Scale Compound PV Nano-grid (5kW capacity); Port Narvin on Erromango

16 Taefa Province Mini Census - 2016

4.4.4 TORBA PROVINCE

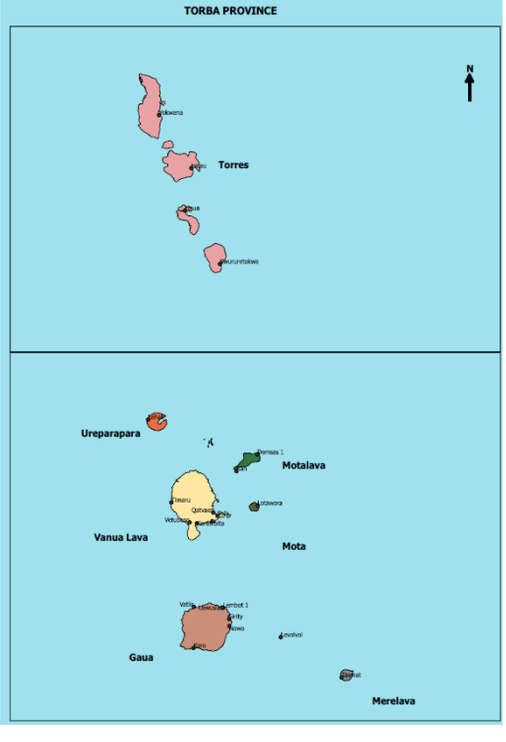
(Area councils: Mere Lava, Torres, Mota, Gaua, Ureparapara, Mota Lava, Vanua lava)

Torba province covers seven area councils with a total population of 9,875 which is 3.7% of the total population of Vanuatu (as per 2016 mini-census). Torba province has a youthful population with 40% of the population under the age of 15 years of age. About a quarter (2,460) of Torba population are between the age of 15-29 years and the percentage keeps decreasing as the age increases.

The majority of the Torba population are from Vanua Lava area council (3,072) followed by the population of Gaua (2,533), Mota Lava (1,571), Torres (981), Mota (673), Mere Lava (588), Ureparapara (454). Majority of the population in Torba are in the category of working age groups. In Torba province, there are more males than females.

Torba province's area council have total 1,980 Household[17] (HH); which is 3.6 % of total households Vanuatu. Torba province's total households include 1,960 Private Households, 18 Institutions (e.g. schools, hospitals, hotels, apartments, and other lodging houses) and 2 Mobile households (e.g. vessels, and construction camps). Merelava has the highest number of private households (130 HH) compared to the other area councils in Torba. On the other hand, Vanua Lava is the most populated area council. The average household size in Torba Province is 5 people per household and Almost 20% (347) of the total private households are headed by women.

The main source of income for Torba province was; 86% (1,690HH) from Household sales like sales of fish, crops, and handicrafts, 29% (572 HH) through household owned businesses and 23% (444 HH) from other sources of income like land leases and house rents. Households that earn income through normal wages and salary were 18% (350 HH) while 6% (118 HH) is from remittances. Vanua Lava had the highest number of households (485) that earned income through household sales. On the other hand, Merelava has the lowest with only 75 households that earned income through this activity. The second highest source of income is through own business where Motalava has the highest number with 209 households engaged and lowest with Mota.



The lighting and cooking are the two major energy consuming area in Torba province; 94% (1,835 HH) of households are using solar for lighting in Torba; other sources for lighting are grid electricity (1%, 19 HH), Generator (2.2%, 44 HH) and Battery lamp (2.8 54HH). Almost all Households in Torba had stated that Firewood is their preferred choice of energy used for cooking. [18]

17 The statistical definition of a household (HH) in a census is "a family that live together and share the cost and work of preparing a meal".

18 Torba Province Mini Census - 2016

The key energy initiatives proposed and planned for the Torba province under the National Energy Roadmap (NERM) and Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu (BRANTV) programs include:

- Extend the Energy Access in all Area Councils (ACs)
- Off-grid rural electrification using the Biofuels for residential (for over 300 HH) and institutions including hospitals, dispensaries, and schools
- Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos at Siriti/Nemen/Santa Maria (15kW) and Barvet/Aworor (7.5kW)
- Village-Scale Community_PV demo (5kW) at Ngenreniuman, Mota Lava Island
- Family-Scale PV Nano-Grid on Loh
- Distributing EE cook stove in all Area Councils (ACs)

4.4.5 MALAMPA PROVINCE

(Area Councils: South East Malekula, South West Malekula, North West Malekula, South East Ambrym, West Ambrym, North East Malekula, Paama, Central Malekula, South Malekula, North Ambrym)

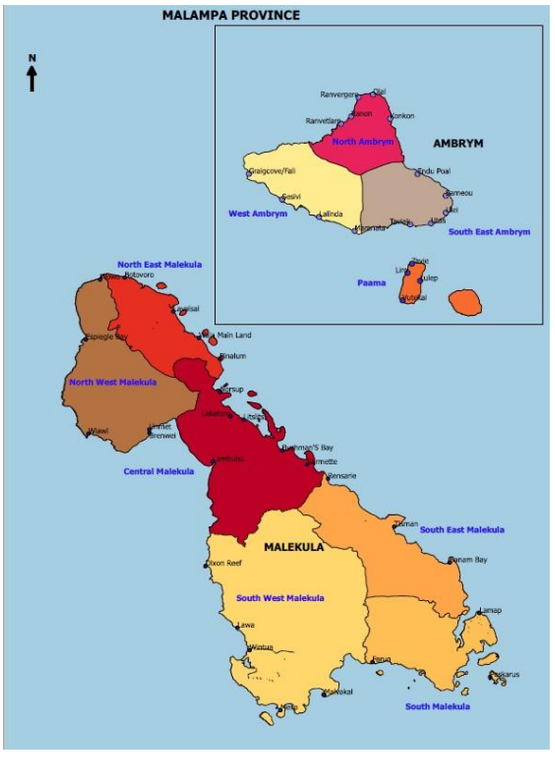
Malampa province comprises of Ambrym, Paama and Malekula islands and covers ten area councils. The total population of Malampa province is 39,997; which is 15.1% of the total population of Vanuatu (as per 2016 mini-census). More than 40% of the population of Malampa province was made up of young people under the age of 15 years 16,443 (41%). However, the population decreased as age increased.

Majority of the population in Malampa province were from North-east Malekula area council 7,150 people, followed by Central Malekula (6,115 people), North-West Malekula (5,407 people), South-East Malekula (4,942 people), South Malekula (3,879 people), South-West Malekula (3,488 people), North Ambrym (3,019 people), West Ambrym (2,817 People), Paama (1,631 people), South-East Ambrym (1,549 people).

Malampa province's area councils have total 8,925 Household[19] (HH); which is 16.1 % of total households Vanuatu. Malampa province's total households include 8,896 Private Households, 26 Institutions (e.g. schools, hospitals, hotels, rooming houses, and other lodging houses) and 3 Mobile households (e.g. vessels, and construction camps). Paama, on the other hand, accommodates only 390 of the total private households of Malampa. The average household size in Malampa Province is 4 person per household. A typical house in Malampa would be the concrete floor, traditional wall, and traditional roof.

19 The statistical definition of a household (HH) in a census is "a family that live together and share the cost and work of preparing a meal".

The main source of household income in the Malampa province includes; 78% (6,895) of the households earning income through household sales like sales of fish, crops and handicrafts, 24% (2,151) through own business and 22% (1,956) from remittances. A further 15% (1,339) of household relied on wages and salaries and 14% (1,235) through other sources of income. 15% of the Vanuatu labor force was represented by Malampa and about 50% of Malampa population were in the activity of the producing good.



The lighting and cooking are the two major energy consuming area in Malampa province; over 90.9% (8,083 HH) of households are using solar for lighting; other sources for lighting are grid electricity (5.8%, 516 HH), Generator (0.9%, 76 HH) and Battery lamp (2%, 177 HH). Almost all Households in Malampa had stated that Firewood is their preferred choice of energy used for cooking. [20]

The key energy initiatives proposed and planned for the Malampa province under the National Energy Roadmap (NERM) and Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu (BRANTV) programs include:

- Extend the Energy Access in all Area Councils (ACs)
- UNELCO Grid extension in Malekula - Low Voltage and Medium Voltage Extensions
- Extension of off-grid electricity access under Rural Electrification program in Malekula
- Brenwei Hydro is a 400-kW mini-hydro project with mini-grid on Malekula
- Ambrym Electrification (Hybrid Wind and Solar) Project
- Pico-Hydro/ Small Micro-Hydro Mini-Grid demos at: Lawa (10kW) on Malekula Island
- Village-scale Community Solar PV demo at (all 5kW capacity):, Olal and Nepul on Ambrym Island, Vinmavis on Malekula and Liro on Paama
- Distributing EE cook stove in all Area Councils (ACs) ; specifically in northeast Malekula, on the offshore islands of Vao, Achin, and Uripiv, a target of 1,620 stoves to be sold.
- Improve Diesel generation efficiency (g/kWh)

4.4.6 PENAMA PROVINCE

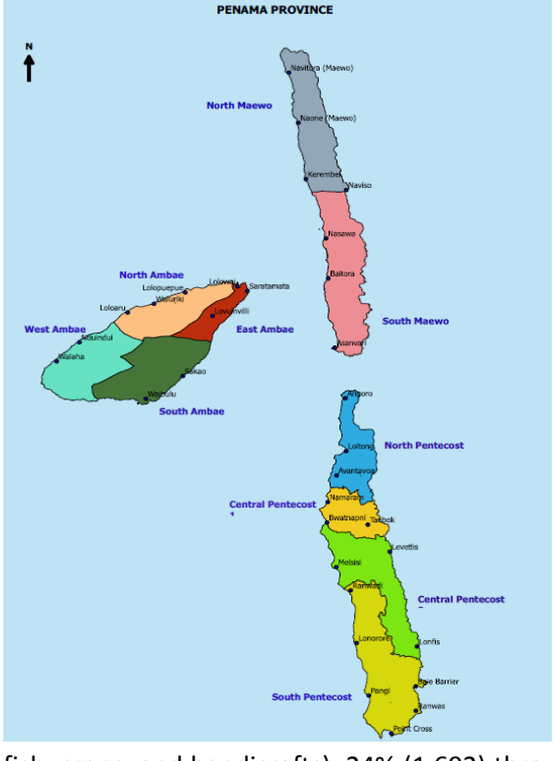
(Area Councils: North Pentecost, East Ambae, North Maewo, Central Pentecost-1, South Maewo, West Ambae, Central Pentecost-2, North Ambae, South Pentecost, South Ambae)

20 Malampa *Province Mini Census - 2016*

Penama Province comprises of Pentecost, Ambae, and Maewo islands; also covers ten area councils. The total population of Penama Province is 31,334 people; which is 11.8 % of the total population of Vanuatu (as per 2016 mini-census). Nearly half the population of Penama province is made up of young people under the age of 15 years.

