Republic of Marshall Islands

Second National Communication

Submitted by Republic of Marshall Islands

to United Nations Framework Convention on Climate Change

Supported by

President

REPUBLIC OF THE MARSHALL ISLANDS

FOREWORD

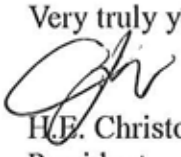
Despite the inherently political nature of the engagements between nations, technical information often underpins discussions of the impacts of climate change and of human actions that impact a changing climate. Data-derived information has a high value on the international stage of conventions and negotiations pertaining to climate change and its effects. The primary international convention on climate change (United Nations Framework Convention on Climate Change, UNFCCC) differentiates the responsibilities of countries with respect to their participation in the convention. The Republic of the Marshall Islands (RMI) is a Pacific Island, small state, non-Annex 1 country. So defined, this country has common but differentiated responsibilities (CBDR) from countries that are otherwise defined. This Second National Communication (SNC) report to the UNFCCC is one expression of the RMI's fulfillment of one of its responsibilities.

Despite the fact that the RMI cannot, by any stretch of imagination, be considered in the global context to be an "emitter" of greenhouse gases (GHG), the process of inventorying GHG emissions is valuable. It offers an opportunity to evaluate the changes in the energy, transportation, agriculture, waste management and related sectors. An evaluation of the trends allows a reflection on changes at the national level and the economic impacts of such changes. Inter-agency cooperation and collaboration is encouraged during the collection of data. It also permits an appreciation of the tremendous effort that large countries would expend to develop such an understanding. This report shows that the RMI should pay attention to the trends in these sectors in order to better manage the downstream economic impacts and environmental effects. By doing so, we will have a better appreciation for any possible changes that are desirable, even if symbolic, to reduce our insignificant emissions. Similarly, this report outlines actions specific to the RMI that are adaptive to the effects of climate change. These actions have been considered at a national level and are defined in other national plans. Yet, unlike the others, this study provides the linkages between emission, mitigation and adaptation actions.

A shortage of technically skilled and informed personnel is an issue that is commonplace in a Pacific small island developing state. It is a challenge to produce a technical report to fulfill the UNFCCC's requirements. Yet, this process engages personnel and upgrades their awareness of technical vocabulary, provides insights from data and bring into relevance the participation of a small country on the international stage. In this regard, I commend and thank the groups of personnel and institutions that have participated to make possible the completion of this report.

This report paves the path to a greater engagement by RMI's national level agencies in the development of its successor- the Third National Communication.

Very truly yours,



H.E. Christopher Jorbon Loeak
President
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August 1, 2015

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Abbreviation

ADB	ASIAN DEVELOPMENT BANK
A&E	A&E ARCHITECTURE AND ENGINEERING
AC	ALTERNATING CURRENT
ADMIRE	ACTION FOR THE DEVELOPMENT OF MARSHALL ISLANDS RENEWABLE ENERGIES
ADO	AUTOMOTIVE DIESEL OIL
AFOLU	AGRICULTURE, FORESTRY AND OTHER LAND USE
AG	ATTORNEY GENERAL
AOSIS	ALLIANCE OF SMALL ISLAND STATES
ARM	ATMOSPHERIC RADIATION MEASUREMENT
AUSAID	AUSTRALIAN AGENCY FOR INTERNATIONAL DEVELOPMENT
AWS	AUTOMATIC WEATHER STATION
BTU	BRITISH THERMAL UNIT
CBD	CONVENTION ON BIOLOGICAL DIVERSITY
CBO	COMMUNITY BASED ORGANIZATION
CCA	CLIMATE CHANGE ADAPTATION
CDL	CONTAINER DEPOSIT LEGISLATION
CH4	METHANE
CMI	COLLEGE OF THE MARSHALL ISLANDS
CO	CARBON MONOXIDE
CO2E	CARBON DIOXIDE EQUIVALENT
COC	CHAMBER OF COMMERCE
COFA	COMPACT OF FREE ASSOCIATION
COP	CONFERENCE OF PARTIES
DOE	U.S. DEPARTMENT OF ENERGY
DOI	U.S. DEPARTMENT OF THE INTERIOR
DPK	DUAL PURPOSE KEROSENE
DRD	DEPARTMENT OF RESOURCES AND DEVELOPMENT
DRR	DISASTER RISK REDUCTION
DSM	DEMAND SIDE MANAGEMENT
EDF	EUROPEAN DEVELOPMENT FUND
EE	ENERGY EFFICIENCY
EERS	ENERGY EFFICIENCY RESOURCE STANDARD
EIA	ENVIRONMENT IMPACT ASSESSMENT
ENSO	EL NI-O-SOUTHERN OSCILLATION
EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY
EPD	ENERGY PLANNING DIVISION
EPPSO	ECONOMIC POLICY PLANNING & STATISTICS OFFICE
ER	EMISSION REDUCTION
ESTS	ENVIRONMENTALLY SOUND TECHNOLOGIES
FAO	FOOD AND AGRICULTURE ORGANIZATION

FY	FISCAL YEAR
GAO	U.S. GOVERNMENT ACCOUNTABILITY OFFICE
GDP	GROSS DOMESTIC PRODUCT
GEF	GLOBAL ENVIRONMENT FACILITY
GG	GIGA GRAMS
GHG	GREENHOUSE GAS
GHGI	GREEN HOUSE GAS INVENTORY
GOM	GOVERNMENT OF MARSHALL ISLANDS
GPCP	GLOBAL PRECIPITATION CLIMATOLOGY PROJECT
HECO	HAWAIIAN ELECTRIC COMPANY
HFC'S	HYDRO FLORO CARBONS
HZ	HERTZ
IECC	INTERNATIONAL ENERGY CONSERVATION CODE
ILO	INTERNATIONAL LABOR ORGANIZATION
IPCC	INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
IPPU	INDUSTRIAL PROCESSES AND PRODUCT USE
IRENA	INTERNATIONAL RENEWABLE ENERGY AGENCY
IUCN	INTERNATIONAL UNION FOR CONSERVATION OF NATURE
JCC	JOINT COORDINATING COMMITTEE
JET A-1	JET A-1 JET FUEL
JICA	JAPAN INTERNATIONAL COOPERATION AGENCY
JPRISM	JAPAN PROMOTION OF REGIONAL INITIATIVE ON SOLID WASTE MANAGEMENT
KAJUR	KWAJALEIN ATOLL JOINT UTILITIES RESOURCES
KAJUR	KWAJALEIN ATOLL JOINT UTILITY RESOURCE
KV	KILOVOLT
KVAR	KILOVOLT-AMPERES REACTIVE
KWH	THOUSANDS OF WATT HOURS
KWH/GAL	KILOWATT HOURS PER US GALLON OF FUEL (FUEL EFFICIENCY)
LB	POUND(S)
LED	LIGHT EMITTING DIODE
LEED	LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN
LPG	LIQUEFIED PETROLEUM GAS
LULUCF	LAND USE, LAND USE CHANGE AND FORESTRY
M	METER(S)
MAEC	MARSHALLS ALTERNATIVE ENERGY COMPANY
MALGOV	MAJURO ATOLL LOCAL GOVERNMENT
MAWC	MAJURO ATOLL WASTE COMPANY
MEC	MARSHALLS ENERGY COMPANY
MECO	MAUI ELECTRIC COMPANY
MFA	MINISTRY OF FOREIGN AFFAIRS
MIA	MINISTRY OF INTERNAL AFFAIRS

MICS	MARSHALL ISLANDS CONSERVATION SOCIETY
MIMRA	MARSHALL ISLANDS MARINE RESOURCE AUTHORITY
MIVA	MARSHALL ISLANDS VISITORS AUTHORITY
ML	MILLION LITERS
MOC	MOBILE OIL COMPANY
MOE	MINISTRY OF EDUCATION
MOF	MINISTRY OF FINANCE
MOH	MINISTRY OF HEALTH
MPS	MEMBER OF PARLIAMENTS
MPW	MINISTRY OF PUBLIC WORKS
MRD	MINISTRY OF RESOURCES AND DEVELOPMENT
MRF	MATERIAL RECOVERY FACILITY
MSW	MUNICIPAL SOLID WASTE
MVA	MEGAVOLT AMPERE
MW	MEGAWATTS (MILLIONS OF WATTS)
N2O	NITROUS OXIDE
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NCD	NON COMMUNICABLE DISEASES
NDRM	NATIONAL DISASTER RISK MANAGEMENT
NEPF	NATIONAL ENERGY PROGRAM FRAMEWORK
NERM	NATIONAL ENERGY ROAD MAP
NGO	NONGOVERNMENTAL ORGANIZATION
NIP	NATIONAL IMPLEMENTATION PLAN
NMVOC	NON-METHANE VOLATILE ORGANIC COMPOUNDS
NPS	NATIONAL PARK SERVICE
NREL	NATIONAL RENEWABLE ENERGY LABORATORY
O&M	OPERATION AND MAINTENANCE
OEPPC	OFFICE OF ENVIRONMENTAL PLANNING AND POLICY COORDINATION
OIA	OFFICE OF INSULAR AFFAIRS
OTEC	OCEAN THERMAL ENERGY CONVERSION
PCCSP	PACIFIC CLIMATE CHANGE SCIENCE JOINT PROGRAM
PEQD	PACIFIC EQUATORIAL DIVERGENCE
PFC'S	PER FLORO CARBONS
PIC	PACIFIC ISLAND COUNTRIES
PICCAP	PACIFIC ISLANDS CLIMATE CHANGE ACTION PROGRAM
PIGGAREP	PACIFIC ISLANDS GREENHOUSE GAS ABATEMENT THROUGH RENEWABLE ENERGY PROJECTS
PIPSO	PACIFIC ISLAND PRIVATE SECTOR ORGANISATION
PIREP	PACIFIC ISLANDS RENEWABLE ENERGY PROJECT
POPS	PERSISTENT ORGANIC POLLUTANTS
PPA	POWER PURCHASE AGREEMENT OR PACIFIC POWER ASSOCIATION

PPM	PARTS PER MILLION
PREFACE	PACIFIC RURAL RENEWABLE ENERGY FRANCE-AUSTRALIA COMMON ENDEAVOUR
PV	PHOTOVOLTAICS
RDF	REFUSE DERIVED FUEL
RE	RENEWABLE ENERGY
RFP	REQUEST FOR PROPOSALS
RMI	REPUBLIC OF THE MARSHALL ISLANDS
RO	REVERSE OSMOSIS
RPC	REGIONAL PROCESSING CENTRE
RPS	RENEWABLE PORTFOLIO STANDARD
SEP	STATE ENERGY PROGRAM
SF6	SULFUR HEXAFLOURIDE
SHS	SOLAR HOME SYSTEM
SIDS	SMALL ISLAND DEVELOPING STATE
SPCZ	SOUTH PACIFIC CONVERGENCE ZONE
SPREP	SECRETARIAT OF THE PACIFIC REGIONAL ENVIRONMENTAL PROGRAMME
SWH	SOLAR WATER HEATING
TCO2E	TONNES OF CARBON DI-OXIDE EQUIVALENT
TEO	TERRITORIAL ENERGY OFFICE
TFR	TOTAL FERTILITY RATE
TNA	TECHNOLOGY NEEDS ASSESSMENT
TPD	TONS PER DAY
TTM	TAIWAN TECHNICAL MISSION
TVET	TECHNICAL VOCATIONAL EDUCATION AND TRAINING
TWG	TECHNICAL WORKING GROUP
TWP	TROPICAL WESTERN PACIFIC
UNCCD	UNITED NATIONS CONVENTION ON DESERTIFICATION
UNDP	UNITED NATIONS DEVELOPMENT PROGRAMME
UNEP	UNITED NATIONS ENVIRONMENTAL PROGRAMME
UNFCCC	UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE
USDA	UNITED STATES DEPARTMENT OF AGRICULTURE
USP	UNIVERSITY OF THE SOUTH PACIFIC
V&A	VULNERABILITY AND ADAPTATION
VDS	VESSEL DAY SCHEME
WARM	WORK ADJUSTMENT FOR RECYCLING MANAGEMENT
WP	WATTS PEAK
WTE	WASTE-TO-ENERGY
WTH	WATTS THERMAL
YTYIH	YOUTH TO YOUTH IN HEALTH

National Circumstances

The RMI is in the northern Pacific Ocean, and is part of the larger island group of Micronesia. The RMI has built a very close relationship with the United States (US) since 1944 when the US gained military control of the Marshall Islands from Japan. The isolated location of the country and the small, sparsely distributed population mean that RMI suffers the common obstacles to development experienced by other small island developing states (SIDS); a small domestic market; difficulty in achieving economies of scale in production, large distances from import and export markets and associated high transportation costs, high transportation costs domestically, and very high energy costs.

The islands have few natural resources and are therefore heavily reliant on imports; agricultural production is primarily of subsistence nature; and small-scale industry is limited to handicrafts, tuna processing and copra. Tourism provides a small source of foreign exchange, but is not as well developed as in several other Pacific Island countries, and currently employs less than 10% of the labour force. RMI is heavily dependent on external assistance; since independence, grants have averaged 60% of government revenue. A Compact of Free Association signed in 1986 and renewed in 2003 guarantees annual financial aid from the US until 2023.

The moist, tropical climate of the Marshall Islands is heavily influenced by the north-east trade wind belt. Annual rainfall varies considerably from north to south within the archipelago, the southern atolls receiving 300-340 cm and the northern atolls receiving 100-175 cm. The average annual temperature is 27.C, with monthly means scarcely varying from 26.9.C to 27.1.C. The RMI has a population of 53,000 people. The Marshallese reside on approximately 24 municipalities including atolls and individual islands. Majuro, the capital city, is the most populated atoll with 52% of the country's population. The economy of the RMI is heavily dependent on external assistance, with grants averaging 60% of GDP since independence in 1986. Most of the outer island population is a subsistence economy. On the urban atoll of Majuro, the government is by far the largest employer and is heavily dependent on US Compact and development partner inputs.

