A Pwiyeiy bwio – light up my land

Nauru Energy Road Map 2014 – 2020

An Implementation Plan for Energy Sector Development

Second Draft

7th January 2014

Table of Contents

FOREWORD

Minister CIE

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
ADO	Automotive Diesel Oil
ANU	Australian National University
AOSIS	Alliance of Small Island States
AUD	Australian dollar
CBO	Community Based Organisation
CCCPIR	SPC-GIZ Coping with Climate Change in the Pacific Island Region programme
CEDAW	Convention for the Elimination of Discrimination Against Women
CEO	Chief Executive Officer
CIE	Department of Commerce, Industry and Environment
DoA	Department of Agriculture
DPK	Dual Purpose Kerosene
EEZ	Exclusive Economic Zone
EHS	Environmental Health and Safety
EU	European Union
FY	Financial Year
FY	Financial Year
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GNI	Gross National Income
GoN	Government of Nauru
HFO	Heavy Fuel Oil
HIES	Household Income and Expenditure Survey
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kV	Kilo Volts
kWh	Kilo Watt Hour
LCT	Local Coastal Tanker
LPG	Liquid Petroleum Gas
M&E	Monitoring and Evaluation
MDG	Millennium Development Goals
MoF	Nauru Ministry of Finance
MR	Medium Range
MW	Mega Watt
NEPF	National Energy Policy Framework
NERM	Nauru Energy Road Map

NGO	Non Governmental Organisation
NIANGO	Nauru Island Association of Non Governmental Organisations
NRC	Nauru Rehabilitation Corporation
NSDS	National Sustainable Development Strategy
NUA	Nauru Utilities Authority
NUC	Nauru Utilities Corporation
ODA	Overseas Development Assistance
OTEC	Ocean Thermal Energy Conversion
PAD	Planning and Aid Division of the Ministry of Finance
PIC	Pacific Island Country
PIFS	Pacific Islands Forum Secretariat
PIGGAREP	Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project
PIPSO	Pacific Islands Private Sector Organisation
PPA	Pacific Power Association
PSC	Project Steering Committee
PV	Photovoltaic
RO	Reverse Osmosis
RONPHOS	Republic of Nauru Phosphate company
RPC	Regional Processing Centre
SD	Sustainable Development
SE4ALL	United Nations Sustainable Energy for All initiative
SIDS	Small Island Developing States
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Regional Environment Programme
TWGEn	Technical Working Group on Energy in Nauru
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USc	United States cents
UV	Ultra Violet
V	Volts

EXECUTIVE SUMMARY

The Nauru Energy Road Map 2014 – 2020 builds upon the energy sector development agenda laid out in the National Sustainable Development Strategy 2005 -2025 (revised 2009) and the National Energy Policy Framework (NEPF) of 2009.

The purpose of the NSDS, the NEPF and that of the Nauru Energy Road Map is to enable the achievement of Nauru's overall vision of "*A future where individual, community, business and government partnerships contribute to a sustainable quality of life for all Nauruans"*. The Nauru Energy Road Map will contribute to the long-term development goals of a stable, trustworthy, fiscally responsible government; provision of enhanced social, infrastructure and utilities services; development of an economy based on multiple sources of revenue; rehabilitation of mined out lands for livelihood sustainability; and development of domestic food production.

The outcomes of the Nauru Energy Road Map will be:

1. A reliable, affordable and safe power supply and services.
2. A reliable and safe supply of fossil fuels.
3. Universal access to reliable and affordable energy services.
4. An efficient supply and use of energy.
5. A significant contribution from renewable energy towards electricity supply
6. Financial sustainability of the energy sector.
7. Efficient, robust and well resourced institutions for energy planning and implementation.

The targets of the Energy Road Map by 2020 are:

1. 24/7 grid electricity supply with minimal interruptions
2. 50% of grid electricity supplied from renewable energy sources
3. 30% improvement in energy efficiency in the residential, commercial and government sectors

The Energy Road Map lays out strategies and activities in six thematic areas of power, petroleum, renewable energy, demand side energy efficiency, transport and institutional strengthening and capacity building to achieve the above outcomes and targets.

The strategies and estimated costing for the Road Map implementation are given in the table below.

Sector	Strategy	Estimated budget / AUD
POWER	1. Upgrade assets	7,400,000
	2. Improve planning and management	665,000
	3. Improve supply-side energy efficiency	850,000
	4. Move toward full recovery of operation and maintenance costs	580,000
	5. Develop and safeguard NUC staff	150,000
	TOTAL POWER	**9,645,000**
PETROLEUM	1. Establish an economically efficient, secure and safe National Fuel Terminal and fuel supply	345,000
	2. Investigate ways to reduce use of or find alternatives to liquid fuels	80,000
	TOTAL PETROLEUM	**425,000**
RENEWABLE ENERGY	1. Phased implementation of large-scale solar up to 8.5 MWp	50,125,000
	2. Investigation and implementation of other renewable energy resources	1,190,000
	3. Build in-country capacity to operate and maintain solar PV systems	60,000
	TOTAL RENEWABLE ENERGY	**51,375,000**
DEMAND SIDE ENERGY EFFICIENCY	1. Data collection and analysis for preparation for DSM implementation	200,000
	2. Implementation of demand side energy efficiency	335,000
	3. Introduction of energy labeling and minimum energy performance standards	170,000
	TOTAL ENERGY EFFICIENCY	**705,000**
TRANSPORT	1. Implement energy efficiency in transport	280,000
	2. Investigate substitutes to diesel and petrol for transport	50,000
	TOTAL TRANSPORT	**330,000**
INSTITUTIONAL STRENGTHENING & CAPACITY BUILDING	1. Establish appropriate policies, regulations and legislation for the energy sector	430,000
	2. Facilitate development of appropriate local skill base to meet ongoing demand in the energy sector	160,000
	3. Improve governance and accountability in the energy sector	140,000
	4. Foster a culture of partnership between the public and private sector, including communities	90,000
	TOTAL INST'NAL STRENGTHENING & CB	**820,000**
	TOTAL COST NAURU ENERGY ROAD MAP	**63,300,000**

ACKNOWLEDGEMENTS

This is a publication of the Government of Nauru.

This document was prepared by the Technical Working Group on Energy (TWGEn) which consists of the Department of Commerce, Industry and Environment (CIE), the Planning and Aid Division (PAD) of the Ministry of Finance, the Nauru Utilities Corporation (NUC) and the Ministry of Foreign Affairs. The Technical Working on Energy is chaired by the Department of CIE.

The Government of Nauru would like to acknowledge the assistance of a dedicated technical assistance team in the development of the Nauru Energy Road Map. This technical assistance team was comprised of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Secretariat of the Pacific Community (SPC) and the International Renewable Energy Agency (IRENA) with additional support from the Pacific Power Association (PPA), the IUCN-International Union for the Conservation of Nature, the United Nations Development Programme (UNDP), the Asian Development Bank (ADB), the Secretariat of the Pacific Regional Environment Programme (SPREP) and the Pacific Islands Forum Secretariat (PIFS).

The document incorporates views submitted by national stakeholders via a participatory consultation process and the Government of Nauru would like to thank all those who participated in national and community consultation workshops.

The development of the Nauru Energy Road Map was supported by the German Government through the SPC-GIZ Coping with Climate Change in the Pacific Island Region (CCCPIR) programme, IRENA and SPC.

1 NAURU'S ENERGY VISION

The Nauru energy vision is taken from the energy sector goals of the National Sustainable Development Strategy 2005 -2025 (NSDS, revised 2009):

"Provide a reliable, affordable, secure and sustainable energy supply to meet the socio economic development needs of Nauru"

The NSDS developed Nauru's long term vision, message and goals, including those for the energy sector. The NSDS overall vision for development is stated as: "*A future where individual, community, business and government partnerships contribute to a sustainable quality of life for all Nauruans*".

The purpose of the sector goals of the NSDS, including the energy goal, is to enable the achievement of Nauru's overall vision and the long-term goals below:

1. Stable, trustworthy, fiscally responsible government;
2. Provision of enhanced social, infrastructure and utilities services;
3. Development of an economy based on multiple sources of revenue;
4. Rehabilitation of mined out lands for livelihood sustainability;
5. Development of domestic food production.

2 OUTCOMES AND TARGETS

The outcomes of the Nauru Energy Road Map are taken from the policy statements of the 2009 NEPF.

The outcomes are:

1. A reliable, affordable and safe power supply and services.
2. A reliable and safe supply of fossil fuels.
3. Universal access to reliable and affordable energy services.
4. An efficient supply and use of energy.
5. A significant contribution from renewable energy towards electricity supply[1]
6. Financial sustainability of the energy sector.
7. Efficient, robust and well resourced institutions for energy planning and implementation.

[1] The renewable energy outcome has been adapted from the NEPF policy statement based on guidance from the Nauru Government, September 2013

The targets of the Energy Road Map are based on existing targets in the NSDS and on guidance from the NEPF and the Nauru Government[2].

The targets are:

1. 24/7 grid electricity supply with minimal interruptions
2. 50% of grid electricity supplied from renewable energy sources
3. 30% improvement in energy efficiency in the residential, commercial and government sectors

A target for the transport sector is not foreseen in the Road Map due to lack of baseline data against which to set a target. However, as data becomes available and is analysed, a review of the effectiveness of a transport sector target may be carried out.

3 PURPOSE AND DRIVERS OF THE ROAD MAP

3.1 NATIONAL

The NSDS recognises that a reliable, affordable, secure and sustainable energy supply is a key part of social and economic development. The purpose of the Road Map is to create a practical implementation plan (the Road Map) to reach the goals laid out in the NSDS and NEPF.

The Road Map will therefore be the Government's official document serving as an implementation plan for the 2009 NEPF[3] for the period 2014 – 2020 and will take a whole-of-sector approach[4]. The implementation plan will operate at two levels: strategies and associated activities.

A key driver in initiating and implementing the Road Map was Nauru's ambitious goal of reducing the country's high reliance on imported fossil fuel by meeting 50% of its electricity needs from renewable energy sources by 2015[5].

As well as the goals of the NSDS and NEPF, in May 2012 stakeholders in Nauru[6] identified the following as drivers for the energy Road Map (the order below does not indicate any ranking in terms of importance):

1. Reduce dependence on fossil fuels
2. Improve planning and coordination

[2] Letter from the Secretary of the Department of Commerce, Industry and Environment, September 2013

[3] The results of the November 2012 national consultations indicated that there was "a common understanding that the Road Map would in effect be an implementation plan for the 2009 national energy policy framework (NEPF)", Second Round of National Consultation for the Nauru Energy Road Map, Final Report, March 2013

[4] Whole-of-sector is taken to mean the intention to examine the energy sector in the broader sense including power, petroleum, renewable energy, energy efficiency and transport.

[5] The goal set in the NSDS and the NEPF was for 50% of energy used in Nauru to come from renewable sources, however, the Government has now confirmed that this goal has been revised to 50% of electricity supply to be from renewable energy and this is the target used in the energy Road Map.

[6] National stakeholder consultation for the development of an energy Road Map for Nauru, May 1st 2012, Final Workshop Report

3. More reliable energy supply
4. Improve energy efficiency
5. More sustainable, cleaner energy
6. Improve cost-effectiveness of energy services
7. Attract funding for energy sector development

Consultations also found that driving the need for a Road Map are perceived gaps and constraints in the energy sector that development of a Road Map can address, such as the lack of an implementation plan for the 2009 NEPF and limited of coordination between implementing agencies.

At a more fundamental level, the Road Map is seen as a means to address unreliable energy supply for households and businesses, constraints in improving the standard of living of Nauruan households, need for changes in attitudes and awareness on the use and cost of energy, limited technical knowledge and capacity in the energy sector, shortage of spare parts for repairs and maintenance and financial constraints to energy sector development[7].

3.2 GLOBAL

As with many Small Island Developing States (SIDS) in the Pacific, Nauru is heavily dependent on imported fossil fuels for its commercial energy, importing 99% of its total energy supply in 2009 (SPC, 2012). Rising world prices and volatility of fossil fuel prices has increased Nauru's vulnerability to oil price shocks and reducing fossil fuel imports is a key driver of the Energy Road Map.

At the same time, Nauru is a signatory of the United Nations Framework Convention on Climate Change (UNFCCC) and is the current Chair of the Alliance of Small Island States (AOSIS) that has called for developed countries to reduce their greenhouse gas emissions and for a legally binding second commitment period for the Kyoto Protocol. By adopting actions in the present Road Map to reduce fossil fuel use and increase electricity production from renewable sources Nauru seeks to express its leadership in energy and climate change.

Also driving sustainable energy development at the global level is the United Nations Sustainable Energy for All (SE4ALL) initiative. The global SE4ALL targets on energy access, renewable energy and energy efficiency[8] are very relevant for Nauru, and the Road Map presents an opportunity for Nauru to make its own commitments towards these objectives.

[7] National stakeholder consultation for the development of an energy Road Map for Nauru, May 1st 2012, Final Workshop Report

[8] The SE4ALL objectives are: 1) Ensure universal access to modern energy services; 2) Double the global rate of improvement in energy efficiency; and 3) Double the share of renewable energy in the global energy mix.

3.3 HOW THE ROAD MAP HAS BEEN DEVELOPED

The Nauru energy Road Map has been developed through a consultative process involving stakeholders from the public and private sector and civil society groups. The process has been lead by the Nauru Department of Commerce, Industry and Environment (CIE) and the Technical Working Group on Energy consisting of CIE, the Nauru Utilities Corporation (NUC), the Planning and Aid Division of the Ministry of Finance and the Ministry of Foreign Affairs.

The national stakeholders were supported in the development of the Road Map by a team of regional and international experts from the Secretariat of the Pacific Community, the Deutsche Gesellshaft für Internationale Zusammenarbeit (GIZ) and the International Renewable Energy Agency (IRENA), with additional support from the Pacific Power Association (PPA), the United Nations Development Programme (UNDP) Pacific Centre, the IUCN-International Union for the Conservation of Nature (IUCN), the Secretariat of the Pacific Regional Environment Programme (SPREP) and the Pacific Islands Forum Secretariat (PIFS).

The principles which guided the energy Road Map development were:

1. The Road Map will take a "whole-of-sector" approach
2. To be effective, the Road Map must be designed to fit within the capacity of government to obtain funding, to manage the projects and to sustain them once installed.
3. To align with existing policy and institutional frameworks, the Road Map will closely follow the policies and strategies laid out in the Nauru Sustainable Development Strategy (NSDS) and the Nauru Energy Policy Framework (NEPF).

The Energy Road Map is the product of:

- Broad direction provided in strategic Government documents such as the *National Sustainable Development Strategy 2005 – 2025 and the 2009 National Energy Policy Framework,* guidance from the Technical Working Group on Energy and from recent Cabinet decisions.

- A thorough review of documentation and reports relating to the implementation of the 2009 NEPF and other documentation from a variety of sources relating to the development of Nauru's energy sector in the last decade.

- A broad consultation process that has involved all of the key stakeholders (private sector, public institutions, NGOs, CBOs, key development partners, civil society representatives). This includes three National Consultation Workshops held in May 2012, November 2012 and October 2013, as well as community consultations held in November 2012.

- Preparatory work and analysis undertaken by the technical assistance team with the assistance of CIE and NUC.

This energy Road Map is accompanied by the following preparatory and supporting documents:

- National Stakeholder Consultation Workshop Report, May 2012 – Records the outcomes of the first national consultation workshop on the Road Map development
- Second national consultations on the Nauru energy report map report, November 2012 – Records the feedback, discussions and outcomes of the second national consultation workshop and of two community consultation workshops.
- Third national consultations on the Nauru energy road map first draft, October 2013 - Records the feedback, discussions and outcomes of the third national consultation workshop.
- Power Utilities Assessment Report, February 2013 – Assesses the status of power generation, transmission and distribution at NUC
- Energy Sector Overview Report, August 2013 – Assesses the status of the energy sector in Nauru in 2013
- Solar Pre-feasibility study, September 2013 – Provides a preliminary assessment of the feasibility of introducing large-scale solar energy installations for electricity supply

3.4 CONTENTS OF THE ROAD MAP

The Energy Road Map deals with national energy supply and demand and takes a whole-of-sector approach. For the purposes of the Road Map, the energy sectors are split into six themes, five of these are broadly aligned directly to the themes of the 2009 NEPF and the sixth theme, Transport has been added to address a gap in this area in the NEPF and recognise the importance of transport in the energy sector. The six themes of the Road Map are:

1. Power (including supply side energy efficiency)
2. Petroleum
3. Renewable energy
4. Demand side energy efficiency
5. Transport
6. Institutional strengthening and capacity building

It is recognised that these are artificial boundaries for the purpose of ease of organisation and reading and that there are many interrelations betweens the themes. Some strategies and activities of the Road Map will impact more than one theme. In the action plans cross-referencing between themes has been used where practical.

The Energy Road Map does not include information on the Regional Processing Centre (RPC) as the RPC currently caters for its energy requirements largely independently of the rest of the Nauru energy sector.

Chapter 4 of the Energy Road Map gives a brief overview of Nauru and its socio-economic development as well as an introductory overview of the energy sector itself.

Chapters 5, 6, 7, 8, 9 and 10 then provide a more detailed analytical perspective aligned to the six themes of the energy Road Map.

Chapter 11 examines cross-cutting issues such as health, education, gender, environment and community involvement.

Chapter 12 then delivers the framework for action of the energy Road Map which is then elaborated in six thematic action plans in Chapter 13.

Chapter 14 provides the outline for a monitoring, evaluation and reporting framework for the Road Map.

4 COUNTRY OVERVIEW

4.1 PHYSICAL CHARACTERISTICS[9]

Nauru is one of the world's smallest countries and one of the most remote. Consisting of a single, isolated raised coral equatorial island, Nauru is about half way between Sydney and Honolulu. Total land area is 21 km2 with an exclusive economic zone (EEZ) of 320,000 km2. There are two separate plateau areas: "bottom side" that is a few metres above sea level and "topside" that is typically 30 metres higher. Topside is dominated by pinnacles and outcrops of limestone, the result of nearly a century of mining of the high grade, tricalcic phosphate rock that lay between those formations. One third of the island is habitable and homes and businesses are commonly located on the coastal fridge (with the exception of one district). There are no natural harbours and the island is surrounded by a fringing reef 120-400 metres wide. The reef falls off very rapidly and deep-water ships can moor within a short distance of the reef edge.

4.2 POPULATION[10]

The latest census was undertaken in 2011 and points to continuously growing population for Nauru during the next 40 years. The total population at the time of the census was 10,084 (5,105 males and 4,979 females). This compares with 9,233 people in 2006 – an increase of 9% or 851 people. This population increase represents an average annual growth rate of 1.8% which is equivalent to 170 people per year for the period 2006-2011. However, currently the population growth is much higher than 1.8% as Nauru's fertility is increasing, and should be around 2.9% which translates into an annual increase of about 300 people per year. The census report predicts that Nauru's population will increase to between 13-15 thousand people in 2030 and will increase to about 15-21 thousand people in 2050 depending on the level of migration. However, should the population continue to grow at its current level without any significant levels of emigration, the population will be 27 thousand people in 2050. The population will age, with a decreasing proportion of young people aged 15 and younger, and an increase in people aged 60 and older. In 2013 a significant influx of people into Nauru has been noted due to the reopening of the RPC, however, this increase in people arriving into Nauru may not be permanent.

4.3 ENVIRONMENT

Phosphate mining has occurred on Nauru for over a century, with consequent landscape degradation over a wide area and decline in soil quality, rendering over 70% of the land area uninhabitable and almost all of the land non-productive. This loss of soil fertility and

[9] *Pacific Regional Energy Assessment 2004 – Nauru National Report*, SPREP, pp. v, 2005, *Poverty Incidence in Nauru - An assessment of Poverty*, Ramrakha Detenamo, Final Draft, 27 August 2009 & *Millennium Development Goals - Nauru Progress Report 1990-2011*¸Government of Nauru, August 2012

[10] *Republic of Nauru – National Report on Population and Housing*, Government of Nauru, UNFPA, SPC and Government of Australia, p. xvi, 2012

reduced crop cover exposes soils to high levels of UV radiation which further reduces the organic components. Ultimately this may lead to desertification[11].

Land availability is also constrained by Nauru's size and land tenure system. The current system is seen as preventing planned land use, encouraging 'random building' by landowners, and generally in need of reform. For example, it provides that only Nauruans may own land as freehold, and non-Nauruans may lease land only with the President's signature[12]. In the 2009 review, the Nauru NSDS identifies that the lack of clarity within the land tenure system has seen disagreements which have been a major obstacle to development including achieving the 2008 milestones[13].

Lack of data also brings a challenge to accurately assessing the importance of some environmental issues. This is particularly true for forest area, carbon dioxide emissions, and consumption of ozone-depleting substances, which all lack data[14].

Environmental management legislation has been proposed and drafted. This could address Environmental Impact Assessment, land use, marine reserves and reef conservation. Sustainable management of natural resources, including energy and land use, has been identified as a need to support MDG 7 under the NSDS. Rehabilitation of the mined phosphate areas (pinnacles) is also identified as a need[15].

Waste management is a significant issue on Nauru. A new landfill is likely to be required in the next few years, although SPREP is working on a project to improve waste management and hence extend landfill life. Since 1999, NRC has undertaken solid waste management by collecting and dumping all materials in an unlined pit[16].

Nauru's contribution to CO2 emission is 25,735 tons per year calculated from total fuel imported[17] into Nauru in 2009. Nauru's annual GHG emissions are very small compared to global annual CO2 emissions.