The majority of Penama populations are from North Pentecost area council with over 5,778 people followed by South Pentecost (4,705 people), Central Pentecost-2 (3,769 people), West Ambae (3,735 people), North Ambae (3,564 people), Central Pentecost-1 (2,647 people), North Maewo (2,310 people), Easte Ambae (2,116 people), South Ambae (1,443 people), South Maewo (1,267 people).

Penama Province's area councils have total 7,001 Household[21] (HH); which is 12.6 % of total households Vanuatu. Penama Province's total households include 6,959 Private Households, 40 Institutions (e.g. schools, hospitals, hotels, rooming houses, and other lodging houses) and 2 Mobile households (e.g. vessels, and construction camps). All the households (100%) in Central Pentecost are private households with no institutions or mobile households. All other nine area councils also have a higher number of private households with a smaller number of an institution or mobile households.



The average household size in Penama Province is 5 person per household; however, in South and North Pentecost, the household size is much bigger for household size 6 and above.

The main source of household income in the Penama Province includes; 78% (6,895) of the households earning income through household sales like sales of fish, crops and handicrafts, 24% (2,151) through own business and 22% (1,956) from remittances. A further 15% (1,339) of household relied on wages and salaries and 14% (1,235) through other sources of income. 15% of the Vanuatu labor force was represented by Malampa and about 50% of Malampa population were in the activity of the producing good. A typical house in Penama would be the concrete floor, traditional wall, and traditional roof.

The main source of income in Penama province includes 87% (6,035) of Household Sales (sales of fish, crops, and handicrafts), 24% (1,692) through Own businesses and 16% (1,141) from Wages and Salary. However, the remaining 8% (542) is earned through Remittance and 4% (275) from other sources of income. 12% of Vanuatu labor force found in Penama also about 50% of Penama population are in producing goods sector.

The lighting and cooking are the two major energy consuming area in Penama province; over 95.3% (6,630 HH) of households are using solar for lighting; other sources for lighting are grid electricity (0.7

21 The statistical definition of a household (HH) in a census is "a family that live together and share the cost and work of preparing a meal".

%, 50 HH), Generator (1.5%, 107 HH) and Battery lamp (1.9%, 129 HH). All households are using Firewood for cooking in Penama. [22]

The key energy initiatives proposed and planned for the Shefa province under the National Energy Roadmap (NERM) and Barrier Removal for Achieving the National Energy Road Map Targets of Vanuatu (BRANTV) programs include:

- Extend the Energy Access in all Area Councils (ACs)
- Off-grid rural electrification using the Biofuels for residential (for over 350 HH) and institutions including hospitals, dispensaries, and schools on East Ambae
- Loltong Hydro Project, North Pentecost
- 75 kW micro-hydro unit (Talise Hydro on Maewo) – Transmission & Distribution component
- Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos: Rangusuksuk (7.5kW); Waterfall (15kW) Melsisi (19kW; Nambwarangiut (5kW), Laringmat (10kW) and Big Water, Maewo (8.82kW).
- Village-scale Community Solar PV Demo at Angoro, Abwatuntora, Amatbobo Pentecost, Betarara on Maewo
- Pico-/Micro Hydro PV Hybrid Mini-Grid (14kW) at Loltong, North Pentecost
- Family-Scale PV Nano-Grid (5kW) at Bwatnapni in Pentecost
- Distributing EE cook stove in all Area Councils (ACs); specifically, in northern Pentecost, Ivo and 3 or 4 other villages, with a target of 1,225 EE cook stoves to be sold.

22 Penama *Province Mini Census - 2016*

4.5 SUSTAINABLE ENERGY STRATEGY AND ACTION PLAN FOR LOCAL ADMINISTRATIVE BODIES (PROVINCIAL GOVERNMENTS AND MUNICIPALITIES)

The result of the provincial strategy and corporate plan, national policies, project, and program review followed by the exhaustive consultation with multiple stakeholder consultation summarised in the table:

Province (Area Councils/ Municipal Council)	Access to Energy/Sustainable Energy Strategies to be included in the Corporate Strategic Plan / as per NERM Priorities
Sanma Province (Area Councils: West Santo, North Santo, South Santo, East Malo, West Malo, Canal – Fanafo, East Santo, South East Santo North West Santo, Municipal Council: Luganville)	• Grid Extension, East Cost Santo (Matevulu to Shark Bay, Port Olry, Stone Hill and Palekula) • Low Voltage and Medium Voltage Extensions, Santo • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • The lighting of Luganville Town Streets • 1,512 Energy efficient cook stove to be sold in Luganville and Santo • Demonstrating a few efficient hot air driers on the east coast • Implement household and institutional scale biogas digesters for cooking energy needs • Village-scale Community PV Demos: • Lelek, Lathi, Kole, Sara Santo – 5kW • Family-Scale PV-Nano-grids (of 300 W): (i) Saufeli Youth Centre Malo: 8 systems x average of 700W per system (2.5 kW)

	• Sarakata Hydro Power Extension Project (600 kW), Santo • Assessment of Renewable Energy Sources: Incremental pico- and small micro-hydro demo sites: (ii) Falambil, Santo (5 kW) (iii) Pesena, Santo (17kW)
Shefa Province (Islands: Efate outer islands, Efate, Epi, Sheperd islands; Area Councils: South Epi, Tongariki, Eratap, Eton, Malorua, Makimae, Varisu, Erakor, Emau, Nguna, North Efate, Vermaul, Mele, North Tongoa, Pango, Ifira and Vermali; Municipal Council: Port Vila)	• Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • Vermaul Area Council: Establish power supply for Burumba Dispensary • Identification of potential power sources (focused on Renewable sources) for all Area Councils offices. • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Efate Area Council: Expand power supply to increase the accessibility of Shefa residents • Implement household and institutional scale biogas digesters for cooking energy needs • Village-scale community PV demos to demonstrate off-grid renewable energy systems. (i) 5 kW Village-scale Community PV Demo on Sara Epi Island, Finonge/Nofo on Emae Island and Pele on Tongoa Island • Distributing EE cook stove beyond Port Vila/ Efate to allow lower cost and more effective distribution of the cook stoves; specifically, in northern Efate and the two mainland sites of Epau and Lelepa, and the offshore island of Nguna, with a target of 530 EE stoves to be sold. • Crop drying technology based on an energy efficient stove model combined with a solar-powered fan to be developed demonstrated and deployed. • Relocation of two new 5 million liter petroleum storage tanks in Port Vila, Efate • Reduction in petroleum distribution costs by 10%-15% (primarily by using a barge to supply outer islands and developing wharves in Port Vila and outer islands).
Tafea Province (Islands: Tanna, Aniwa, Futuna and Erromango; Area Councils: Middle Bush	• Whitesands Solar PV Micro-grid, Tanna

Tanna, South Tanna, West Tanna, Whitesands, South West Tanna, North Tanna, Aneityum, North Erromango, Futuna, South Erromango, Aniwa; Municipal Council-Lenakel)	• Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • UNELCO Grid extension in Tanna • Extension of off-grid electricity access under Rural Electrification program in Tanna and Aniwa. • Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos on Tanna: (i) Isaka, Tanna (7.5 kW) (ii) The site near the village on Mt. Malin, Tanna (5 kW) (iii) Tanna site 3, Tanna (5kW) (iv) Village near the site in DOE hydro study, Aneityum (5 kW) • Village-scale Community solar PV Demos: (i) Ipak and Lapangtawat, Tanna (5 kW) (ii) Isahvani, Aniwa (5 kW) (iii) Unpongkor/Dillons bay, Erromango (5kW) • Family-Scale PV Nano-Grid ○ Port Narvin, Erromango Island • Improving diesel generation efficiency (g/kWh) • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Distributing EE cook stove in all Area Councils (ACs) • Implement household and institutional scale biogas digesters for cooking energy needs
Torba Province (Area Councils: Mere Lava, Torres, Mota, Gaua, Ureparapara, Mota Lava, Vanua Lava)	• Off-grid rural electrification using the Biofuels for residential (for over 300 HH) and institutions including hospitals, dispensaries, and schools • Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos: (i) Siriti/ Nemen/ Santa Maria, Gaua (15 kW) (ii) Barvet/ Aworor, Gaua (7.5 kW) • Village-Scale Community PV ○ Ngenreniuman, Motal Lava

	• Family-scale PV Nano-Grid ○ Low island • Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Distributing EE cook stove in all Area Councils (ACs) • Implement household and institutional scale biogas digesters for cooking energy needs

Malampa Province (Area Councils: South East Malekula, South West Malekula, North West Malekula, South East Ambrym, West Ambrym, North East Malekula, Paama, Central Malekula, South Malekula, North Ambrym)	• Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs)
	• North East Malekula Rural Electrification Project
	• Carry-out sustainable energy/RE resource assessment at the provincial and municipal level
	• UNELCO Grid extension in Malekula - Low Voltage and Medium Voltage Extensions
	• Implementation of a comprehensive hydro-based energy generation demo program – 600 kW mini-hydro unit (Brenwei Hydro on Malekula)
	• Extension of off-grid electricity access under Rural Electrification program in Malekula
	• Brenwe Hydro Power Project (< 1.2MW), Malekula
	• Brenwei Hydro is a 400-kW mini-hydro project with mini-grid on Malekula
	• Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos:
	  (i) Lawa Village, Malekula (10 kW)
	• Village-scale Community PV Demos:
	  (i) Vinmavis, Malekula (5kW)
	  (ii) Olal & Nepul (5 kW)
	  (iii) Liro, Paama (5 kW)
	• Distributing EE cook stove in all Area Councils (ACs); specifically in northeast Malekula, on the offshore islands of Vao, Atchin, and Uripiv, a target of 1,620 stoves to be sold.

	• Improve Diesel generation efficiency (g/kWh)
Penama Province (Area Councils: North Pentecost, East Ambae, North Maewo, Central Pentecost-1, South Maewo, West Ambae, Central Pentecost-2, North Ambae, South Pentecost, South Ambae)	• Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • Off-grid rural electrification using the Biofuels for residential (for over 350 HH) and institutions including hospitals, dispensaries, and schools • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • 75 kW micro-hydro unit (Talise Hydro on Maewo) • Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos: (i) Rangusuksuk, Pentecost (7.5 kW) (ii) Melsisi, Pentecost (10 kW) (iii) Bwatnapni Pentecost (5 kW) (iv) Nambwarangiut, Pentecost (5 kW) (v) Waterfall, Pentecost (7.5 kW) (vi) Laringmat, Pentecost (5 kW) (vii) Big Water, Maewo (7.5 kW) • Village-scale Community PV Demos: (i) Angoro, Pentecost (5 KW) (ii) Abwatuntora, Pentecost (iii) Betarara, Maewo (iv) Amatbobo, Pentecost • Family-Scale PV Nano-Grid ○ Batnapni, Pentecost • Distributing EE cook stove in all Area Councils (ACs); specifically, in northern Pentecost, Ivo and 3 or 4 other villages, with a target of 1,225 EE cook stoves to be sold.