In a low-lying atoll nation such as the RMI, extremely high vulnerability to the impacts of climate change..sea level rise, coastal erosion, impacts on plants and animals, and changes in rainfall patterns ..makes climate change an environmental sustainability issue, exacerbate development pressure and a security threat. In 2011, the RMI Government adopted the National Climate Change Policy Framework (NCCPF), which sets out the RMI's commitments and responsibilities to address climate change. The NCCPF recognizes that climate change exacerbates already existing development pressure These pressures arise from extremely high population densities (on Ebeye and Majuro in particular), rising incidences of poverty, a dispersed geography of atolls over a large ocean area (making communication difficult and transport expensive), and a small island economy that is physically isolated from world markets but highly susceptible to global influences. Environmental pressures are also acute, with low elevation, fragile island ecosystems, a limited resource base and limited fresh water resources (exacerbating the reliance on imports) resulting in an environment that is highly vulnerable to overuse and degradation. A Joint National Action Plan for Disaster Risk Management and Climate Change (JNAP) for RMI has been developed. The JNAP Matrix aligns with actions identified under the RMI National Action Plan for Disaster Risk Management 2008-2018 and the aforementioned NCCPF.

Most of the primary energy supply (90%) in RMI comes from petroleum, with biomass used for cooking accounting for nearly all the rest. RMI is heavily reliant on external assistance, with grants averaging 60% of Gross Domestic Product (GDP). Like other island nations in the Pacific, the RMI suffers from high and volatile fuel prices while lacking any known fossil fuel reserves of its own. Solar electricity generation is expected to expand rapidly but contributed less than 1% of RMI energy.. Biofuel from coconut oil is also expected to increase in future. Imported petroleum-based products are gasoline, diesel fuel, dual purpose kerosene (used both as aviation turbine fuel and household kerosene) and LPG. Gasoline and aviation fuel are imported by Mobil. Automotive diesel oil is imported and distributed by MEC.

Electricity is provided mainly by two public sector utilities KAJUR and MEC. KAJUR only serves Ebeye in

Kwajalein. MEC operates throughout the rest of the country. Its main grid is on the Majuro atoll, along with a diesel mini-grid on Rongrong islet. Approximately 75% of the RMI population has access to grid electricity; 92% in the urban areas of Majuro and Ebeye and 32% in the rural outer islands. Some outer islands have central power plants, some of which run during limited hours of the day, and other remote populations receive electricity services from photovoltaic-battery systems provided by international donors and maintained by the central utility.

The National Energy Policy is currently under review and will be based on a National Energy Balance, which will account for various energy sources that RMI uses, how each energy sources are utilized in the various end sectors of RMI, as well as stock-piles and losses. The energy policy review is envisaged to assess the actions currently appropriate to implement the policy, and to consider whether amendments to the policy are needed. Waste management is among one of the top priorities for action in the RMI. As an atoll nation, the RMI lacks the suitable land space to accommodate environmentally sound disposal facilities for these changing waste streams and simply cannot afford to increase its waste generation. Any suitable and available land requires large investment in infrastructure and environmental protection systems to preserve the integrity of the coastal marine environment and potential underground water resources.

The RMI's 2009 MDG Progress Report showed mixed progress on environmental sustainability overall, with forward movement in areas such as conservation threatened by the aforementioned issues of climate change and sea-level rise but also complicated by other serious challenges such as improving sanitation and water quality. Water testing data show that there remain serious quantity and quality problems related to household drinking water. On the sanitation side, the problem is two fold: 1) a significant number of households with no sanitation facilities whatsoever; and 2) strained solid waste management systems in urban centers and (increasingly) rural areas.

With nearly all of its land on or immediately adjacent to its coastline, sustainable land use management in the Marshall Islands is, by definition, a coastal management concern. The National Coastal Management Framework (2008) provides the basis for local coastal management and guides environmental concerns for strategic development. While climate change is a new and emerging challenge for the RMI, achieving economic growth as well as long-term economic and fiscal sustainability has been a dilemma of long-standing for the country. Inclusive economic development is predicated upon eradicating income poverty and hunger, reducing inequalities, and ensuring decent work and productive employment. Corresponding to the "blue economy" in which the RMI exists, fisheries have been a key source of employment and growth in recent years, with increasingly diversified operations in harvesting, processing, trans-shipment and exports. The Government is also focusing on shipping as a critical element in sustainable development of the nation, particularly with regard to outer islands development.

In 2009, progress on the MDG goal of universal primary education was on track, with expanding classrooms and a falling fertility rate as drivers. However, the report also noted that while this 'quantity' challenge is likely to be met, the 'quality' challenge of improving educational performance and outcomes must be addressed. The RMI is a matrilineal society, with children belonging to their mother's lineage and having rights to use land owned by their lineage group. Although modern pressures have changed the land tenure system in many ways, land continues to be a source of women's influence in the community. Despite the status afforded by secure land rights, improving the status of women in the modern context remains an issue of concern.

National Greenhouse Gas Inventory

The RMI Inventory for Greenhouse Gases has been estimated for the base year 2000 using the revised 1996 IPCC Guidelines for National Greenhouse Gas

Inventories, the IPCC "Good Practice Guidance and Uncertainty Management in National GHG Inventories (GPG 2000)" and software for "Non Annex1 National Greenhouse Gas Inventory Software, Version 1.3.2". Sectoral data for GHG emissions estimation was compiled from various sources primarily using available national data, data collected and presented for National Energy Report, National Waste Management Strategy 2012-2016 and other statistical reports, studies, brochures and other country specific information sources.

Total national GHG emissions excluding removals in year 2000 was 122.53 Gg CO2e; which comprises GHG emission 84.97 Gg CO2e from Energy Sector and 37.56 Gg CO2e from Waste Sector. Emissions for other GHGs like per fluorocarbons (PFCs), hydro fluorocarbons (HFCs) and sulphurs hexafluoride (SF6) are negligible in RMI as the products containing these gases are not produced in the country. The data on Agriculture, Industrial Process and land-use change and forestry (LUCF) activities were not available for RMI, therefore emissions for these sectors were not estimated and considered for year 2000.

Nearly 100% of GHG emissions in RMI come from four activities: energy industries (electricity production); transport (road); other (residential & commercial) and waste - solid waste disposal on land and wastewater handling. The largest contributor to GHG emissions in year 2000 was energy industries (electricity production) amounting to 51.37 % of total emissions. The next biggest contributor was waste management (solid waste disposal on land and waste water handling) with 330.65 % of total GHG emissions followed by road transport and other (residential & commercial) which contributed to 13 % and 4.98 % of total emissions respectively. RMI, with very limited industrial sector presence and relatively poor energy infrastructure results in high share of GHG emissions from energy sector.

The total GHG emissions increased by 22.94 % over 1995-2010, due to increase in petroleum fuel consumption and population increment. Emissions from the Agriculture, Industrial Processes, Solvent & Other Product Use land-use change and forestry (LUCF) sector were not considered in this 2000 GHG inventory. The GHG emissions for RMI for the years 2005 and 2010 has also been calculated based on the similar data source and methodology used for estimation of GHG emissions for year 2000. The quantity of CO2e emissions increased from 122.53 Gg CO2e in 2000 to 169.82 Gg CO2e in 2010.

To diversify away from nearly total dependence on diesel for power generation will require the development of domestic, renewable energy resources. Private sector participation will be an important element of achieving significant reduction in the use of diesel for power generation. The different options have very different cost structures. The sector structure as defined in the policy, legal and regulatory instruments should facilitate and encourage private participation in the electricity sector. To implement the required measures to reduce GHG emissions, RMI will need to put in place policy, measures and regulatory aspects to provide strong leadership, coordination and oversight of the energy and other sectors activities. Principles to be followed to improve the performance, sustainability and security of the energy sector include focusing on a least cost approach, managing risks, financial sustainability, social and environmental sustainability and clear, appropriate and effective definition of roles for Government, MEC and private sector.

Vulnerability And Adaptation Assessment

The Republic of the Marshall Islands is one of four countries that consist entirely of low lying atolls and islands, and which face perhaps the most urgent and daunting of climate change challenges in the world. The main climate change threats of immediate concern for the Marshall Islands include sea level rise in combination with storm surges causing flooding, accelerated coastal erosion and saline intrusion into freshwater lenses; periodic droughts associated with El Ni.o Southern Oscillation (ENSO) events and coral bleaching resulting

from increased temperature and ocean acidification in combination with extreme low tides.

The wind-wave climate of the Marshall Islands shows spatial variability between the northern and southern Islands. The wind-wave climate displays strong inter-annual variability at both Majuro and Kwajalein, varying with the El Ni..o.Southern Oscillation (ENSO). During La Ni..a years, wave power is greater than during El Ni..o years in June..September at both locations. Warming trends in annual and half-year mean temperatures at Majuro since 1955 and Kwajalein since 1949 are statistically significant at the 5% level. Maximum and minimum temperature trends at Kwajalein are much stronger compared to Majuro. The warming temperature trends at both sites are consistent with global warming trends.

When tropical cyclones affect the Marshall Islands they tend to do so between June and November. The tropical cyclone archive of the Northern Hemisphere indicates that between the 1977 and 2011 seasons, 78 tropical cyclones developed within or crossed the Marshall Islands EEZ. This represents an average of 22 cyclones per decade. According to climate models further warming is expected over the northern and southern Marshall Islands. Under all IPCC Representative Concentration Pathways (RCPs) the warming is up to 1.1..C by 2030, relative to 1995, but after 2030 there is a growing difference in warming between each RCP.

The long-term average rainfall in the northern and southern Marshall Islands is projected by almost all models to increase. The increase is greater for the higher emissions scenarios, especially towards the end of the century. The temperature on extremely hot days is projected to increase by about the same amount as average temperature. For the northern Marshall Islands the temperature of the 1-in-20-year hot day is projected to increase by approximately 0.7..C by 2030 under the RCP2.6 (very low) scenario and by 0.8..C under the RCP8.5 (very high) scenario. The frequency and intensity of extreme rainfall events are projected to increase. For the northern Marshall Islands current 1-in-20-year daily rainfall amount is projected to increase by approximately 1 mm by 2030 for RCP2.6 and by 7 mm by 2030 for RCP8.5 (very high emissions).

For both the northern and southern Marshall Islands the overall proportion of time spent in drought is expected to decrease under all scenarios. All models show that the aragonite saturation state, a proxy for coral reef growth rate, will continue to decrease as atmospheric CO2 concentrations increase (very high confidence). Projections from CMIP5 models indicate that under RCPs 8.5 (very high emissions) and 4.5 (low emissions) the median aragonite saturation state will transition to marginal conditions (3.5) around 2030. Mean sea level is projected to continue to rise over the course of the 21st century. There is very high confidence in the direction of change. The CMIP5 models simulate a rise of between approximately 7..19 cm by 2030 (very similar values for different RCPs), with increases of 41..92 cm by 2090 under the RCP8.5.

Climate change impacts are already being felt across the Republic of the Marshall Islands, including increased intensity and frequency of extreme events and droughts. Already, some of the country's northern atolls are suffering more frequent drought conditions, and much of the archipelago is under threat from storm surges and flooding. The major climate-related natural hazards impacting the Marshall Islands are sea level rise, droughts, and tropical storms and typhoons. Climate variability and change has and will continue to affect the Republic of the Marshall Islands.

The RMI's hazards and vulnerabilities are linked to both physical and social characteristics of its islands and people, in addition to ongoing unsustainable development practices. Key drivers of the RMI's vulnerability include:

- Rapid population growth and over-population in urban centres
- Environmental degradation and unsustainable development
- Localized pollution (including contamination of water supply) and waste management
- Potential climate change impacts including accelerated sea level rise, which may increase

vulnerability and exposure to shocks and stresses, as well as increase uncertainty and unexpected events

- Limited resources (particularly food, water and fuel)
- Limited economic potential due to small size and remoteness
- High exposure to external market shocks (demonstrated by the State of Economic Emergency declared in 2008 following unprecedented increases in costs of imported food and fuel)
- Sparse and scattered nature of islands and atolls, making communication and transportation to outer islands more difficult, with infrequent and at times unreliable transport links

Additional challenges include pollution and waste management, including sanitation. Outbreaks of disease via contamination of water is not uncommon ..an issue that is exacerbated by the high population densities of the urban centres.

The Joint National Action Plan (JNAP) for Climate Change Adaptation and Disaster Risk Management (2014-2018), endorsed by cabinet in 2014, provides a detailed strategy for holistically and co-operatively addressing risk in the Republic of the Marshall Islands (RMI). The JNAP draws upon and is informed by existing policies and frameworks at the national, regional and international level. At an international level, the RMI is committed to the principles outlined in the Mauritius Strategy for Sustainable Development of Small Island Developing States 2005. The RMI's National Strategic Development Plan: Vision 2018 (currently under review) provides an overarching framework for sustainable development. Containing ten sustainable development goals, Vision 2018 contains several strong linkages to disaster risk management and climate change

The identified 6 priority areas where appropriate interventions, consistent with the JNAP goals, could prove especially effective in removing obstacles and promoting DRR and CCA objectives include: Strengthening the capacity of the National Emergency Management and Coordination Office; Developing an information management system; Enhancing community-based awareness and education to change attitudes and behaviour toward effective risk reduction; Climate-proofing new water supply developments; Reviewing and revising draft building codes and Testing early warning response. RMI's JNAP identifies the strong synergies and commonalities in the DRM NAP and the NCCPF. It ensures all risks, threats and priorities are covered, by incorporating the NCCPF's five strategic goals and national priorities with the DRM NAP's ten goals. It allows for partnerships between government ministries and agencies, local governments, the non-government sector (NGOs, private enterprise, communities, traditional leaders), the donor community and regional and international agencies and organizations.

Mitigation Measures And Analysis

RMI is committed to formulating strategies, national policies and best practices for addressing GHG emissions and making a practical contribution to the global mitigation efforts. While at the same time the country is also pursuing its national and regional development priorities. This is planned to be achieved by integrating GHG abatement efforts with other social, environmental and economic priorities.