4.4 ECONOMY

In 2009 the country's Gross Domestic Product (GDP) was Australian dollars (AUD) 70 million and the GDP per capita in 2009 was AUD 5,897.[18] Nauru exports phosphate and imports fuel, food, live animals, machinery and transport equipment. Aid is an essential source of funding for Nauru's development.[19] As a percentage of GDP aid receipts are higher in Nauru than any other Pacific Island Country (PIC) – it has been estimated that overseas development assistance (ODA) comprised 31% of GDP in 2008 and 72% of

[11] Feary, A., *Restoring the soils of Nauru: Plants as tools for ecological recovery* (MSc thesis, 2011).
[12] Nauru National Sustainable Development Strategy (NSDS) 2005-2025 (as revised 2009), Republic of Nauru
[13] *Ibid.*
[14] *Ibid*, p74
[15] *Ibid*
[16] Nauru Infrastructure Sector Review, 2013, Government of Nauru, p20
[17] In 2009 all fuel imported into Nauru was retained and none was re-exported.
[18] *Nauru: Updating and Improving the Social Protection Index*, ADB, p.4, August 2012
[19] The major donor to Nauru is Australia, which has supported Nauru's reform programmes in finance and governance, education and training, health, utilities, fisheries and law and order.

Gross National Income (GNI) in 2009.[20] The economy is still dependent on rapidly diminishing phosphate reserves[21]. The population depends on cash incomes and imported goods and employment opportunities are mostly limited to the public sector with the government being the main employer.

Since 2004, successive governments have been dealing with the near-exhaustion of primary phosphate reserves and the legacy of years of economic mismanagement.[22] The country's dependence on highly volatile sources of revenue which includes fisheries licenses and phosphate, has led to a priority to broaden the economic base.[23] In 2012 phosphate exports from Nauru reached 519,000 tons, the highest annual figure since production recommenced in 2007, and contributed strongly to economic growth of 4.9% in fiscal year (FY) 2012 (ending 30 June 2013).[24] Phosphate exports are expected to hold steady in FY2014 as mining exhausts primary phosphate reserves and taps into deeper secondary phosphate resources.[25]

According to ADB growth forecasts for FY2013 and FY2014 are 4.5% and 6.0% respectively.[26] Infrastructure upgrades will likely be the primary drivers of growth over the next 2 years including the reopening/rebuilding of the Regional Processing Centre (RPC) for asylum seekers through its impact on construction, hotels and accommodation, restaurants, and retail trade, as well as on government finances (ADB, 2013). Inflation is projected at a low 0.5% in FY2013, before rising to 2.5% in FY2014. The government FY2013 budget incorporates an expansionary stance supported by higher-than-expected revenues from fishing licenses and continued aid flows (ADB, 2013). As the reopening/planned expansion of the RPC will mean higher income from visa fees, fuel sales, and customs duty collections, the expansionary fiscal stance has been further amplified, and domestic expenditure will be almost double in FY2013. In the long term sound management of phosphate wealth and of revenues from the reopening/planned expansion of the RPC will largely determine Nauru's fiscal and economic sustainability.

4.5 PROGRESS ON THE MILLENNIUM DEVELOPMENT GOALS

Since the signing of the Millennium Declaration in 2000, Nauru has made progress towards '…achieving universal basic education, reducing maternal mortality, providing universal access to treatment for HIV/AIDS, halting and reversing the spread of tuberculosis, providing access to essential drugs, and making the benefits of new technology more accessible to all'.[27] However according to the Nauru MDG progress report from 2012, there is potential to accelerate progress in reducing child mortality and improving access to safe drinking water and basic sanitation. In addition in accordance

[20] *Millennium Development Goals - Nauru Progress Report 1990-2011*, Government of Nauru, p. 73, August 2012

[21] Since Nauru's independence, profits from phosphate mining contributed to the strong economic growth of the country in the 70's and 80's until the economy collapsed in the 1990s.

[22] *Asian Development Bank & Nauru Fact Sheet*, 31 December 2012

[23] *Nauru Economic Infrastructure Strategy & Investment Plan*, Government of Nauru, P. 7, November 2011

[24] *Asian Development Outlook 2013 – Asia's Energy Challenge*, ADB, p. 281, 2013

[25] *Pacific Economic Monitor*, p. 8, July 2013

[26] *Pacific Economic Monitor*, p. 8, July 2013

[27] *Millennium Development Goals - Nauru Progress Report 1990-2011*, Government of Nauru, p. iii, August 2012

with the MDG reports more focused interventions are needed to promote gender equality in leadership positions, improve access to reproductive health services, reduce the prevalence of non-communicable diseases, reduce biodiversity loss, and to deal comprehensively with debt problems.

According to the Nauru MDG progress report from 2012 poverty is '…best defined in Nauru as hardship and lack of opportunities. It is hardship in the sense that people do not have adequate access to basic services such as clean water and sanitation; full opportunities to participate in the socio-economic life of the community; or sufficient money to pay for basic household needs as well as customary obligations to the extended family, village community or church'(GoN, 2012).

4.6 NATIONAL SUSTAINABLE DEVELOPMENT STRATEGY

The NSDS is a 20 year plan that provides a roadmap for Nauru's development. The NSDS articulates the national vision, goals, strategies and priorities of Nauru and presents where Nauru wants to be in the medium term (5 to 10 years) and long term (10 – 20 years). The NSDS vision emphasizes the desired outcome of sustainable improvements in the quality of life experienced by Nauruans and signals that partnerships at all levels will be a key vehicle to achieving this. The theme of the NSDS therefore is *"Partnerships for Quality of Life"* (NSDS, revised 2009).

Energy within the NSDS is included under the broader priority sector of "Infrastructure" with a priority of: *Provision of enhanced utilities and transport services including the increased use of renewable energy, power (non-diesel generation i.e. OTEC and solar), water, waste management, roads, sea and air services".*

4.7 NAURU ENERGY POLICY FRAMEWORK

The Nauru Energy Policy Framework developed and endorsed by the Nauru Government in 2009 was integrated into the revised NSDS (2009). The NSDS includes a goal for the energy sector "Provide a reliable, affordable, secure and sustainable energy supply to meet socio-economic development needs" and includes energy under its major priorities and states that "whilst there has been considerable progress in achieving more stable electricity … services, the current way in which electricity … services are delivered is not sustainable for Nauru. Urgent measures need to be taken to upgrade infrastructure, raise efficiency, secure the benefits of renewable energy ...". The revised NSDS includes a revised set of strategies for the energy sector:

i. Cost effective, secure and sustainable procurement and supply of fuel
ii. Reliable and efficient energy supply and distribution
iii. Management of demand focusing on consumption efficiency and conservation
iv. Increased use of renewable energy and other alternative forms of energy

These strategies are still valid today and are included in the Road Map. The Road Map builds on the framework laid out in the NSDS while providing a more detailed breakdown of strategies, activities, costs and responsibilities and aims to directly contribute to the focus of the NSDS. The 2009 Energy Policy Framework has a vision

statement*: "Reliable, affordable and sustainable energy, enabling the social-economic development of Nauru".* The NEPF has seven strategic policy areas:

1. Power
2. Petroleum
3. Renewable Energy
4. Consumers
5. Finance
6. Institutional capacity
7. Energy conservation and efficiency

Under each policy area, there is a policy statement and strategies. Although many of the strategies have remained valid and included in this Road Map, in some areas a need for change was identified during the Road Map process. For example, both the NSDS and the 2009 Energy Policy Framework state Nauru's aim to make 50% of energy provided through renewable energy by 2015. Through consultations with local stakeholders and development partners, it is now clear that this cannot be achieved in this time frame and Government has acknowledged this and proposed new targets as elaborated in this Road Map. Nevertheless, the NEPF, alongside the NSDS, provides the broad policy framework for the Road Map and therefore the vision, outcomes, targets and strategies of the Road Map are closely aligned to the NEPF and NSDS visions, targets and strategies. Moving forward the Road Map will be the implementation plan for the NEPF.

4.8 OVERVIEW OF ENERGY SECTOR

Nauru is 100% electrified and has relatively low average electricity tariffs of 14USc/kWh. Imported petroleum fuels are the main energy source in Nauru. Renewable energy contributes around 1% to electricity supply with the remaining 99% provided by diesel generators. Fuel demand is about 10 million litres per year and Nauru has a relatively high (estimated) 73 days of fuel supply security. There is currently no national energy data base or energy balance and energy datasets are fragmented with irregular data reporting (SPC, 2012). Electricity is supplied by a single power station operated by NUC. Maximum demand is currently around 3.3 MW (PPA, 2013).

There are currently three entities with key responsibilities in the energy sector: the Ministry of Finance, including the Planning and Aid Division (PAD), the Department of CIE and the Nauru Utilities Corporation (NUC). The Ministry of Finance provides national budget for energy, procures and sets prices for fuel, oversees implementation of the NSDS and the PAD manages development partner finance flows, crucial for capital investment in the energy sector. CIE carries out policy and planning functions and NUC is the sole provider of grid electricity and also manages the fuel tank farm.

Nauru has a proven solar resource and this is the renewable energy technology most commonly implemented to date. There is no hydro or geothermal energy potential. Further investigation is needed to a greater or lesser extent for all other renewable energy options (wind, bio-energy, ocean energy). In terms of energy efficiency, there is no legislative framework in place to regulate the importation of energy efficient end-use devices and no long-term programmes have been put in place to improve demand side energy efficiency (SPC, 2012).

5 ANALYSIS OF POLICY, REGULATORY AND INSTITUTIONAL FRAMEWORK

Developing and managing the energy sector through an appropriate policy and regulatory framework is a function of the government that is essential to national economic development. This function often spreads across various arms of government with legal mandates and regulatory and policy supporting mechanisms. The analysis of Nauru's policy, regulatory and institutional framework examines the existing policy instruments in effect; roles and responsibilities of relevant public and private institutions, how these institutions and their activities are linked and coordinated; and capacity of the institutions to deliver on their mandates to achieve sustainable energy development on the island.

5.1 POLICY AND REGULATORY FRAMEWORK

A number of policy instruments impacting the energy development on the island have been introduced since 2005 through the economic reform programme and these instruments are listed in Table 1 below. These predominantly focus on electricity supply and lack attention to petroleum and renewable energy supply, including fuel handling, storage and distribution.

To date, the institutional roles and responsibilities of the various players in the energy sector have not been well defined and coordination mechanisms have not been developed. A legislative framework is required which provides for an appropriate governance regime including consideration of an overarching Energy Act. Having the appropriate legislation in place will be essential to improving the performance of the energy sector. The legislation should also promote and encourage active participation of the private sector and civil society.

While the existing instruments provide some guidance on development priorities and platform for action, the absence of implementation strategies has often resulted in unsustainable and ad hoc practices.

Table 1 - Key policy, legislation and strategic planning documents

Year	Legislation, policy, strategic planning document
2005 (rev. 2009)	National Sustainable Development Strategy 2005-2025
2006	Nauru's Utilities Sector – A Strategy for Reform
2008	Price Regulation Act
2009	National Energy Policy Framework
2011	Nauru Utilities Corporation Act
2012	Nauru Economic Infrastructure Strategic Investment Plan
2012	Nauru Utilities Corporate Strategy

A number of regulatory instruments are needed to further define accountabilities for the overall management of the sector and development of national energy legislation and regulations will be part of this process. An area where new legislation needs to be considered is in order to address safety and environmental issues regarding the importation, storage, handling and distribution of fuel on the island and lessons may be drawn from other countries in the region such as Samoa and American Samoa.

The NUC Act 2011 must be supported by regulations that define performance and safety standards of the Corporation including the processes and procedures required. As Nauru is planning to increase the contribution of renewable energy into the national energy mix, it may be necessary now to consider a legal framework that encourages private and community participation in energy generation through Power Purchase Agreements, net metering and other similar arrangements where feasible. A number of utilities across the region have now established similar arrangements that may be useful for Nauru.

There is no independent regulator in Nauru, as this would not be a cost-effective option given the size of the country. Regulation of the energy sector is therefore carried out by Government entities and through self-regulation by NUC.

Economic regulation is carried out primarily by the Ministry of Finance, through the Price Regulation Act 2008. The Ministry sets wholesale and retail prices for each fuel shipment and removes duty charges for power generation fuel. The Cabinet sets electricity tariffs.

Financial and performance regulation of NUC is provided for under the Nauru Utilities Corporation (NUC) Act which states the legal obligations of the utility for the supply of electricity, water and fuel. Under the Act, the CEO of NUC reports directly to the Minister of Utilities. However, under the Act the process, including frequency and content of reporting are not specified. At the moment these aspects are agreed in the CEO's employment contract. The Minister also plays a role in overseeing financial management of the NUC; however, this function needs to be clarified further.

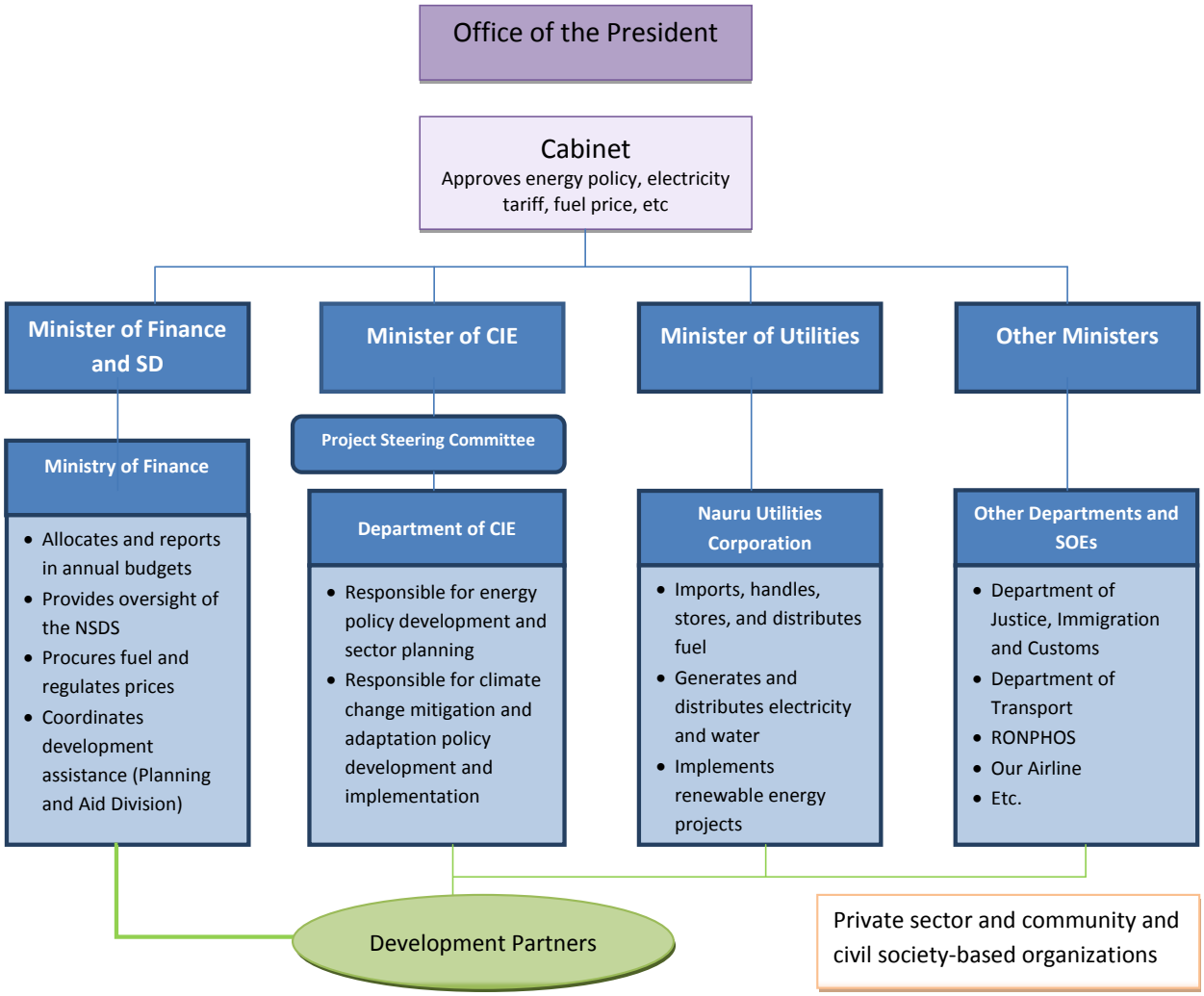
NUC is to an extent self-regulating in the area of technical regulation. There is no framework for Independent Power Producers (IPPs), net-metering or feed-in-tariffs, or any technical standards that would govern connection of third parties to the electricity grid. The role of CIE in relation to the development and management of the NUC is unclear. Once the capacity of CIE is strengthened it may be appropriate for it to take on a regulatory role in terms of technical standards for the NUC.

5.2 INSTITUTIONAL FRAMEWORK

The role for planning, developing and regulating the energy sector has been shared amongst the key entities depicted in Figure 1 below. A clear structure is in place but there is a lack of formal mandate, the processes and procedures are not sufficiently developed and in some cases they are unclear. In addition, the functioning of institutions is

constrained by limited financial resources and staff capacity. Energy investment on the island has been dominated by grant funding through various development partners.

Figure 1 - Institutional Map



The main actors in the energy sector are the Ministry of Finance, including the Planning and Aid Division (PAD), the Department of Commerce, Industry and Environment (CIE) and the Nauru Utilities Corporation (NUC). The functions of each these entities are outlined below.

5.2.1 MINISTRY OF FINANCE

The Ministry of Finance is responsible for the overall planning, coordinating and accounting for the national budget including receipts and disbursements of aid funds received by the government. The Treasury Division of the Ministry allocates financial resources and regulates disbursements through the annual budgets.

Project funds from development partners' contribution are received by the government through the Ministry's Planning and Aid Division (PAD) and PAD reports to development partners on the disbursement of these funds.

Annually, fuel budget (consisting of local and aid funds from Australia and Japan) is allocated mainly for power generation and local transportation requirement in collaboration with the NUC. The Department procures fuel through open spot tender process. Through the Price Regulation Act 2008, the Ministry sets wholesale and retail prices for each fuel shipment and removes duty charges for power generation fuel.

The Ministry of Finance drives the 3-yearly review process of the NSDS. The last NSDS review took place in 2009; however the next review is planned in 2014.

The PAD division needs additional human capacity to meet the demands for coordinating and reporting to government and development partners on the implementation of projects. Reporting requirements can be significant and in many instances ministries also have to prepare progress reports on aid funded projects. Strengthening PAD's capacity through, among others, additional human resources and further training and awareness, to coordinate and report effectively on donor funded energy projects may improve the existing delays to disbursing funds and reporting effectively.

5.2.2 DEPARTMENT OF COMMERCE, INDUSTRY AND ENVIRONMENT

The Environment Division of the Department of Commerce, Industry and Environment (CIE) is responsible for energy policy development and coordinates and monitors the NEPF implementation. The Department has established and provides a secretariat for a multi-stakeholder Project Steering Committee (PSC) to advise the Secretary on project development and implementation issues. The PSC has been effective in serving the development and coordination of the water sector and has potential to do likewise for the energy sector.

CIE is severely under-resourced; there is no single staff or clear budget allocation committed annually to meeting the minimum public sector energy functions. The role of CIE is unclear in relation to the development and management of the NUC. Once the capacity of CIE is strengthened it may be appropriate for it to take on the regulatory role in terms of technical standards for the NUC.

CIE staff take action on energy related matters largely on an "as needed" basis, under the direction of the Secretary of CIE. As part of the process of the development of the Road Map, an Energy Coordinator has been recruited (within external funding assistance) to be located in CIE and to facilitate the coordination of energy sector activities and support the implementation of the Road Map. However, this role should be supported by additional staff with a broad knowledge of the energy sector and experience across the region.

The Energy Coordinator position and any additional energy sector staff positions would need to eventually be integrated into the Nauru public service and reflected in the annual budget provision to CIE.

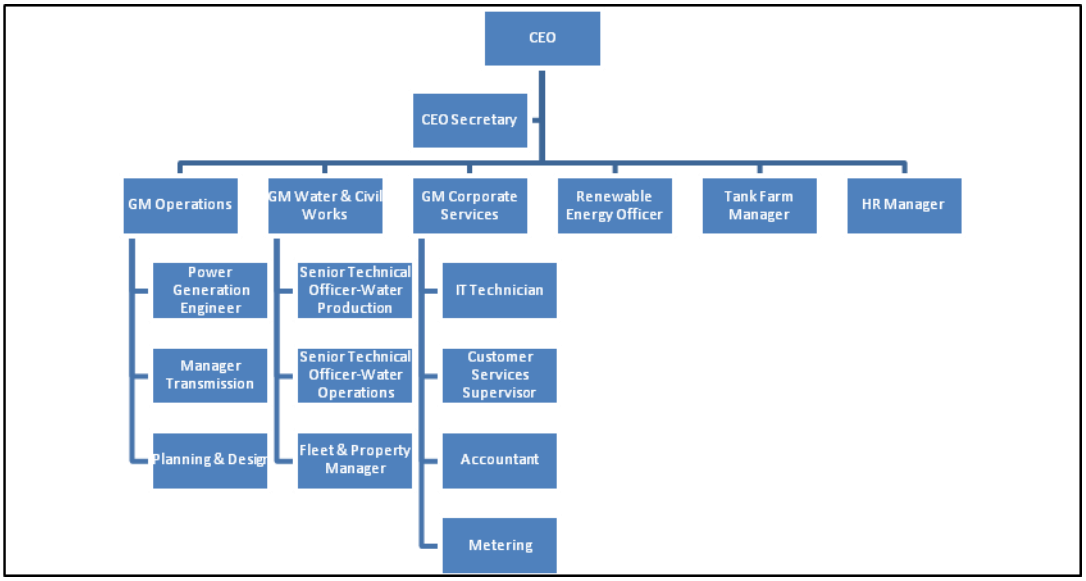
5.2.3 NAURU UTILITIES CORPORATION

Until 2005, the Nauru Phosphate Corporation provided all the island's electricity and water services. In 2005 the Nauru Utility Authority (NUA) was formed to separate the water and electricity utilities function from the phosphate corporation. It was later decided to corporatize NUA and the Nauru Utilities Corporation (NUC) was created. The current organizational structure of NUC is shown in Figure 2.