4.6 RECOMMENDATIONS

Some of the common priority actions for all the provincial and municipal councils include:

- ***Access to Sustainable and Affordable Energy:*** The priority actions include the following:
    - Expansion of the existing grid and rural electrification program
    - Grid-connected or Off-grid/grid electrification of Health Care Facilities (Hospitals and Dispensaries)
    - Grid-connected or Off-grid/grid electrification of Institutions (Government/provincial offices, Schools, community centers etc)
    - Off-grid Rural Electrification (Standalone pico-micro PV Systems, Family campus PV System, Community PV Systems, Village Scale micro-Grid)
    - Identification and Techno-economic feasibility assessment of local Renewable Energy Sources: (Solar, Pico-micro hydro, wind, etc.)
    - Implementation of RE projects achieved the financial approval including secure financial support for the projects completed the technical feasibility study
- ***Access to modern cooking fuels for all households:***
    - Distribution of the EE cook stoves in rural households, stimulation of domestic capacity for manufacturing of maintenance cookstoves.
    - Enabling the policy and fiscal instrument for the distribution of cookstove;
    - Secure Financial support (international or donor-funded) finance for cookstove program.
    - Explore alternate options for cooking solutions like Biogas program for rural households.
    - Expansion of the LPG distribution system in an urban area
- ***Review and Update the Provincial and Municipality level strategies*** and corporate plans to align with the NERM priorities and NDC roadmap by incorporating the energy sector priorities as discussed in the above summary.
- ***Establish Institutional Coordination Framework:*** The provincial and municipal authorities need to establish an institutional co-ordination and collaboration framework with the Department of Energy in order to implement and monitor the actions and initiatives incorporated under the strategic/corporate plans.
- ***Seek Implementation Support:*** Liaise with Ministry of Internal Affairs (DLA), Prime Minister's Office (DSPPAC) and other Government stakeholders to mobilize technical and financial support to implement the actions and initiatives incorporated under the strategic/corporate plans.
- Capacity building and awareness for adopting energy efficiency, renewable energy and modern cooking solutions for urban and rural population (Technology demonstration center).
- Capacity building of financial institutions (Banks) for RE financing and IPPs on microfinancing for RE systems.
- Implementation of effective and efficient M&E System for all projects and programs

5 MONITORING REPORTING AND VERIFICATION (MRV) PLAN

5.1 BACKGROUND

MRV helps to assess and track the implementation of planned interventions/actions including the status of implementation and progress achieved under the NERM.

Some of the key benefits of MRV include:

- Build capacities within the DoE and ensure the sustainability of NERM progress reporting processes
- Provides the information basis for planning and implementing NERM interventions/actions
- Creates avenues to access new sources of finance by documenting impact and good governance practices
- Informs national and international policymakers on the NERM implementation status

The updated Vanuatu National Energy Road Map 2016-2030 defines a robust Monitoring, Verification, and Evaluation Plan (MRV) to monitor the status and progress for the NERM actions. All the NERM priorities have defined monitored objectives and key result indicators, targets that are not monitored have limited value. There are four key elements in effective monitoring and evaluation for the NERM:

- Baseline/Base year Data and Targets: Defining performance measures
- Monitoring: Collecting, collating, and analysing performance data
- Reports: Generating and Communicating the results
- Roles & Responsibilities: Using the information to improve performance of DoE and stakeholders

The objectives, quantitative targets, and implementation plan under the NERM sets the framework for DoE to monitor and evaluate NERM implementation. The quantitative targets under the NERM and specified indicators and baselines against which progress will be measured are intended to be Specific, Measurable, Achievable, Relevant, and Time-bound (SMART) so that they can be used effectively for monitoring and improving progress. Although the target on petroleum distribution costs is currently not monitored, this is expected to change once regulations (currently under development) to monitor petroleum prices are in place. Similarly, biomass consumption data may not be available on a regular basis, but the implementation plan also includes an action to develop a better information base on biomass use in Vanuatu.

The NERM implementation progress will be measured against these parameters.

Table 11: NERM Priority (Objectives) and Monitoring Indicators

Priority/Objective		Indicator
Accessible Energy	Increase electricity access by households in and near concession areas	% with access

Priority/Objective		Indicator
	Increase electricity access by households in off-grid areas	% with access
	Increase electricity access by public institutions (on- and off-grid)	% with access
Affordable Energy	Improve the efficiency of diesel generation	Grams of diesel fuel per kWh of electricity
	Reduce the cost of distributing petroleum products in Vanuatu	Distribution cost in Vatu per liter
Sustainable Energy	Increase the proportion of electricity generated from renewable sources	% of grid-based electricity from renewable sources
	Improve electricity sector end-use efficiency	% saving on BAU projection
	Improve transport (land and marine) energy efficiency	% saving on BAU projection
	Improve biomass end-use (cooking and drying) efficiency	% saving on BAU projection
	Ensure all energy infrastructure projects comply with government and donor environmental and social safeguard requirements	% of projects complying
Green Growth	Increase the proportion of electricity generated from biofuels	% of electricity generated from biofuels
	Increase renewable electricity use by rural tourism bungalows	% of bungalows using renewable energy sources for electricity supply

5.1.1 ROLES & RESPONSIBILITIES:

The Department of Energy (DoE) will have primary responsibility for monitoring the progress including collection and analysis of progress information, in collaboration with other government agencies, donors, and energy sector stakeholders. As the lead agency for energy policy, DoE is also responsible for leading the collection and analysis of data on progress towards the NERM's quantitative targets. The NERM Implementation Plan includes an action to improve the collection, analysis, and monitoring of data on energy consumption by DoE (to include training and capacity building for DoE officials provided). DoE will need to collaborate with other government agencies and other energy sector stakeholders to obtain the required information. DoE will then collate the data and maintain a central database on its intranet server (NERM-MRV Tool).

The above table summarises the targets, indicators and data sources that will be used to track progress, and the frequency of data collection. Ideally, data should be collected and reviewed more frequently than once a year (for example, quarterly). This allows DoE to remain up-to-date with implementation progress and gives more opportunity to address implementation challenges and issues encountered. The Implementation Plan assigns a lead agency to each action. For most actions,

DoE is expected to lead implementation, often in close partnership with other key government agencies. The information will be used to improve the performance of DoE.

5.1.2 REPORTS

The MRV results are in the form of individual project based or consolidated reports will be communicated to senior government officials, and to broader stakeholders. DoE will prepare annual reports for the Minister of Climate Change and the Energy Task Force[23] that: (i) summarise progress in implementing the NERM, especially the quantitative targets, (ii) highlight key implementation issues and (iii) propose ways to accelerate progress. Summary information could also be shared with interested stakeholders such as development partners and the utilities, and/or published on DoE's website.

Previous initiatives in Vanuatu have faced significant challenges translating initial success (for example in mobilising investments) into long-term success (by making these investments last). The Government seeks to achieve durable results from all actions implemented under the NERM. Confirming that investment has taken place, or that a piece of legislation has been enacted, will not guarantee that the NERM's objectives are achieved over the long-term. An important task for DoE will, therefore, be regular verification that investments (such as micro-grids or solar home systems) remain operational over the long-term in order to make an ongoing contribution to achieving the NERM's objectives up to 2030 and beyond. Similarly, legislation—if not enforced and acted upon—has limited benefit.

DoE's responsibility to track the progress of action in the NERM Implementation Plan does not end after the action is first implemented. DoE will need to conduct regular checks throughout the full duration of the NERM to confirm that the desired results continue to be achieved.

With the above objective, an integrated National Energy Roadmap-Monitoring, Reporting and Verification (NERM-MRV Tool) has been designed and developed. The NERM-MRV Tool is an IT-based tool which complies with the all current requirements discussed above and also has scope to scale up to adopt new requirements of revising target, data collection, reporting, etc. The following sections provide more details of this unique IT-based tool and application process.

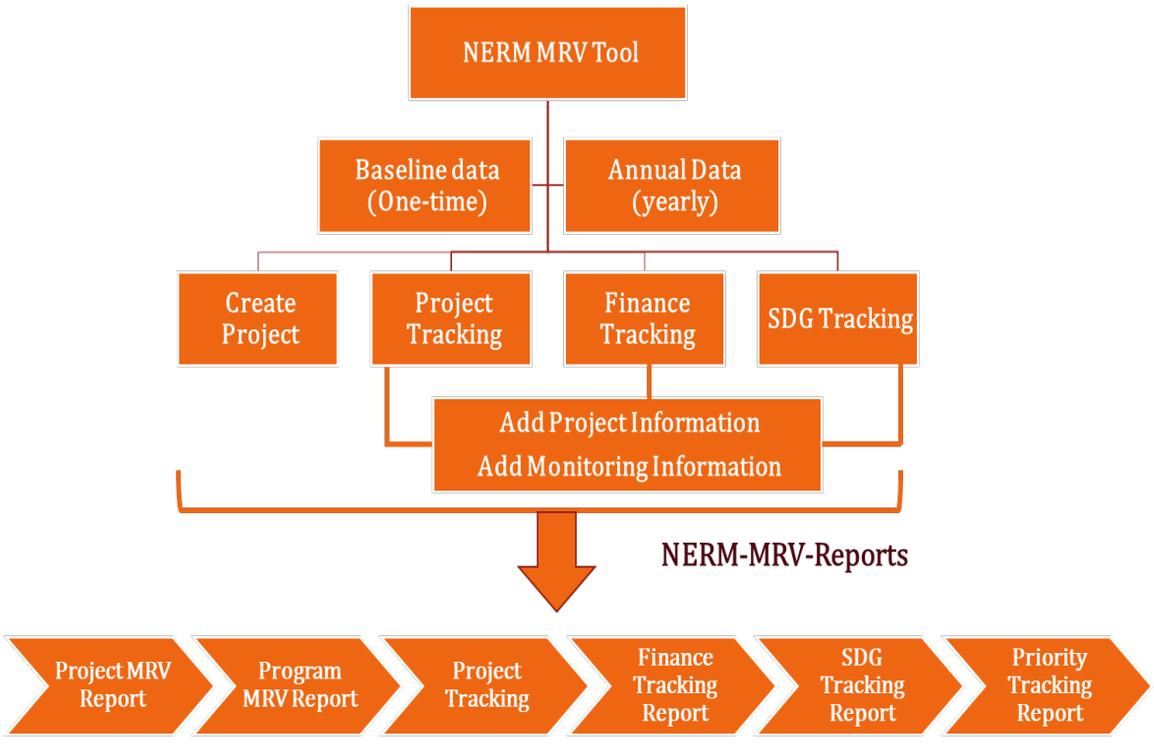
5.2 NATIONAL ENERGY ROADMAP -MONITORING, REPORTING AND VERIFICATION TOOL

The NERM-MRV Tool is a unique IT-based tool designed to fulfill all monitoring-including data collection, tracking and reporting requirements of NERM priorities, targets and actions. The tool has a central data repository and desktop-based data input feature to efficiently and effectively track, report and verify (1) NERM Targets against the baseline year and interim target year i.e. 2020 and 2030 (2) Performance of NERM actions (including projects and programmes), GHG emissions (3) NERM finance flows for each NERM action (4) NERM action SDG impacts (Based on the UNDP Climate

[23] The Taskforce was established to develop the 2013 NERM. It includes senior government officials representing DoE, the Prime Minister's office, and other key government agencies with an interest in energy policy.