Energy is one of the crucial development indicators in any country and like the other Pacific Island Countries; RMI's primary energy needs are mainly met by imported petroleum fuel. The majority of electricity is produced from Diesel. RMI is exploring opportunities to further utilize the renewable energy sources and energy efficiency in supply and demand side. RMI is also focusing on mitigation options for emissions from transportation and other sectors. The GHG emissions from the waste sector makes a significant contribution to GHG emissions from RMI. However the limited resources (financial and technical) poses

a larger challenge in planning and implementation of GHG mitigation measures. RMI is an active participant in Pacific island regional affairs and has signed on to a number of regional policies and initiatives that have implications for climate change mitigation.

Based on the available data and the observed trend for the years 2000, 2005 and 2010, GHG emission profile (excl. removals) for RMI under the business as usual scenario were projected to increase by 77.50 % between 2000 and 2025, with an average increase of 8% per year. The emissions scenarios illustrate that without intervention, emissions are projected to rise sharply over the next decade due to increased fossil fuel consumption. It is important, however, to note that even with this growth RMI's emissions will still be small compared to other developing countries, in both absolute and per capita terms. There is significant potential for RMI to reduce the GHG emissions by implementing renewable energy technology in the energy sector and energy efficiency in supply and demand side. This investment is largely beyond RMI's financial capacity and is only achievable with support from development partners. New breakthroughs will be needed to tackle other sectors' emissions. This will also depend largely on progress made in developing viable options for the reduction of emissions from other sectors.

The chapter outlines RMI's contribution towards global climate change mitigation efforts, including effectiveness of potential greenhouse gas abatement actions for long-term sustainable development including priority climate change mitigation areas that require international support.

Other Relevant Information

The chapter details RMI's capacity to respond to climate change including implementation strategies and key initiatives. It also discusses issues and challenges to integrate climate change with long term sustainable development goals such as the need for technology transfer, appropriate policies, research, data and information gaps.

CHAPTER 1
National Circumstances

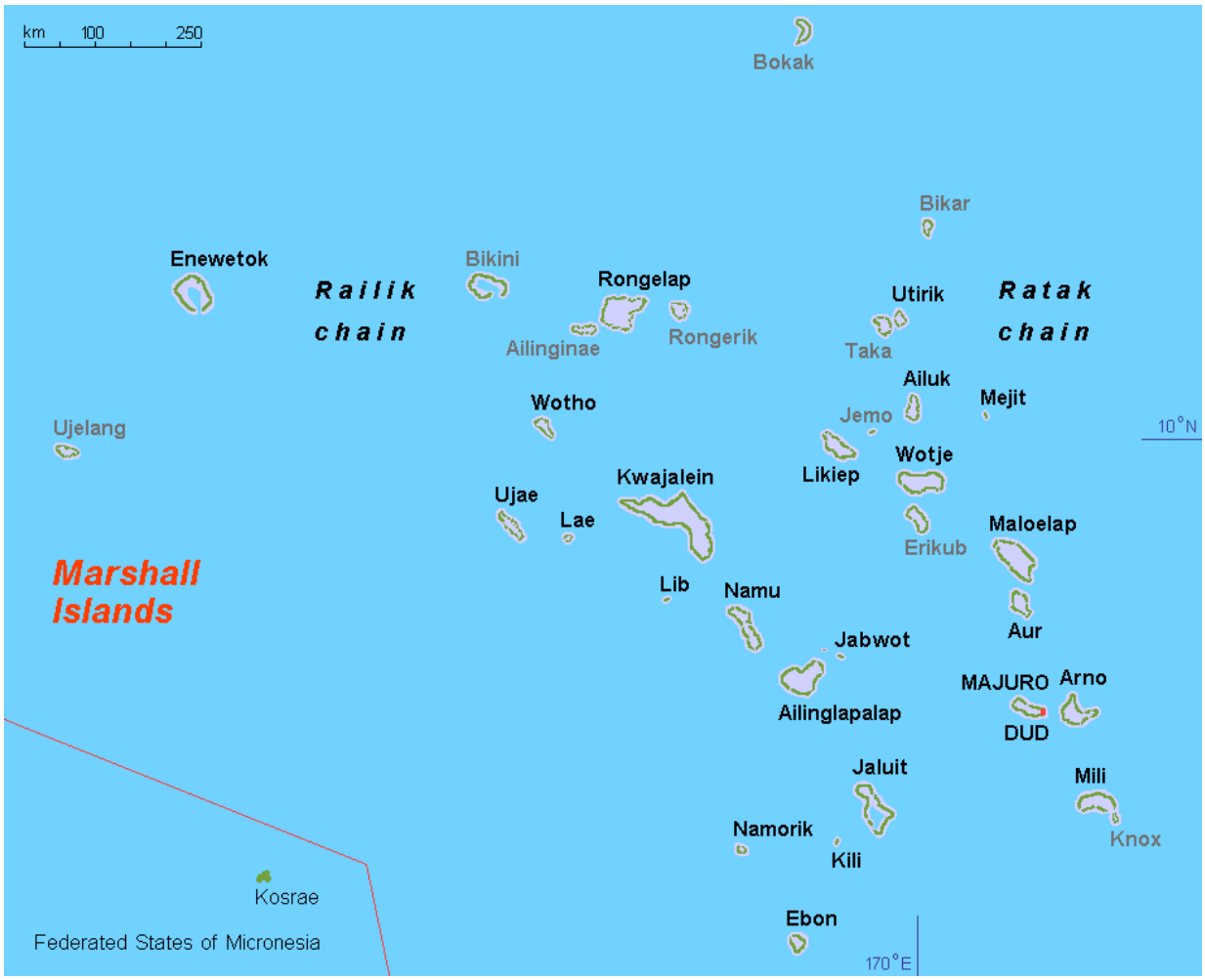
Introduction

The RMI is in the northern Pacific Ocean, and is part of the larger island group of Micronesia, as illustrated in figure1. The RMI has built a very close relationship with the United States (US) since 1944 when the US gained military control of the Marshall Islands from Japan. It subsequently provided defence, subsidies and access to social services under a Compact of Free Association that entered into force in 1986. This was amended in 2003 to provide around US dollars (USD) 70 million each year over the period 2004-2024.

The isolated location of the country and the small, sparsely distributed population mean that RMI suffers the common obstacles to development experienced by other small island developing states (SIDS); a small domestic market; difficulty in achieving economies of scale in production, large distances from import and export markets and associated high transportation costs, high transportation costs domestically, and very high energy costs.

The islands have few natural resources and are therefore heavily reliant on imports; agricultural production is primarily of subsistence nature; and small-scale industry is limited to handicrafts, tuna processing

Figure 1: Map of RMI



Source: Wikimedia Commons

and copra. Tourism provides a small source of foreign exchange, but is not as well developed as in several other Pacific Island countries, and currently employs less than 10% of the labour force. RMI is heavily dependent on external assistance; since independence, grants have averaged 60% of government revenue. A Compact of Free Association signed in 1986 and renewed in 2003 guarantees annual financial aid from the US until 2023.

Geography

The RMI consists of two groups of atolls and islands in the Central North Pacific Ocean about 3,200 kilometres (km) away from both Honolulu and Tokyo. Twenty-two of the 29 atolls and four out of the five small raised coral islands are inhabited. The atoll islands are typically several km long and are rarely more than 200 metres (m) in width. The maximum height above sea level of almost all the land is rarely more than 2 m.

Photo 1: RMI Kwajalein and Majuro Atolls

The islands of Bikini and Enewetak are former U.S. nuclear test sites. The Kwajalein atoll, famous as a World War II battleground, surrounds the world's largest lagoon and is used as a U.S. missile test range. The island city of Ebeye is the second largest settlement in the Marshall Islands, after the capital of Majuro, and one of the most densely populated locations in the Pacific.

Climate

The moist, tropical climate of the Marshall Islands is heavily influenced by the north-east trade wind belt. While trade winds prevail from December through April, periods of weaker winds and doldrums occur from May through November. Annual rainfall varies considerably from north to south within the archipelago, the southern atolls receiving 300-340 cm and the northern atolls receiving 100-175 cm.

The average annual temperature is 27.C, with monthly means scarcely varying from 26.9.C to 27.1.C. The maximum daily variation is about 7.C. Temperatures are much the same throughout the country. Relative humidity ranges from 86 per cent at night to a low of 76 per cent at noon. Although hot and moist, the climate is also sunny, since rain storms seldom last longer than a few hours.

There is some climate seasonality, marked by changes in rainfall and wind speeds; there are also significant regional variations in rainfall. The southern atolls, including Majuro, where long-term weather data exists have high rainfalls that average between 3,000 to 4,300 mm whereas the northern atolls receive 1,000 to 1750 mm. The northernmost atolls (Wake, Taongi and Bikar) are direr, support limited flora and fauna and have not been occupied in recent times.

Photo 2: RMI Environment

Annual rainfall in Majuro averages 3,500 mm and there are seasonal variations between the dry months of December to April, with February having an average rainfall of 158 mm, and the wet months of April to November, with October having an average rainfall of 390 mm. Rain usually occurs in brief storms, hence sunshine hours are long. Trade winds prevail in the dry months whereas weaker winds, and occasional doldrums conditions, prevail in the wetter months. Major storms do not often impact the Marshall Islands, but typhoons and hurricanes frequently originate in the area, gathering strength as they move away from the equator.

Demographics

The RMI has a population of 53,000 people. The Marshallese reside on approximately 24 municipalities including atolls and individual islands. Majuro, the capital city, is the most populated atoll with 52% of the country's population; 27,800 people live within the Majuro Atoll and 21% (11,400 people) reside on Ebeye within the Kwajalein Atoll, which is approximately 250 miles northwest of Majuro. The next three most populous atolls are Arno (1,794 people), Jaluit (1,788 people), and Ailinglaplap (1,729 people).

The RMI's population is 92.1% Marshallese, 5.9% mixed Marshallese, and 2% of the population is of a non-Marshallese ethnicity. The official languages of the RMI are Marshallese, which is spoken by 98.2% of the population, and English, with 1.8% of the population speaking other languages. The net emigration rate on the RMI is 5/1,000 people with annual rates of outward migration averaging 1.7% since 2003.

Photo 3: Glimpse of Marshallese Demographics

In signing the Compact of Free Association Agreement in 1986, the Marshall Islands became a Freely Associated State with close ties to the United States, mutually terminating the U.S. trusteeship over the islands that had been assumed after World War II. Under the Compact, the Marshall Islands became a sovereign nation, but as amended in FY 2004, the U.S. Government provides annual payments to the Government of the RMI through FY 2023. The broad goal of the payments is to assist economic development towards "self-reliance." Payments include grants, trust fund contributions (for use after FY 2023 annual payments cease), and lease payments for U.S. Department of Defense (DOD) use of multiple islets in the waters around the Kwajalein Atoll. Grant money goes towards projects selected by the RMI, but the projects are reviewed and approved through a joint committee of both U.S. and RMI government personnel to "strengthen management and accountability." Grant money is disbursed to support the following sectors: education, health, infrastructure, environment, private sector, and capacity building, with some money specifically allocated to "address the special needs of the community of Ebeye and other communities within the Kwajalein Atoll.

Most of the outer island population is a subsistence economy. On the urban atoll of Majuro, the government is by far the largest employer and is heavily dependent on US Compact and development partner inputs. Known as bunkering, diesel fuel exports are supplied to foreign fishing fleets operating in the area, providing some export income. Remittances from family members overseas - mostly in the US - are also significant. Income from the US military base on Kwajalein completely supports the Ebeye population.

The RMI economy experienced negative growth in 2008 and 2009 during the international recession. In June of 2008, the government of the RMI declared a State of Economic Emergency due to high food and fuel prices. Recent strong economic growth in 2010 is attributed to low inflation and expansion of the fisheries sector, according to a DOI report. However, growth in 2011 was less than 1%, blamed in part on high commodity prices.

Climate Change

In a low-lying atoll nation such as the RMI, extremely high vulnerability to the impacts of climate change… sea level rise, coastal erosion, impacts on plants and animals, and changes in rainfall patterns … makes climate change an environmental sustainability issue, exacerbate development pressure and a security threat.

Photo 4: Prestine RMI Marine Environment

In 2011, the RMI Government adopted the National Climate Change Policy Framework (NCCPF), which sets out the RMI's commitments and responsibilities to address climate change. The NCCPF recognizes that climate change exacerbates already existing development pressures. These pressures arise from extremely high population densities (on Ebeye and Majuro in particular), rising incidences of poverty, a dispersed geography of atolls over a large ocean area (making communication difficult and transport expensive), and a small island economy that is physically isolated from world markets but highly susceptible to global influences. Environmental pressures are also acute, with low elevation, fragile island ecosystems, a limited resource base and limited fresh water resources (exacerbating the reliance on imports) resulting in an environment that is highly vulnerable to overuse and degradation.

Partnerships at all levels of society are key to a successful strategy for responding to climate change. The Micronesia Challenge is an example of a sub-regional partnership that has been translated into local action through the RMI's community-based conservation area management framework called Reimaanlok. As part of the MC/Reimaanlok, the RMI is working to preserve its cultural heritage through effective conservation of natural resources thereby enhancing resilience to impacts of climate change. The Reimaanlok strategy provides relevant agencies with a collection of tools for community engagement. If the Reimaanlok strategy could be coordinated across sectors and support provided for stronger decision-making and oversight, it could help enormously in addressing any disconnect between international measures, government policies, non-government organizations and civil society.

Gaps to be addressed include severe lack of capacities to manage funds that are available and accessible from international sources to support development, financing challenges, the need for enhanced technical capacity, and systematic mainstreaming of climate change considerations into development strategies and activities. In terms of financing challenges, each MC jurisdiction has developed a draft sustainable finance plan for achieving its goals under the Micronesia Challenge. These plans include an estimate of the overall costs of achieving the Micronesia Challenge goals, an assessment of internally-sourced existing and potential revenues for these costs, a calculation of the "gap" between the costs and existing and potential funding, and a unified regional plan to achieve a MC target endowment of $58 million to fill the gap. Specific to the RMI, a target endowment of $13 million has been determined, and to date over $2 million has already been raised. Bolstered by the burgeoning merits of biodiversity and healthy ecosystems including the mitigation of and adaptation to climate change, the RMI is championing new thinking and innovative ways of engaging development partners and countries to raise the remaining amount. The RMI carries national debt of over $70 million with debt service projected to last 25-35 years, and is actively pursing "debt for adaptation swap" opportunities based on the premise that the Micronesia Challenge/Reimaanlok is an effective tool to alleviate poverty while also increasing national economic stability and climate change resilience.