In June 2011, the status of the utility as a corporation was formalised with the passing of the Nauru Utilities Corporation (NUC) Act which states the legal obligations of the utility for the supply of electricity, water and fuel. Under the Act, the CEO of NUC reports directly to the Minister of Utilities. However, under the Act the process, including frequency and content of reporting of the CEO to the Minister are not specified and instead are agreed in the CEO's employment contract. The Act also sets up an Advisory Committee to "advise the Minister about matters related to the operations of NUC". The Advisory Committee is made up of 5 members, appointed by Cabinet (GoN, 2011).

In terms of governance, a further step in making the governance of NUC more transparent could be to define the performance reporting framework for the CEO and, or, convert the Advisory Committee into a Governing Board similar to the structure of many other Pacific Island state-owned utilities, where the CEO would then report directly to the Board.

Figure 2 - Organizational structure of NUC



It should also be noted that although the NUC Act sets up the aims and responsibilities of the utilities corporation, it does not provide for all the legislation and regulations needed for everyday operations. The NUC Act provides for recovery of fees from post-paid customers and for a small number of operational issues such as providing the power of

entry of NUC staff to enter land and buildings to undertake functions of the utilities. Regulations for the storage, handling and transporting of fuel and water, among others, have not been developed. Therefore, there is a need for regulations to guide the day-to-day operations of the utility.

In 2012 NUC developed a Corporate Strategy including vision, objectives and performance indicators. Priority areas identified in the strategy include: power generation and distribution systems, research and implementation of renewable energy projects, energy efficiency, improved tank farm management and overarching financial management and control and capacity building.

The NUC currently provides all electricity services to Nauru except for the RPC and the main processing plant of RONPHOS both of which generate their own power. Diesel, petrol and jet fuel (dual purpose kerosene - DPK) are purchased by the government for all customers except RONPHOS which procures its own fuel. The diesel, petrol and jet fuel are stored and distributed by NUC to all users except RONPHOS who maintains a separate diesel fuel storage facility for their industrial use. Jet fuel is used only by the national airline, Our Airline, which purchases it from the government. LPG is privately imported and distributed.

A Renewable Energy Officer is accommodated at NUC and is primarily responsible for renewable energy project implementation and for energy efficiency campaigns. There is also an Assistant Renewable Energy Officer, although this position does not seem to be formalised.

It should be noted that because NUC is responsible for both electricity and water supply at the operational level, there is an opportunity for synergies to be maximised for the development of both these sectors.

5.2.4 Other Departments and State Owned Enterprises

In addition to the key entities outlined in the previous sections, the entities shown in Table 2 also play an important role in developing and managing the energy sector.

Activities of the Road Map should coordinate closely with each of these entities as appropriate. For example, in developing programmes for energy and transport, a close working relationship with the Department of Transport should be developed.

Table 2 - Other Entities playing a role in the energy sector

Entity	Role
Department of Justice	Oversees government contracts including CIE employment and service contracts. Drafts legislation.
Department of Transport	Regulates the transport sector which is a main user of fuel on the island.
RONPHOS	Imports its own fuel and stores it at the NUC fuel tank farm. Owns generators and produces its own electricity off the grid for industrial applications although does use grid-connected electricity for its offices.
Customs and Immigration	Implements border control.

5.2.5 PRIVATE SECTOR AND COMMUNITIES

Nauru has a limited private sector that is dominated by small grocery stores, a few restaurants and a handful of bigger trading companies. There are a few local electrical contractors engaged in wiring of new houses including repair services and a limited number of other skilled tradespeople operating on the island. There are no financing facilities available for new investment by local entrepreneurs. There is no local capacity to service the solar home systems currently operating on the island. Procedures for setting up new businesses are unclear and there is a lack of incentive for private sector participation in building the local economy.

Community groups are limited to district councils, the Community Based Organization (CBO), youth and women's groups and church groups. These on occasion interact with the Nauru island Association for Non-Government Organisation (NIANGO) which was established to represent community interests. NIANGO has not been able to serve its members effectively due to limited resources and it has relied heavily on external assistance through donor funded projects. NIANGO has participated in a number of energy awareness raising campaigns on the island and it has been active in engaging women and youth based groups. To facilitate increased participation of NIANGO and other NGOs and community groups in energy sector activities, they must be given the right level of resources and assistance to contribute in a meaningful away.

The Nauru Business Private Sector Organisation (formerly known as the Nauru Small Business Association) represents the business community interest has been functioning for some time and is a member of the Pacific Island Private Sector Organisation (PIPSO), although its development is highly affected by lack of financing facilities on the island. The government is in negotiations to establish a bank on the island and this currently planned for 2014. The Nauru Business Private Sector Organisation may become more involved in the energy sector in the medium term when the investment environment improves thus private businesses may be expected to play an important role in the process of increasing the share of renewable energy in the national energy mix.

6 ANALYSIS OF POWER SECTOR

This chapter covers generation, distribution and sales of electricity, including supply-side energy efficiency (demand side energy efficiency is covered separately in chapter 8).

6.1 SUPPLY - GENERATION

Nauru is 99% dependent on diesel fuel for electricity generation (SPC, 2012). Electricity is supplied by a single power station operated by NUC. Most of the power is currently generated by four ageing medium-speed Ruston stationary engines[28] with a high-speed Cummins generator providing essential supplementary capacity. Table 3 below provides information on the generators.

Table 3 - Installed Diesel Capacity

Generator Type	Rating (MW)	Speed (RPM)	Year Installed	Running Hours[29]	De-rated Capacity (MW)
#1 Ruston	2.6	750	1989	32,616	1.0
#4 Cummins	1.0	1,500	2008	19,032	0.35
#5 Ruston	1.0	750	1976	19,626	Out of Service
#6 Ruston	2.0	750	1977	26,070	1.6
#7 Ruston	2.8	750	2008	26,435	1.6
#? Ruston 16RK3C	2.0	750	TBC	To be installed	-
#3 Caterpillar	1.4	1,500	TBC	607	-
Total	**12.8**				**4.55**

Source: NUC, August 2013

Maximum demand was once in excess of 7 MW but has since dropped to between 3.6 to 3.8 MW (NUC, 2013). The existing diesel engines have a nameplate total of 10.4 MW power generation capacity; but have been de-rated to 4.15 MW. This is enough to meet demand but if any one engine breaks down, load shedding is necessary. This also means that NUC does not currently have sufficient capacity to carry out planned or scheduled generator maintenance without causing load shedding (NUC, 2013). The Nauru Economic Infrastructure Strategy and Investment Plan (GoN, 2011) called for the establishment of an O&M spare parts store and workshop for NUC to enable more regular and timely maintenance of its generators and reduce lead time for spare parts. Generation and fuel use is shown in Table 4 below.

[28] The Ruston engines, except one funded by Turkey more recently, date to the years of high phosphate production. These engines stopped operating for a couple of years when the economy collapsed. AusAID stepped in from 2006/7 and provided four high speed Catepillars (500kW each) which powered the island on a daily load shedding schedule of 16hrs total supply. Around 2008 a decision was made by the Nauru Government to overhaul the Ruston engines and return them to operation to enable decommissioning of the high speed engines in 2009 because they were expensive to run. The maintenance on the Rustons was (and is still) affected by lack of spare parts that are not available "on the shelf" and have had to be custom made in the UK because the engines are so old.

[29] Since last overhaul

Table 4 - Total generation and fuel use 2008-2010

Year	Generation / MWh	Fuel used / litres	kWh / litre
2008	19 382	5 929 740	3.26
2009	21 174	6 299 460	3.36
2010	22 462	7 181 100	3.13
2011	23 024	7 360 628	-
2012	23 600	7 544 644	-

Source: NUC, 2012; 2012 and 2013 figures estimated.

6.2 SUPPLY – DISTRIBUTION

The distribution system is a ring main configuration and includes 11 kV, 3.3 kV and 415 V sections. The overhead distribution network is ageing and large parts are in need of overhaul or complete replacement. NUC has recently commenced a programme of replacing the steel poles with wooden ones as well as the replacement of faulty line fuses to reduce the extended outages. NUC also has plans to replace and upgrade distribution equipment to cater for future load growth and future renewable energy generation that is connected to the grid (PPA, 2013).

6.3 ELECTRICITY DEMAND

Peak demand is currently between 3.6 and 3.8 MW (NUC, 2013) with the minimum at 2.0MW (PPA, 2011). During the years of high phosphate production, industrial use dominated the Nauru energy economy. That use has diminished and the domestic sector is now the dominant user of grid electricity.

RONPHOS has offices and 18 staff houses which are still connected to the NUC grid. The offices are estimated to consume 100 kWh / day. The RONPHOS large mechanical equipment and drying kilns are powered by their own generators on an as-needed basis. RONPHOS has a 1.8MW generator for its production facility and a 0.8MW generator for primary crushing and screening (which runs at about 45% of capacity). Both run for 20 hrs /day, 12 days a fortnight.

RONPHOS occasionally draws additional electricity from the grid for its operations, specifically when phosphate loading is carried out. This has lead in the past to load shedding on other parts of the island so that RONPHOS power demand can be met. There have been occasions when NUC has not been able to supply RONPHOS demand.

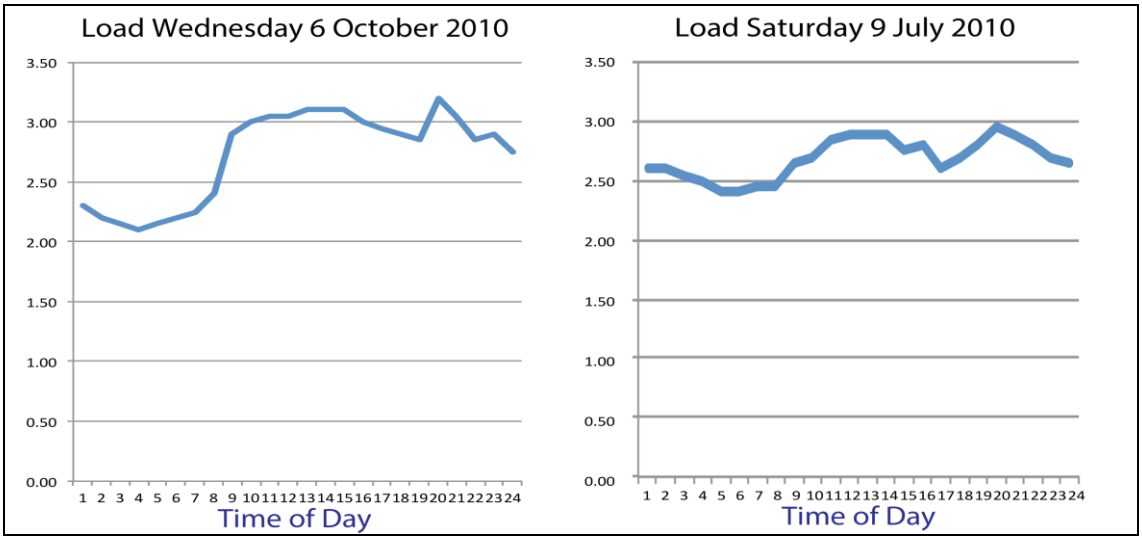
The water supply by reverse osmosis (RO) plants is also a significant user of electricity but specific use data is unavailable and therefore the contribution of the RO plants to electricity demand cannot be quantified at this time.

The RPC generates its own electricity. The Nauru Rehabilitation Corporation (NRC) is connected to the grid but uses its own generator to supply most of its electricity. The agriculture and tourism sectors are very small and are not treated here separately. There is also no specific data on these sectors.

Daily load curves for 2010, as shown in Figure 2 below, indicate a weekday baseload of around 2MW and an evening peak of around 3.2MW. This is probably due to cooking

using electricity. The 2011 census found that 60.2% of households use electricity as their main cooking fuel (GoN, 2013). There is little demand for water heating and there is limited data available on the extent of household use of air-conditioners, although these are widely used in the Government buildings. The weekend load varies from around 2.5 to 3MW with the peak again in the evening.

Figure 3 - Load curves for 2010



Source: NUC, 2011

6.4 ELECTRICITY TARIFFS

Historically electricity was provided for free. When tariffs were introduced these were artificially low and bill collection was not enforced. This has resulted in a very high average household electricity use by Pacific standards, estimated at around 400 kWh / month (although there is likely a significant variation between households). 29% of homes own air-conditioners, though there is no data on type, size or extent use of use. Other common electrical appliances are televisions owned by 75% of households, refrigerators (57%), deep freezers (48%), computers (46%) and fans (93%) (GoN, 2013).

To gradually shift the population to paying for electricity, prepaid meters were installed in 2009 for most domestic and some commercial customers. Some domestic and most commercial, government and industrial customers are still on standard post-pay meters. The tariff is still heavily subsidised with a very high "lifeline" allocation of 300kWh/month (see Table 5).

Table 5 - Customer Meters and Tariffs

Sector	Number of prepaid customers	Number of billed (post-paid) customers	Tariff AUD/kWh
Residential	1980	41	300< 0.10 300>0.25
Commercial	124	52	0.30
Industrial	0	7	0.50
Government	0	23	0.50

Source: NUC, 2012 & 2013

Full cost recovery is estimated to be between AUD 0.45 - 0.49 per kWh by various sources (PPA, 2013, PRIF, 2013, GoN, 2013), so the subsidy to residential and commercial customers is significant.

6.5 PREDICTED GROWTH IN ELECTRICITY DEMAND

Planning for the power sector is constrained by a highly uncertain economic environment and high exposure to external influencing factors. Nevertheless demand for electricity is expected to grow due to the increasing population, the number of new buildings and the expansion of businesses (NUC, 2012). Construction, hotels, restaurants, and retail trade, along with government finances, are expected to expand due to the RPC which reopened in September 2012. The RPC has also directly created approximately 200 jobs. Partial payment of government salaries in arrears will be financed from RPC-related revenues, and is expected to boost domestic consumption (ADB, 2013a). All these factors may in turn increase electricity use.

Ronphos and NRC currently generate most of their own electricity. However, if these organisations were to change this policy and start to draw electricity from the main grid, this would also greatly increase grid-connected power demand.

However, due to changes in the phosphate production from year to year, some factors such as the RPC and fishing revenues being potentially transitory and ongoing changes such as the planned expansion of the RPC (ADB, 2013b & 2013c), accuracy is low for forecasting long-term future energy use.

6.6 FUTURE OPPORTUNITIES

Several studies since 2010 have underscored the need for NUC to improve its efficiency in electricity generation and its delivery to customers. A number of relatively simple actions such as purchase of a new generator, overhaul of old engines to improve fuel efficiency, upgrade of the transmission and distribution network, including replacement of transformers and more regular and timely maintenance of assets could quickly contribute to improvements in reliability and efficiency of electricity supply.

NUC has already put in place plans to replace and upgrade generation and distribution equipment to cater for future load growth and replacement of old generating equipment with renewable energy generation. Analysis of the difficulties in maintaining the old

generators (limited “off the shelf” spare parts, need for once-off special manufacture of old parts, long supply chains, long waiting times for spare parts, need to bring in specialist expertise for overhaul work) indicates that investing in new generation may be the most effective step in the coming years.

When bringing in new diesel generation, transmission lines and distribution equipment these can be designed to be better suited for renewable energy integration in the future. Development partners have indicated willingness to support capital investment projects both to improve baseload diesel generation and to expand renewable energy generation. Further planning for supply side energy efficiency, asset management and replacement is an important part of this Road Map.

In terms of demand-side actions, there are some actions in the water sector that should be considered. First there is potential to use the RO machines as discretionary load to reduce peaks if needed or utilise surplus renewable energy supply when this is introduced at a larger scale. There is also some potential to reduce the energy needed to operate multiple reverse osmosis plants which produce fresh water. If rainwater is collected and stored from the runoff from the over 8.5 MWp of solar panels needed to provide 50% renewable power generation, the requirement for energy to produce desalinated fresh water could be greatly reduced if not eliminated for most of the year. The full feasibility study for solar power to be carried out under this Road Map should include the feasibility of rainwater collection from solar panel runoff and its large-scale storage.

Besides technical improvements, there is a need to reduce non-technical losses by improving metering, carrying out regular analysis of data obtained from metering and enforcement of penalties for customers found to be effectively stealing power by wiring around meters.

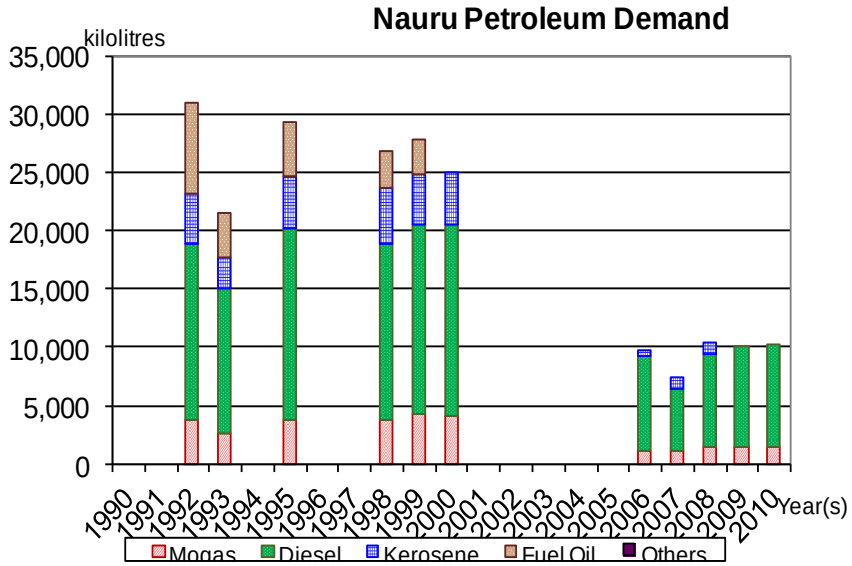
7 ANALYSIS OF PETROLEUM SECTOR

7.1 FUEL SUPPLY

Imported, refined petroleum fuel is the main energy source in Nauru. Fuel imports are delivered by either medium range (MR) tanker ships directly from Asian refineries, from high seas bunkering vessels that service the Pacific fishing fleet or occasionally via local coastal tanker (LCT) from a Pacific large regional bulk fuel supplier such as Fiji.

There are two main importers of fuels into Nauru, the Government and RONPHOS. Joint procurement was carried out until 2000 when RONPHOS, then the Nauru Phosphate Company, was still part of Government. At present, fuel procurement and supply by the Government and RONPHOS is carried out separately. The Government fuel imports to Nauru from 1990 to 2010 (where data is available) are shown in Figure 4 below. All fuel imports into Nauru are retained, there is no re-export, although facilities were installed recently which would be capable of re-fueling passing fishing vessels.

Figure 4 - Nauru Government fuel imports



Source: ANU data 1990 - 2000; SPC data 2006-2010

Current government fuel supply in Nauru is broken down between diesel fuel, mainly for electricity generation, DPK for jet fuel and cooking and petrol. As shown in the chart fuel oil was also imported by Government in the 1990s for the phosphate industry. Imports of fuel oil continue today but are handled by RONPHOS directly. These are estimated at 4 million litres per year but may vary from year to year depending on phosphate production. LPG is also imported into Nauru by two private sector companies with imports estimated at 9.5 tonnes per year (IRENA, 2013).

In August 2008, the Government of Nauru stopped importing Jet A1 (DPK in figure 4 above) but recommenced imports in 2010. Jet fuel interruptions have also affected supply in 2013.

Retail prices for diesel were reported at 1.72 AUD/litre (SPC, 2013), while NUC purchases diesel for electricity generation at 1.23 AUD/litre. Retails prices for LPG were observed to be in region of 60 AUD for an 11kg cylinder. Kerosene the retail price observed at 7 AUD / litre[30].

7.2 ANNUAL FUEL DEMAND

Total fuel demand in Nauru is estimated at 14 million litres per year[31], which is around half of what it was in the 1990s (see Figure 4 above). The decrease in fuel imports can be attributed to the significant decline of the phosphate mining industry in the intervening years. There is a very limited data on the breakdown of fuel use between sectors. Table 6 below provides an estimated breakdown.

Table 6 - Estimated breakdown of fuel demand in Nauru

Sector	Type of fuel	Quantity
Electricity	Diesel	6-7 million litres per year
Phosphate (RONPHOS)	Fuel Oil (for drying process) Diesel (for own generators)	Self-imported ~ 4 million litres per year Self-imported – no data
Our Airline	Kerosene (DPK)	~ 0.5 – 1 million litres per year
Transport	Diesel Petrol	~ 1 million litres ~ 2 million litres
Cooking[32]	Kerosene (DPK) LPG[33]	~ 0.1 million litres per year ~ 9.5 tonnes per year

7.3 FUEL SUPPLY, QUALITY, TESTING AND CERTIFICATION ISSUES

In recent years, fuel supply to Nauru has been through periodic spot tender. While at times of high regional supply, this may lead to some competitive pricing for fuel supplied, there are significant national risks with relying on the spot market for ongoing supply over the long term. These risks include diminished supply options when regional supply

[30] Observation made in retail outlets during SPC-GIZ CCCPIR technical mission, November 2012
[31] SPC energy indicators, 2012; RONPHOS communication, 2013
[32] 31% of households used LPG and 3.1% used kerosene as their main cooking fuel (2011 Census)
[33] A report on "Economic and financial analysis of the use of Liquid Petroleum Gas (LPG) for household cooking in Nauru" was prepared by SOPAC for the Nauru Government in 2008 but does not include LPG import data.

is tight, the potential for accepting sub-standard quality fuel and the resultant impacts on the local economy and population.

Based on evidence from Samoa and American Samoa, there is a sound basis to recommend that there should be an investigation of the feasibility of tendering out the national fuel supply to a reliable international supplier that would take responsibility for reliable and consistent fuel supply over a defined period.