Action Impact Tool-CAIT). Further mapping of progress towards each NERM Priority. The structure of the NERM MRV Tool depicted below:

Figure 6: Structure of NERM-MRV Tool



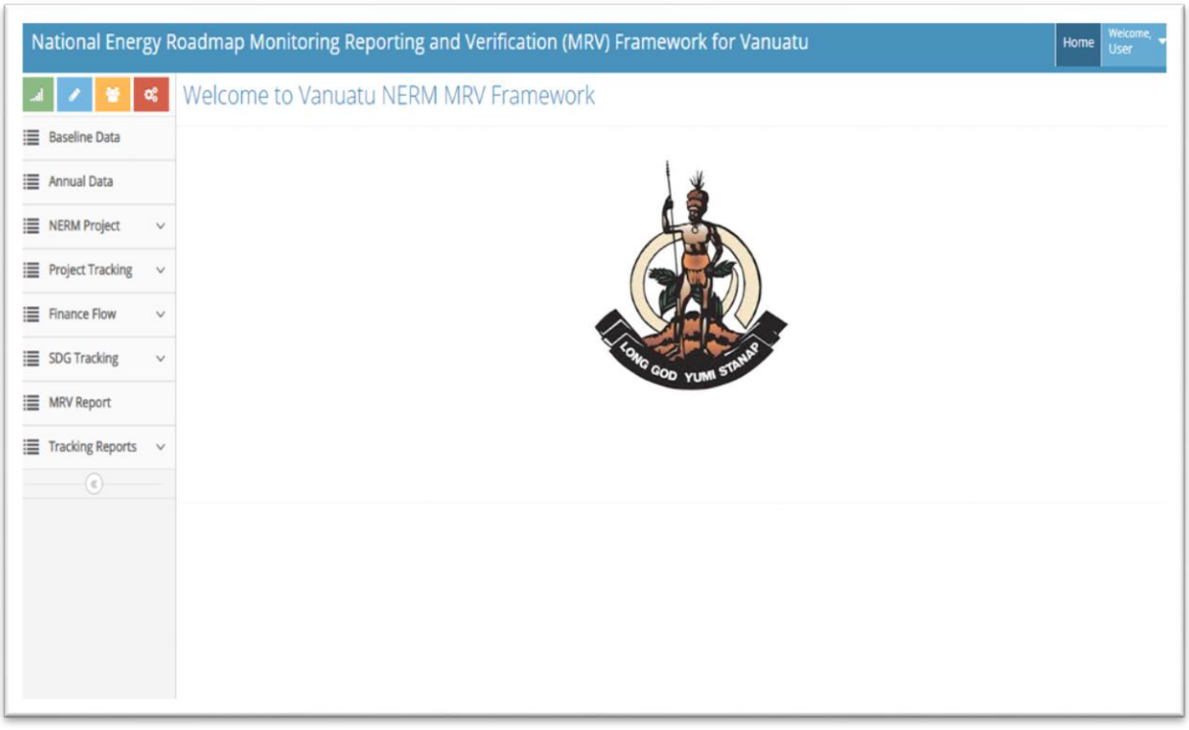
The integrated NERM MRV Tool is robust but also flexible to accommodate the needs of government & stakeholders keeping in mind the capacity and resource constraints. The integrated approach is modular and can be tailored to align with the updates and development policies including communicating the progress reports domestically and under donor assistance reporting framework. The monitoring of GHG emission reductions, SDG parameters and financial flow for each NERM action/project/program will also result in improved international/bilateral cooperative cooperation. The key advantage of the integrated NERM MRV Tool being the ability to track the SDG impact (as per the UNDP CAIT https://climateimpact.undp.org/#!/) of each NERM action at the project/programme level which immensely assists in aligning mitigation actions including NDCs with SDG's through linking the policies and priorities for climate change mitigation with the national sustainable development goals.

5.2.1 HOW DOES THE NERM-MRV TOOL WORK?

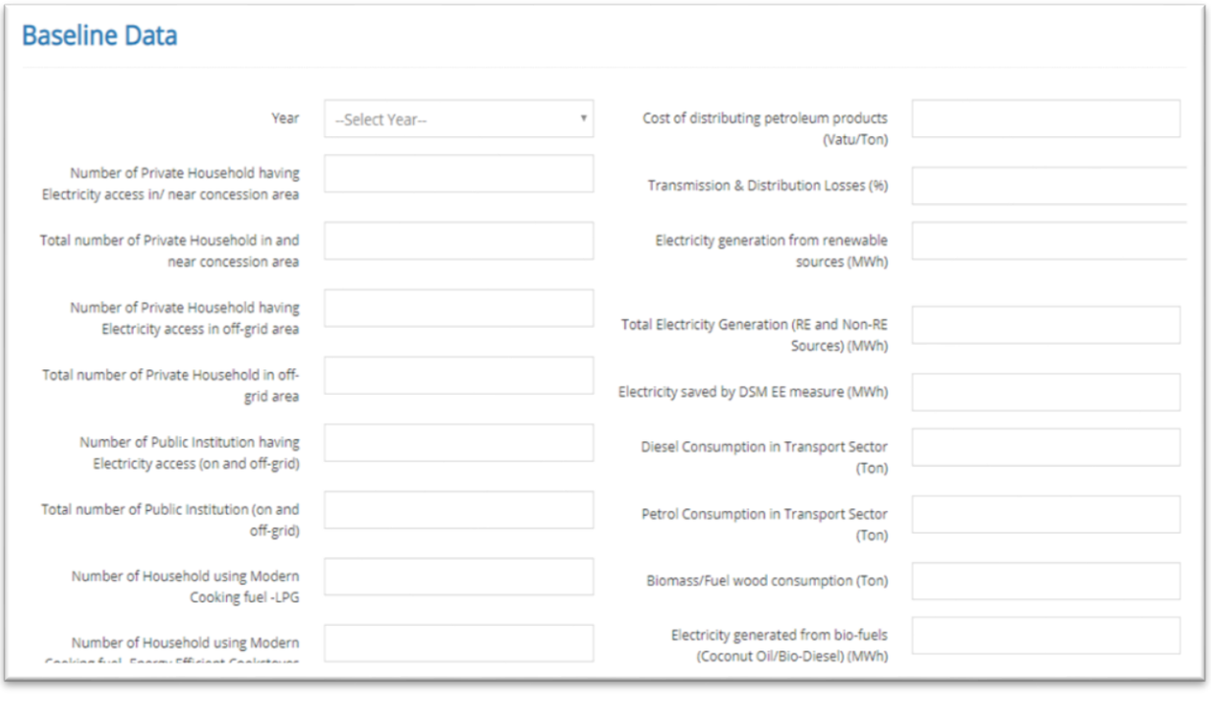
As discussed above the NERM MRV Tool has a modular feature and primary objective is to track progress towards NERM priority and targets. The Tool can be used with all its functionality i.e. NERM Target tracking, NERM action/project tracking, NERM Finance Flow tracking, SDG tracking, etc. or using the single module of the NERM MRV Tool (though each module interacts with each other to avoid the data duplicity and generating reports).

Following section describe the steps necessary to initialize the NERM MRV Tool and the database.

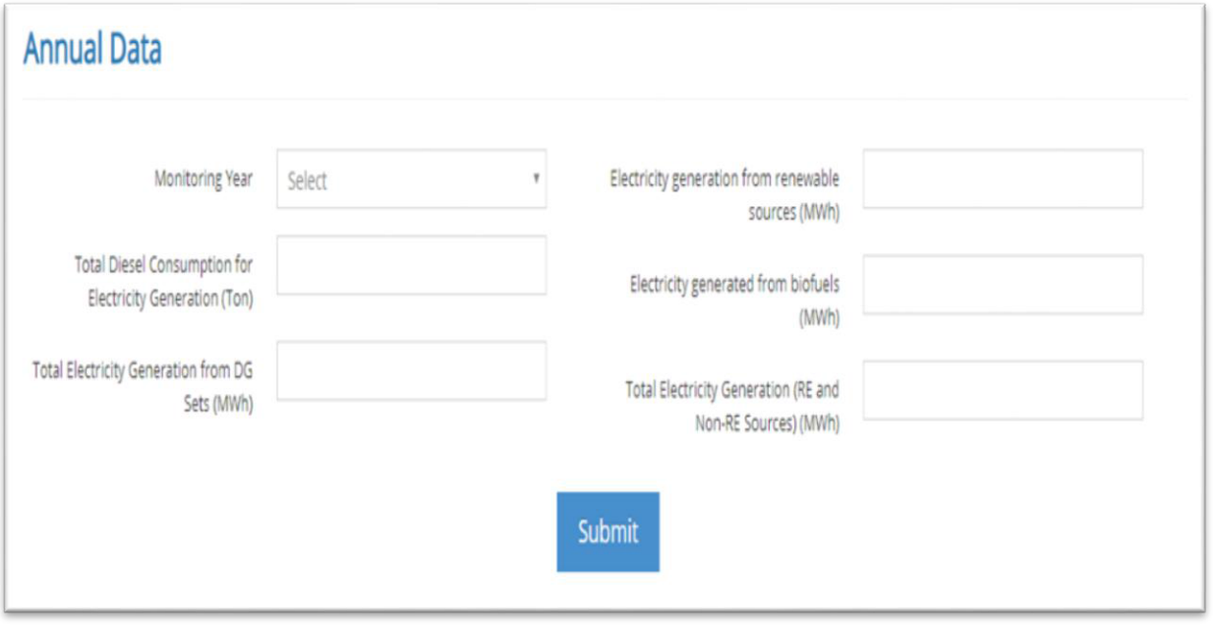
Figure 7: Dashboard of NERM-MRV Tool



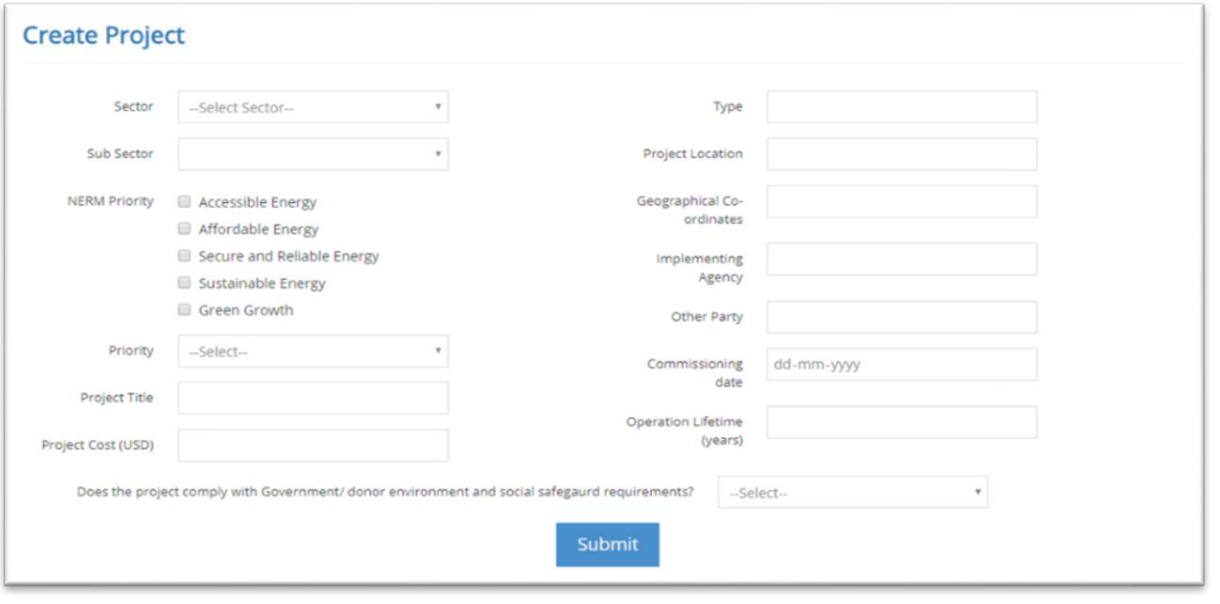
Step-1: Define the Baseline (Base year) Data: After installing the NERM MRV Tool, the first task is to perform a mandatory action i.e. defining the baseline year and baseline data for NERM targets indicators. After performing this step, the database is ready for distribution and sharing among users, this also helps in maintaining consistency among users.