Photo 5: King Tides and Storm Surge in RMI

Data management also remains a key gap to be addressed in RMI's response to climate change. Topographic data and GIS layers relevant to climate change management in the Marshall Islands remain to be digitized from old maps, created from fieldwork, and/or consolidated. These data are the building blocks needed to develop models to simulate weather events and impacts. One recommendation that has been made is to support a nascent GIS users group by establishing a National Spatial Analysis Facility (NSAF) at the College of the Marshall Islands.

With support from SPREP and Canada Aid, another recommendation the Government has begun outlining

is for a proposed new Ministry of Environment, Energy, and Conservation headed by a new Minister who would oversee the implementation of the NCCFP, JNAP, and other corresponding resource management policies and action plans. The Office of Environmental Planning and Policy Coordination (OEPPC) is currently devising a work plan to engage with as many stakeholders as possible to ensure the value and viability of this landmark Government reform. A similarly far-reaching proposal is underway for the RMI to take on an enhanced profile within the Kyoto Protocol Adaptation Fund as an accredited National Implementing Entity. However, the associated challenges in terms of managing such small funding initiatives need to be duly taken into consideration. This includes building individual capacities for effective management of development projects including strengthened capacities at systemic, institutional and financial levels.

Natural Disaster Preparedness

In a multi-stakeholder process conducted in 2010-2011, the Joint National Action Plan for Disaster Risk Management and Climate Change (JNAP) for RMI was developed. The JNAP Matrix aligns with actions identified under the RMI National Action Plan for Disaster Risk Management 2008-2018 and the aforementioned NCCPF. At the national level, the JNAP Matrix provides a comprehensive guide to the needs of the RMI with regards to reducing risk relating to disaster and climate change.

Externally funded DRR and/or CCA partnerships include UNDP-GEF funds for the Pacific Adaptation to Climate Change (PACC) project focusing on water resources, funds from the East-West Centre, Australia's Pacific Climate Change Science Program, and newly announced EU funds from the EDF10 funding stream. Additional support was identified from Compact Funding and USAID, ROC Taiwan, AusAID and regional partners including SOPAC-SPC, ADB, WHO and SPREP. The Bureau of Oceans and International Environmental and Scientific Affairs (OES) grant through the US Embassy Majuro is funding the position of Senior Technical Advisor for Climate Change, based at OEPPC.

AusAID is funding the positions of senior technical advisors at the Majuro Water and Sewage Company (MWSC) and a Climate Change Clerk based at the RMI legislative Office of the Nitijela. Effective coordination at the national level is paramount to achieving the full benefits of various DRR/CCA project/funding streams such that there are no gaps in services, and that outcomes prove sustainable over the long-term. Moreover, while there are numerous sources of external donor funding for DRR and CCA.

There also remains limicity to undertake DRR/DRM activities both from a human resources and financial perspective. While Local Governments for Majuro and Ebeye have disaster risk reduction plans in place, outside of the more urbanized areas, disaster risk management has been primarily reactive than proactive. According to the National Progress Report on Implementation of the Hyogo Framework 2011-2013, "Strengthened capacity, through appropriately resourced focal points in relevant

Table 1: Recent disaster events affecting the RMI

Year	Event	Area(s) affected
2013	Drought	15 atolls/islands north of Majuro (above 8°N latitude)
2013	Sea swell, King Tide	Majuro
2008	Sea swell, King Tide	Numerous Pacific locations including the RMI
2008	State of Economic Emergency	All of RMI
2007	Severe Drought	Majuro, Utrik, Wotho, Lae, Namu, Ailuk
1998	Severe Drought	All of RMI
1997	Typhoon Paka	Majuro, Aillinglapalap, Namu
1994	High Surf Wave Action	Ajeltake
1992	Typhoon Gay	Majit
1992	Tropical Storm Axel	All of RMI
1991	Typhoon Zelda	All of RMI
1988	Tropical Storm Roy	Kwajalein
1979	Sea swell	Majuro

Source: Republic of the Marshall Islands Joint National Action Plan for Climate Change Adaptation & Disaster Risk Management 2014-2018

offices, is needed at the national level to ensure the JNAP, as the key policy document for DRR/DRM and climate change, is implemented across all sectors."

The Ministry of Internal Affairs (MoIA) is becoming more proactive and better recognized as a key link between national and local levels particularly for DRR/DRM issues. Annual Mayors Conferences and Mobile Teams, organized through MoIA, allow for the communication of important issues (including DRR/DRM and climate change issues) between the national and local levels. Drought relief efforts following the May 2013 Presidential Declaration of Disaster across 14 northern atolls have allowed the Government and development partners to enact what appears to be highly effective disaster relief protocols, though this is ongoing and too recent for closer analysis in this report.

Energy

Successful reform of the energy sector in the RMI in recent years showcases the progress that can be made when local political will and resources are matched with assistance from the international community. The emerging crisis in FY2008 with the onset of the world recession and higher fuel prices precipitated a financial crisis at the Marshalls Energy Company (MEC), which in turn threatened the fiscal stability of the nation. There has been a turnaround at MEC since 2010, when the utility forged ahead on a reform plan that not only allowed it to stabilize power generation, but also gain financial breathing room with lower-interest loans from the ADB and US government's Rural Utility Service.

Key to this success has been the Ministry of Resources and Development Energy Office, which has been able to bolster its technical expertise with the assistance of partners such as the European Union, AusAid, World Bank, Taiwan and Japan and UNDP/GEF to aid in the development and implementation of the RMI National Energy Policy and Energy Action Plan 2009. The RMI Energy Policy and Action Plan clearly sets out electrification, renewable energy (RE), and energy efficiency (EE) goals tied to outputs in 2020.

The National Energy Policy is currently under review and will be based on a National Energy Balance, which will account for various energy sources that RMI uses, how each energy sources are utilized in the various end

Photo 6: Renewable Energy Installations in RMI

sectors of RMI, as well as stock-piles and losses. The National Energy Balance will be compiled during the second half of 2015. The energy policy review willassess the actions currently appropriate to implement the policy, and to consider whether amendments to the policy are needed. Many of the actions proposed at the time the National Energy Policy was adopted have been initiated, and substantial progress has been made in reaching the targets set in the policy. Given technological advancements, and especially the greatly reduced production cost of solar photovoltaics, the review aims to modify these actions and initiate a new round over the next five years.

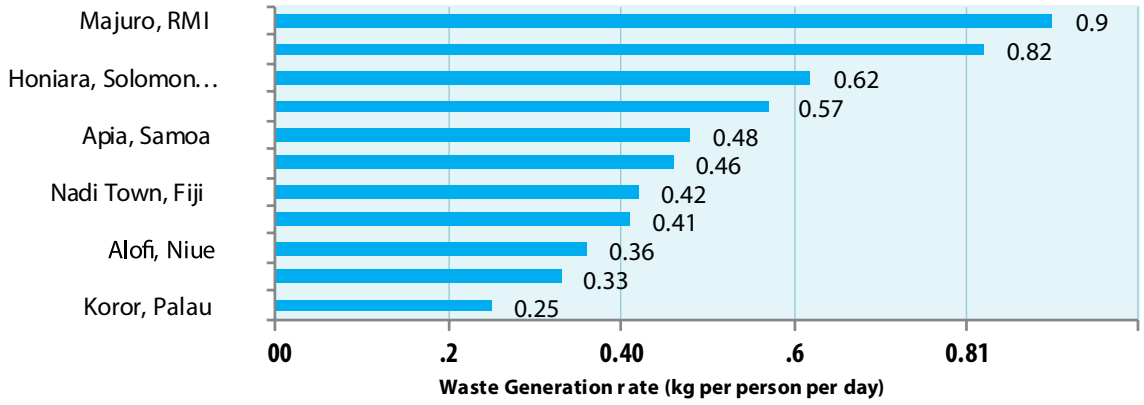
Following a major fuel price spike in July 2008, the RMI Government declared a state of economic emergency. This rapidly drew increasing attention to the scale-up of renewable energy as a fossil fuel replacement. Thus far, the emphasis has been mainly on solar - a familiar technology in the RMI. There are thousands of solar installations on households in the outer islands. The wind resource is under evaluation but no generation trials have yet taken place. In addition, the use of coconut oil as a generation and transport fuel is being seriously considered. Tobolar, the coconut mill owned by the government, has conducted pilot projects, while electricity generation trials are planned by the Marshalls Energy Company (MEC), one of the key utilities.

Challenges intrinsic to the renewable energy sector were highlighted within the Outer Islands Electrification Program in a mid-term review (MTR) of the EU/SPC North Pacific Renewable Energy Program. In essence, the installed energy equipment needs to be routinely maintained. A sustainable financing mechanism to address this need is now being piloted whereby rural women's incomes are increased through handicraft sales specifically for PV payments. Other challenges common across development partner funding streams were also highlighted in the MTR, including bureaucratic and equipment delivery delays. Similar challenges have thwarted the UNDP/GEF Action for the Development of Marshall Islands Renewable Energy (ADMIRE) project, which was recently taken over by the Ministry of R&D in an effort to streamline more effectively with the Energy Division work plan. The ADMIRE project has helped RMI to develop capacities in renewable energy technology through training, trialling and monitoring of renewable energy sources; strengthen institutional capacities, policies and regulatory support; support the renewable energy finance and market development; and conduct advocacy and awareness programmes.

Waste

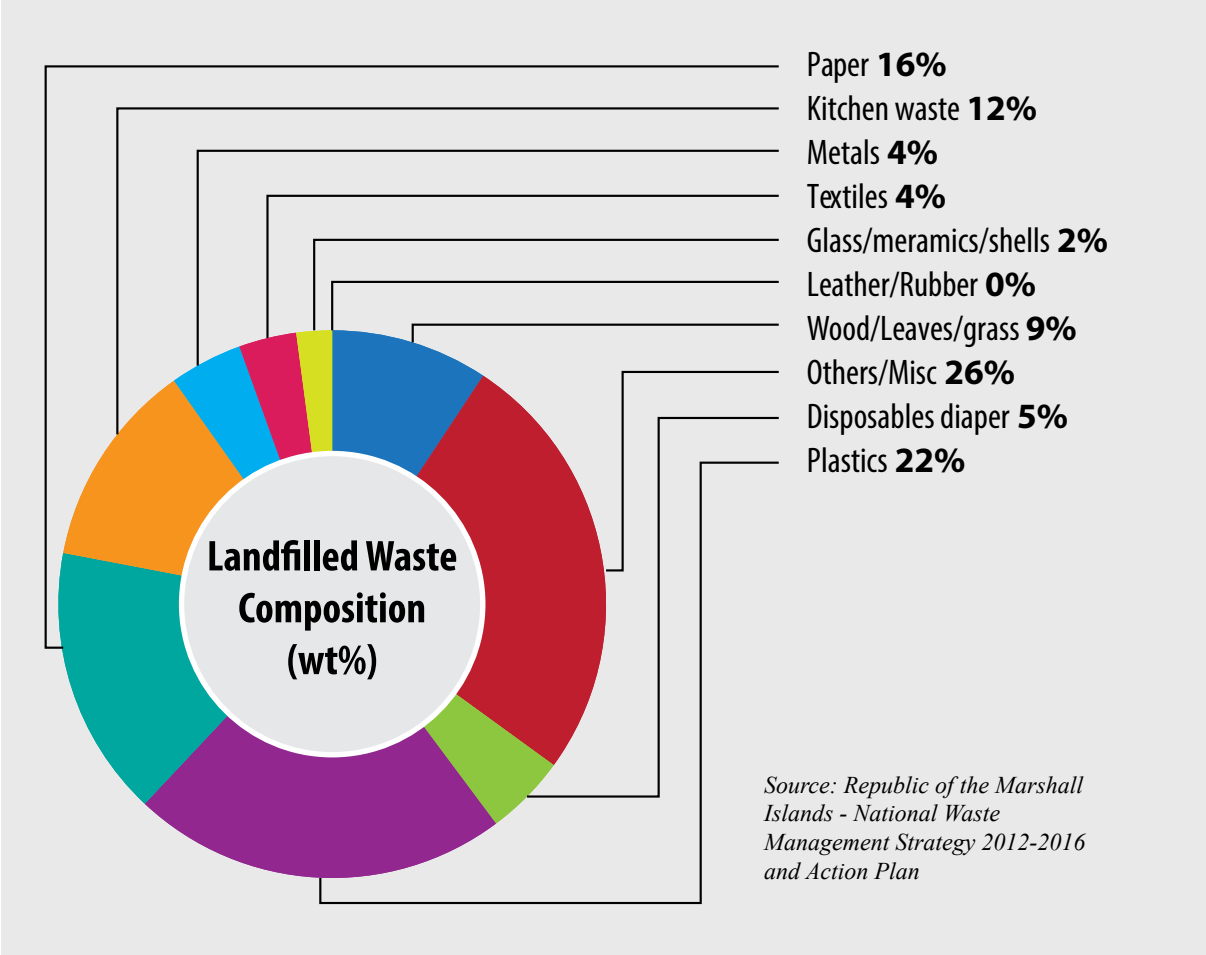
Waste management is among one of the top priorities for action in the RMI. As the RMI develops, the amount

Figure 2: Average Waste Generation Rate in Pacific



Source: Republic of the Marshall Islands - National Waste Management Strategy 2012-2016 and Action Plan

Figure 3: MSW Composition in RMI



of waste generated will likely increase and the nature of the waste will change and will include increasing quantities of toxic elements such as electrical and electronic wastes, chemical wastes, and used oil. As an atoll nation, the RMI lacks the suitable land space to accommodate environmentally sound disposal facilities for these changing waste streams and simply cannot afford to increase its waste generation. Any suitable and available land requires large investment in infrastructure and environmental protection systems to preserve the integrity of the coastal marine environment and potential underground water resources.