The current fuel supply mechanism has led to variable supply and in at least one case, fuel of unacceptable quality being delivered to Nauru, which led to supply shortages on island [34].

The supply of jet aviation fuel was put on hold from August 2008 until December 2010 over concerns with the quality and adequacy of the testing and certification process. Since mid-2012, there has not been adequate testing or proper certification of Jet Aviation Fuel on Nauru, which has led, in July 2013, to the quarantine of the existing jet fuel stocks, pending adequate testing being reinstated[35].

7.4 FUEL TERMINAL

There is one fuel terminal (tank farm) on Nauru which is owned by the Nauru government and is currently operated by the Nauru Utilities Corporation. This arrangement brings with it significant national risks. Bulk fuel terminal operation is a very specialized business requiring qualified and properly trained staff operating under very stringent industry guidelines to maintain product quality and all relevant Environment, Health and Safety (EHS) requirements.

A 2011 plan to have the fuel terminal operation and national imports and supply tendered out on a commercial basis was a move in the right direction, but this initiative was put on hold prior to finalization following a change in Government. The present analysis of the petroleum sector suggests that this option be revisited to facilitate improved management of the tank farm and reduce risk to Government and consumers.

The size of the bulk fuel terminal (see Table 7 below) and the water depth at the port allows the delivery of fuel to Nauru using MR tankers, thus providing the opportunity to realize good economies of scale. This opportunity is somewhat diminished by the shrinking size of Nauru national fuel demand.

Based on a very conservative quarterly (every 3 months) turnover of fuel stock on Nauru, the theoretical annual through-put capacity for the bulk fuel terminal would be 74 million litres. This is compared with annual national demand of about 10 million litres.

[34] Interview, CEO, NUC 28 June 2013
[35] Interview, CEO, NUC 17 July 2013

There exists significant potential to re-export fuel to other markets including near island neighbouring countries and potentially for the Central Pacific fishing fleet. Should this be achieved, it would bring with it the potential for increased commercial activity to be generated on Nauru, such as the provision of ships stores, hardware and engineering maintenance.

Table 7 - Nauru fuel tank farm theoretical storage capacity in 2000

Tank	Product	Capacity (litres)	Capacity (Metric Tonnes)
1	ADO	9,506,363	8,090
2	ADO	1,666,738	1,418
3	DPK	1,667,293	1,348
4	DPK	1,679,538	1,358
5	DPK	1,673,006	1,353
6	Mogas	1,630,344	1,221
7	Mogas	539,835	404
8	HFO	549,654	522
9	Slops	86,322	
34	HFO	4,566,096	4,340
Total		**23,565,189**	**20,059**
	Revised capacity (2011)	**18,500,000**	**15,750**

Source: Nauru Phosphate Corporation, 2000

7.5 POTENTIAL SUBSTITUTES FOR LIQUID PETROLEUM FUEL

The limited availability of biomass on Nauru would make it difficult to support a biofuels industry, unless that changed dramatically into the future. One possibility for this would be if the centre of the island were planted with a potential fuel crop such as coconut, oil palms, pongamia, jathropha or other fast growing vegetation that could be converted into biofuel using advanced biofuel technologies that are currently being developed. However, the issues of food versus cash crops as well as water availability would have to be carefully examined, among others.

Clean technology electric vehicles could be supported if adequate power generation was available from renewable sources.

An interim measure which would bring with it some environmental benefits would be the introduction of LPG vehicles into the future. This could become economic through the importation of bulk LPG which would also have the benefit of reducing the cost of LPG for domestic applications such as cooking.

7.6 PREDICTED GROWTH IN FUEL DEMAND

Although at the moment fuel use to meet electricity demand in the residential and commercial sector is expected to grow, it is also possible that fuel use will not increase, and may even decrease, over the next decade if cost recovery and energy efficiency measures are implemented. Also, industrial fuel use (RONPHOS) is closely tied to phosphate production, which has a long-term downward trend

On the other hand fuel use could increase substantially if the RPC starts drawing power from the main grid and the RPC income and jobs continue to stimulate the economy. If the capacity of the RPC is expanded further, this could imply higher future energy use. The use of jet fuel may show growth over the next 10 years which could be the case if either Our Airline (the national airline of Nauru) expands its operations or if an alternative commercial carrier were to operate to or through Nauru.

8 ANALYSIS OF RENEWABLE ENERGY OPTIONS

8.1 SOLAR RESOURCES

Measurements show an average resource of over 6 kWhr/m^2/day (with solar panels tilted to the angle that maximises energy input) with a seasonal variation of around 10-15% (PIREP, 2004). Solar PV matches well with mid-day demand for the use of air conditioners but cannot meet the demand for the mid-evening cooking-related peak. Therefore, although solar PV offers electricity generation that can supplement the existing diesel generation, due to the intermittency of the resource, expensive electrical storage systems will be required for it to be included into the grid at high levels of penetration.

A dynamic model has not yet confirmed the maximum possible level of solar penetration before grid stability issues occur, but it is likely to be limited to around 20% - 30% of the midday demand which is typically 3 to 3.5 MW. This represents a maximum grid-connected solar capacity of between 700 kWp to 1 MWp when the solar is connected without storage. Above this threshold, storage and control systems will probably have to be introduced to ensure grid stability. . In terms of energy production, a 30% midday demand penetration (1 MWp of solar) represents around a 5% energy penetration for the conditions in Nauru so the 50% goal cannot be reached without substantial additional solar (above 1 MWp) which would need to be accompanied by associated energy storage such as large batteries.

8.2 WIND RESOURCES

Wind data collection, funded by PIGGAREP and the EU[36], has been carried out for more than three years at a telecommunications tower at Anabar District on the northern part of the island where the wind resource is expected to be greatest (Winergy, 2006). However, the telecommunications tower includes components near the wind measurement instruments that may change both the speed and direction of the wind seen by the instruments thus lowering the confidence in the data collected to date. Measurements already made indicate an annual average wind resource of 4.22 m/sec at 30 meters (about 4.7 m/sec if extrapolated to 50 meters) for the period 2009-2010. This is at the low end of practicality for cost-effective wind energy generation.

A further resource assessment using a more suitable 50 metre low-profile guyed mast in Anabar has been underway since 2012 and is intended to determine the appropriateness of further wind energy development and to assess the quality of the data already collected from the nearby telecommunications tower instruments.

8.3 GEOTHERMAL

There is no evidence of a cost effective geothermal resource for Nauru and geothermal is not considered appropriate for development during the Road Map period of 2014 to 2020.

[36] PIGGAREP funded the first 12 months (2009-2010) of the wind data collection. The EU funded an additional two years (2010-2011).

8.4 BIO-ENERGY

Wood is presently used as the main fuel for cooking by 6% of Nauruans[37]. However, with little or no biomass present Topside, there are presently insufficient biomass resources for either electricity generation by combustion or gasification or for significant production of biofuel. Land rehabilitation may eventually result in topside biofuel or biomass plantations if suitable fast growing plants can be grown in the rehabilitated area, but it is not likely that production will be seen in time to help meet the 2020 goal of 50% electrical generation from renewables.

As Nauru has significant areas of unused land (topside) there is the potential to grow biomass that could become a future energy source. This would depend on the plans and timetable for secondary mining and rehabilitation. This needs to be investigated in a future study looking at the long-term options. There are number of issues that have already been identified such as the need for land reforming, soil damage from UV sunlight and the need for extensive rehabilitation (Feary, 2011).

There may be scope for domestic-scale piggery biogas projects to replace LPG for cooking and possibly some transport but the number of penned pigs and chickens in Nauru and their distribution over the island needs to be quantified before their contribution to the energy mix through biogas production can be assessed.

8.5 OCEAN ENERGY

8.5.1 WAVE ENERGY

Wave energy in the equatorial region is generally low with around 10-15 kW/m estimated from satellite observations. Many different types of wave energy devices are being tested at the prototype stage around the world. However, none are yet commercially proven. Even if wave conversion systems become commercially available for utility scale generation, the low resource will make it difficult for Nauru to economically develop wave power at a cost competitive with other more significant renewable resources.

8.5.2 OCEAN THERMAL ENERGY CONVERSION (OTEC) [38]

In 1981 and 1982, the Tokyo Electric Power Company (TEPCO) in association with Toshiba of Japan installed and began technical trials of a mini-OTEC facility on the west coast of Nauru on the shore across from the current location of the Civic Centre in Aiwo. The facility had a gross power continuous rating of 100 kW and provided a maximum net power of 31.5 kW. At the time, the Nauru installation was the first land based OTEC plant in the world to produce net power, it was also the highest power OTEC plant ever operational and the first (and last) to feed power to an operating commercial grid. It was known that it would not be a cost effective power supply for Nauru when it was installed and was not intended purely as a technical trial; it actually operated as a power generator

[37] 2011 Census

[41] Details of the Nauru OTEC trials are from the PIREP Report for Nauru: Wade, Herbert, Pacific Regional Energy Assessment 2004, Vol. 7 Nauru National Report, SPREP 2005.

feeding the Nauru grid for only 240 hours. The actual cost is not available but estimates go higher than US$1 million, all paid by TEPCO and Toshiba.

Since that early installation, there have been significant improvements in high efficiency low temperature heat exchanger designs eliminating the need for the use of very expensive titanium metal. Additionally, an open cycle OTEC design has been successfully operated in Hawaii. That design would be of particular interest to Nauru since a side benefit is the production of large amounts of fresh water. Also, the large volume of nutrient rich 7º C water from the deep water intake could be used for district air conditioning and cold water aquaculture thereby possibly providing significant additional side benefits.

With the very rapid drop-off that occurs beyond the reef in Nauru, there is an opportunity for OTEC energy development once engineering and commercial trials are completed elsewhere. However, the 1981-82 installation in Nauru remains the only OTEC facility that has actually delivered power to a public grid. Several engineering trials have been attempted, up to 1 MW of gross power capacity, but no plants have yet to be built that are suitable for commercial utility use and it does not appear likely that OTEC can be a part of the Nauru energy economy within the next 10 years, since there still are no OTEC plants anywhere in the world currently producing electricity commerically. Even if the go-ahead for utility scale trials were to occur today, it would be at least five years before an operational, utility scale plant would be commissioned and another five years should be allowed to work out the problems and to determine the real costs that such a plant has for O&M before committing to a Nauru installation.

8.6 SUMMARY OF RENEWABLE ENERGY OPTIONS

Given the available resources and the state of renewable energy technology, only solar energy appears to be clearly appropriate for development to replace fossil fuels during the Road Map period of 2014-2020.

After further data collection and analysis, wind energy may also be shown to be a cost effective option and if so, can be integrated into the renewable energy action plan in the future.

There is significant future potential for bio-energy but this will depend on the greening of the Topside with suitable vegetation. This work should be progressed as a matter of priority since it offers significant potential for a low-cost, sustainable energy source over the medium to long term. It also offers the opportunity to develop an indigenous energy industry, encourage private sector participation, increase local employment opportunities and significantly reduce expensive energy imports. All of this without impacting and possibly synergising local food production on what is currently unutilized land.

Given that the existing wind data indicates a marginal resource plus the fact that the existing 202 kWp of grid-connected solar has performed well and met or exceeded expectations while there have been no trials of utility grade, grid-connected wind generation on Nauru, only solar development is presently considered as appropriate for the renewable energy component of the Road Map. Other renewable technologies, including ocean energy and biomass, may be practical for the period beyond 2020.

8.6.1 SOLAR OPTIONS

A pre-feasibility study for solar generation to replace fossil fuels was carried out in April 2013. Technically practical options for reducing the need for fossil fuels for electricity generation in Nauru by solar energy were found to be:

- *Grid-connected solar photovoltaics (PV) with no energy storage.* This type of installation offsets some daytime electricity generated currently by diesel engines but provides no offset at night. It is the cheapest form of solar for electricity generation but cannot be expected to provide more than 10% to 15% of power generation by renewables because the amount of solar that can be connected to the grid without storage is limited by the grid's ability to absorb the wide power fluctuations that will occur with solar generators. The passage of clouds will cause the output from solar panels to drop from 100% to less than 20% of capacity in a minute or less and will recover to 100% equally quickly as the cloud clears the solar array. This rapid and very large variation is difficult for the old diesel engines at NUC to manage without voltage and frequency variations that become unacceptable when the size of the solar becomes too large. Estimated cost of grid-connected solar without storage is 4 USD per Wp for roof mounted PV systems and 5.50 USD / Wp for ground mounted systems though prices have been falling recently.
- *Stand-alone solar photovoltaic power for individual buildings, groups of buildings or communities.* In this form, solar generates all electricity for the buildings or communities with diesel taking over only if solar power is not sufficient due to unusually long cloudy periods. This is the most expensive option and is limited in scope to the served buildings or communities. Such installations would be complex to manage and the cost and reliability benefits of solar power will not be available to all of Nauru energy users. Cost per Wp for this type of installation is estimated to be USD 6-8 per Wp but due to the need to generate essentially all power by solar, larger installations and a large storage capacitywill be needed for the same energy output than would be needed for diesel-solar hybrid installations. This option is therefore not recommended at this point in time.
- *Large scale solar photovoltaics powering the grid entirely during some or all of the daytime period with the diesel generation handling the remaining load* . This approach minimizes the need for expensive storage since the solar only provides energy during the time when the solar panels are generating (during the daytime) so the cost per kWh of generation is lower than other options with energy storage. Also this approach allows the complete shutdown of diesel generation during much of the day. However, the peak load in Nauru is at night and this approach cannot provide the required 50% of generation by renewables. The cost is estimated to be 7-9 USD per Wp installed which is a higher unit cost than for a diesel-solar hybrid because larger storage per installed kWp will be needed to cover cloudy days since the intent is to have all diesel engines shut down during part of the day.

- *Large scale solar photovoltaics with storage that daily contributes around half the load day and night with the other half coming from the diesel generators – a diesel/solar hybrid.* This is the option that can most cost effectively take over 50% of NUC generation using renewable energy. This option combines grid-connected solar without battery storage to offset daytime power generation and grid-connected solar with storage to provide solar generated power at night and during cloudy periods. Including the storage avoids stability problems since solar variations can be filled in by the associated storage. Based on existing installations of this type in the Pacific, the cost of generation can be expected to be about the same as the existing cost of diesel generation but is expected to be substantially less in the future if fuel prices continue to rise at the expected 1.5% to 2% average annual rate. Cost is estimated to be USD 6-8 per Wp with a total of about 10.5 Megawatts of solar capacity (about 3.64 MW without storage and 6.84 MW with storage) needed to provide 50% of current generation.

8.7 PRE-CONDITIONS FOR RENEWABLE ENERGY DEVELOPMENT

A number of activities need to be carried out before actual implementation of hardware begins since it is vital for the longer term success of the Road Map it is vital that funding be directed toward the specific actions that are required for solar PV and that all equipment provided by donors is compatible with the rest of the installations being made. Thus technical designs must be completed and standard equipment specifications developed in advance of actual hardware installations.

8.7.1 GRID STABILITY ISSUES

As noted above, the rapidly changing output from large scale solar arrays can create problems with grid stability either causing excessive voltage/frequency variations or power outages. Before proceeding with more than around 600 kWp of grid connected solar that does not include power management with batteries or other energy storage, the grid characteristics related to its response to varying rates of varying amounts of power demand should be modeled using computer software known to be appropriate for predicting the dynamic response of the type of generation and type of grid system at NUC. IRENA and others have funded trials of modeling software in the Pacific that have successfully predicted the response of an island grid and diesel generators to rapidly changing inputs from solar and wind. Running the model for Nauru will provide information about where best to connect the solar power systems to the grid and the amount of solar (or wind) that can be connected without stability problems.

8.7.2 DESIGN STANDARDS AND GUIDELINES

The solar generation installations will need to be carried out through the staged construction four or five solar power plants each resulting in a solar plant with 2 to 3 MW of capacity that can work with the other solar installations already in place. For this to be managed by NUC, all installations must conform to the same design approach, use the same equipment and incorporate the same control and data management systems. For this to happen, design standards and material specifications will need to be fully developed

before any major solar installations are implemented under the Road Map. By having standard designs that repeat through all the separate solar installations, training will only be required for one type of solar installation and spare parts stocks needed to effect repairs can be minimized.

8.7.3 ROOF SURVEY

A survey of all government owned roofs and parking areas should be carried out immediately to determine the amount of solar that can be installed without access to additional land. Once that survey is complete and component standards and specifications developed, projects to install the solar on those roofs can commence. Note that the survey should include roofs that are surfaced with asbestos materials as well as other roofing materials such as steel and non-asbestos composite shingles. According to the cost of land, it may be found to be possible to exchange the asbestos materials for steel roofing and add the solar arrays with little or no added cost over a ground mounted array of the same size thereby helping solve both the environmental problem represented by asbestos based roofs and the problem of allocating roof area for solar installations.

8.7.4 POWER POLE SURVEY

As has been shown in the USA and currently has been successfully trialed in Tonga, solar panels can be installed on power poles to feed the grid by using standard solar panels with small, weatherproof micro-inverters to connect the panels to the low voltage sections of the grid. However some types of poles are not appropriate for mounting panels due the type of pole, pole design or a pole location that includes shade at some times of the year. Therefore a survey showing the location of suitable poles will be necessary. Once the pole survey is complete, installation of panels can commence since there are no issues relating to land or site preparation.

8.7.5 DEVELOPING ARRANGEMENTS FOR INCLUDING PRIVATE SOLAR INSTALLATIONS

Most countries that have large scale solar development programmes include substantial private investment in solar and have programmes to provide a fair payment for the power that is generated and fed to the grid by private solar or there are other incentives for installing solar. Before such programmes can be successful, the regulations and payment systems for privately generated solar (or other renewable energy) electricity need to be developed and put into effect. Larger scale generation can be developed under an IPP (Independent Power Producer) type agreement and small scale generation can be developed under net-metering and subsidized or loan finance arrangements. Because of the potential for grid stability problems under some circumstances, private installations need to be vetted and licensed by NUC or a government agency with responsibility for technical regulation of the electricity sector.

8.7.6 LAND ISSUES

An estimated 9 MWp of solar arrays will need to be ground mounted with the rest on roofs and/or parking lots. According to the type of solar panels and mounting system used, the total land requirements can vary from around 10 ha to over 20 ha. To properly carry out the design of the arrays, the cost of land will need to be established and

locations allocated for array construction, preferably at widely separated sites so as to minimize power variations from cloud passages and to reduce the need for costly, specially constructed transmission lines for the solar power. Once the cost of land is established, then the type of panel can be determined and the economic decision made whether to opt for high cost high efficiency panels and their minimal land requirements or low cost low efficiency panels requiring more land area. Leased land may be considered, though the lease probably should be for no less than 30 years if the full benefits from the solar panels are to be realized.

8.7.7 TRAINING AND CAPACITY BUILDING

With as many as 25 local persons involved for 5 to 6 years for the construction of the solar installations and as many as 40 permanent employees needed to operate and maintain the final solar installations, a training programme will be required that provides several levels of training for the installation, operation and maintenance of the solar installations and must be available on demand for the operational period of the solar plants. That will need to be developed in association with the manufacturers of the components chosen as standard units for the Road Map installations but must be carried out locally by local instructors who have been trained by the manufacturers. The training programme should be developed in conjunction with the development of the design standards and specifications so that they are in place at the time of the installation of the first component of the Road Map implementation.

9 ANALYSIS OF DEMAND SIDE ENERGY EFFICIENCY OPTIONS

To keep future investment needed for electricity generation (diesel or solar) as low as possible, it is vital that investment in improving generation be carried out in parallel with investments in demand side management (DSM) energy efficiency improvements. Most investments in energy efficiency to reduce the demand for generation will be more cost effective than installing new diesel generators or new solar generation needed to meet that same demand.

In general the commercial sector has a substantially higher level of energy efficiency than does either residential or government sectors. This is because businesses are more likely to understand the economic benefits of improved energy efficiency and their return on investment through lowered electricity costs. Even with the subsidised tariffs for commercial users, the cost of electricity is much higher than that of most industrial countries and represents a significant cost for businesses.

The residential sector is more heavily subsidised and only has to pay around half the real cost of electricity and therefore has less incentive to invest in relatively costly high efficiency electrical appliances. Also, households often have difficulties in making the relatively high one-time investment in energy efficient appliances that is necessary to gain their benefits in the long-term but can afford to continue to pay the relatively low periodic cost of inefficient energy usage. To encourage residential investment in energy efficiency, an easily accessible appliance finance arrangement will need to be developed that allows the purchase of energy efficient refrigerators, freezers and air conditioners with a monthly cash outlay for both electricity and appliance finance that is no more than the existing monthly electricity cost for the old appliance.

The government sector has no effective energy management system that provides any incentives for their end users to conserve energy or to purchase more energy efficient equipment (SPC, 2012).

9.1 RESIDENTIAL SECTOR

9.1.1 HISTORICAL OVERVIEW

From 2007 to 2010 various demand-side activities were undertaken in Nauru under the auspices of the REP-5 project, funded by the European Union. These included in 2009 the installation of over 1800 pre-payment meters in homes and some businesses. A demand-side energy efficiency action plan was also drafted and two energy efficiency officers were hired. The two officers carried out an awareness campaign on energy efficiency and conservation that targeted homes and small businesses. This included such activities as school and community energy efficiency competitions. However, after the end of the project in 2010, the energy efficiency officer contracts were not renewed and the campaigns were not sustained. To maintain efficiency gains, there is the need for continuous programmes for maintenance of energy efficiency improvements. These measures cannot be dependent only on external short-term project funding but need a permanent, locally funded budget.

A number of LED energy efficient street lights were provided through the Government of Taiwan in 2011. Two sizes were provided, larger units for standard street lighting

applications on main thoroughfares and small units for low traffic area lighting. The installations have not been monitored and the overall benefits are not known.