Step-2: Annual Monitoring Data Input: the next step is to select the monitoring year and enter the annual monitored data for some of the indicators that are independent of the NERM actions/projects.

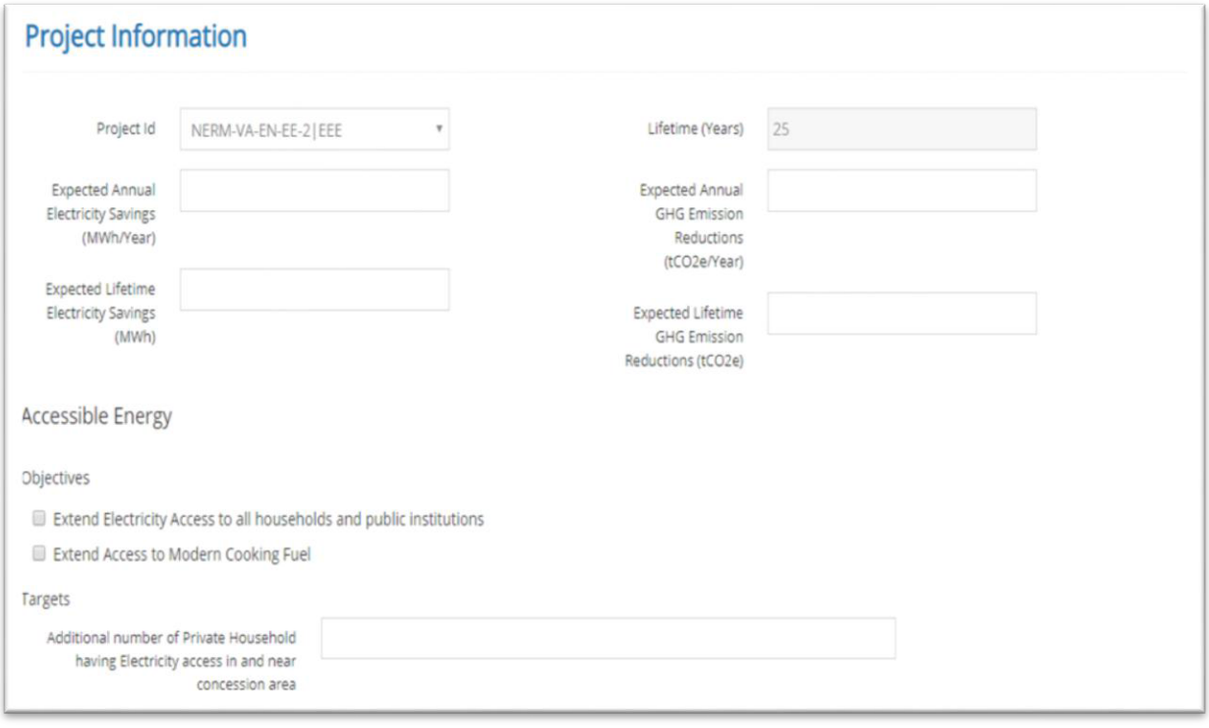


Step-3: NERM Project Creation: The NERM-MRV Tool is a projected tracking tool with a modular function, hence to initiate the process a project database needs to be created (similar to the baseline database).

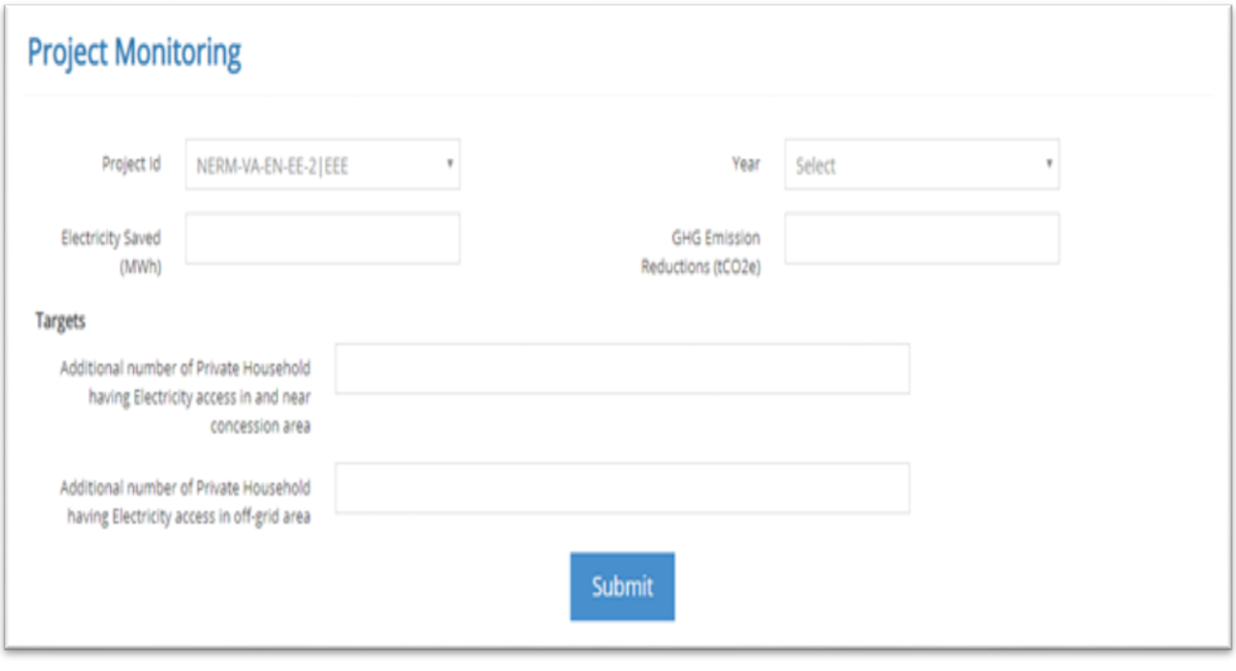


On initiating the project creation with basic information, a unique project will be ID created in the database for the project (this unique project code shall be used in other modules of project monitoring e.g. Finance Flow and SDGs). The unique project ID will also avoid duplication and reduce the effort of the monitoring team.

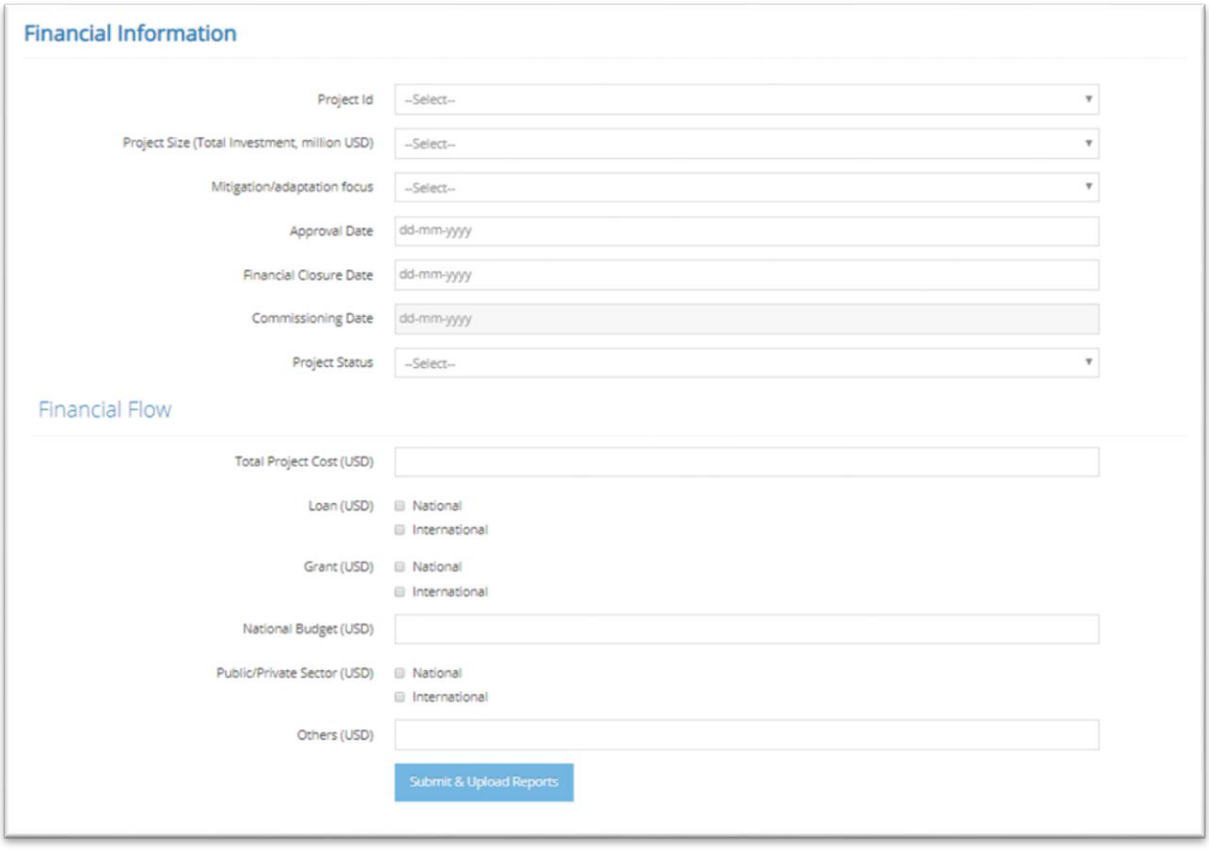
Step-4: Input Project Information and define Monitoring Plan: Once the project is created in the database other project information and monitoring plan/indicators and monitoring parameters have to be defined. The user will have the flexibility to edit or modify the project information (if required).