There are several waste management initiatives which have been started in recent years, and which demonstrate the potential for keeping RMI's waste management issues under control. These include the composting operation, scrap metal recycling, production of paper fuel briquettes, reusable bag campaign, and community-based waste separation. The challenge is to scale-up these initiatives and introduce additional complementary measures to reduce the quantity of solid waste that has to be managed and disposed of to land. Human and institutional capacity to manage these programs is also essential and must be addressed if the programs are to be successful and sustainable.

A waste characterization study was completed for Majuro in 2010 through a JOCV. The results showed that about 20.4 tons of waste was disposed of every day, with each person generating an average of 0.9 kilograms per day. This is the highest generation rate among several Pacific Islands urban centers.

Water and Sanitation

The RMI's 2009 MDG Progress Report showed mixed progress on environmental sustainability overall, with forward movement in areas such as conservation threatened by the aforementioned issues of climate change and sea-level rise but also complicated by other serious challenges such as improving sanitation and water quality. Water testing data show that there remain serious quantity and quality problems related to household drinking water. On the sanitation side, the problem is twofold: 1) a significant number of households with no sanitation facilities whatsoever; and 2) strained solid waste management systems in urban centers and (increasingly) rural areas.

The 2010 Majuro and Kwajalein Atoll Water Survey Report identified the following gaps/needs: a need for more household water catchments in anticipation of the growing trends of water borne diseases/illness in both rural and urban pockets; an equal need for focused attention to environmental health through better surveillance, particularly with the use of GIS systems; improving public awareness about water and allied preventive health issues; and stepping up the government's ability to supply water in the extended dry periods or in the aftermath of a natural disaster.

Progress is being made with the following strategic partnerships in place: UNDP/GEF SOPAC/SPC (Pacific IWRM Project), UNDP/GEF SPREP (PACC and PACC+ Projects), ADB and AusAid (Ebeye Water and Sanitation Project), Forum Secretariat through the Pacific Environment Community Fund (Potable Water Solutions for Outer Islands Proposal), and GIZ (Coping with Climate Change in the Pacific Island Region Project). The challenge in this area, as in others, is managing for development results, coordinating the work and outcomes of these various project/funding streams such that there are no gaps in services, and that outcomes prove sustainable over the long-term.

Coastal management and land use planning

With nearly all of its land on or immediately adjacent to its coastline, sustainable land use management in the Marshall Islands is, by definition, a coastal management concern. The National Coastal Management Framework (2008) provides the basis for local coastal management and guides environmental concerns for strategic development. The framework was developed following considerable consultations with stakeholders and sets out arrangements and activities for coastal zone management in the RMI.

Photo 7: Water Sector Climate Change Adaptation Initiatives in RMI

Photo 8: Construction of Runway Safety Area (RSA) Barrier Wall

The Coastal Management Advisory Council was established by the Marshall Islands Marine Resources Authority (MIMRA), RMI Environmental Protection Authority, College of the Marshall Islands (CMI), and the Marshall Islands Conservation Society (MICS) to assist local government councils to formulate fishery management plans and fisheries management ordinances, and to harmonize efforts in facilitating the implementation of community fisheries management programs to all communities of the RMI. Over the years the group has expanded in membership to include the Ministry of Resources and Development, Marshall Islands Visitors Authority (MIVA), OEPPC, the Historic Preservation Office, and Women United Together in the Marshall Islands (WUTMI).

Land issues are highly sensitive in the RMI and it is challenging to offer advice to the landowners on how to use or develop their land. There remains a need for public awareness campaigns relating to why certain legal regulations exist and what sustainable development means, i.e. to maintain a healthy environment and to ensure future generations have access to resources such as water, food and land. Mechanisms like the Reimaanlok strategy that involve local stakeholders, in particular landowners, in coastal and land use planning processes must also be applied in urban areas.

Biodiversity and Natural Resources

There is no written record of the original vegetation of the Marshall Islands, and no endemic species are known today. Archaeological evidence suggests that humans have inhabited the atolls for over 3,000 years and that these early inhabitants probably altered the vegetation of the atolls by introducing plants used for food and craft materials. Furthermore, during the twentieth century, coconut plantations established by the German, Japanese and American administrators replaced most of the original vegetation. Today, over 60 per cent of the nation's total land area is covered by coconut palms.

Photo 9: RMI Marine Biodiversity

Nine unique mangrove forests are located on the islands within Jaluit Atoll. The largest of the mangrove forests, estimated to be approximately 4 kilometers long and 0.5 kilometers wide at its widest point, is located on Jaluit Jaluit. Three species of mangroves have been identified in this area although it is possible other species are also present.

Freshwater lakes are rare in the Marshall Islands. Only one island, Mehit features a fresh to brackish water lake. Several large islets have central depressions with small brackish water swamps. For the most part however, fresh water resources are limited to sub-surface, Ghyben-Herzberg lenses, generally located on larger islets. Such lenses consist of fresh water "floating" on a denser seawater layer just below the surface. Regularly replenished by rainfall, these lenses can usually be accessed by digging down one to eight feet. The water is often "hard" or "limey", but it is not brackish. As these lenses are not uniformly present, most of the inhabited islands rely heavily on rainwater catchment systems to help meet fresh water needs.

Seventy bird species (mainly seabirds and migratory birds) are reported to be found in the RMI. Of the 31 species of seabirds found, 15 are reported to breed in the islands. No terrestrial mammals are found in the Marshall Islands other than humans and the Polynesian rat it is recorded the presence of seven species of lizards and one species of blind snake in the Marshall Islands but noted that none of these species was endemic to the RMI.

The sea is home to the largest number of Marshalls' species, with over 90% of animals and a large percentage of the plants in the country classified as marine. Among the 1,000 plus species of fishes, 864 are inshore species (found down to a depth of 200 meters or about 700 feet), 121 deep water, 67 open ocean (undoubtedly there are many more), and actually 7 freshwater/brackish water. Almost all are native, with only 6 species that appear to be introduced, mainly recently and into freshwater. There are 7 species and subspecies endemic to the Marshall Islands and another 17 to the Marshalls and other Pacific Islands. There are also endemic mantis

Photo 10: RMI Terrestrial Biodiversity

shrimps, pycnogonid, bryozoa, lamp snail, crinoids, and other species from families, orders and phyla with which many people are not familiar.

Five species of marine turtles occur in the Marshall Islands with at least two species (hawksbill and green turtle) known to nest in the islands. A compilation of published records of marine algae found in the Marshall Islands lists a total of 238 species of green, brown, red, and blue-green algae and the Republic has begun to explore the potential for the commercial production of this resource.

Several preliminary studies undertaken by foreign researchers have confirmed the presence of limited phosphate deposits and extensive quantities of manganese in sea mounts located within the RMI's EEZ.

Economic Inclusiveness

While climate change is a new and emerging challenge for the RMI, achieving economic growth as well as long-term economic and fiscal sustainability has been a dilemma of long-standing for the country. It is a dilemma that must be discussed in the context of the RMI's Compact of Free Association agreement with the United States. Payments by the US under the Compact have contributed an estimated 50-70 percent of Gross Domestic Product since 1986. And yet, despite high levels of assistance under the Compact, the RMI economy has failed to grow in any sustained manner and trends in social indicators are worrying.

Inclusive economic development is predicated upon eradicating income poverty and hunger, reducing inequalities, and ensuring decent work and productive employment. In 2009, the RMI's progress on MDG Goal 1, Eradicate Extreme Poverty and Hunger, was mixed. While the RMI did not yet have abject or extreme poverty, the RMI was not on track to meeting the three targets under MDG1. More recently, the 2010 Majuro and Kwajalein Household Water Survey concluded that poverty was a real and serious problem in urban areas of the RMI, with households facing problems such a no water, no electricity, high unemployment, stagnant wages, rising prices, a need for improved government services, and access to information.

State Owned Enterprise (SOE) Reform

While MEC has had success in its reform efforts, the fact remains that there is an urgent need for broad based SOE reform. The level of subsidy and capital transfer to SOEs amounted to over $8 million per year on average during the FY2009-FY2011 period. The subsidy required by SOEs, which doubled in the past decade, amounts to about 25 percent of the government's locally generated revenue.

Partnerships supporting SOE reform include the ongoing Public Sector Program (PSP) supported by the ADB. As part of the PSP, the Cabinet endorsed a set of good practice principles and a new SOE act was introduced into the Nitijela in September 2012. Specific to the telecommunications sector, the World Bank announced the launch of a multi-million dollar strategy to "reform the telecommunications sector and boost access to mobile phones and internet" in the Marshall Islands. The World Bank project, which is being run in partnership with the Ministry of Finance, aims to help Marshall Islands attract new investment in telecommunications and bring down service costs, including through increased competition. The Marshall Islands National Telecommunications Authority (NTA), which currently enjoys a monopoly in this area, says it supports reform, but questions key elements of the World Bank's planned intervention.

Fisheries

Corresponding to the "blue economy" in which the RMI exists, fisheries have been a key source of employment and growth in recent years, with increasingly diversified operations in harvesting, processing, trans-shipment

and exports. The RMI is benefiting from its participation in the Parties to the Nauru Agreement (PNA), which has more than doubled tuna revenue in the last two years. The PNA also fosters the sustainability of fishery activities through enforcing and exchanging vessel days, which will contribute to sustainable growth over the longer term. Sustainable development of coastal fisheries through is also well underway, following ecosystem based management guidelines established under the Reimaanlok mechanism to assist local governments to formulate fishery management plans and fisheries management ordinances, and to harmonize efforts in facilitating the implementation of community fisheries management programs.

Photo 11: Tuna one of the Key income source for RMI

The Marshall Islands Marine Resources Authority (MIMRA) has evolved as fisheries activities have expanded. The organization has an increasing focus on policy development, participation in regional and international forums, implementation of international treaty requirements and enforcement of new domestic fisheries laws, such as the ban on sharking finning instituted in 2012. The National Fisheries Development Plan and revised Marine Resources Act are two of the most proactive national fisheries documents in the region. MIMRA also operates a National Fisheries and Nautical Training Center, training 75 students per year. Students learn skills that enable them to work on commercial fishing vessels. Several graduates are currently employed on US fishing vessels and reviews from vessel owners and operators regarding these Marshallese fishermen have been positive and encouraging. The construction of a service center for fishing vessels has been identified as a feasible investment opportunity for foreign investors.

Agriculture/Copra

The Government's latest agriculture planning documents are the R&D Strategy and Action Plan 2005- 2010 and the RMI "State"-Wide Assessment and Resource Strategy 2010-2015+. Over the years, the Ministry of R&D Agricultural Division has consistently exercised a facilitating and guidance role in the delivery of services to increase agricultural production across the Marshall Islands and corresponding decrease in consumption of imported goods. This has resulted in greater understanding of growers' situations and their subsequent involvement in identifying and selecting sustainable development options.

A major challenge is the cost of imported versus local food. For local food to be embraced, it must fetch a price that farmers are willing to accept for their efforts. At the same time, consumers must see local foods as an attractive alternative, both economically and via the health and nutritional benefits. For the latter to be achieved, greater educational awareness on the health

Photo 12: Agricultural Produce of RMI

outcomes of food is required, especially given the high rates of non-communicable diseases such as diabetes, obesity and cardiovascular diseases.

Within the Ministry of R&D, the "Coconut Tree of Life" Development program represents an integrated approach to the development of coconut resources in the RMI. Key stakeholders and partners include Tobolar Copra Processing Authority, WAM, SOPAC, FAO, SPC, APPC, and USDA Forestry Service. Replanting and rehabilitation of coconut trees, a major component of the program, was successfully launched in 2012.

In this same vein, Tobolar has itself developed a Strategic Reform Plan for 2012-2016. Funded with assistance from the ADB, the plan shows how copra processing will be expanded and improved while production is diversified into high value coconut products to increase income of coconut producers. Tobolar also recently signed copra cake supply contracts with companies in Vietnam, Taiwan and the Federated States of Micronesia. The latter is key because copra is the main income source for outer islanders who have seen their quality of life decline in recent years and who stand to gain from increased demand for copra products.

Shipping

The Government is focusing on shipping as a critical element in sustainable development of the nation, particularly with regard to outer islands development. The RMI ship registry is currently the third largest in the world shipping business, having grown by 17% during 2014. As of the end of February 2015, the Registry stood at nearly 118 million gross tonne and over 3,400 vessels. Domestically, the RMI will benefit in 2013 from the receipt of two new ships funded by the Government of Japan. This will assist enormously in the transport and services needed for the outer islands. The Government Shipping Vessels Maintenance Fund Act 2011 has been passed to ensure that funds are aside for maintenance, dry docking and safety equipment.

Regionally, the RMI partnered with Kiribati, Nauru and Tuvalu in 2010 to form the Central Pacific Shipping Commission (CPSC). The CPSC represents an effort to jointly regulate international shipping services, and to provide for regular and affordable shipping services to many of the region's island states.

The improvement in shipping services to the RMI and neighbouring Pacific Islands Countries and Territories (PICTs) within the context of sustainable development will require multilateral actions, including decisions by individual Governments. However, to obtain economic and political leverage, regional and international cooperation by PICTs is also necessary.

Seventy percent of the RMI's national energy expenditure is on transportation, in common with most island countries. Vulnerability to energy shocks especially in transportation is amongst the greatest economic hazards for Marshall Islands. Increasing fuel efficiency and gradually substituting renewable biofuels and energies in transportation would reduce the Marshall Islands socio-economic vulnerability to external oil price rises, and also move the nation toward energy independence.

Tourism

Slow growth and in some years decline have characterized the RMI tourism sector since its formal inception in 1997 through the Tourism Amendment Act, so that tourism in the RMI remains in its early stages of development. While the RMI has a small inventory of rooms, it continues to struggle to fill its existing capacity ..national occupancy rates have remained low over the past decade, with occupancy estimates below 30%. Although tourism arrivals continue to be relatively small in comparison to other Small Island States, tourism development remains a Government priority for sustainable development. Following a national tourism summit in November 2007 help by the Marshall Islands Visitors Authority (MIVA), the RMI formulated its National Tourism Development Plan 2008-2011. By country of origin, the United States and Japan remain as the top markets for the RMI, with scuba diving and more recently surfing visitors drawn to the many pristine and remote destinations within the RMI.