In 2012, high efficiency light bulbs were provided by the Government of Taiwan and slated for distribution to all households on Nauru. The lights provided were substantially more efficient than those that were replaced and several per cent of each household's electrical use should have been saved. There was no programme, however, for proper disposal of the replaced fluorescent light bulbs in order to avoid releasing mercury vapour into the environment. Also, there is there no programme for monitoring of the benefits of the programme in order to determine the level of actual benefits received or the appropriateness of similar programmes for the future.

9.1.2 THE EFFECT OF ELECTRICITY TARIFFS ON DSM

A major driver of demand side energy efficiency is the price of electricity. So long as residential electricity tariffs remain artificially low, as has long been the case in Nauru, programmes to improve demand side efficiency will tend to have only a short term effect with energy usage soon rising back to pre-programme levels after the programme concludes. For demand side energy efficiency programmes to have the longest lasting benefit, the energy using hardware needs to be upgraded with low maintenance, long lived, high efficiency equipment (e.g. replacement of standard fluorescent fixtures with long-life high efficiency units) and consumers must expect cost of electricity to increase, e.g. consumers are informed of future electricity price increases in advance through a well publicized government programme to gradually reduce subsidies on electricity and increase tariffs.

9.1.3 ACTION PLAN FOR RESIDENTIAL ENERGY EFFICIENCY

With the relatively inefficient residential sector using around 75% of the electricity that NUC delivers (SPC/GIZ, GoN, 2013); much of the energy efficiency improvement efforts will need to be directed toward domestic users. The cost of incremental energy efficiency measures increase as the level of efficiency increases but for saving up to around 30% of the existing demand, it is reasonable to expect that the investment needed for each kWh saved will have a life-cycle cost that is less than the cost of generating that kWh. Paybacks for many types of energy efficiency investments for residences can be measured in months rather than years. Although available data is inadequate to allow for an accurate estimation of the potential in Nauru for energy efficiency measures to reduce demand – and therefore the amount that can be saved in reduced renewable energy investment – it clearly is substantial, almost certainly in excess of 20% of the existing residential energy usage and possibly as high as 30%.

Although NUC tariffs have increased in recent years, residential energy costs are still heavily subsidised and the message being sent to residential consumers through those subsidised tariffs is not one of investing in energy efficiency or practicing conservation. Specific proactive programmes to engage the public in actions that improve their efficiency of energy usage are therefore needed to reduce the power plant load and in turn make it less costly for renewable energy to take over 50% of that load.

The 2011 census provides basic appliance ownership data though no information was gathered about the appliances or their use patterns. The summary of household appliance ownership is shown in Table 8 below.

Table 8 -Ownership of Selected Household Appliances in Nauru

Appliance	2011 (% of households)	2011 (total units)
Refrigerator	57%	1019
Deep freezer	48%	832
Television	75%	1609
DVD player	70%	1512
Microwave or oven	46%	823
Ceiling or standing fan	93%	4492
Air-Conditioner	29%	685
Computer	46%	1015

Source: Nauru Census 2011

These data indicate that there are substantial numbers of high energy usage appliances, notably air-conditioners, refrigerators and freezers, as well as many lower energy usage appliances in Nauru homes. But, there is no information on their actual size, type, age or usage patterns, which is needed to understand the options available for improving their energy efficiency. That detailed information is expected to be obtained through an upcoming home energy survey and should lead to the development of programmes that target the appliances and the usage patterns that have potential for substantial energy efficiency improvements.

Actions that can lead to a successful national energy efficiency programme for the residential sector include:

1. Community workshops led by NUC to discuss why energy efficiency is important to Nauru families, to help determine what can be done and to introduce any household energy surveys and energy efficiency programmes to be carried out.
2. Determination of just how residences use energy. Focused energy efficiency incentives and programmes cannot be established without first undertaking a thorough residential energy use survey. That will need to include a detailed survey that creates an inventory of energy using devices in each household and their pattern of usage. Such a survey is currently under development.
3. If the survey indicates that there are many households using electric cooking, a programme should be established to exchange electric cook stoves for gas stoves combined with arrangements to reduce the supply cost of LPG for cooking. That can reduce the evening peak load significantly without increasing the cost of cooking for the end user.
4. Establishment of a programme to replace old, inefficient refrigerators and freezers with new high efficiency units through subsidies and multi-year finance arrangements.

5. Incentives should be introduced to discourage the importation of electric water heaters into Nauru. Where water heating is desired, arrangements should be made for low rate financing to install vacuum tube type solar water heaters that are relatively inexpensive and have very low maintenance requirements even where there is high mineral content water that causes clogging in conventional flat plate solar water heaters.
6. Determine which homes are in the upper segment of energy usage in order to focus on them for actions to improve energy efficiency. To do that using the NUC pre-payment meter records, it will be necessary to purchase the services or software needed to provide an analysis of pre-payment meter data so NUC can have a reasonably accurate determination of the monthly and annual electricity usage of each Nauru residence. With that information, those residences that are above average in electricity usage can be the primary focus for programmes to improve energy efficiency.
7. Development and delivery of public information programmes that tell households how energy efficiency can be improved and therefore their energy costs reduced.
8. Pass legislation making power theft a crime with substantial penalties. Publicise a date for the start of enforcement that allows customers that have wired around meters to reconnect before criminal penalties begin. NUC to purchase the necessary software to analyse the pre-payment meter data to determine users that have an anomalous energy usage that indicates possible electricity theft.
9. Determine whether or not mandatory energy efficiency labelling of large appliances is appropriate to Nauru and if so establish procedures to obtain the appliances that are properly labelled for energy efficiency and establish legislation making the labels mandatory and requiring customs to reject the importing of appliances that do not comply.
10. Establish guidelines for energy efficient home designs and construction and for the improvement of energy efficiency in existing homes. Make available financial incentives (extended loans, lower interest rate loans, etc.) for financing energy efficiency in new homes and upgrading existing homes for improved energy efficiency (such incentives have been made available in Palau with good results and the programme could be replicated in Nauru on the pre-condition that there is a local bank to provide the financial services). These guidelines can be extended to new and existing buildings in the commercial and government sectors and may form the basis for mandatory standards for new government buildings.

9.1.4 FINANCIAL BENEFITS

Without the details of appliance ownership and their use patterns that will become available from the household energy survey, it is not possible to determine the benefits that are likely to be achieved through energy efficiency programmes directed at residential users. Also without software to analyse the pre-payment meter purchase records, it is not possible to know how energy usage is distributed over the households in Nauru. Without these data, it is not practical to do more than make a gross estimate of the possible benefits of a residential energy efficiency programme. If we make the gross

assumption of a 20% saving – an amount that appears likely to be achievable based on experience elsewhere – that would amount to around 3.5 GWh per year or approximately AUD 1 million in NUC annual fuel savings.

9.2 COMMERCIAL DSM INCLUDING RONPHOS AND NRC OFFICES

Commercial activities include local businesses and RONPHOS and Nauru Rehabilitation Corporation (NRC) offices. The RPC generates its own electricity and is not considered as part of the Road Map energy efficiency effort.

The educational and public information programmes directed toward residences can be expected to carry over to local businesses. However the usage patterns of commercial entities are quite different from those of residences and surveys/energy audits will need to be carried out to determine energy use patterns. Unfortunately, the experience in other Pacific countries has been that energy audits of commercial entities often do not result in significant investment in energy efficiency measures by the audited businesses.

Therefore, audits should be provided only to businesses that specifically state their intent to follow through with actual investments that are determined to have a payback that is less than a pre-agreed upon time period. RONPHOS and NRC offices should also be targeted as these are some of the bigger office spaces and also these are state-owned enterprises. It may be reasonable for a nominal fee to be charged to businesses, RONPHOS and NRC for the audit if reasonable measures for efficiency improvement are found to be cost effective but no investment results from the audit report.

9.3 INDUSTRIAL

Industrial usage is limited to phosphate processing by RONPHOS. There has been no energy audit of RONPHOS industrial activities since it was established as a company in its current form in 2005. All of the electricity for phosphate processing is generated by RONPHOS itself, not by NUC. Therefore the industrial activity of RONPHOS is not considered a high priority of the Road Map energy efficiency effort at this point in time.

However, if RONPHOS is willing to pay part of the cost and agrees to invest in energy efficiency measures if pre-agreed payback times are met, it would be reasonable for the Road Map to support the relatively high cost of an industrial energy audit of the RONPHOS facilities. An audit could examine amongst others, the drying plant and consider more energy efficient ways of drying the phosphate product. An industrial energy audit, if recommendations are implemented, could result in lower costs to RONPHOS which could in turn be passed on to its shareholders, i.e. the Nauru Government and the people of Nauru.

9.4 GOVERNMENT

Government should be the driver of these programmes and as such needs to take the lead in improving its own efficiency of energy use. Improving government energy efficiency will need to be a major component of any action plan designed to reach the 50% renewable energy goal, as well as the 30% improvement in energy efficiency.

Specific actions that government can take to improve its internal energy efficiency include:

1. The establishment of an energy management structure at the departmental level and recurring training to the persons assigned to energy management efforts within government departments
2. The provision of budgetary incentives for government departments to save energy
3. Preparation of guidelines for government employees in the management of energy for computers, air-conditioning, transport and lighting.
4. Ensure that all government offices turn off unnecessary power, including air conditioning, overnight.
5. Replacement of air-conditioners, lights and computing equipment with higher efficiency equipment.
6. Upgrading of existing government owned buildings to reduce the need for air-conditioning.

10 ANALYSIS OF TRANSPORT SECTOR

10.1 TRANSPORT ENERGY USE

An estimated 3.5 million litres or approximately 35% of Nauru's fuel imports are used for transport. The majority of transport energy is for land transport (estimated at 2.5 million litres of fuel), although some fuel is also used for small domestic fishing boats and cooking (31.3% of households use LPG as their main cooking fuel and 1.3% use kerosene[39]) and jet fuel is used for air transport (0.5 – 1 million litres). Air transport to Nauru is provided by the national airline, Our Airline.

10.2 LAND TRANSPORT

In the 2011 census, a total of 573 motor cars, 1066 motor bikes, 98 trucks, vans or mini buses, and 763 bicycles were counted in Nauru. The census found that 29% of households owned at least one car, while motor bikes were much more common than cars, with 46% of households having at least one motor bike available. The census also found that only 5% of households owned a truck, van or mini bus and just over one-quarter of all households in Nauru owned at least one bicycle (GoN, 2011).

10.3 MARINE TRANSPORT

In marine transport, the 2011 census counted a total of 130 aluminum, 24 fiberglass boats and 4 wooden boats. A further 79 traditional canoes and 33 outboard motors were also counted. The census found that only 6% of all households in Nauru owned a boat in working order and even fewer, 4%, owned a traditional canoe. Only 28 households (2% of all households) owned an outboard motor in working order (GoN, 2011).

10.4 ENERGY SOURCES FOR TRANSPORT

Retail fuel rationing affected the transport sector between 2010 and 2012. There have also been interruptions in the supply of jet fuel to the air transport sector (in 2008 and in 2013) due to inadequate fuel testing and storage.

There is no public transport system apart from very limited bus services in the morning and afternoons to take children to school and civil servants to work. The use of bicycles is not widespread and is constrained due to the large number of dogs freely roaming the island which are not afraid to attack cyclists.

There has been almost no investigation or action into energy efficiency and renewable energy options for the transport sector in the past and the Road Map will constitute the first effort to examine this area.

As the majority of fuel use is for land transport and the other major user of fuel is the airline industry where international regulations limit scope for national interventions, the Road Map will focus on land transport.

[39] Nauru Population and Housing census 2011, Government of Nauru

Programmes need to be developed that improve the average efficiency of vehicles on the road plus programmes that increase average vehicle occupancy per trip. At the same, non-motorised transport needs to be promoted as a viable alternative.

Options to improve land transport efficiency include:

1. Restricting the import of vehicles that have a larger engine displacement than is considered appropriate for the Nauru transport requirements.
2. Imposing significant extra import duty for large capacity engines while reducing import duty on more efficient vehicles. Reduce to a minimal level, import duty on motorcycles, bicycles and electric bicycles.
3. Programmes to provide incentives and facilities to improve the quality of maintenance of vehicles.
4. Implementation of a privately operated public transport system on Nauru following a study of public transport systems in Pacific Islands, with similar traffic patterns. These include the approach used on Majuro in the Marshall Islands which is based on private vehicles that can be flagged down at any point on the main roads and deliver passengers to their specifically desired destination for a flat fee and that on Tarawa in Kiribati that depends on a number of private passenger vans that regularly ply specific routes with charges based on zones or on distance travelled. Another option could be two buses going around the island, one going clockwise and one counter-clockwise. If waiting times are too long, the number of buses can be increased (or smaller mini-vans used instead of buses which would be more cost-effective to run in greater numbers).
5. Consideration of incentives to increase the use of bicycles and small motorcycles for personal transport and measures to control the number of dogs on the island.

On the renewable energy and alternative fuel side, as noted in the renewable energy section of the Road Map, there is limited short-term potential for biofuel to be grown on the island, although this is an option that should be studied for the long-term.

LPG cars and hybrid electric-diesel vehicles may also be options to investigate for the future. As renewable energy for power generation is developed in Nauru, it may also be worth examining the feasibility of fully electric vehicles with solar (or wind) charging. However, fully electric vehicles are far from becoming a commercial reality in practice even worldwide. Due to Nauru's size the infrastructure investment would not be as high as elsewhere as Nauruan's would be able to keep their vehicle charged from their own home. However, there would be a need for additional generating capacity. Therefore, a preliminary investigation into the benefits and costs of LPG, hybrid and electric vehicles would be needed before any further concrete steps are taken in this direction.

A target for the transport sector is not foreseen in the Road Map due to lack of baseline data against which to set a target. However, as data becomes available and is analysed, a review of the effectiveness of a transport sector target may be carried out. Therefore one of the major activities which needs to be undertaken is the systematic collection of data regarding energy use in transport.

11 SOCIAL AND ENVIRONMENTAL ASPECTS

11.1 HEALTH

Nauru's small population and distance from larger population presents specific challenges in providing high quality, cost effective health care. The current life expectancy in Nauru is 58 for men and 63 for women. As compared to the life expectancy in New Zealand, at 79 for men and 83 for women, the life expectancy in Nauru is low.[40]

However some advantages of being one island is the accessibility to all population in terms of infrastructure; transport, energy access (Nauru has 100% access to electricity) and water access are readily available. Electricity access means vaccines are easily available (currently there is 100 per cent coverage of vaccines to children[41]) and access to electricity also contributes to good maternal health and reduced child mortality.

Overcrowding in homes is becoming an issue and will continue to threaten health[42]. Multiple families living under one roof has implications on payment for electricity and number of prepayment meters needed per household. Where families living under the same roof do not eat together or share economic means they will also wish to pay for electricity separately.

Nauru has limited health issues relating to indoor air pollution as most households use clean fuels for cooking such as electricity. In 2011, 60% of households cooked using electricity, 31% used LPG, 1.3% used kerosene and 6% used wood or an open fire[43]. While electricity and LPG are considered clean cooking fuels, kerosene and wood are considered hazardous for health, especially when used with inadequate ventilation, as well as posing a fire risk.

In recent years there is some evidence that households have tended to move down the energy ladder; from using electricity to more affordable but less "clean" cooking fuels such as kerosene and open fire (biomass). As noted by participants during community consultations, cooking fuel preferences are based on affordability and while electricity remains the preferred choice, it is now too expensive to use.[44] There is limited awareness on the safe use of LPG gas and this, as well as affordability, continues to be a barrier to the use of LPG for some households.[45] Removing the barriers to increased LPG use for cooking could be investigated with inputs from relevant stakeholders, such as Ministry of Home Affairs, Community Based Organisation (CBO), Church Groups, Youth groups and Women's Groups.

[40] Government of Nauru 2013, " Nauru National Assessment Report for the Third International Conference on Small Island Developing States (SIDS)
[41] Ibid
[42] Ibid
[43] Nauru 2011 Census
[44] National consultations report, November 2012
[45] Ibid

11.2 EDUCATION

Primary school enrolment is almost universal; however, less than a quarter of adults (aged 15 and over) have completed their secondary leaver's certificate and only 5% have a tertiary qualification. [46] This presents a challenge for finding staff with the appropriate qualifications and skill base for energy sector organizations (NUC, CIE, RONPHOS, etc).

Education is a major limiting factor in developing the human capacity necessary for sustainable development. Very few students are pursuing an education in the technical fields where Nauru is experiencing a capacity gap, particularly, science, technology, ICT and healthcare. The lack of education for sustainable development increased the dependence of Nauru on expatriate workers and consultants.[47] This is reflected in the energy sector where there is limited capacity relating to energy sector planning and management, engineering, renewable energy, energy efficiency and other areas. Identifying training needs and developing short-term and long-term training programmes for the energy sector is vital in order to build up a skills base to serve the future implementation of the Road Map.

In general, education and awareness relating to energy consumption and efficient electric appliances is still very low. The need to switch to more efficient appliances such as energy efficient lights, refrigerators and air conditioners is a policy issue that will need to be addressed through education, awareness raising and demonstrations in the districts. While some past projects have showcased energy efficient measures, these projects may have had limited impacts due to lack of awareness. Some of the training and awareness raising needs highlighted during the focus group discussions held with women in November 2012 were[48]:

- Training should involve the local people and more funding and resources should be put towards training.
- Employ more local people and provide then with appropriate and adequate training.
- More awareness campaigns on both energy efficiency and renewable Energy through media, local news and the GIO (Government Information Officer), and through community consultations.
- Introducing topics on energy efficiency and renewable energy through the school curriculum
- Community leaders should be involved through the community awareness programmes (train the trainers programmes). Women should be engaged in these trainings as they have a higher tendency to apply the TIP model which is to *Teach, Instill and Practice.* Trainers are to be selected from the communities and training

[46] Nauru national assessment report for the third international conference on small island developing states (SIDS), 2013
[47] Ibid
[48] Second national consultations report, November 2012

content should include specific issues such as changing the behaviour of energy usages.

- Those who are to install, maintain, repair solar energy systems should be identified and their training carried out before solar projects are commenced
- Sustainability and management of solar home systems, if these are used further, in terms of operation and maintenance should be clearly explained to the end-users
- Provide booklet on appliances and their energy consumption
- Promote alternatives ways of cooking and conservation of water as these are the most high consumption energy uses in the households.

11.3 GENDER AND YOUTH

Goal 3 of the MDG is to "Promote gender equality and empower women". Nauru has achieved Target 4 of this goal: *"Eliminate gender disparity in primary and secondary education, preferably by 2005 and to all levels of education no later than 2015"* (NSDS, 2009). There is no gender disparity in primary and secondary education as in 2009 the ratio of boys: girls are 51:49 in primary and 52:48 in secondary.

In terms of women in parliament, one woman was elected as a MP and selected as Cabinet Minister in the August 2013 election. This was the first time a woman had been elected to Parliament in 17 years, so despite the fact that Nauru is a matrilineal society where women own land and hold high positions in the public service with almost equal gender representation in the public service, women in leadership positions is still a challenge.

Nauru signed the Convention on the Elimination of Discrimination Against Women (CEDAW) in 2011 but implementation has been slow given the economic situation that Nauru has faced and the considerable requirements for international reporting. The work of the Department of Women Affairs is directed by a 5 year Plan of Action for Women which is closely linked to the NSDS. The government is in the process of developing a gender policy. Although not directly involved in the energy sector, the Department of Women Affairs can play a role in relaying information, raising awareness and organising consultations with women's groups with regard to energy projects and programmes.

Nauru has a National Youth Council which has undertaken literacy programmes. The National Youth Council could be approached to be involved in energy awareness raising activities towards youth.

With the estimated 2.9% population growth rate (NBoS, 2013), the demand on resources such as energy and water will increase in the coming years. A household energy use survey is foreseen to take place under the Road Map. The survey approach should consider a gender and youth sensitive approach to household energy data collection. This will be important in order to gather accurate data, establish current energy use, forecast energy demand and design appropriate energy services, including specific actions where needed to address different gender and youth needs.

During community consultations[49] it was noted that past energy projects, such as the installation of 60 solar PV home systems, did not properly disseminate information on the operation and maintenance of equipment installed to the end-users.

Gender mainstreaming in energy projects and planning is important for sustainability. Identifying and understanding gender differences in energy use can assist in designing more effective programmes, such as those intended to provide incentives to reduce electricity use in the household, including for cooking.

Gender disaggregation should be considered in designing data collection programmes and when energy projects or programmes are designed, implemented and evaluated, views of women and youth should be sought and taken into account.

[49] November 2012

11.4 ENVIRONMENT AND CLIMATE CHANGE

11.4.1 ENVIRONMENTAL ASPECTS AND IMPACTS OF ENERGY OPTIONS

A range of energy activities are proposed within this Road Map, each with consequences which need to be considered in light of Nauru's environment and ecosystems. The recommended energy activities are reviewed against the key environmental issues identified in section 4.3. This review is summarised in Table 9 below. Given the environmental situation in Nauru, as outlined in section 4.3, it is important that energy choices do not create an unnecessary waste burden, and that hazardous materials are appropriately taken care of thus eliminating as far as possible the risk of damage to Nauru's limited land and valuable ocean resources.