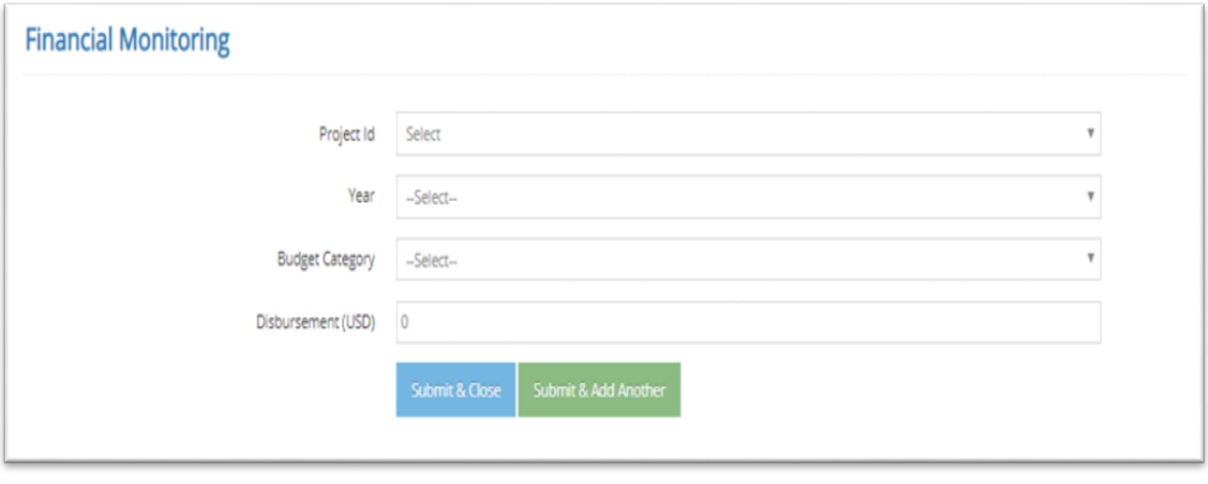
Step-4.1: NERM Project Monitoring: This module includes the periodic operational monitored data and information as per the defined monitoring plan for the project.



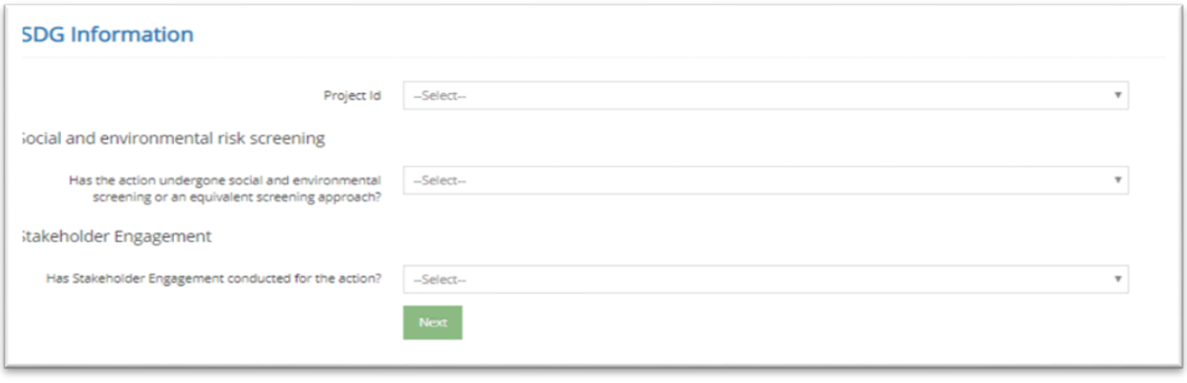
Step-5: NERM Project Finance Flow Information and define Monitoring Plan: The NERM Projects/action; those selected for finance flow tracking needs to define the financial information and budget expenditure schedule in the database. The user will have the flexibility to edit or modify the budget information (if required).



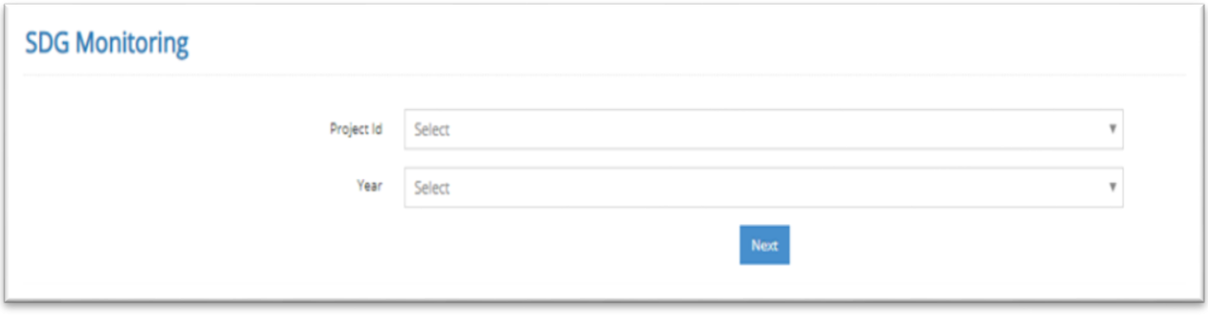
Step-5.1: NERM Project Finance Flow Monitoring: This module includes the periodic monitoring of the financial data and budget information as per the defined financial monitoring



Step-6: NERM Project SDG Information and define Monitoring Plan: The NERM Projects/action; SDG impacts will be tracked within this module; the user needs to define/set the SDG criteria for NERM action in a database that shall be used for environmental and social screening and SDG impact tracking.



Step-6.1: NERM Project SDG Monitoring: This module includes the periodic monitoring of the SDG Parameters as per the defined financial monitoring plan for the project.



Reports: The NERM-MRV Tool allows the user to generate multiple reports such as:

(a) NERM Progress Tracking Report
(b) NERM Priority Tracking Report
(c) NERM Finance Tracking Report
(d) NERM SDG Impact Report
(e) Consolidated NERM Project MRV Report (includes a summary of all the above reports)

The report format is predefined and easily exported in MS-Excel and pdf format. There is a flexibility to modify the reporting format (if required).

Capacity Building & Training on NERM M&E: The Department of Energy (DoE) will have prime responsibility for implementing NERM M&E and monitoring the progress on NERM targets. There is a need to develop the in-house capacity at DoE on implementation of the NERM-MRV system. A training and capacity building program need to be designed for the staff (as early as possible) for effective implementation of MRV and efficient deployment of resources.

The integrated NERM MRV tool has been demonstrated and validated in consultation with the stakeholders during the validation workshop on 15th April 2019.

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ANNEX I – UPDATED NERM IMPLEMENTATION PLAN

Accessible energy

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing
Extension of VREP I	There is considerable unused fund under VREP I. According to the latest Project Report (Jan-Jun 2018), a total of USD 3.14 million has still been available by 30 June 2018. Taking into account the total budget (USD 7.8 million) and the number of households which received access to electricity between project start and 30 June 2018 (6,034), approximately 4,000 additional off-grid households can be provided with access to electricity. Reducing the grant contribution per household (aligning with VREP II) would help in increasing this number to around 6,000 households.	High	USD 6.2m	DoE, World Bank	Ongoing, fully financed	2019
VREP II	Under VREP II, microgrids will be installed and Solar Home Systems will be disseminated to off-grid households. Until 2022, a total of 8,400 households will be electrified. The project is fully financed and operational.	High	USD 5.4m	DoE, World Bank	Ongoing, fully financed	2022

Extension of GPOBA	The GPOBA provided one-off subsidies to assist low-income households to connect to the existing electricity grid in concession areas in Port Vila, Tanna, Malekula and Luganville. A continuation of the project is suggested, funding has not been secured. A minimum of additional 1,000 households needs to receive electricity access to achieve the NERM targets.	High	USD 1.1m	DoE	No financing	2025
BRANTV	2,000 households will gain access to village-scale power systems or to family compound-scale nano-grids installed in all compounds in a village. Project is fully financed and activities started. Work will end in 2022.	High	USD 20.8m (entire project)	DoE, GEF, UNDP	Ongoing, financed	2022
Wintua/Lorlow mini-grid	Under the Wintua/Lorlow mini-grid, around 75 households and 14 public buildings will be electrified. The project is fully financed and construction is about to start.	High	USD 1.1m	DoE, the Austrian government	Ongoing, financed	2020
Ambrym mini-grid	Erection of 2 hybrid solar PV & wind mini-grids on Ambrym island, connecting around 160 households to the grid. The concept is being prepared with DoE Office.	High	USD 2m	DoE, GCF	No financing	2022
Distributed Energy Generation	DoE is interested to explore the option of using the "Distributed Energy Generation" by installing micro/mini-grids in concession areas (Efate, Santo, Malekula & Tanna) in locations where grid extension is hard to reach or very expensive. Once the grid penetration is achieved eventually the micro/mini-grids could be integrated on to the main grid.	High	USD 5m	DoE	No financing	2023

Electrification of all Educational and Health Centres by 2022	DoE is keen to launch a program similar to VREP focusing on electrification of all education and health centers in Vanuatu by 2022. The idea is to have a targeted approach to electrify on one of the key sub-sectors (Schools & Health centres) and replicate the approach across other sub-sectors. DoE is of the view that this kind of approach could assist in efficient utilization of resources and fast track achieving the NERM targets. DoE intends to explore potential subsidy options under VREP and GCF submissions.	High	USD 1.3m	DoE, Ministry of Health, Ministry of Education & Training	DoE, Ministry of Health, Ministry of Education & Training	2022
Extension of VREP I+II	A minimum of an additional 800 households needs to receive electricity access to achieve the NERM targets.	High	USD 0.3m	DoE	No financing	2025

Affordable energy

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing
Conversion of diesel generators on Tanna	Existing diesel generators should be converted to make sure coconut oil can be used for electricity generation.	Medium	n/a	DoE, UNELCO	No financing	2021
Investment in Barge	Invest in a barge to improve the efficiency and reliability of fuel distribution within Vanuatu by shifting away from deliveries of fuel in drums and towards the use of regular bulk deliveries to outer islands	Medium	USD 1.6m	GoV & Pacific Petroleum	No financing	2022