Challenges to tourism development include in envisaging its development profile, difficulties in doing business in the RMI, untrained and unexposed tourism workers, substandard infrastructures, cumbersome and expensive domestic and international travel; unexplored sea-bed tourism; and weakness in both policy and planning. Small-scale operations, such as diving and surf company Indies Trader, can have a large and positive impact.

Health Care

In the RMI, the health care system is comprised of two hospitals, one in Majuro and one in Ebeye, and fifty eight (58) health care centres in the outer atolls and islands. Both hospitals provide primary and secondary care, but limited tertiary care. Patients who need tertiary care are referred to Honolulu or the Philippines (off-island referrals consume much of the health resources). Over the last decade, the people of the Marshall Islands have seen improvements in health indicators with decreases in maternal and child mortality.

Photo 13: RMI Tourism Hotspots

A sedentary lifestyle and processed foods have brought about a sharp rise in the levels of adult obesity and non-communicable diseases (NCDs). Diabetes-related diseases and cancer are now the leading causes of death. High population growth and crowded conditions in urban areas have also contributed to the re-emergence and/or rise of certain communicable diseases, such as tuberculosis and leprosy. Other areas of concern include malnutrition in children, immunization coverage, a high teen pregnancy rate, and alarming rates of STIs.

The Ministry of Health recently developed a revised National Health Strategy 2012-2014. This strategy acknowledges the national goals and objectives stated in the Vision 2018 while providing insight on current priorities in the health sector.

MOH has produced its Decrement and Medium Term Strategy (FY2011-FY2014) budget document. However, challenges remain in terms of low human resource capacity on one hand, and the multiplicity of donors, some with parallel reporting requirements, on the other hand. Better coordination within the health sector between MOH and its many partners is needed. Donors as well as local NGOs and CSOs (e.g., Youth to Youth in Health, WUTMI, WAAM, etc.) should be included in a common strategic and financing framework. There is also a need for in-depth investigation into the reasons that prevention and outreach programs to address individual ownership of health and healthy lifestyles have not worked to bring down rates of NCDs. Communities must be empowered to take charge of health issues as a key to building a sustainable health care system. Finally, MOH partnered with the World Health Organization (WHO) to incorporate climate change impacts into its plans and policies, focusing particularly on improved drinking water safety planning and rainwater harvesting, as well as household and community-based water quality monitoring.

Education

The RMI Ministry of Education (MOE) oversees delivery of public education from Kindergarten through grade 12. While a number of private schools also operate in the RMI, the vast majority of children attend public school. In 2009, progress on the MDG goal of universal primary education was on track, with expanding classrooms and a falling fertility rate as drivers. However, the report also noted that while this 'quantity' challenge is likely to be met, the 'quality' challenge of improving educational performance and outcomes must be addressed.

2011 Census figures bear out concerns with educational outcomes. The 2011 Census found: (1) 28.6% of people aged 25 or older had started but not completed high school, and that (2) this proportion actually increased since the late 1990s (21.6%). School enrolment figures also show that significant numbers of school-age children are simply not in school: 20% of children ages 5-9 are not in school; 8% of children ages 10-14 8% are not in school; and 62% of youth 15-24 are not in school. Given that the RMI has some of the highest levels of per capita spending on education in the Pacific, these numbers suggest that an overriding issue for the government is how to use resources more efficiently and effectively.

The MOE's most recent three-year strategic plan for 2008-2011 addresses many of the challenges facing the education sector. Major outcomes targeted under the plan include: Improve early childhood enrolment; Provide a quality primary schooling; Assuring higher school attendance, particularly at the primary levels; Provide high-quality secondary education; and Increasing the success rate among college students. The MTBIF performance-based budgeting model mandated under the renewed Compact is incorporated into the plan to help policy makes evaluate progress on the plan and make adjustments as needed. Adopting this performance-based approach is indeed a step forwards in management and planning, but institutionalizing the MTBIF remains a challenge for MOE and other government functionaries.

Efforts to improve quality of education are vigorously executed under a number of initiatives, including programs to create a pathway for newly trained teachers as well as revitalized in-service teacher education programs. The MOE is also developing a certification program for teachers and accreditation of public and private schools to improve the quality of the education at primary, secondary and tertiary levels.

The MOE and the National Training Council (NTC) developed the Technical-Vocational Education and Training (TVET) Strategic Plan 2012-2014 to address the need for more and better TVET services to combat the country's rampant unemployment and underemployment, and to grow an economy that is based less on external aid and more on private sector wealth. The emphasis of the plan is on building the basic infrastructure of a modern TVET system. The TVET Strategic Plan is organized around four major goals: (i) develop a demand-driven TVET system; (ii) expand the output of TVET programs; (iii) improve the internal efficiency of the TVET system; and (iv) clarify roles, responsibilities, and relationships within the TVET system.

Women's empowerment and gender equality

The RMI is a matrilineal society, with children belonging to their mother's lineage and having rights to use land owned by their lineage group. Although modern pressures have changed the land tenure system in many ways, land continues to be a source of women's influence in the community. Despite the status afforded by secure land rights, improving the status of women in the modern context remains an issue of concern.

The RMI's 2011 Census showed a distinct gender differential in economic activity, with 51 percent of all men of working age engaged in either paid or unpaid work, compared to 28 percent of women of working age. Despite a small increase in female participation in employment since the last Census in 1999, it is clear that the Marshall Islands are a long way from reaching employment gender parity. The recent creation of the NGO, Women Entrepreneurs in the RMI, is an example of recent initiatives to support women's engagement in the economy. This focus on economic empowerment is particularly important for women in the outer islands given the difficulty that communities there face in terms of low incomes, lack of basic services, and poverty of opportunity.

Women generally are not discriminated against when applying for employment, especially in the private and non-government sectors. That said, there has never been more than one female senator in the Nitijela (parliament). RMI ratified CEDAW in 2006, but domestic violence is a serious issue.

There is generally equal access to education and health services for young men and women. However, women face particular burdens in both sectors. High rates of teenage pregnancy disproportionately impacts women not only in health terms - nearly 19% of births to teenage girls are low weight, and there is a high risk of premature labour, anaemia and high blood pressure but also in terms of compromised educational outcomes and, consequently, income-earning opportunities. Women living in the outer islands face additional challenges if they require professional obstetric or gynaecological care, which are only available in the urban centres.

The official focal point for gender-related work in the RMI is the Gender in Development Office, which is housed in the Ministry of Internal Affairs. The office coordinates much of its work with WUTMI (Women United Together for the Marshall Islands), the umbrella organization for most women's civil society organizations in the Marshall Islands. Through the UNDP/GEF ADMIRE project, WUTMI is currently engaged in community-based activities that require the trialling of renewable energy technologies as well as in the design of innovative ways to finance such renewable energy technologies. SPC conducted a stock take of the gender mainstreaming capacity of the government in 2011 and as a result of this process several potential starting points for increasing the capacity of the RMI government to mainstream gender and women's human rights in an effective and sustainable way were identified.

CHAPTER 2

National Greenhouse Gas Inventory

Background

Most of the primary energy supply (90%) in RMI comes from petroleum, with biomass used for cooking accounting for nearly all the rest. RMI is heavily reliant on external assistance, with grants averaging 60% of Gross Domestic Product (GDP). Like other island nations in the Pacific, the RMI suffers from high and volatile fuel prices while lacking any known fossil fuel reserves of its own. Solar electricity generation is expected to expand rapidly but contributed less than 1% of RMI energy.. Biofuel from coconut oil is also expected to increase in future. Imported petroleum-based products are gasoline, diesel fuel, dual purpose kerosene (used both as aviation turbine fuel and household kerosene) and LPG. Gasoline and aviation fuel are imported by Mobil. Automotive diesel oil is imported and distributed by MEC.

Electricity is provided mainly by two public sector utilities KAJUR and MEC. KAJUR only serves Ebeye in Kwajalein. MEC operates throughout the rest of the country. Its main grid is on the Majuro atoll, along with a diesel mini-grid on Rongrong islet. Approximately 75% of the RMI population has access to grid electricity; 92% in the urban areas of Majuro and Ebeye and 32% in the rural outer islands. Some outer islands have central power plants, some of which run during limited hours of the day, and other remote populations receive electricity services from photovoltaic-battery systems provided by international donors and maintained by the central utility.

As per the Article 4 (paragraph 1) and Article 12 (paragraph 1) of the United Nations Framework Convention on Climate Change (UNFCCC), each party is required to report to the Conference of Parties (COP) information on its emissions by sources and removals by sinks of all Greenhouse Gas Emissions (GHGs) not controlled by Montreal Protocol. In accordance, RMI has prepared and submitted its Initial National Communication to UNFCCC in 2000. Further, as required by decision 17/CP.8 of COP, "For the second national communication, non-Annex I Parties shall estimate national GHG inventories for the year 2000. The least developed country Parties could estimate their national GHG inventories for years at their discretion[1]".

As a non-Annex I country and a developing country, RMI has considered year 2000 (as per the UNFCCC reporting requirements) as the base year for estimating GHG inventory as part of its Second National Communication. GHG emissions has also been estimated for the years 2005 and 2010 for comparison purposes based on the available data and information.

Methodology

The second national GHG inventory for RMI has been prepared using the methodology provided in "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"(hereafter 1996 IPCC guidelines); The IPCC Guidelines for National Greenhouse Gas Inventories are approved internationally and developed through a consultative process. Further, the IPCC "Good Practice Guidance and Uncertainty Management in National GHG Inventories (GPG2000)" and software for "Non Annex1 National Greenhouse Gas Inventory Software, Version 1.3.1" has been used for the estimation of RMI's second GHG inventory.

The energy sector emissions data for RMI inventory was compiled by OEPPC. The data was sourced from National and Regional Energy Database, statistics office, other Government ministries and departments, and from Private Companies along with relevant emission factors based on the IPCC 1996 Guidelines. There are occasions where data are unavailable due to confidentiality reasons (such as the fuel import and consumption).

1 http://unfccc.int/resource/docs/cop8/07a02.pdf#page=2

The key steps carried out in inventory preparation include:

- Team formation for GHG Inventory (Working Group)
- Capacity building and training
- Data collection for sectors covered under the GHG Inventory
- Identification of data gaps and uncertainty assessment
- Documents/data review for quality assurance
- Preparation of GHG Inventory Report

Sectoral data for GHG emissions estimation was compiled from various sources primarily using available national data, data collected and presented for national energy sector, other statistical reports, studies, brochures and other country specific information sources.

The emission factors used were based on the IPCC 1996 Guidelines. Generally, greenhouse gas emissions are calculated by multiplying the emission factor of specific fuels by the activity data. Similar to the Initial National Communication, this National Greenhouse Inventory was carried out in accordance with the methodology developed by the IPCC.

The preparation of the national inventory included the following tasks:

- Collecting and validating sources of data
- Identification of data gaps and uncertainties
- Application of tables and worksheets established in the IPCC methodology
- Processing and analysis of information
- Preparation of GHG Emission Sectoral reports
- Preparation of GHG Emission National Report.

Data collection and analyzing methodology used according to 1996 IPCC Guidelines:

- Apparent consumption in original units
- Convert to common energy units
- Multiply by emission factors to compute the carbon content Compute carbon stored
- Correct for carbon unoxidised
- Convert carbon unoxidised to CO_2 emissions

There were no national conversion and emission factors therefore all sectoral calculations used the IPCC default values.

In this SNC RMI has used Tier 1 approach (the 'Reference Approach' and the 'Sectoral Approach')

The Reference Approach estimates CO_2 emissions from fuel combustion in several steps:

Estimation of fossil fuel flow into the country (apparent consumption);

Conversion to carbon units;

Subtraction of the amount of carbon contained in long-lived materials manufactured from fuel carbon;

Multiplication by an oxidation factor to discount the small amount of carbon that is not oxidised;

Conversion to CO_2 and summation across all fuels.

The reference approach calculation identifies the apparent consumption of fuels in RMI from import data. This information is included as a check for combustion related emissions (IPCC, 2000).

For the Tier 1 Sectoral Approach, total CO_2 is summed across all fuels (excluding biomass, i.e. memo item) and all sectors. The Reference Approach provides only aggregate estimates of emissions by fuel type distinguishing between primary and secondary fuels, whereas the Sectoral Approach allocates these emissions by source category.

Methodology Issues

Some of the private fuel importers were unwilling to provide any information on its sales and there are serious inconsistencies in the fuel data for 2000. MEC, provided a breakdown of ADO use for power generation, re-exports (largely for foreign fishing boats) and other activities. Kerosene imports do not distinguish between fuel used for aviation fuel and for household cooking and lighting. Some limited data on LPG sales suggest that most is probably used mainly for commercial purposes

in hotels and restaurants. A large amount of ADO is re-exported it is the RMI's largest export in value and this is not included as domestic consumption.

The following assumptions were made for electricity and petroleum use in 2000:

- electricity generation. MEC reportedly used 19.0 ML of ADO to generate 69.26 GWh. This is 3.6 kWh/liter, which is reasonable. Assuming that KAJUR generated 14.99GWh and used 3.3 kWh/liter, it would have used about 4.13 ML. Other use is minor. The total is about 23.2 ML;
- ground and sea transport. It is assumed that all of Mobil's ADO imports and the remainder of MEC's inland ADO imports, is for ground and sea transport. There are no data available to distinguish between sea and ground transport use. All petrol is for transport.
- household kerosene use. At the time of the 1999 census, 31% of all households, and 71% of rural households (i.e. all households outside of Majuro and Ebeye) reported that their main lighting energy source was kerosene. About 41% of all households and 56% of urban households reported that their main cooking fuel was kerosene. Unfortunately, there are no data on sales to households and no recent household energy use studies to provide information on typical consumption levels for lighting and cooking. At best, old energy use surveys can provide rough estimates of RMI household kerosene use, about 1 ML in 2003.
- LPG use. Only 1.7% of households cooked primarily with LPG in 1999. This is unlikely to exceed 1% in 2000. Old surveys suggest that those households which use LPG for cooking typically consume about 12 kg per household per month, suggesting household use in the RMI of 20 tonnes per year, about half of LPG imports. The rest is probably used by hotels, restaurants and other commercial users.