Table 9 - Summary of potential environmental impacts of energy developments

	Soil quality & rehabilitation	Land use and tenure	Contribution to climate change	Resource use	Waste management
Generation					
Solar roof mounted	No impact	Minor	Positive	No impact	Potential hazardous waste
Solar farm	Linked to land use	Major	Positive	Minimal impact	Management required
Wind farm	Linked to land use	Major	Positive	Minimal impact	Management required
Petroleum	Moderate risk	As existing	Negative	Moderate risk	Management required
Transmission & distribution					
Network upgrades	No impact	Moderate	Potentially positive	Activity-specific	Potential hazardous waste
Battery storage (central)	No impact	Moderate	Potentially positive	No impact	Hazardous waste
Battery backup (decentralised)	No impact	Moderate	Potentially positive	No impact	Hazardous waste
Energy efficiency					
Supply side activities	Opportunity	Activity-specific	Positive	No impact	Potential hazardous waste
DSM: government/industrial	No impact	Activity-specific	Positive	No impact	Management required
DSM: household/SMEs	No impact	Moderate	Positive	No impact	Management required

Electricity generation options have the most varied environmental impacts. Using petroleum-based fuels for combustion produces the most negative impacts, through air pollution and contribution to climate change. Handling and storage of liquid fuels also involves risks of leaks and spills, which can affect land, groundwater, freshwater, and the

ocean, as liquid petroleum fuels are classified as harmful and toxic to aquatic organisms with potential for long-term adverse effects[50].

Renewable energy generation has potential for both positive and negative environmental impacts. Centralised renewable energy can require large areas of land, including for access. This may further impact on the limited land available for farming and on rehabilitation of land. However, land leases for wind or solar farms may enable income to be earned on land that is unsuitable for farming or other productive uses.

While elsewhere in the world, wind farms can pose risks to bats and birds, in Nauru there is only one native bird and therefore this risk seems to be low[51]. Where roof space is used for installation of solar PV, particular attention may be needed to asbestos management[52]. However, using roofs is beneficial in terms of reducing the total land area required for solar PV. In all cases, appropriate planning is required to ensure adequate waste management for materials and components during construction and long-term operation of the generation plants.

Power generation may potentially also be sourced from the oceans. Wave, tide and OTEC electricity generation are all heading towards commercialisation but are many years from maturity. Should Nauru wish to develop energy systems in this area, a precautionary approach should apply as there are very few independent assessments of the environmental impacts of these technologies. While considering costs and benefits of these energy technologies, an appropriate value should be placed on Nauru's large, resource-rich oceans.

Upgrades to the transmission and distribution network are envisaged under the energy Road Map. The exact changes will depend on whether generation is centralised or decentralised, the location of new generation, demand arising from new development, and upgrades made to improve efficiency. Impacts are primarily linked to land use, such as clearing and edge effects, and substation materials such as chemicals used as insulation in switchgear.

Where batteries are used for storage, their environmental impacts should be assessed against the benefits of avoided fossil fuel use. Typical batteries are lead-acid and need management from procurement through to disposal, to avoid impacts and risks such as spills and leaks. Disposal must be secure, otherwise lead may leach into soils, groundwater, and from there into freshwater or marine environments. As a toxic heavy metal, once lead reaches the environment it remains, and can bioaccumulate in species higher on the food chain, such as tuna. Lead toxicity mainly affects the nervous system,

[50] E.g. Shell, http://www.shell.com.au/products-services/on-the-road/fuels/msds-tds/commercial-fuels-msdspds.html#textwithimage_6, Material Safety Data Sheet (MSDS) for petrol and diesel.

[51] Analysed from data extracted from IUCN Red list on 3/10/2013: http://www.iucnredlist.org/

[52] Asbestos was historically common in Nauru, as asbestos cement such as sheeting and pipework. The *National Integrated Water Resource Management Diagnostic Report, Nauru*, 2007 (SOPAC Miscellaneous Report 640) identifies asbestos cement use in pipework (p22), while *Nauru Technical Report Rainwater Harvesting: Asset condition survey of domestic infrastructure*, 2007 (EU-SOPAC Project Report 80), identified that 23% of surveyed roofs comprised asbestos cement sheeting (p27) with some clustering in the Yaren district.

and can also affect blood pressure and cause anaemia[53]. Depending on the size of the energy storage required, additional land may be needed to house battery banks.

Activities to improve demand side energy efficiency comprise mostly of changes to behaviour and equipment. As such improving energy efficiency is seen as the most environmentally friendly activity as it largely does not require new infrastructure. However, where equipment replacement is envisioned in order to move towards more efficient technologies / models, obsolete equipment and other associated waste must be properly managed and disposed of in an environmentally friendly manner.

Looking forward, legislation proposed for environmental management is expected to include a requirement for environmental impact assessment[54]. This would provide the opportunity for major energy projects to be reviewed and appropriate management actions planned. Use of best practices and policy-level screening may also be undertaken to develop a strategic approach to specific activities.

11.4.2 FUTURE CLIMATE SCENARIOS

As a tropical raised atoll, Nauru has constant temperatures year-round, closely related to sea surface temperatures. Typically there is a wet season from November to April, and May to October is drier, however, Nauru experiences drought from time to time, which can last for up to three years[55].

The El-Niño Southern Oscillation (ENSO) is the main influence on climate variability, creating very high year-on-year variation. Rainfall as high as 4,500mm can be received in El Niño years, while drier conditions and delayed onset of rainfall in La Nina years can result in droughts with rainfall as low as 500mm.

Recent analysis of climate scenarios for the Pacific gave the following projections[56] for Nauru:

- Temperature: very high confidence of increased temperature, intensity and frequency of extremely hot days;
- Rainfall: high confidence of increased annual and seasonal mean rainfall, and increased intensity and frequency of days of extreme rainfall, within a continuing context of ENSO variation;
- Marine: very high confidence that mean sea-level rise and ocean acidification will continue;
- Drought: moderate confidence of decrease in the incidence of drought, however mild droughts would still occur[57].

[53] National Pollutant Inventory factsheet *Lead and compounds*, http://www.npi.gov.au/resource/lead-compounds
[54] *Nauru NSDS,* 2009 revision, p7
[55] p130, *Climate Change in the Pacific: Scientific Assessment and New Research | Volume 2: Country Reports; Chapter 8 Nauru.* Australian Bureau of Meteorology and CSIRO, 2011.
[56] *Ibid*. p130
[57] *Ibid,* p137

These projections could in turn have the following future impacts on demand within the energy sector:

- Increased demand for cooling technologies such as refrigeration and air-conditioning, of which the timing (peak demand) could affect power generation and energy storage infrastructure needs
- Reduced need for electricity for water desalination and treatment due to reduced periods of extreme drought and increased mean rainfall (assuming rainwater collection and storage is well managed)

In the context of energy supply and transition to renewable energy sources, the timing of demand and the ability of available generation plants to respond to this demand is important. The likely changes to rainfall patterns may result in reduced sunshine hours, while hotter days would reduce the efficiency of panels. Both these impacts could potentially reduce solar production. This would in turn affect ability to meet the peak load, increase storage needs and may change overall infrastructure requirements.

Hotter days may also reduce efficiency in electricity power lines, thus increasing losses before electricity is delivered to customers. Again this may have implications for the total amount of generating capacity required.

Sea level rise is of moderate concern in Nauru. While not an absolute threat, it would affect infrastructure on the coastal fringe, including network assets. The associated salinity and increasing acidity could potentially impact on buried infrastructure and concrete within the affected area.

In general, while climate change is expected to affect Nauru, most effects are expected to show an incremental increase and can best be managed through early planning and due consideration in decision-making, as this can mitigate much of the cost associated with climate change preparedness.

However, existing constraints on capacity and reliability will be placed under further pressure by the combination of intermittent generation from renewables, and increased peak demand associated with refrigeration and cooling during hot periods. As such, additional generation or storage capacity may be required to ensure peak demand is suited for future climate scenarios.

11.5 COMMUNITY INVOLVEMENT - AN ENERGY PLAN FOR EVERYONE

Nauru is a small island where interrelations between all levels of society are very strong. This applies from national level down to community level government and non-governmental organisations. Nauru has 14 district council and a Community Based Organisation (CBO) which covers the 14 districts (Aiwo, Buada, Boe, Yaren, Meneng, Anibare, Ijun, Anabar, Anetan, Ewa, Baitsi, Uaboe, Nibok and Denig) plus Location. There are also a number of NGOs, womens groups, youth groups, church groups and other civil society groups. The Road Map will need to engage CBO and the district councils and civil society groups to facilitate participation at all levels from a national, to a district and community and just as importantly down to each individual.

There are some important activities under the Road Map that will need strong support from communities and whose implementation will largely be at the community level. These include, among others:

- Undertaking a household energy survey
- Raising awareness of energy use and energy efficiency and conservation measures
- Making consumers aware of energy consumption of different appliances and vehicles
- Training end-users in energy efficiency and renewable energy
- Raising awareness of vehicle maintenance practices
- Raising awareness of efficient driving (e.g. car pooling)
- Information dissemination regarding use of prepayment meters
- Promoting acceptance of change and behavioural change when it comes to how energy is used

It will therefore be important to involve communities early in further consultations and discussions on the activities under the Road Map and define their role and mechanisms for engagement with the implementation of activities. An initial step will be to undertake information and consultation meetings which each of the fourteen communities on how to get them involved in implementing the Road Map and within which activities they would see as having a key role to play.

The communities of Nauru are the main beneficiaries of the Road Map activities, however, this should not imply that they should be regarded as passive actors in the process. There are many activities within which the community organisations, civil society groups and districts councils will have a key active role to play. In these cases, appropriate information, training, communication mechanisms and human and financial resources should be provided in order to enable them to engage fully and provide their experience and expertise to contribute into the implementation of the Road Map.

For example, in consultations undertaken for the Road Map, CBO indicated that they would be willing to participate in Road Map implementation and saw their role in information dissemination, community outreach and monitoring and evaluation. As mentioned in previous sections, consultations have shown that more training is needed at the local level in energy usage, energy appliance usage and energy efficiency and conservation and groups are willing to participate in this training and have requested for it to take place.

Finally, the involvement of Community leaders in implementation of Road Map activities must not be overlooked. Consultations at the local level indicated that Community leaders should be involved with awareness raising programmes and information dissemination, as well as train the trainer approaches. Women should also be targeted to be specifically engaged in these activities, as they have a higher tendency to pass of information to others in their household.

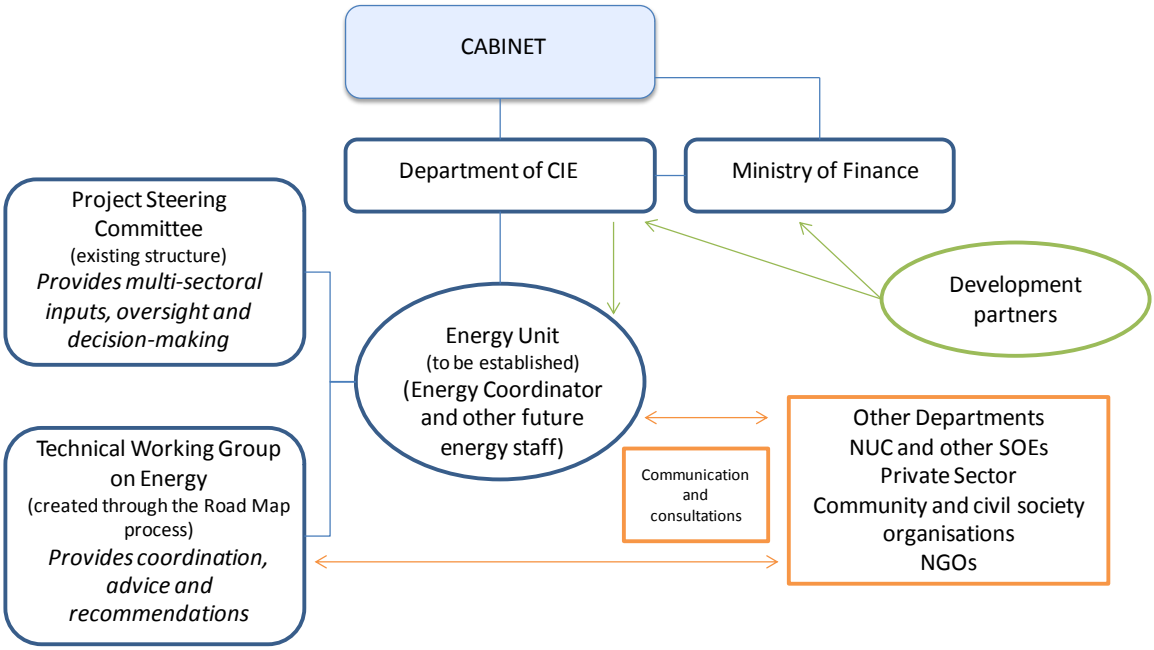
12 ROAD MAP IMPLEMENTATION FRAMEWORK

12.1 ROLES AND RESPONSIBILITIES

The implementation of the NERM requires collaboration and commitment across the public and private sectors complemented by strong support of the local community and development partners. It requires that resources be used efficiently and effectively therefore it is important that the Government and development partners recognise and act in accordance with the Road Map implementation framework, strategies and activities. One of the purposes of the Road Map is to provide an implementation plan for all partners to work towards and thus avoid partial or incomplete solutions and different kinds of energy sector equipment and regulations being implemented which may not be compatible.

The implementation framework aims to be closely aligned with the NSDS monitoring and reporting process to reduce duplication and confusion amongst stakeholders. A proposed implementation structure is illustrated in Table 10 below. This sits alongside and links directly to the existing NSDS and national budgetary framework and uses existing structures where possible but at the same time introduces two new institutional bodies, the Energy Unit under CIE and the Technical Working Group on Energy, which will focus on the energy sector and facilitate the implementation of the NERM.

Table 10 - Road Map Implementation Framework



12.1.1 CREATION OF AN ENERGY UNIT

Under the Implementation Framework the Department of CIE in consultation with other Government Ministries and Departments will establish within its existing corporate

structure an 'Energy Unit". The Energy Unit will be responsible for the following areas in the energy sector:

- Planning and policy advice and development
- Coordination of energy sector activities and actors within the framework of the NERM
- Where appropriate, implementation of energy sector projects within the framework of the NERM
- Collection, storage and analysis of energy data and information
- Monitoring and reporting on the NERM implementation and relevant sector activities
- Updating of the NERM action plans annually in consultation with the TWGEn and energy stakeholders
- Communication with stakeholders within and outside government and information dissemination
- Perform the role of Secretariat to the Technical Working Group on Energy and provide on-going support
- Reporting to the Project Steering Committee as necessary
- Performance of additional functions designed by Cabinet from time to time in response to on-going reforms in the sector

The Energy Unit will report directly to the Secretary of the Department of CIE. The Energy Unit would currently consist of one staff, the Energy Coordinator, reporting directly to the Secretary CIE, and would need to be strengthened with additional human and financial resources in the near future.

12.1.2 STEERING STRUCTURE

It proposed to use CIE's existing Project Steering Committee (PSC) as the Steering Committee of the NERM, providing oversight and decision-making where needed. As the PSC is a multi-stakeholder committee and also includes NUC this will provide the cross-sectoral inter-governmental agency oversight and direction that is needed for the implementation of the NERM.

The PSC should also consult from time to time with nominated representatives of the private sector through the Nauru Business Private Sector Organisation, nominated community representative through NIANGO and/or CBO, plus a independent member to be co-opted from time to time when required.

The PSC is expected to consider proposals and implementation matters related to the NERM. The PSC will support the Secretary for CIE, with inputs from the Energy Unit, in leading, managing and reporting to the Cabinet on NERM implementation and energy sector performance. The PSC meetings must be recorded in Minutes to ensure the direction given and decisions made on energy matters are documented. The PSC and Secretary may refer for direction and decisions to the Cabinet where necessary and appropriate.

12.1.3 TECHNICAL ADVISORY AND COORDINATION MECHANISM

A Technical Working Group on Energy (TWGEn), consisting of the Department of CIE, Nauru Utilities Corporation, the Planning and Aid Division of the Ministry of Finance and the Ministry of Foreign Affairs was established with Secretariat provided by CIE during the development of the Road Map to provide advice and technical inputs. It is recommended that the TWGEn is continued as a permanent technical advisory and coordination mechanism for the NERM.

The role of the TWGEn during the implementation of the Road Map will be to provide timely and regular technical advice and recommendations to the Energy Unit and the PSC, including advice on the annual updating of the NERM action plans. The TWGEn will also service as a coordination mechanism for the implementation of NERM activities.

Membership of the TWGEn is proposed to constitute technical officials who are engaged in daily operations affecting the energy sector. Proposed organisations represented on the Working Group include CIE, Department of Finance and Sustainable Development, Nauru Utilities Corporation and the Department of Transport. The Energy Coordinator and other staff of the Energy Unit would provide the Secretariat support services.

12.1.4 PRIVATE SECTOR, CIVIL SOCIETY AND DEVELOPMENT PARTNERS

Private sector, community and Non-Government Organisations including development partners will contribute to the NERM implementation through engagement with the Energy Unit. This engagement should be done through the Department of CIE and the Ministry of Finance Planning and Aid Division. Where matters need attention of the PSC and/or Cabinet, the Energy Unit will work with the TWGEn and the Secretary CIE to see that these matters are tabled and decided-upon.

12.1.5 CONSULTATIVE AND COMMUNICATION MECHANISMS

Following the endorsement of the NERM, convening a national workshop will be important to occur immediately not only to raise awareness about the NERM but more importantly to communicate and discuss further with relevant stakeholders of how they fit in with the implementation framework, strategies and activities. This initial workshop is essential for establishing a communication and coordination network from the outset. The Energy Unit and Energy Coordinator would take the lead in preparing this workshop, with support from the TWGEn, the Secretary CIE and the PSC.

Initial consultations to be held separately with the government's development partners is equally important. These initial consultations may be held on Nauru or elsewhere as appropriate. A donor consultation will inform donors about the NERM and seek their support and commitment to achieving the NERM vision and outcomes, through the identified strategies and activities. Following initial consultations, the Energy Unit with support from the TWGEn should establish a mechanisms for regular communication and consultation with the energy sector development partners to serve for the duration of the Road Map.

Annually through a national workshop, local and external stakeholders will be brought together to discuss the NERM implementation progress and issues. This consultative workshop must be a working event where participants are provided opportunity to suggest remedial actions that strengthens the NERM process and implementation of the strategies and activities. The action plans of the NERM are "living documents" which should be updated annually through this process.

12.2 CREATING AN ENABLING ENVIRONMENT

The effective implementation of the NERM will be reliant on a clear and transparent policy, planning and implementation environment. There will be several aspects to creating this enabling environment, including creation of new legislation and regulations, implementation of communication and consultation mechanisms and information dissemination, among others. The enabling environment will have to cover all the different actors involved in the implementation of the Road Map, from those involved in direct implementation, to funders and decision-makers, to recipients and end-users. This section summarises some of the enabling mechanisms that will need to be put in place to facilitate the participation of the broad range of stakeholders must be engaged to achieve an effective implementation of the NERM.

National energy legislation will be important in facilitating NERM implementation and in enabling good governance requirements to be met. Thus development and adoption of national energy legislation is essential for the success of the NERM implementation and overall development of the energy sector. Energy legislation should define the role of the government, in terms of planning, developing, and coordinating energy initiatives, energy sector regulation and creating a market where private sector and community stakeholders can engage effectively, for example, by the introduction of net-metering.

Constraints on new private sector investments must be addressed with urgency through enabling policies that serve to attract local and foreign investors. Rules of engagement in the market to set performance standards and outcomes must also be clearly articulated through legal instruments and appropriate resources and capacity must be committed.

Transparent and clear processes and systems for financial management and reporting must be in place for NERM implementation. Although there are existing frameworks in place for national policy development and implementation that are structured upon the NSDS, a review of these systems may be necessary to ensure that the NERM vision is achieved.

The NERM implementation is expected to bring new technologies through new projects to the island therefore appropriate strategy and policy must be established to respond to ongoing change particularly the increasing integration of renewable energy. Arrangements that encourage private and community participation through net metering, power purchase agreements etc must be developed during the immediate to short term.

A significant opportunity for additional funding and local investment will result from the NERM implementation thus existing governance and accountability measures must be reviewed and strengthened where necessary to facilitate efficient securing and utilisation of new funds and reporting on activities' progress. Development partners may play a key role in providing financial resources and technical assistance to the government. Effective communication, consultation, engagement and reporting mechanisms must be in place to facilitate engagement of development partners.

12.3 FINANCING THE ROAD MAP

In recent years, development partners have made a significant contribution to funding for energy sector projects covering a wide range of areas from petroleum to power sector reform and including renewable energy and energy efficiency (SPC, GoN, 2013). Estimated confirmed funding for the period 2004 to 2013, indicates that the contribution of development partners to energy sector projects has increased over the last decade (see also Figure 5 below).

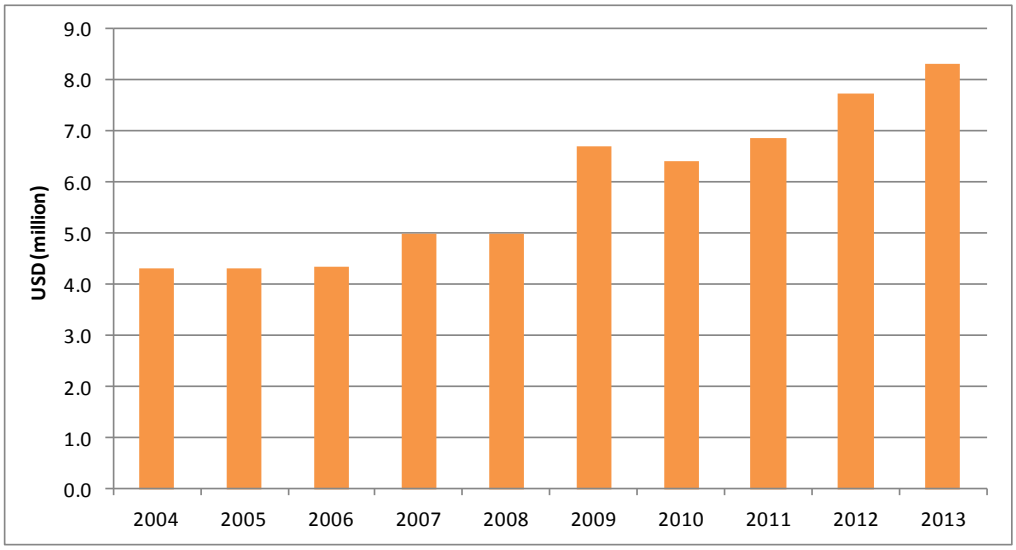


Figure 5 - Estimated funds disbursed 2004 - 2013

Figure 6 presents a breakdown of the contribution between different development partners.