Sustainable energy

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing
Brenwe 400 kW Hydro Power Project	The Brenwe Hydro Power project is a 400kW run-of-river hydropower plant on the island of Malekula. Funding secured is secured and the project will be fully financed through an ADB loan and contributions from the Government of Vanuatu. Completion is expected in 2022.	Medium	USD 6.5m	DoE, UNELCO	Preparation for implementation, fully financed	2022
Sarakata 800 kW Hydro Power Extension Project	Preparation of the project is underway, currently, the feasibility study is being carried out. Funding through Japanese Grant for Projects envisaged, the project will also receive a contribution from the Government of Vanuatu. Commissioning is expected for 2023	Medium	n/a	VUI, GoV	Feasibility study under preparation, funding under preparation	2023
Vanuatu Rural Electrification Project (VREP) Phase II (micro-grids)	VREP II will finance around 4.5 MW installed capacity of solar PV with battery backup, generating around 2.7educational GWh annually of solar-based power. The project has received approval and implementation has started. It is expected that the installations of SHS and microgridsare finalised by 2022, therefore 2023 will be the first year of full operation of these systems.	High	USD 6.8m	DoE, World Bank	Ongoing, fully financed	2023
Talise 75 kW Micro Hydro Power Project	Project is currently under preparation and will be supported through the BRANTV Project. It is expected that the project will be operational latest 2022.	Medium	USD 0.5m	DoE, GEF, UNDP	Ongoing, fully financed	2022

Revision of Electricity Supply Act and Coconut for Fuel Strategy	Revision of the Electricity Supply Act is necessary to allow Independent Power Producers (IPPs) to erect grid-connected renewable energy projects. The Coconut for Fuel Strategy is a key component of the NDC Implementation Roadmap to secure a well-established agreement among all relevant stakeholders to provide coconut oil for electricity generation.	High	USD 0.3m	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil producers, utilities	Financing under preparation	2020
Batteries (Efate grid)	Due to the planned expansion of renewable energy capacities (solar PV and wind), batteries are a key component for the functioning of the grid. Surplus electricity will be stored and will then be consumed at times when renewables do not provide sufficient contribution.	Medium	USD 25.9m	DoE, UNELCO	No financing	
Expansion of solar PV	Solar PV will be expanded by 7.6 MW on Efate to achieve a total installed capacity of 10 MW, in combination with storage capacity.	High	USD 11.7m	DoE, UNELCO	No financing	2022-2026
Expansion wind	Addition of 5.1 MW (Option 1) or 2.6 MW (Option 2) on Efate, in combination with storage capacity.	Medium	USD 13.5m	DoE, UNELCO	No financing	2022-2026
Coconut oil	Usage in Efate grid up to a maximum of 12.5 liters (Option 1) or 6 million liters (Option 2) in 2030. Agreements between key stakeholders based on Coconut for Fuel Strategy.	High	n/a	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil producers, UNELCO	No financing	2020-2030

Geothermal	The first stage of 4 MW in Takara, providing a base load to the Efate grid. Batteries will need to be added to the grid to balance the fluctuations in the production of electricity from wind and solar.	Medium	n/a	DoE	No financing	n/a
Mini geothermal	A potential project in Takara under investigation, using 50°C warm source without deep drilling. A draft business proposal submitted to DoE.	Medium	n/a	DoE, Greenstorc Oceania	n/a	n/a
Solar for hydrogen	An Australian company is interested to develop a 3.5 MW solar farm, which will be used in a second phase to produce hydrogen (to be used in pilot fuel cell cars) and feed excess to the grid. The company is currently negotiating land for the project. DoE has received a draft proposal.	Medium	USD 6.0m	DoE, MyGrid Vanuatu	No financing	n/a
Airport solar farm	Airports Vanuatu Limited (AVL) has expressed interest to implement 1 or 2 MW solar farm as part of the airport upgrade project. It's still not clear whether it would be a grid-connected or a stand-alone initiative.	Medium	n/a	Airports Vanuatu Limited (AVL)	No financing	n/a
BRANTV	12,000 households will be provided with energy efficient cookstoves under the program	High	USD 20.8m (entire project)	DoE, GEF, UNDP	Ongoing, financed	2022
National energy efficiency strategy and action plan	Development of a national energy efficiency strategy and action plan. In the process of applying for GCF Readiness funding to undertake this task.	High	USD 0.3m	Ministry of Climate Change, GGGI	No financing	2020

Import duties, tariffs, and VAT reform	Reform import duties, tariffs, and VAT to encourage imports of energy efficient and renewable energy equipment: - Energy efficient products for use in buildings—in particular, efficient electrical appliances and lights - Spare parts for vehicles and marine vessels - Energy efficient vehicles - Improved cookstoves and crop dryers - Renewable energy systems (solar PV, wind, biomass) and spare parts	High	n/a	Ministry of Finance (with DoE)	No financing	2020
GHG Emission Inventory Tool	Develop GHG Emission Inventory for the transport sector based on GIZ-IFEO tool.	Medium	USD 0.1m	DoE, Ministry of Infrastructure and Public Utilities, Public Works Department	No financing	2021
Pilot projects hybrid/electric vehicles	Develop pilot demonstration project for 10 hybrids/electric vehicles for government including solar carports for charging of vehicles.	Medium	USD 0.9m	DoE	No financing	2022
Strategy for energy efficiency in the transport sector (including in tourism uses) and development of action plan for cost-effective implementation	Development of a strategy to improve efficiency in the transport sector.	Medium	USD 0.3m	DoE, Ministry of Infrastructure and Public Utilities, Public Works Department	No financing	2021

Green growth

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing
Coconut for Fuel Strategy	The Coconut for Fuel Strategy is a key component of the NDC Implementation Roadmap to secure a well-established agreement among all relevant stakeholders to provide coconut oil for electricity generation.	High	Costs already covered under Sustainable Energy	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil producers, utilities	Financing under preparation	2020
Coconut oil	Usage in Efate grid up to a maximum of 12.5 litres (Option 1) or 6 million litres (Option 2) in 2030. Agreements between key stakeholders based on Coconut for Fuel Strategy.	High	Costs already covered under Sustainable Energy	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil producers, UNELCO	No financing	2020-2030
Expansion of VREP I or VREP II for bungalows	Use the existing structure in the VREP program to supply equipment to around 20 bungalows.	Medium	0.1	DoE, Ministry of Tourism	No financing	2022

ANNEX II – PRIORITIZATION CRITERIA APPLIED

Accessible energy

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing	Prioritization							
							14	14	14	14	14	14	16	100
							Sustainability	Scale/repl	Private sector	Social/ gender	Safeguards	Comm./ben. involvement	Financial	Total
Extension of VREP I	There are considerable unused fund under VREP I. According to the latest Project Report (Jan-Jun 2018), a total of USD 3.14 million has still be available by 30 June 2018. Taking into account the total budget (USD 7.8 million) and the number of households which received access to electricity between project start and 30 June 2018 (6,034), approximately 4,000 additional off-grid households can be provided with access to electricity. Reducing the grant contribution per household (aligning with VREP II) would help in increasing this number to around 6,000 households.	High	USD 6.2m	DoE, World Bank	Ongoing, fully financed	2019	12	14	8	14	14	14	14	90
VREP II	Under VREP II, micro grids will be installed and Solar Home Systems will be disseminated to off-grid households. Until 2022, a total of 8,400 households will be electrified. The project is fully financed and operational.	High	USD 5.4m	DoE, World Bank	Ongoing, fully financed	2022	12	14	10	14	14	14	14	92
Extension of GPOBA	The GPOBA provided one-off subsidies to assist low-income households to connect to the existing electricity grid in concession areas in Port Vila, Tanna, Malekula and Luganville. A continuation of the project is suggested, funding has not been secured. A minimum of additional 1,000 households need to be receive electricity access to achieve the NERM targets.	High	USD 1.1m	DoE	No financing	2025	14	14	12	14	14	14	14	96
BRANTV	2,000 households will gain access to village-scale power systems or to family compound-scale nano-grids installed in all compounds in a village. Project is fully financed and activities started. Work will end in 2022.	High	USD 20.8m (entire project)	DoE, GEF, UNDP	Ongoing, financed	2022	12	12	12	14	14	14	14	92
Wintua/Lorlow mini-grid	Under the Wintua/Lorlow mini-grid, around 75 households and 14 public buildings will be electrified. The project is fully financed and construction is about to start.	High	USD 1.1m	DoE, Austrian government	Ongoing, financed	2020	10	8	8	14	14	14	14	82
Ambrym mini-grid	Erection of 2 solar PV mini-grids on Ambrym island, connecting around 160 households to the grid. Concept has been handed in at GCF.	High	USD 2m	DoE, GCF	No financing	2022	10	8	8	14	14	14	14	82
Distributed Energy Generation	DoE is interested to explore the option of using the "Distributed Energy Generation" by installing micro/mini grids in concession areas (Efate, Santo, Malekula & Tanna) in locations where grid extension is hard to reach or very expensive. Once the grid penetration is achieved eventually the micro/mini grids could be integrated on to the main grid.	High	USD 5m	DoE	No financing	2023	10	8	8	14	14	14	14	82
Electrification of all Educational and Health Centres by 2022	DoE is keen to launch a programme similar to VREP focusing on electrification of all education and health centres in Vanuatu by 2022. The idea is to have a targeted approach to electrify on one of the key sub-sectors (Schools & Health centres) and replicate the approach across other sub-sectors. DoE is of the view that this kind of approach could assist in efficient utilization of resources and fast track achieving the NERM targets. DoE intends to explore potential subsidy options under VREP and GCF submissions.	High	USD 1.6m	DoE, Ministry of Health, Ministry of Education & Training	DoE, Ministry of Health, Ministry of Education & Training	2022	14	10	6	10	14	14	14	82
Extension of VREP I+II	A minimum of additional 800 households need to receive electricity access to achieve the NERM targets.	High	USD 0.3m	DoE	No financing	2025	12	14	8	14	14	14	14	90

Sustainable energy

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing	Prioritization							
							14	14	14	14	14	14	16	100
							Sustainability	Scale/repl	Private sector	Social/ gender	Safeguards	Comm./ben. involvement	Financial	Total
Brenwe 400 kW Hydro Power Project	The Brenwe Hydro Power project is a 400kW run-of-river hydro power plant on the island of Malekula. Funding secured is secured and the project will be fully financed through and ADB loan and contributions from the Government of Vanuatu. Completion is expected in 2022.	Medium	USD 6.5m	DoE, UNELCO	Preparation for implementation, fully financed	2022	14	10	6	8	14	10	12	74
Sarakata 800 kW Hydro Power Extension Project	Preparation of the project is underway, currently the feasibility study is being carried out. Funding through Japanese Grant for Projects envisaged, the project will also receive a contribution from Government of Vanuatu. Commissioning is expected for 2023	Medium	n/a	VUI, GoV	Feasibility study under preparation, funding under preparation	2023	14	10	6	8	14	10	12	74
Vanuatu Rural Electrification Project (VREP) Phase II (micro-grids)	VREP II will finance around 4.5 MW installed capacity of solar PV with battery backup, generating around 2.7educational GWh annually of solar based power. The project has received approval and implementation has started. It is expected that the installations of SHS and micro grids is finalised by 2022, therefore 2023 will be the first year of full operation of these systems.	High	USD 6.8m	DoE, World Bank	Ongoing, fully financed	2023	12	14	10	14	14	14	14	92
Talise 75 kW Micro Hydro Power Project	Project is currently under preparation and will be supported through the BRANTV Project. It is expected that the project will be operational latest 2022.	Medium	USD 0.5m	DoE, GEF, UNDP	Ongoing, fully financed	2022	14	8	6	8	14	10	12	72
Revision of Electricity Supply Act and Coconut for Fuel Strategy	Revision of the Electricity Supply Act is necessary to allow Independent Power Producers (IPPs) to erect grid-connected renewable energy projects. The Coconut for Fuel Strategy is a key component of the NDC Implementation Roadmap to secure a well-established agreement among all relevant stakeholders to provide coconut oil for electricity generation.	High	USD 0.3m	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil producers, utilities	Financing under preparation	2020	14	14	14	14	14	14	16	100