Sectors and Gases Assessed

The sectors and gases assessed for the estimation of second national GHG inventory includes the emissions by sources and removals by sinks of all anthropogenic GHGs. As per the 1996 IPCC guidelines, the inventory estimates the GHG emissions from following sectors which are relevant for RMI:

- Energy Sector
- Waste Sector

In addition to the sectoral approach, the reference approach has also been used to estimate equivalent CO_2 emissions from the energy sector. Emissions from International bunker and Biomass are also estimated and reported as memo items in the inventory; however the GHG emissions from the international bunker and biomass are not included in the RMI's total GHG emissions. The direct GHG emissions are estimated in this national GHG inventory are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

Emissions from the following indirect GHGs are also estimated and reported in this second national GHG inventory:

- Oxides of Nitrogen (NOx)
- Carbon Monoxide (CO)

Non-Methane Volatile Organic Compounds (NMVOC) and

- Sulphur dioxide (SO_2)

However the indirect GHG emissions are not accounted for RMI's aggregated national GHG emissions. In this report RMI has reported emissions mainly in Giga-grams (Gg). The aggregated GHG emissions and removals are expressed in CO_2 equivalents (Gg CO_2e) using the Global Warming Potential (GWP) defined by Intergovernmental Panel on Climate Change (IPCC). The concept of a Global Warming Potential (GWP) has been developed by IPCC to allow the comparison of the ability of each greenhouse gas to trap heat in the atmosphere relative to carbon dioxide (CO_2) over a specified time horizon. The greenhouse gas emissions are calculated in terms of how much CO_2 would be required to produce a similar warming effect over the chosen time horizon. This is called the carbon dioxide equivalent (CO_2e) value and is calculated by multiplying the amount of gas by its associated GWP. Below Table provides the GWP of GHG assessed in the inventory report.

Table 2: Global Warming Potential (GWP)

	Chemical formula	GWP	Species	Chemical formula	GWP
Carbon Dioxide	CO_2	1	HFC-23	CHF_3	11,700
Methane	CH_4	21	HFC-236fa	$C_3H_2F_6$	6,300
Nitrous Oxide	N_2O	310	HFC-143a	$C_2H_3F_3$	3,800
Perfluoroethane	C_2F_6	9,200	HFC-134a	CH_2FCF_3	1,300
Perfluoropentane	C_5H_{12}	7,500	HFC-134	$C_2H_2F_4$	1,000
Perfluorohexane	C_6H_{14}	7,400	HFC-32	CH_2F_2	650
Sulphur hexafluoride	SF_6	23,900	HFC-41	CH_3F	150
Source: IPCC 1996					

Source: IPCC 1996 Guidelines

The sector and sub-sectors considered for the sectoral greenhouse gas inventory of anthropogenic emissions of RMI has been listed in the below table.

Table 3: Sectorial GHG Inventory of anthropogenic emissions in RMI

Sector	Comment
Energy Sector	
Fuel Combustion Activities – CO_2 and Non-CO_2 Emissions	Estimated
Fugitive Emissions from Fuels	Not Estimated
Industrial Processes	
Not Occuring	
Solvent And Other Product Use	
Not Estimated	
Agriculture Sector	
Enteric Fermentation	Not Estimated
Manure Management	Not Estimated
Rice Cultivation	Not Occuring
Agricultural Soils	Not Estimated
Prescribed Burning of Savannas – Non – CO_2 Gases	Not Occuring
Field Burning of Agricultural Residues – Non – CO_2 Gases	Not Estimated
Land-Use, Land-Use Change & Forestry Sector (LULUCF)	
Changes In Forest And Other Woody Biomass Stocks	Not Estimated

Forest And Grassland Conversion	Not Estimated
Abandonment Of Managed Lands	Not Estimated
Co2 Emissions And Removals From Soil	Not Estimated
Waste Sector	
Solid Waste Disposal On Land	Estimated
Wastewater Handling	Estimated
Waste Incineration	Not Estimated
Other (Memo Items)	
International bunkers	
Aviation	Estimated
Marine	Not Estimated
CO_2 emissions from biomass	
	Estimated

Source: RMI GHGI 2000

Uncertainty Assessment

Uncertainty estimates are an essential element of the complete emissions inventory. The purpose of uncertainty information is not to dispute the validity of the inventory estimates, but to help prioritize efforts to improve the accuracy of inventories in the future and guide decisions on methodological choice (IPCC 1996). While every attempt has been made to prepare an accurate estimate of RMI's GHG emissions, there is inevitably some level of uncertainty in the GHG inventory. Some of the sources of these uncertainties are known and have been documented as part of the inventory processes. Other uncertainties will be discovered at a later stage and will have to be rectified during future inventories. It is hoped that over time, with successive inventories, the level of uncertainty will be reduced.

The availability of detailed data remains the biggest source of uncertainty in the emission estimates for the relevant sectors. There is relatively good data available for electricity generation and transport. However, the fuel consumption data for other activities is based largely on estimate and the past trends. It was based on the assumption that all gasoline sold in gas stations are used for road transportation and sea transportation. This is obviously not the case, but given the lack of more detailed data, this is considered the best available option. Another significant source of uncertainty in the estimates for the energy sector is the data used for biomass fuel consumption. There is very little information available on the amount of biomass fuels used in RMI.

Uncertainty in greenhouse gas emissions from fuel combustion varies depending on the gas. The uncertainty of CO_2 emissions is relatively low at percentage and is primarily due to uncertainty in activity data rather than emission factors (IPCC, 2000). This is because of the direct relationship between fuels' carbon content and the corresponding CO_2 emissions during combustion. The focus for the 2000 inventory has also been on improving the inventory national system. This has included improving quality control and assurance processes and improving the data analysis and reporting tool for the energy sector. Additional information was sought from various industries involved in the energy and industrial processes sectors to help improve transparency. It was also focused on completeness, ensuring all estimates were calculated in accordance with Good Practice

Guidance and increased transparency.

The other major improvements to the 2000 inventory are:

- The inclusion of SO2 emissions in the report with more detailed non-CO2 emissions.
- The compilation of an aggregated CO2 emission trends as from 2000 2005 2010

The IPCC Guidelines provides a comprehensive overview and categorization of all potential sources of GHG emissions; however not all of them are relevant to RMI. Furthermore there is insufficient data on certain sources for them to be included in this inventory exercise. This has been discussed in the sections below, a detailed assessment of each IPCC category was carried out as part of RMI's second GHG inventory, including each category's relevance to RMI and the availability of data required to estimate emissions from these categories. The IPCC guidelines provide guidance for an advance and technical uncertainty analysis. Such a detailed analysis is beyond scope of RMI's second GHG inventory.

In RMI, key uncertainties are associated with data availability, lack of comprehensive information, data archiving and lack of country specific emission factors. It is recognized that having country specific emission factors and more detailed activity data will help reduce uncertainty in future inventory. It can be concluded that with adequate training and capacity building on GHG inventory requirements, RMI can provide more detailed and accurate information in subsequent GHG inventories.

RMI's Greenhouse Gas Emissions

GHG Emissions in RMI

The key objectives of inventory developed under the SNC include :

Develop baseline data suitable for scientific understanding of GHGs emissions and their relationship to climate change

Enhance RMI's ability to monitor and report national inventories of GHGs emissions and sinks

Promote the exchange of information related to climate change at national level to develop policy options and technology choices suitable to mitigate GHGs sources and emissions

As per the methodology for GHG inventory discussed in the previous section, the GHG emissions for RMI has been estimated for the base year 2000. Total national GHG emissions excluding removals in year 2000 was 122.53 Gg CO_2e; which comprises GHG emission 84.97 Gg CO_2e from Energy Sector and 37.56 Gg CO_2e from Waste Sector. Emissions for other GHGs like per fluorocarbons (PFCs), hydro fluorocarbons (HFCs) and sulphurs hexafluoride (SF6) are negligible in RMI as the products containing these gases are not produced in the country. The data on Agriculture, Industrial Process and land-use change and forestry (LUCF) activities were not available for RMI, therefore emissions for these sectors were not estimated and considered for year 2000. Below table presents total GHG emissions by sources and removals by sinks for RMI for the reference year 2000.

Table 4: GHG Emissions in RMI 2000

GHG Sources & Sinks	Sectoral Total GHG emissions in Gg in 2000							
	(CO_2,CH_4 and N_2O), CO_2-equiv	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
Energy	84.97	80.92	0.15	0.0026	0.37	4.00	0.59	0.15
Industrial Processes	NO	NO	NO	NO	NO	NO	NO	NO
Solvent and Other Product Use	NO	NO	NO	NO	NO	NO	NO	NO
Agriculture	NE	NE	NE	NE	NE	NE	NE	NE
Land-Use Change & Forestry	NE	NE	NE	NE	NE	NE	NE	NE
Waste	37.558	-	1.731	0.004	0	0	0	0
Total GHG Emissions, excl. Removals	122.53	80.92	1.89	0.01	0.37	4.00	0.59	0.15

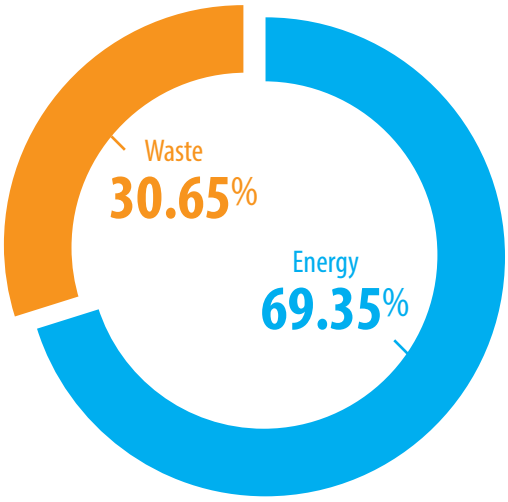
Source: RMI GHGI 2000

The sectoral contribution of RMI's total GHG emissions for reference year 2000:

- Energy (84.97 Gg CO_2 e.) 69.35 %
- Waste (37.558 Gg CO_2 e.) 30.65 %

The GHG emission for reference year 2000 shows that the energy sector is the biggest source of emitter in RMI followed by the waste sector; there is negligible contribution from industrial process and solvent &other product use. Further, CO_2 is the main GHG emitted as result of energy sector activities in RMI.

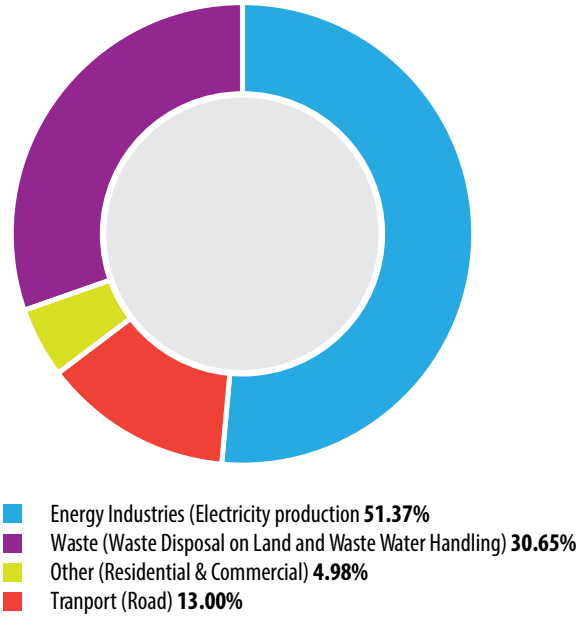
Figure 4: RMI GHG Emission (2000) by Sectors(Gg CO_2 e)



Source: RMI GHGI 2000

The figure below highlights the sectoral activity breakdown in RMI's GHG emissions for year 2000. Each of these sub-sectors are further discussed in following section. The largest contributor to GHG emissions in year 2000 was energy industries (electricity production) amounting to 51.37 % of total emissions. The next biggest contributor was waste management (solid waste disposal on land and waste water handling) with 30.65 % of total GHG emissions followed by road transport and other sector (residential & commercial) which contributed to 13 % and 4.98 % of total emissions respectively.

Figure 5: RMI GHG Emission (2000) by Sectoral Activities (Gg CO_2 e)



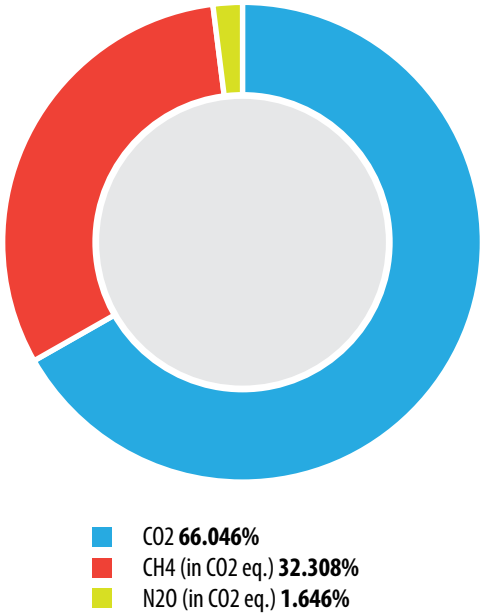
Source: RMI GHGI 2000

It is observed that nearly 100% of GHG emissions in RMI come from four activities: energy industries, transport, other (residential & commercial) and waste (waste disposal on land and waste water handling). The highest contributors among these subsectors includes energy industries, waste and transport. RMI has very limited industrial sector presence and relatively poor energy infrastructure results in high share of GHG emissions from energy sector. RMI needs both technical and financial support to come up with mitigation plans e.g. renewable energy, energy efficiency to reduce GHG emissions from the energy sector.

Gas by Gas Emission Inventory

The gas by gas GHG emission inventory for RMI for year 2000 has been provided in this section. Greenhouse gases covered in this analysis include CO_2, CH_4 and N_2O and are estimated to be 66.046% CO_2, 32.308% CH_4 and 1.646% N_2O of the total GHG emissions (all gases are converted in single equivalent unit of $CO_{2\ eq.}$).