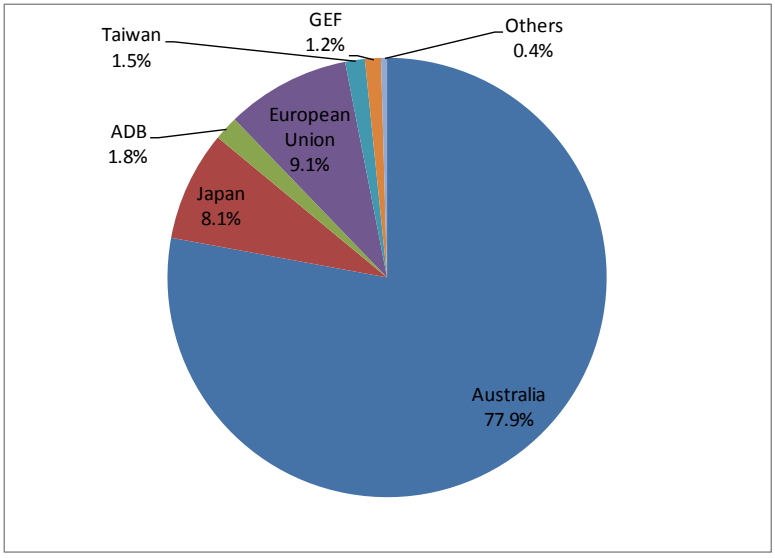


Figure 6 - Estimated contributions from development partners to energy sector 2004-2017

It can therefore likely that some funding for the energy sector will continue to be available from development partners and can be utilised to maximum benefit for Nauru's energy sector by being used to implement the actions of the Road Map. It should be noted that while funding from development partners may become available, CIE, NUC and the other stakeholders of the Road Map must collaborate in securing the funds and completing planning, design and proposal writing to access these funds.

However, there should not a reliance only on development partner funding. The Road Map will seek to identify a variety of potential mechanisms to attract financing from government and private sector that can match with Road Map activities which have sustained and long-term funding requirements. In recent years a focus on innovative financing has helped to develop and promote funding beyond the traditional government and donor models. These financing models aim to overcome barriers that have hindered the energy sector, such as:

- Costs are incurred up-front while benefits such as savings occur later
- Cost of renewable or efficient choices may be paid by one entity, but the benefits and savings go to another, e.g. consumers may be led to purchase energy-intensive whitegoods, but this may be due to the choice of retailers who stock items that bring more profit
- Discounts on fossil fuels make it hard for renewable energy and efficiency improvements to compete, unless they are provided equivalent funding
- Subsidy on fossil-fuel based electricity and embedded value of NUC assets, resulting in new technologies and efficiency improvements competing at a disadvantage
- Constraints on banking infrastructure

Mechanisms that enable the transfer of funds in such a way as to overcome these barriers can create new enabling models. Some successful models from the region are:

- Direct funding (traditional model): funds provided by donors and/or through government budgetary mechanisms, it is expected this will continue as government and government institutions presently have the most capacity to secure these funds. Sometimes funds are provided via NGOs and communities.
- Feed-in-tariffs: e.g. Cook Islands, Australia; small power generators (e.g. households) are paid a higher-than-retail price to recognise the subsidy components which are in addition to NUC's retail price, and the avoided cost of network losses and infrastructure.
- Concessions (also known as Build-Own-Operate(-Transfer)) e.g. UNELCO in Vanuatu, where the government enters a contract with a private company to provide and sell energy services at an agreed price
- Subsidised activities:
    - For example, Palau Energy Efficiency Subsidy Programme, where participating home builders receive a discount on their home loan, when including energy efficient features; the bank increases their portfolio value, residents have more comfortable housing and use less air-conditioning and lighting, and the utility is relieved of demand during peak periods.
    - For example, the Cook Islands Fridge/Freezer Replacement Programme, where customers receive a rebate for switching inefficient fridges/freezers with newer ones, cutting their upfront cost and helping them to benefit from lower electricity bills, while spreading the donor funds
- On-bill financing: where one company (utility or private company) undertakes energy efficiency, and the repayments are made via the electricity bills
- Technical assistance, information sharing and capacity building may be required to address non-financial barriers to financing, particularly in light of the particular constraints of Nauru's financial system.

An example to potentially apply this in Nauru would be to identify the subsidy value for the current fossil fuel-powered electricity system, and make a similar subsidy available to other activities that achieved the same outcome. This could be a feed-in tariff to make solar PV economically viable, at a lower price than the current subsidy and would be win-win for the government and consumer.

The preferred financial models will need to consider the perceptions of the target market as well as practical aspects of implementation. Beyond relying on traditional banking, creativity and cooperation can be applied to enable non-traditional stakeholders to provide some financial functions.

As with all financial markets, there is a strong human element. In a small island state, with few economies of scale, thin markets and high risk for entrepreneurship, such models can best be supported through clear communication and strong political backing.

13 ACTION PLANS

The Road Map action plans set out the key activities for the period 2014 to 2020 that are required by different stakeholders to reach the targets of the Road Map. The action plans are applicable to all stakeholders in the energy sector, although most actions are led by NUC and CIE. The action plans are "living documents" and should be reviewed and updated on a yearly basis. This means that not every detailed activity between now and 2020 needs to be included from the outset, as the action plans will change and evolve as they are reviewed, in light of new information and as further activities are added in future.

There are six action plans, one for each of the six themes of the Road Map:

- Power (including supply side energy efficiency)
- Petroleum
- Renewable Energy
- Demand Side Energy Efficiency
- Transport
- Institutional Strengthening and Capacity Building

These lay out the strategies and activities needed to progress towards the vision, outcomes and targets of the Road Map, the NEPF and the NSDS.

Each action plans include:

- Policy statement (where available from the NEPF)
- Strategies
- Activities under each strategy
- Organisation responsible for each activities and supporting organisations
- Activity importance: the importance of each activity to progress towards the desired outcomes classified as very high, high and medium. Low importance activities are not included in the Road Map.
- Timeframe: the estimated timeframe for completion of the activity
- Expected Results: expressed as outputs and/or outcomes
- An estimated budget based on available information. This is expected to change as the action plans are revised on a yearly basis.
- Many of the indicative timeframes are dependent on each other and therefore they will need to be updated regularly based on progress.

The aim of the action plans is to provide a basis for all partners in Nauru to work together and avoid partial or incomplete solutions and different kinds of energy sector equipment and regulations being implemented which may not be compatible.

Cross-cutting themes such as health, education, gender and youth, environment and climate change, and community participation are not addressed explicitly in the action plans. However, for each activity undertaken consideration should be given to the impacts and opportunities presented with regard to these cross-cutting areas, including but not limited to the information as presented in previous chapters of this Road Map.

13.1 POWER SECTOR ACTION PLAN

Policy statement: *A reliable, affordable and safe power supply and services*

Strategy 1: Upgrade assets					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.1: Purchase and install new Transmission and Distribution (T&D) equipment	NUC	Very high	1 to 2 years	T&D equipment purchased and installed	2,000,000
Activity 1.2: Carry out structural repairs to the NUC powerhouse, including removal of the asbestos roofing and replacement	NUC	Very high	1 to 2 years	Roof and building refurbished.	1,500,000
Activity 1.3: Purchase and install power quality equipment at the power station including AVR replacement and governor and upgrade of controls	NUC	Very high	1 year	Power quality equipment purchased and installed	200,000
Activity 1.4: Purchase and install of a new generator	NUC	Very high	1 year	Generator installed	2,500,000
Activity 1.5: Carry out major overhaul of the newest existing generator	NUC	High	1 year	Generator overhauled; working at full capacity.	500,000
Activity 1.6: Purchase and install capacitor banks or batteries and advanced inverters to allow integration of high shares of variable renewables	NUC	Medium	3-5 years	Equipment purchased and installed.	500,000
Activity 1.7: Carry out safe and environmentally sound disposal of retired generators and other old equipment that is replaced	NUC	High	2-4 years	Safe and environmentally sound disposal of equipment.	200,000
				Sub-total Strategy 1	**7,400,000**

Strategy 2: ***Improve planning and management***					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 2.1: Review the corporate governance of NUC	NUC (MoF)	Very high	1 year	Recommendations for corporate governance.	50,000
Activity 2.2: Carry out capacity planning exercise for 2014 to 2020 including projected demand and generation	NUC	Very high	6 months	Power development plan developed.	50,000
Activity 2.3: Establish process for long-term financial planning and develop first long-term financial plan	NUC	Very high	1 year	Process established. Plans developed.	20,000
Activity 2.4: Develop annual procurement plan and maintenance plan	NUC	Very high	Every year	Annual procurement and maintenance plan	5,000
Activity 2.5: Undertake comprehensive technical assessment of generation, transmission and distribution , including thermo-graphic analysis	NUC	High	6 months	Report on generation & T&D assets	200,000
Activity 2.6: Undertake comprehensive mapping, data compilation, inventory, storage planning and maintenance planning for all assets	NUC	High	1 to 2 years	GIS database. Asset Inventory. Asset management plan.	200,000
Activity 2.7: Develop manuals for operation, safety, maintenance and service for all key equipment	NUC	High	1 to 2 years	Manuals prepared.	20,000
Activity 2.8: Develop asset security, disposal and revaluation policy	NUC	Medium	3 to 4 years	Policy developed.	10,000
Activity 2.9: Collect baseline information and establish collection, storage, management and back-up processes for all financial and sales data	NUC	High	1 to 2 years	Baseline information established Processes established.	100,000

Strategy 2: ***Improve planning and management***					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 2.10: Develop procedures for handling and monitoring customer complaints and train staff.	NUC	Medium	1 to 2 years	Procedure developed. Staff trained.	10,000
				Sub-total Strategy 2	**665,000**

Strategy 3: Improve supply-side energy efficiency					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 3.1: Establish a clear process for reconciling the fuel supplied by the tank farm and the fuel used by generating units.	NUC	Very high	6 months	Clear process established. New meters installed where needed.	50,000
Activity 3.2: Analyse fuel use data, identify opportunities to reduces losses and implement	NUC	High	1 to 2 years	Fuel losses reduced.	200,000
Activity 3.3: Develop new project proposals for improvement of transmission and distribution line losses as more information from metering becomes available	NUC	Medium	2 to 3 years	Proposals submitted to appropriate funding agencies. Securing of new funding.	10,000
Activity 3.4: Implement further T&D loss reduction projects	NUC	Medium	3 to 5 years	T&D losses reduced.	500,000

Strategy 3: Improve supply-side energy efficiency					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 3.5: Review opportunities for savings of electricity from water pumping and RO units and by reducing leakages in the reticulation, delivery and storage systems /tanks.	NUC	High	2 to 3 years	Opportunities for electricity savings identified.	20,000
Activity 4.6: Carry out feasibility study for most promising water sector opportunity and if favourable, implement		High	3 to 4 years	Feasibility study completed. Project implemented.	70,000[58]
				Sub-total Strategy 3	**850,000**

Strategy 4: Move toward full recovery of operating and maintenance costs					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 4.1: Carry out a cost-of-service study for NUC across all three service areas of fuel, water and electricity, including water and electricity tariffs study (price, structure, etc.)	NUC (CIE, PAD)	Very high	6 months	Cost-of-service defined for fuel, water and electricity. Electricity and water tariffs proposed.	200,000
Activity 4.2: Carry out willingness-to-pay and affordability studies (carried out in conjunction with the cost-of-service and tariff studies above)	NUC (with Government)	Very high	6 months	Better understanding of consumers' ability and willingness to pay.	100,000

[58] Feasibility study only

Strategy 4: Move toward full recovery of operating and maintenance costs					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 4.3: Establish separate business unit financial information for water, electricity and fuel services	NUC	Very high	1 year	Separate business unit financial information available.	20,000
Activity 4.4: Improve accounting systems through integration of the asset registry and the financial management information system	NUC	High	1 to 2 years	Improved accounting systems.	50,000
Activity 4.5: Continue and strengthen prepayment and metering system, including a) Move all residences and businesses to prepaid; b) meter all industrial and government buildings; c) Check systematically correct functioning of meters; and d) develop measures to prevent meter tampering	NUC (CIE and other stakeholders)	Very high	1 year	All residences and businesses have pre-paid meters. Meter tampering reduced.	200,000
Activity 4.6: Develop and implement process to move fuel purchasing responsibility from government to NUC	MoF (NUC)	High	2 years	Fuel purchase cost appears in NUC annual budget	10,000
				Sub-total Strategy 4	**580,000**

Strategy 5: Develop and safeguard NUC staff					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 5.1: Identify training needs across all units and at all levels, develop a training plan and implement training programmes	NUC	Very high	6 months, ongoing training	Appropriately qualified staff. Improved staff retention.	40,000[59]
Activity 5.2: Develop and implement talent identification, apprenticeship and scholarship scheme for power sector	NUC (MoE, MoF, CIE)	High	1 to 2 years, ongoing	Appropriately qualified staff. Improved staff retention.	20,000[60]
Activity 5.3: Design and implement a Performance Management System for lower level NUC staff	NUC	High	1 to 2 years	Performance Management system implemented.	30,000
Activity 5.4: Develop and implement improved administrative procedures including payroll, job descriptions, workload planning and employee leave and related entitlements	NUC (with Public Service system)	Medium	2 to 4 years	Appropriate administrative procedures implemented.	50,000
Activity 5.5: Provide additional health and safety (H&S) training and enforce all H & S policies and practices	NUC	High	1 year	Training provided. H&S policies implemented.	20,000
Activity 5.6: Purchase sufficient personal protection equipment (PPE) for all staff	NUC	High	1 to 2 years	Equipment purchased. Fewer accidents.	50,000
				Sub-total Strategy 5	**150,000**
				TOTAL POWER SECTOR ACTION PLAN	**9,645,000**

[59] 20,000 for needs assessment and training plan development. 20,000 recurring annual training costs.
[60] 10,000 for setting up apprenticeship and scholarship scheme, 10,000 recurring annual apprenticeship and scholarship cost

13.2 PETROLEUM SECTOR ACTION PLAN

Policy statement: *A reliable and safe supply of fossil fuels*

Strategy 1 : Establish an economically efficient, secure and safe National Fuel Terminal and fuel supply					
Activity	**Organization Responsible (Supporting organization)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.1 - Establish a technical service agreement with a fuel testing laboratory to sample, test and certify jet fuel existing stocks and new deliveries	NUC	Very high	3 months	Certified, safe, quality compliant jet fuel.	10,000
Activity 1.2 – Prepare fuel pricing template and provide training to NUC and MoF staff	NUC (MoF)	Very high	6 months	Template developed. Staff trained.	10,000
Activity 1.3: Carry out training and recertification of staff at the fuel terminal including for shore officers, testing officers, terminal managers and aviation refuelers and fitters	NUC	Very high	6 months	Staff trained and certified	50,000
Activity 1.4 – Carry out a feasibility study for the tender of the fuel terminal operation and bulk fuel supply to a private sector operator	NUC (MoF)	Very high	6 months	Feasibility study completed.	100,000
Activity 1.5 – If feasibility study is favourable, prepare documents for tender for private fuel terminal operator and bulk fuel supplier	NUC (MoF)	High	1 year	Tender related documents prepared.	100,000
Activity 1.6 - Undertake tender for a terminal operator and defined term (3-5 years) bulk fuel supplier	NUC (MoF)	High	1 year to 2 years	Fuel Terminal operator contracted. Long term supply arrangement in place. Technical Service Agreement in place.	50,000

Strategy 1 : Establish an economically efficient, secure and safe National Fuel Terminal and fuel supply					
Activity	**Organization Responsible (Supporting organization)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.7 - Establish a fuel industry levy to support government administration and regulation of fuel operator	MoF	High	2 to 3 years	Fuel industry levy established.	20,000
Activity 1.8 – Develop mechanism using the TWGEn for decisions on future capital works related to fuel supply	CIE (TWGEn)	Medium	3 to 4 years	Mechanism established for decision making.	5,000
				Sub-total Strategy 1	**345,000**

Strategy 2 : Investigate ways to reduce use of or find alternatives to liquid fuels					
Activity	**Organization Responsible or Supporting**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 2.1 – Undertake a study to explore options for more economic supply of LPG	NUC (CIE)	High	1 to 2 years	Long term LPG supply options identified	30,000
Activity 2.2 – Identify barriers to the increased use of LPG for cooking and design actions to remove those barriers (parallel with activity 2.1)	CIE (Various stakeholders)	High	1 to 2 years	Barriers to increased LPG use for cooking identified and removed.	30,000
Activity 2.3 – Implement actions to remove barriers to use of LPG as identified in Activity 2.1 and 2.2	CIE (Various other stakeholders)	High	2 to 3 years	LPG use for cooking increased.	Depending on results of Activity 2.1 and 2.2
Activity 2.4 – Carry out a study on potential substitutes of petroleum (e.g. biofuel, biomass)	CIE (DoA, NRC)	Medium	2 to 3 years	Realistic alternative fuel options for Nauru identified	20,000
				Sub-total Strategy 2	**80,000**
				TOTAL PETROLEUM SECTOR ACTION PLAN	**425,000**

13.3 RENEWABLE ENERGY ACTION PLAN

Policy statement: *50% of electricity used in Nauru comes from renewable energy sources by 2020*

Strategy 1: Phased implementation of large-scale solar up to 8.5 MWp[61]					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.1 – Prepare Solar Feasibility Study and technical standards and specifications for all phases of solar installations	NUC (CIE)	Very high	6 months	Location, specifications, grid connections and costs of all solar plants determined.	100,000
Activity 1.2 – Undertake a survey of roof tops and parking areas to establish locations for solar installations and locate land topside for potential large scale solar plants	NUC (CIE)	Very high	6 months	Sites (roofs, power poles and parking lots) suitable for grid-connected solar identified.	5,000
Activity 1.3 - Develop regulations, standards and payment methods for private generation using solar energy sources	NUC (CIE)	Medium	2 to 3 years	Incentives and information to support private investment in solar in place.	10,000
Activity 1.4 – Prepare tender documents and carry out tender for first 600 to 1000 kWp of grid-connected solar without storage	NUC (MoF, CIE)	Very high	1 year	Contract awarded for installation of up to 1000 kWp	10,000

[61] The final capacity of the total solar energy components, including energy storage size, required to meet the goal of 50% of generated electricity from renewables by 2020 will be defined by the solar feasibility study (Activity 1.1) to be carried out under this action plan when data has become available regarding the predicted level of load growth and load distribution. The results of the feasibility study may lead to modifications in Activities 1.4 to 1.7 of this action plan.