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing	Prioritization							
							14	14	14	14	14	14	16	100
							Sustainability	Scale/repl	Private sector	Social/ gender	Safeguards	Comm./ben. involvement	Financial	Total
Batteries (Efate grid)	Due to the planned expansion of renewable energy capacities (solar PV and wind), batteries are a key component for the functioning of the grid. Surplus electricity will be stored and will then be consumed at times when renewables do not provide sufficient contribution.	Medium	USD 25.9m	DoE, UNELCO	No financing		10	14	10	6	14	6	8	68
Expansion solar PV	Solar PV will be expanded by 7.6 MW on Efate to achieve total installed capacity of 10 MW, in combination with storage capacity.	High	USD 11.7m	DoE, UNELCO	No financing	2022-2026	14	14	10	8	14	10	12	82
Expansion wind	Addition of 5.1 MW (Option 1) or 2.6 MW (Option 2) on Efate, in combination with storage capacity.	Medium	USD 13.5m	DoE, UNELCO	No financing	2022-2026	14	14	10	8	14	10	10	80
Coconut oil	Usage in Efate grid up to a maximum of 12.5 liters (Option 1) or 6 million liters (Option 2) in 2030. Agreements between key stakeholders based on Coconut for Fuel Strategy.	High	n/a	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil producers, UNELCO	No financing	2020-2030	14	14	14	14	14	14	16	100
Geothermal	First stage of 4 MW in Takara, providing base load to the Efate grid. Batteries will need to be added to the grid to balance the fluctuations in production of electricity from wind and solar.	Medium	n/a	DoE	No financing	n/a	14	14	8	8	14	8	6	72

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing	Prioritization							
							14	14	14	14	14	14	16	100
Solar for hydrogen	An Australian company is interested to develop a 3.5 MW solar farm, which will be used in a second phase to produce hydrogen (to be used in pilot fuel cell cars) and feed excess to grid. The company is currently negotiating land for the project. DoE has received a draft proposal.	Medium	USD 6.0m	DoE, MyGrid Vanuatu	No financing	n/a	12	12	14	8	14	10	10	80
Airport solar farm	Airports Vanuatu Limited (AVL) has expressed interest to implement 1 or 2 MW solar farm as part of the airport upgrade project. It's still not clear whether it would be a grid connected or a stand-alone initiative.	Medium	n/a	Airports Vanuatu Limited (AVL)	No financing	n/a	12	12	14	8	14	10	10	80
BRANTV	12,000 households will be provided with energy efficient cook stoves under the program	High	USD 20.8m (entire project)	DoE, GEF, UNDP	Ongoing, financed	2022	14	14	12	14	14	14	12	94
National energy efficiency strategy and action plan	Development of a national energy efficiency strategy and action plan. In process of applying for GCF Readiness funding to undertake this task.	High	USD 0.3m	Ministry of Climate Change, GGGI	No financing	2020	14	14	10	10	14	14	10	86
Import duties, tariffs and VAT reform	Reform import duties, tariffs and VAT to encourage imports of energy efficient and renewable energy equipment: - Energy efficient products for use in buildings—in particular, efficient electrical appliances and lights - Spare parts for vehicles and marine vessels - Energy efficient vehicles - Improved cook stoves and crop dryers - Renewable energy systems (solar PV, wind, biomass) and spare parts	High	n/a	Ministry of Finance (with DoE)	No financing	2020	14	14	14	10	14	10	14	90
GHG Emission Inventory Tool	Develop GHG Emission Inventory for transport sector based on GIZ-IFEO tool.	Medium	USD 0.1m	DoE, Ministry of Infrastructure and Public Utilities, Public Works Department	No financing	2021	12	10	6	10	14	10	10	72
Pilot projects hybrid/electric vehicles	Develop pilot demonstration project for 10 hybrid/electric vehicles for government including solar car ports for charging of vehicles.	Medium	USD 0.9m	DoE	No financing	2022	10	8	6	6	14	6	8	58
Strategy for energy efficiency in the transport sector (including in tourism uses) and development of action plan for cost-effective implementation	Development of strategy to improve efficiency in transport sector.	Medium	USD 0.3m	DoE, Ministry of Infrastructure and Public Utilities, Public Works Department	No financing	2021	14	10	12	12	14	8	8	78

ANNEX III – NGEF PROJECT PIPELINE

Activity	Description
Teachers Solar - Targeted at solar home systems for teachers in off-grid villages/schools, delivered through the Vanuatu Teachers Union Co-operative	*Could be part of VREP 1 or 2 subsidies. Include estimates there are 1000 teachers in off-grid areas and require an average of 50W each costing $500 each. 50% of the capital required will be financed through NGEF, the balance from VREP 1 and 2.*
Schools Solar - Targeted at the basic needs of schools (not teachers) such as printer/copier/ scanner, projector, computer power, classroom lights, fan, refrigerator, etc.	*Could be part of the VREP-2 subsidy. Include estimates there are 50 schools in off-grid areas and require an average of 1kW each costing $10,000 each. Assuming an average of 300 students per school for 60,000 students, it is estimated there are 200 schools in Vanuatu (which agrees with GIS data from Lands, but not cross-checked with Dept of Education), and it is assumed 25% of schools may currently lack power. It is unlikely the Dept of Education or others will invest in these projects, but some VREP2 subsidy may help. NGEF will support through co-financing arrangements directly with schools, with Ministry of Education's support.*
Improved copra/cocoa dryers sold for cash to Dept of Agriculture	*Solar/biomass hybrid system (100W fan with 250W solar with 0.5 kWh battery for up to 10 hours drying) for smoke-free high-quality drying of coconut for copra or grated coconut for oil production, and can also be used for cassava flour drying and fruit/meat dehydrating. As per Gilbert Gibson prototype developed for VIA. Cost estimate of $1000 each, deploy 100.*
Solar coconut/cassava graters sold for cash to Dept of Ag	*The solar grating machine of 250W / 250Wp solar for 4 hours operation per day to make 100 kg of grated cassava or coconut that could yield 50 L/day of oil. 12 already ordered by Dept of Ag from VIA, more expected. Cost estimate of $2000 each, deploy 100.*
Solar refrigerators for meat, milk and some vegetables/fruit sold for cash to Dept of Ag	*Inland villages with cows may need refrigeration, as may small-medium businesses. Small quantity expected, maybe 20, at $5000 each for 500L capacity, 1000Wp, 5kWh battery.*
Solar meat grinders for beef sold for cash to Dept of Ag	*Solar meat/kava grinding machine of 1000W / 1000Wp solar for 1 hour's operation per day already ordered by Dept of Ag from VIA, more expected. Cost estimate of $3000 each, deploy 50.*
Dept of Industry can assist to help roll out other value-adding infrastructure for other sectors not covered in EU grant, like kava grinders, coffee pulpers, and cocoa dryers.	*Solar powered kava grinders, coffee pulpers and cocoa dryers (already mentioned above in coconut section) can also be of interest for lending as per VIA 3-5-year lending model, but unlikely to get EU grant support (could qualify for 20% grant from VREP 2, so 80% maximum finance is required, which could possibly come from NGEF). Assume an average of $2000 each, a total of 250 in near future (600 manual pulpers are estimated to exist and hundreds of villages produce cocoa and kava, so potential is there for 1000)*
Solar refrigerators/freezers for rural businesses, communities and fishermen.	*Huge demand exists for solar refrigeration for fishermen around the country. VIA has a waiting list of 70 already without excessive marketing. Could be part-financed by VREP 2 (if all VREP 2 funds financed only these,*

	could fund 8,000 for 40,000 off-grid households). Estimated demand of 500 over 3 years or 150/year, needs lending capital to be affordable. $2000 each at scale. 20% deposit or equity required, 80% from NGEF. Census stats note 4% of 57,000 urban people and 21% of 177,000 rural households engage in fishing, so a total of 40,000 people or 8000 around households. Assuming 50% could benefit from a solar fridge/freezer costing $2000-3000 each, the market potential is up to $8-12 million.
Anelcauhat village microgrid on Aneityum, for 231 households.	*160 kW 800 kWh microgrid for daily demand of 246 kWh/day with 30kW peak load. Aiming to use Tesla batteries. No generator backup included forecast reliability of 99%. Cost of Vt 160 million including VAT; revenue estimated at Vt 120/kWh Vt 13.4 million/year (Vt 4834/house/month average). 5-year additional service contract + 20% risks charges applied for Vt 238 million total of which Vt 106 million is sought (other funding from cruise ship companies and VREP 2). Cost is $6500-9800/household.*
Facilitating the development of run-of-the-river hydro mini-grids for rural electrification - 1) 17kW Epilmail Waterfall, Tanna ***2) 58kW Miru Waterfall, Erromango*** ***3) 42kW Ranwadi, Pentecost*** ***4) 106kW Panbo, Pentecost***	*Detailed feasibility studies are planned to be conducted.*
Rehabilitation and extension of Tanna pico-hydro project by UNSW	*A pico-hydro project was installed in south-east Tanna Island for the main buildings but not surrounding households which is currently not operational. But calculations suggested that 50-100 nearby households could be served by it for basic lighting and phone charging services, either via a grid or battery charging or both.*
Demonstration of Solar Pico-grid Pilot for Rural Vanuatu using low voltage DC (<60V) distribution and 20-100W per household.	*$200-500/household target plus project administration costs to connect 5-15 buildings (probably best suited to a tourist bungalow) for a total cost of US$15,000. Possible to serve up to 50 households nearby too via grid or battery charging services. A hybrid 1-2kW system with back generator to give >99% reliability. Income is likely to be Vt 1000-3000 ($10-30)/house or bungalow per month or $1500-3000/year for the whole project.*
Solar system for small tourism operators	*It is estimated 43 off grid bungalows of 1-2-star rating require 0.4-1kW systems, of which 50% may take up an offer. This would total approximately 12kW of demand or $120,000 worth at $10,000/kW. NGEF may provide 80% debt to 20% other finance from the owner or developer.*
Solar system for medium tourism operators	*It is estimated 31 off grid bungalows of 3-star rating require 5kW systems, of which 50% may take up an offer. This would total approximately 76kW of demand or $608,000 worth at $8,000/kW. NGEF may provide 80% debt to 20% other finance from the owner or developer.*

-SUSTAINABLE ENERGY-

THE GAME CHANGER VANUATU'S SUSTAINABLE GROWTH AND DEVELOPMENT

Department of Energy, PMB 9067, Port Vila, Vanuatu

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