Strategy 1: Phased implementation of large-scale solar up to 8.5 MWp[61]					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.4 – Install 600 to 1000 kWp of grid-connected solar without storage "Bottomside" on government owned buildings, power poles, parking lots, etc.	NUC	Very high	1 year	600 to 1000 kWp installed.	5,000,000
Activity 1.5 - Install 2.5 MW solar plant including storage to maintain grid stability and decrease the generation requirement during the day and evening peak	NUC	High	3 years	2.5 MWp installed	15,000,000
Activity 1.6 – Install 2.5 MW solar plant including storage to maintain grid stability and decrease the generation requirement during the day and evening peak	NUC	High	5 years	2.5 MWp installed	15,000,000
Activity 1.7 – Install 2.5 MW solar plant including storage to maintain grid stability and decrease the generation requirement during the day and evening peak	NUC	High	6 years	2.5 MWp installed	15,000,000
				Sub-total Strategy 1	**50,125,000**

Strategy 2: Investigation and implementation of other renewable energy resources					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 2.1 – Carry out a wind resource assessment and feasibility study	NUC	High	1 year	Determination of feasibility of wind power project.	50,000
Activity 2.2 – Prepare and implement wind generation project if determined to be economically feasible	NUC	Medium	5 years	Wind project implemented.	1,000,000
Activity 2.3 – Undertake consolidated renewable energy options study for other possible sources of electricity generation	CIE (NUC)	Medium	By 2020	Study completed.	40,000
Activity 2.4 – Study the feasibility of back-up solar powered RO units in alternative locations	NUC (CIE)	Medium	1 to 2 years	Feasibility determined.	30,000
Activity 2.5 – Investigate the potential for and identify suitable plants that can be used to green the Topside and provide appropriate biomass for future biofuels production	CIE (DoA, NRC)	Medium	3 to 5 years	Level of potential determined and suitable plants identified.	50,000
Activity 2.6 – Investigate the potential for biogas from pigs (and other) for domestic cooking	CIE	Medium	2 to 3 years	Level of potential for biogas cooking identified	20,000
				Sub-total Strategy 2	**1,190,000**

Strategy 3: Build in-country capacity to operate and maintain solar PV systems					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 3.1 - Develop and implement installation, operating and maintanance training programmes for the solar installations	CIE (NUC, Ministry of Education, Nauru College and other stakeholders)	Very high	6 months to ongoing	Local persons capable of installing and O&M of solar plants	30,000
Activity 3.2 - Establish in a local college regular training in solar energy and other renewables and energy efficiency in a local training institution	CIE (NUC, Ministry of Education, Nauru College and other stakeholders)	High	2 to 3 years	Course on solar energy available locally	30,000[62]
				Sub-total Strategy 3	**60,000**
				TOTAL RENEWABLE ENERGY ACTION PLAN	**51,375,000**

[62] 20,000 for setting up training course, 10,000 recurring annual cost

13.4 DEMAND SIDE ENERGY EFFICIENCY ACTION PLAN

Policy statement: *An efficient supply and use of energy*

Strategy 1: Data collection and analysis for preparation for DSM implementation					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.1 – Carry out household energy use survey	Statistics Office (CIE, NUC, IUCN and UNDP)	Very high	3 months	Characteristics of energy use in residences determined.	30,000
Activity 1.2 – Procure the necessary software and analyse pre-payment meter data to identify customers tampering with meters and to categorize customers as to energy use to allow for targeted EE programmes	NUC	Very high	6 months	Software purchased. Pre-payment meter data analysed.	40,000
Activity 1.3 – Undertake energy surveys/audits of hotels and commercial buildings	CIE (NUC)	Very high	6 months	Identify measures to reduce electricity use in hotels and commerce	10,000
Activity 1.4 – Undertake industrial energy audits of RONPHOS and NRC facilities	CIE (RONPHOS and NRC)	Medium	1 to 2 years	Measures to reduce fuel use at RONPHOS and NRC identified.	50,000
Activity 1.5 – Assess feasibility of EE technologies, including cost benefit analysis and develop relevant financing options for end users to make EE investments which are compatible with local institutional and financing structures	CIE (MoF)	High	6 months to 2 years	List of EE technologies defined. Incentives and financing options for support investment into EE identified.	40,000
				Sub-total Strategy 1	**200,000**

Strategy 2: Implementation of demand side energy efficiency					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 2.1 – Prepare and implement energy efficiency campaign (NUC) to communities	NUC	Very high	6 months	Communities consider energy efficiency.	5,000
Activity 2.2 – Prepare and implement long term energy efficiency for communities campaign including financial incentives for people to exchange less energy efficient appliances for new, more efficient ones	NUC	Very high	6 months to ongoing	Communities and individuals chose more efficient appliances	10,000[63]
Activity 2.3 – Prepare and enact legislation making electricity theft a crime	CIE (Department of Justice)	High	6 months	Lowered non-technical losses for NUC.	5,000
Activity 2.4 – Establish guidelines and financial incentives for energy efficiency measures in construction or retrofitting of buildings	CIE	High	1 year	Guidelines and financial incentives in place.	150,000
Activity 2.5 – Undertake energy efficiency actions in Government Buildings	CIE (Government)	Medium	3 years	EE actions undertaken.	50,000
Activity 2.6 – Replace street lights to EE technologies combined with solar power	NUC	High	2 years	EE street lights installed.	100,000
Activity 2.7 – Study the feasibility of additional water storage with reticulated water distribution	NUC (CIE)	Medium	2 years	Reduce need for delivery of water by tankers.	30,000
				Sub-total Strategy 2	**335,000**

[63] Recurring annual budget

Strategy 3: Introduction of energy labeling and minimum energy performance standards					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 3.1 – Prepare feasibility study to determine the best approach to appliance testing and labelling for energy performance	CIE	Medium	1 to 2 years	Best approach to appliance testing and labeling determined.	30,000
Activity 3.2 – Introduce energy labelling of high electricity consumption appliances such as air conditioners, freezers, refrigerators, etc	CIE (NUC, private sector and other stakeholders)	High	2 years	Energy labeling for appliances introduced.	50,000
Activity 3.3 –Carry out awareness raising to communities, businesses and government	CIE	High	Ongoing for 3 years	Communities, businesses and government are aware of energy labeling.	60,000
Activity 3.4 - Prepare and enact appropriate legislation for energy labelling and MEPS	CIE (Department of Justice)	Medium	2 to 3 years	Legislation enacted.	20,000
Activity 3.5 - Training to customs and other government departments on labelling and MEPS, including enforcement	NUC (with CIE)	Medium	2 years and ongoing	Customs and other government departments trained.	10,000
				Sub-total Strategy 3	**170,000**
				TOTAL DEMAND SIDE ENERGY EFFICIENCY ACTION PLAN	**705,000**

13.5 TRANSPORT ACTION PLAN

Policy statement: *to be developed as part of Road Map implementation*

Strategy 1: Implementation of energy efficiency in transport					
Activity	**Organization Responsible (supporting organizations)**	**Activity Priority**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.1 – Develop a policy statement and if appropriate, a target, for the transport sector with regard to energy related issues	CIE (Department of Transport)	Very high	1 year	Policy statement developed. Target agreed.	10,000
Activity 1.2 – Design and implement programmes to provide incentives and facilities to improve the quality of maintenance for personal transport (cars)	CIE (Department of Transport, civil society)	High	1 year	Improved maintenance and fuel efficiency of land vehicles.	50,000
Activity 1.3 – Undertake a study of incentives to increase the use of bicycles and motorcycles for personal transport, as well as car pooling and other behavioural changes to encourage energy efficiency, and implement as appropriate	CIE (Department of Transport, civil society)	Very High	6 months	Options for incentives identified. If implemented, increase	25,000
Activity 1.4 - Undertake a study of public transport systems in Pacific Islands, with similar traffic patterns.	CIE (Department of Transport)	High	2 to 3 years	Study completed.	25,000
Activity 1.5 – Using results of Activity 1.3, deisgn and implement a public transport system for Nauru	Department of Transport (CIE)	High	3 to 4 years	Public transport system designed and implemented.	100,000

Strategy 1: Implementation of energy efficiency in transport					
Activity	**Organization Responsible (supporting organizations)**	**Activity Priority**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.6 – Assess options to discourage the importation of vehicles that have larger engines (e.g. through increased import duties, etc.)	CIE (MoF)	High	1 year	Options assessed.	10,000
Activity 1.7 – Implement appropriate options to discourage the importation of vehicles with large engines	CIE (MoF, Customs and others)	High	2 to 3 years	Options to discourage importation of vehicles with large engines implemented.	20,000
Activity 1.8 – Design and implement awareness campaign to communities on energy efficiency in transport	CIE (Department of Transport)	High	6 months and ongoing		10,000[64]
Activity 1.9 – Establish a data collection system for energy and transport data (related to other databases as appropriate)	CIE (Department of Transport, NBoS, Our Airline and others)	High	6 months to 1 year	Energy and transport data collected.	30,000
				Sub-total Strategy 1	**280,000**

[64] Recurring annual budget

Strategy 2: Investigate substitutes to diesel and petrol for transport					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 2.1 – Study the feasibility of LPG, hybrid and electric (powered by renewable electricity) vehicles, including buses	CIE	High	1 to 2 years	Feasibility of options established.	30,000
Activity 2.2 – Investigate the future potential of biofuel production on Topside for vehicles and small vessels	CIE	Medium	3 to 5 years	Potential for biofuel identified.	20,000
				Subtotal Strategy 2	**50,000**
				TOTAL TRANSPORT SECTOR ACTION PLAN	**330,000**

13.6 INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING ACTION PLAN

Policy statement: *Efficient, robust and well resources institutions for energy planning and implementation*

Strategy 1: Establish appropriate policies, regulations and legislation for the energy sector					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 1.1 - Develop a legislative and governance framework for the energy sector	CIE (DoJ and others)	Very High	1 to 2 years	Energy Act or similar appropriate legislation and regulatory instruments in place.	100,000
Activity 1.2 - Develop supporting regulations for the NUC Act	NUC (DoJ, CIE)	Very High	1 year	NUC regulations in place.	80,000
Activity 1.3 - Develop Petroleum Act	CIE (NUC, DoJ)	High	1 to 2 years	Petroleum Act and relevant regulatory instruments in place.	80,000
Activity 1.5 – Review of regulatory or policy barriers (e.g. import duties) to EE and RE investment	CIE (NUC, MoF, DoJ)	High	1 to 2 years	Changes that will enhance investment proposed.	20,000
Activity 1.6 – Investigate options, develop and implement a framework for private sector (IPPs, businesses and residences) renewable energy grid-connection and relevant supporting instruments (e.g. net-metering)	CIE (NUC, MoF, DoJ)	Medium	2 to 3 years	Appropriate framework developed and implemented.	150,000
				Sub-total Strategy 1	**430,000**

Strategy 2: Facilitate development of appropriate local skill base to meet ongoing demand in the energy sector					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 2.1 - Assess training needs and develop appropriate training strategy for secondary and primary school teachers, managers, small businesses, technicians, tradespeople, etc.	CIE	High	1 year	Training plan / strategies developed.	30,000
Activity 2.2 – Carry out training in technical skills for EE and RE as identified in Activity 2.1	CIE (NUC)	High	1 to 2 years	More people in key positions trained.	20,000
Activity 2.3 - Establish train the trainers programmes in EE and RE for local teachers, equipment operators, managers and technicians	CIE (NUC)	Medium	2 to 3 years	Qualified local trainers. Training programmes established.	60,000
Activity 2.4 - Develop energy curriculum for schools focusing on energy efficiency and RE	CIE (Education)	High	1 to 2 years	Increased knowledge base on energy	50,000
				Sub-total Strategy 2	**160,000**

Strategy 3: Improve governance and accountability in the energy sector					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 3.1 - Establish an Energy Unit within the Department of CIE	CIE (MoF, Public Service)	Very High	6 months	Functioning Energy Unit	20,000

Strategy 3: Improve governance and accountability in the energy sector					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 3.2 – Establish position of Energy Coordinator within public service	CIE	Very high	1 year	Position and annual salary integrated into national budget.	15,000[65]
Activity 3.3 - Recruit new staff to support the function of the Energy Unit and NERM implementation.	CIE	Very high	1 year to ongoing	Established Energy positions	20,000
Activity 3.4 - Support and facilitate the activities of the PSC and the Technical Working Group on Energy	CIE	Very high	Ongoing	Appropriate support provided to the TWGEn and the PSC.	10,000
Activity 3.5 – Carry out an assessment of the institutional arrangements for the implementation of the road map including recommendations for long-term implementation of the road map	CIE (TWGEn, MoF, Public Service)	High	2 years	Assessment carried out and appropriate recommendations made.	30,000
Activity 3.6 – Develop detailed monitoring and evaluation plan for the Energy Road Map	CIE (TWGEn)	Very high	1 year	M&E Plan for Road Map developed and used.	20,000
Activity 3.7 – Support capacity to collect and manage data and data sharing and reporting	CIE	High	Ongoing	Support provided to energy data systems.	5,000
				Sub-total Strategy 3	**140,000**

[65] Recurring annual budget

Strategy 4: Foster a culture of partnerships between public and private sectors including the community					
Activity	**Organization Responsible (supporting organizations)**	**Activity Importance**	**Time Frame**	**Expected results / outputs**	**Estimated budget / AUD**
Activity 4.1 - Develop private sector and community strategy, including engagement and multi-stakeholder partnerships	CIE (Private sector, civil society and others)	Very high	6 months to 1 year	Private sector and community strategy developed.	20,000
Activity 4.2 – Implement engagement and multi-stakeholder participatory activities as laid out in the strategy developed under Activity 2.1	CIE (Various stakeholders)	Very high	1 to 3 years	Greater engagement of private sector and communities in the energy sector. Development of multi-stakeholder partnerships.	50,000
Activity 4.2 – Disseminate information on EE measures, net metering and other information regarding changes in the power sector as and when appropriate	CIE (NUC, Civil society and others)	High	3 months to ongoing	Information on net metering and IPP policy and others disseminated	20,000
				Sub-total Strategy 4	**90,000**
				TOTAL INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING ACTION PLAN	**820,000**

14 MONITORING, EVALUATION AND REPORTING FRAMEWORK

14.1 INTRODUCTION

Overall guiding principles for the monitoring,[66] evaluation[67] and reporting[68] framework of the Energy Road Map are as follows:

- Simplicity – the Framework should reflect the relative smallness of Nauru including the energy sector (only collect data that will be actively used);
- Realism – including reflecting the limited resources available to implement the framework (institutional, human, financial, etc.);
- Practicality – including using indicators for which data can be collected on a timely basis and at a reasonable cost;
- Synergistic – including taking advantage of already existing relevant monitoring and reporting frameworks both at national and Pacific regional levels;
- Objectivity – including using objective evidence that intended changes are occurring (e.g. via objectively verifiable indicators); and,
- Independence – including undertaking external independent assessment of implementation progress when necessary.

14.2 MONITORING AND REPORTING

14.2.1 MONITORING AND REPORTING AT ACTIVITY LEVEL

Monitoring of individual activities associated with each of the six action plans – i.e. for power, petroleum, renewable energy, demand side efficiency, transport and institutional strengthening and capacity building will be undertaken according to the respective action plans. Thus refer to relevant sections for information about activities, responsible agency, prioritization, time frame, expected results/outputs and estimated budget. It is likely that a significant part of the planned activities will be supported via externally funded projects and programmes. The majority of development partners have various monitoring frameworks including reporting requirements for projects and programmes, which will be used as appropriate. With regard to reporting, this may include inception reports, work plans (quarterly and/or yearly), substantial and financial progress reports (quarterly and/or yearly), audits (yearly), etc. Gender disaggregation should be considered in designing data collection programmes and reporting on activities. Copies of such reports will be provided to CIE, which will act as a central repository and share these with the Technical Working Group on Energy.

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[66] Monitoring can be defined as '…the ongoing process by which stakeholders obtain regular feedback on the progress being made towards achieving their goals and objectives' (UNDP, p. 8, 2009).

[67] Evaluation can be defined as a '…rigorous and independent assessment of either completed or ongoing activities to determine the extent to which they are achieving stated objectives and contributing to decision making' (UNDP, p. 8, 2009). The key distinction between monitoring and evaluation is that evaluations are done independently to provide managers and staff with an objective assessment of whether or not they are on track. Evaluations are also more rigorous in their procedures, design and methodology, and generally involve more extensive analysis. However, the aims of both monitoring and evaluation are similar: to provide information that can help inform decisions, improve performance and achieve planned results (UNDP, p. 9, 2009).

[68] A reporting mechanism '…state where information is documented' (ADB, 2009).

14.2.2 MONITORING AND REPORTING AT PLAN LEVEL

In the table below are proposed indicators and outlined associated reporting mechanisms, which will assist monitoring overall progress of the Energy Road Map including key results[69] in each of the six thematic areas. Guiding principles for the proposed indicators include that they should:

- Reflect specific result/policy statements in the 2009 Energy Policy Framework (where available); e.g. for the power sector the result statement in the 2009 Energy Policy Framework is: 'A reliable, affordable and safe power supply and services', therefore where possible indicators related to various aspects of reliability, affordability and safety have been included;

- Use high-level indicators, i.e. indicators will not reflect activity, input, etc. levels; and,

- Use existing indicators as much as possible. Considered are: i) indicators mentioned in relevant national strategies and plans, e.g. the NSDS revised in 2009 and the Economic Infrastructure Strategy and Investment Plan from November 2011; ii) data regularly collected and reported on nationally for instance by the Nauru Bureau of Statistics/Ministry of Finance. E.g. micro-level data captured in census or household income and expenditure surveys (HIES) and macro-economic data such as GDP, import of commodities (including mineral fuel/lubricants), etc.; or iii) indicators regularly reported on by the Council of Regional Organisations in the Pacific (CROP) agencies. E.g. Secretariat of the Pacific Community (SPC) via their planned yearly Country Energy Security Indicator Profiles and the Pacific Power Association (PPA) via their also yearly planned power utility benchmarking reporting.

[69] Results include impact, outcome and output. These terms can be defined as follows (UNDP, 2009, p. 55): i) impact: 'Actual or intended changes in human development as measured by people's well-being; improvements in people's lives'; ii) outcome: '…short-term and medium-term effects of an intervention's outputs; change in development conditions'; and iii) outputs: 'capital goods and services that result from development interventions'.

Table 11 – Energy Road Map monitoring plan

Energy Road Map Theme and 2009 NEPF Policy Statement	Indicator	Baseline (year)	Relevant Target(s)	Means of Verification	Planned Reporting Frequency
Power Sector A reliable, affordable and safe power supply and services	Hours of interruptions per customer[70]	0.92 (2010)	N/a	• NUC reports • PPA Benchmarking reports • SPC Nauru Country Energy Security Indicators	Yearly
	Price of electricity	*Domestic:* 300 kWh ≤ = AUD 0.10/kWh >300 kWh = AUD 0.25/kWh *Commercial:* AUD 0.30/ kWh *Industrial:* AUD 0.50/kWh (2013)	N/a	• NUC reports • PPA Benchmarking reports • SPC Nauru Country Energy Security Indicators	Yearly
	Household electricity expenditure load[71]	Data not available	N/a	• Nauru Bureau of Statistics Household Income and Expenditure Survey (HIES) reports • Dedicated household energy survey reports	Approximately every five years (or more often if dedicated surveys are carried out)
	Total system losses	22.41% (2009)	30% improvement in energy efficiency by 2020[72]	• NUC reports • PPA Benchmarking reports • SPC Nauru Country Energy Security Indicators	Yearly
	Non-technical losses	15.77% (2009)	N/a	• NUC reports • PPA Benchmarking reports • SPC Nauru Country Energy Security Indicators	Yearly

[70] I.e. System Average Interruption Duration Index (SAIDI).
[71] I.e. average household expenditure on electricity as a proportion of average household income.
[72] Letter from CIE to GIZ, dated 6 September 2013.

Energy Road Map Theme and 2009 NEPF Policy Statement	Indicator	Baseline (year)	Relevant Target(s)	Means of Verification	Planned Reporting Frequency
Petroleum sector A reliable and safe supply of fossil fuels	Fuel supply security (days)	73 (2009)	N/a	• NUC Reports • SPC Nauru Country Energy Security Indicators	Yearly
	Fuel imports as a percentage of GDP	8.5% (2009)	N/a	• Nauru Bureau of Statistics • Ministry of Finance • SPC Nauru Country Energy Security Indicators	Yearly
Renewable energy 50% of electricity used in Nauru comes from renewable energy sources by 2020	% of NUC electricity generated or sent out by renewable sources	0.3% (2009)	50% of electricity generation to come from renewable energy sources by 2020[73]	• NUC Reports • PPA Benchmarking reports • SPC Nauru Country Energy Security Indicators	Yearly
Demand Side Efficiency An efficient supply and use of energy	NUC and CIE annual budget allocations for DSM	Baseline data for this indicator is to be collected for 2013.	30% improvement in energy efficiency by 2020	• NUC Reports and Budget • Ministry of Finance Reports and National Budget • CIE Reports and Budget	Yearly
	NUC and CIE full-time equivalent employees engaged in DSM	Baseline data for this indicator is to be collected for 2013.	30% improvement in energy efficiency by 2020	• NUC Reports and Budget • CIE Reports and Budget	Yearly

[73] Letter from CIE to GIZ, dated 6 September 2013.

Energy Road Map Theme and 2009 NEPF Policy Statement	Indicator	Baseline (year)	Relevant Target(s)	Means of Verification	Planned Reporting Frequency
	One more indicator to be developed for residential EE once more information becomes available	This will be established once the household energy use survey has been carried out.	30% improvement in energy efficiency by 2020	N/a	Yearly
Transport Policy statement to be developed	To be developed once more information becomes available	N/a	N/a	N/a	Yearly
Institutional Strengthening and Capacity Building Efficient, robust and well resources institutions for energy planning and implementation	CIE annual budget allocation from Government budget	AUD 448,966 (2012-2013)	N/a	• Ministry of Finance, National Budget	Yearly
	Status of Government energy administration	No unit within Government dedicated to energy sector planning and development (2009)	Established unit (or equivalent) within Government dedicated to energy sector planning and development	• CIE Reports • Public Service Reports • Ministry of Finance, National Budget • SPC Nauru Country Energy Security Indicators	Yearly
	NUC specific fuel consumption (kWh/litre)	3.54 (2011)	30% improvement in energy efficiency by 2020	• NUC Reports • PPA Benchmarking reports	Yearly

Energy Road Map Theme and 2009 NEPF Policy Statement	Indicator	Baseline (year)	Relevant Target(s)	Means of Verification	Planned Reporting Frequency
	NUC generation labour productivity[74]	1.16 (2011)	N/a	• NUC Reports • PPA Benchmarking reports	Yearly
	NUC training expense as a % of payroll	7.63 (2010)	N/a	• NUC Reports • PPA Benchmarking reports	Yearly

Based on activity level reporting as well as monitoring of changes to the Road Map level indicators mentioned above, the Technical Working Group on Energy with support from CIE will prepare an annual progress report, which will be submitted to the PSC and Cabinet for their information and action as required. The report will cover progress made toward results, key challenges, lesson learned/good practices and recommendations for the way forward. Gender disaggregation should be considered when reporting on activities. Timing, specific template and details of the process will be determined when the Energy Road Map is operational.

[74] Ratio of total electricity generation in GWh to the number of full-time equivalent (FTE) employees who operate and maintain the systems generating plant (PPA, p. 26, 2011).

14.3 EVALUATION

14.3.1 EVALUATION AT ACTIVITY LEVEL

It is likely that a significant part of the planned activities will be supported via externally funded projects and programmes. The majority of development partners include external evaluations as a standard requirement including either mid-term review and/or terminal evaluation when a given project or programme is operationally complete. Copies of evaluation reports will be provided to CIE by the development partners, which will act as a central repository and share these with the Technical Working Group on Energy. These reports, as well as an annual, activity-level progress report on the action plans prepared by the TWGEn with support from CIE, will provide the information needed to update and adjust the action plans on a yearly basis.

14.3.2 EVALUATION AT PLAN LEVEL

An external mid-term independent evaluation of Energy Road Map implementation progress will be undertaken in 2017. This will assess status of implementation (including level of integration into key government planning and budgetary processes) and identify course correction if/as needed. In addition they will include: an assessment on effectiveness, efficiency and timeliness; highlight issues requiring decisions and actions; and lessons learned including on planning, implementation and management aspects.

Where practical and feasible, the mid-term evaluation will be aligned with the three year review cycle of the Nauru National Sustainable Development Strategy (NSDS). A final evaluation of the Road Map is tentatively planned for 2020. The detailed organization, terms of reference and exact timing of the evaluations will be reflected in a detailed monitoring and evaluation (M&E) plan for the Road Map, which will be developed when the Energy Road Map is operational.

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