Figure 6: RMI GHG Emission (2000) by Gas (Gg CO_2e)



Source: RMI GHGI 2000

Carbon dioxide (CO_2)

Net CO_2 emissions in RMI are estimated to be 80.92 Gg i.e. 66.046 % of total GHG emissions in the year 2000. The energy sector is the main source of CO_2 emissions, accounting for almost 100% of emissions. Combustion of fossil fuels is the main contributor of CO_2 emissions in RMI.

Table 5: Carbon dioxide (CO_2) Emissions (Gg), RMI, 2000-2010

Sectors	2000	2005	2010	Average % Change till 2010
Energy	80.92	97.66	124.94	19.49%
Industrial Processes	NO	NO	NO	NO
Solvent and Other Product Use	NO	NO	NO	NE
Agriculture	NE	NE	NE	NE
Land-Use Change & Forestry	NE	NE	NE	NE
Waste	0.00	0.00	0.00	0.00
Total	**80.92**	**97.66**	**124.94**	**19.49%**

Source: RMI GHGI 2000

Table 6: Fuel Deliveries in RMI for 2000 to 2010 (in MT)

Fuel	2000	2005	2010	Average
ADO	20526	25245	32220	25997
Motor Gasoline	4195	4540	5795	4843
Jet Fuel (DPK)	23520	29423	42729	31891
LPG	348	429	548	442
Lubes & Cres	284	348	445	359

Source: RMI Customs Department

The CO_2 emission is mainly from the energy sector and from year 2000 to 2010 it increased by 19.49% (on an average) due to increment in consumption of imported petroleum fuel.

Methane (CH_4)

The net Methane (CH_4) emissions in RMI has been estimated to be 1.89 Gg and constitute 32.308% of total GHG emissions in year 2000. Waste sector is the biggest source of methane emissions and accounts for 91.84 % of total methane emissions in the country followed by 8.16 % from energy sector.

The overall methane emission in RMI has increased by 1.92% (average) since 2000 to 2010. The increment is mainly attributed to increase in population and change in lifestyle.

Table 7: Methane (CH_4) Emissions (Gg), RMI, 2000-2010

Sectors	2000	2005	2010	Average % Change till 2010
Energy	0.15	0.185	0.33	31.43%
Industrial Processes	NO	NO	NO	NO
Solvent and Other Product Use	NO	NO	NO	NO
Agriculture	NE	NE	NE	NE
Land-Use Change & Forestry	NE	NE	NE	NE
Waste	1.731	1.50	1.674	-2.50%
Total	**1.89**	**1.69**	**2.004**	**1.92%**

Source: RMI GHGI 2000

Methane Conversion Factor is used as per IPCC Guidelines, which states that "default values are 1.0 for anaerobic, and zero for aerobic systems. Here it is assumed that after the discharge of the wastewater to a river, lake, sea, etc., half of the degradable organic carbon will decay anaerobically".

Nitrous Oxide (N_2O)

The net Nitrous oxide (N_2O) emissions in RMI is estimated to be 0.0065 Gg; which translates to 1.646 % of total GHG emissions in year 2000. Energy and waste sectors are the biggest source of nitrous oxide emissions and accounts for 40.43% and 59.57% of N_2O emissions respectively in the country. The overall nitrous oxide emissions shows an increment of 13.88% (average) from 2000 to 2010, mainly due to change in fuel consumption and demography.

Table 8: Nitrous Oxide (N_2O) Emissions (Gg), RMI, 2000 – 2010

Sectors	2000	2005	2010	Average % Change till 2010
Energy	0.0026	0.0032	0.0053	29.19%
Industrial Processes	NO	NO	NO	NO
Solvent and Other Product Use	NO	NO	NO	NO
Agriculture	NE	NE	NE	NE
Land-Use Change & Forestry	NE	NE	NE	NE
Waste	0.004	0.0034	0.0038	-3.56%
Total	**0.0065**	**0.00653**	**0.0090**	**13.88%**

Emissions from per-fluorocarbons (PFCs), hydro-fluorocarbons (HFCs) and sulphurs hexafluoride (SF_6) in RMI are negligible as the products containing these gases are not produced in the country. Emissions from the consumption of Halocarbons and SF_6 were not estimated due to lack of activity data.

Table 9: Other Greenhouse Gases Emissions in RMI, 2000

Type of Gas	Emissions (Gg)
PFCs	Not Estimated
HFCs	Not Estimated
SF_6	Not Estimated

Source: RMI GHGI 2000

Indirect Greenhouse Gases (NOx, CO, NMVOC, SO_2)

Apart from the direct GHG emissions NOx, CO, NMVOC, SO_2 are the main indirect gases emitted in RMI. The main sources of these gases are from energy sector wherein these gases are emitted due to burning of fossil fuel.

Table 10: Indirect Greenhouse Gases Emissions in RMI, 2000

Type of Gas	Emissions (Gg)
NOx	0.37
CO	4.00
NMVOC	0.59
SO_2	0.15

Source: RMI GHGI 2000

GHG Emissions Trend Analysis (2000 - 2010)

The total GHG emissions of energy sector increased by 36.36% over 2000-2010, due to increase in petroleum fuel consumption and demographic change. The table below represents RMI's sectoral total GHG emissions trend.

Table 11: RMI Sectoral GHG emissions trend, 2000-2010

Sectors	2000	2005	2010	% change since 2000 to 2010
Energy	84.97	102.52	133.51	36.36%
Industrial Processes	NO	NO	NO	NO
Solvents and Other Products Use	NO	NO	NO	NO
Agriculture	NE	NE	NE	NE
Land Use Change and Forestry (removals)	NE	NE	NE	NE
Waste	37.56	32.57	36.31	-3.44%
Total GHG Emissions (excl. removals)	122.53	135.09	169.82	27.85%

Source: RMI GHGI 2000

The sectoral GHG emissions trend 2000-2010 (Gg $CO_{2\,eq.}$) in RMI shows increasing trend in fossil fuel consumption particularly in the energy sector (estimated as per available data); mainly due to increase in fossil fuel consumption and total petroleum fuel import (the fuel consumption pattern within the electricity generation, transportation and other sub sectors has also varied due to fluctuating economy).

GHG Emissions by Sector in RMI

Energy Sector

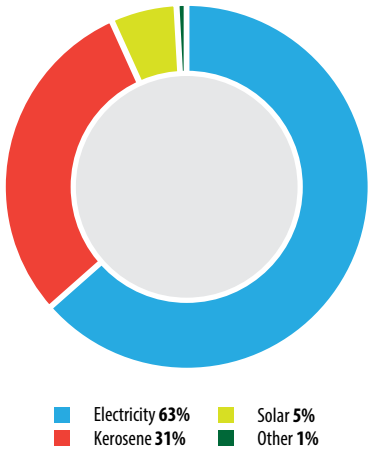
The energy use in the Marshall Islands has been mainly dependent on imported fossil fuel. Electricity is delivered to a majority of the population (75%) however, only in the urban centres of Majuro, Ebeye, Wotje, Jaluit and Rongrong. The Marshall Islands energy economy is dominated by petroleum products (petrol, diesel, kerosene and LPG). These products account for approximately 88.5% of gross energy supply, the balance being biomass and solar mainly used in the outer islands as a cooking fuel. During 2000, Marshall Islands imported approximately 57.04 million liters of diesel, with 29.51 million was re-exported, resulting in a consumption of 24.22 million liters. This figure includes both (reference year) transport and power generation.

Renewable energy sources available on the outer islands of the Marshall Islands include solar, biomass, biofuel and various forms of ocean energy. The wind resource has been subject to some measurements, however since most islands are located close to the equator, it is assumed that the average wind speed is too low for economic application of wind energy.

The rapid development of energy intensive economic activities thus intensifies RMI's dependence on imported petroleum products. The high cost of these products remains a fundamental obstacle to improving standards of living and business profitability in the country. The Government of the RMI is currently supported by donors and development partners to mitigate impacts of high oil prices at policy level with voluntary commitments to mitigate GHG emissions. This is focusing on increasing energy efficiency, minimizing the costs of imported fuels and also investing in renewable energy sources such as solar, biofuel and ocean energy.

There are three power utility services in the Marshall Islands namely: Majuro, Ebeye and Jaluit Atoll. On Kili, the local Government manages a power station to supply power to residents. Solar energy is being used for lighting and for operation of HF radios in some of the islands. Majuro alone had 2 power stations with a total rated power output of 12.8MW. The new station number 2 was commissioned in 1999 which reflect in the increase in Majuro electricity generation.

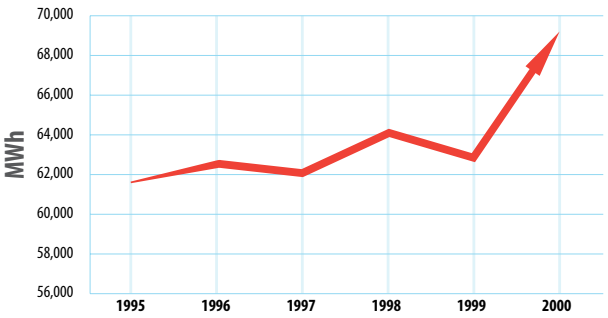
Figure 7: Source of Lighting in RMI



Source: Republic of the Marshall Islands National Energy Policy and Energy Action Plan -2009

The main sources of energy for lighting in the reference year 2000 were electricity (63.3 %), kerosene (30.9 %) and solar energy (5.2 %). For cooking, the main sources were kerosene (40.5 %), wood (29.9 %), electricity (26.3 %), propane gas (1.7 %) and charcoal (1.1 %).

Figure 8: Power Generation in Majuro



Source: RMI GHGI 2000 and RMI Statistical Year Book 2004

There were 675 street lights in MAJURO in year 2000, among them, 275 or about 41%, were on private property. Power consumed by street light was neither metered nor billed. Based on 175 watts per light, annual consumption is 519.3 MWh for 12 hour daily usage.

GHG emissions in the energy sector are primarily associated with fuel combustion and fugitive emissions from fuels. Since RMI is 100% dependent on imported fossil fuels to meet its energy demand and has no energy resource mining and exploration activities, fugitive emissions from fuels are not considered for the GHG Inventory. GHG Emissions from the energy sector from fuel combustion includes following categories:

- Energy Industries
- Transport
- Other (Residential & Commercial)

Emissions from Energy sector grew by approximately 39.52% from 1995, rising from 51.39 Gg CO_{2e} in 1995 to 84.97 Gg CO_{2e} in year 2000. Energy sector was the major dominant source of GHG emissions in RMI in year 2000 accounting for 69.35% of total GHG emissions in the country. Table below presents Gg CO_2e emissions from different sub sectors under the energy sector. Fuel consumption in institutional, agriculture, forestry and fishing was not estimated and considered in this inventory due to unavailability of data (except residential & commercial).

Table 12: CO_2e Emissions from Energy Sub sectors in RMI (Gg CO_2e), 2000

Source	2000
Energy Industries	62.94
Transport	15.92
Other (Residential & Commercial)	6.10
Total CO_2e Emissions	84.97
International Bunkers (not included in national total)	73.52

Source: RMI GHGI 2000

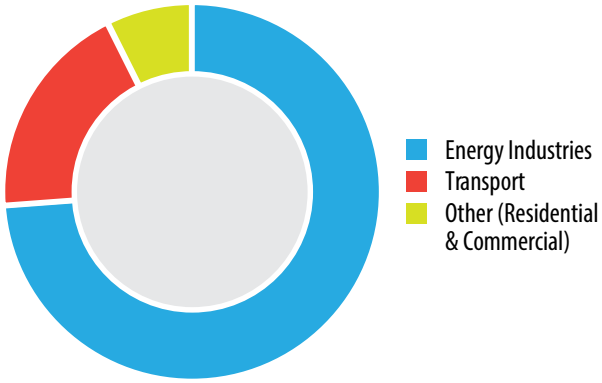
Table below presents emission of different gases from energy sector in RMI. From the calculated data, it can be inferred that the most prominent GHG emitted from the energy sector is CO_2 amounting to 80.92 Gg followed by CH_4 emissions of 0.154 Gg and N_2O emissions of 0.0034 Gg . Some minor NOx, NMVOC, CO and SO_2 emissions associated with the energy sector exist.

Table 13: GHG Emissions from Energy Sub sectors in RMI (2000)

Source	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Total CO_2e (Gg)
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	
Energy Industries	62.726	0.003	0.001	0.172	0.013	0.004	0.065	62.726
Transport	15.798	0.004	0.000	0.143	1.541	0.289	0.007	15.798
Other (Residential & Commercial)	2.399	0.147	0.002	0.053	2.448	0.294	0.078	2.399
Total GHG Emissions	**80.923**	**0.154**	**0.003**	**0.367**	**4.003**	**0.588**	**0.151**	**80.923**
International Bunkers (not included in National total)	72.87	0.0005	0.0021	0.3088	0.1029	0.0515	0.0000127	**73.52**

Source: RMI GHGI 2000

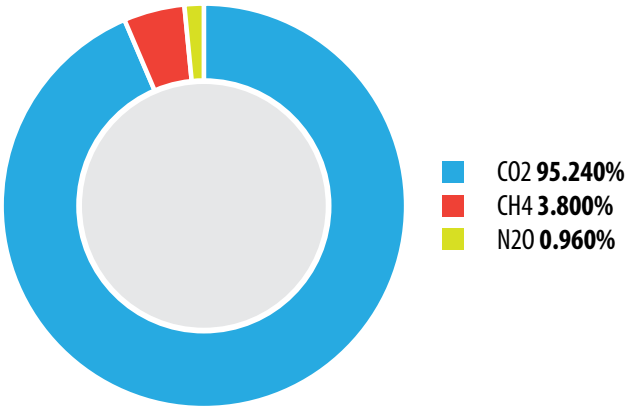
Figure 9: Energy Sub-Sector GHG Emissions (Gg CO_2e), 2000



Source: RMI GHGI 2000

During the year 2000, under the energy sector CO_2 emissions contributed 95.24% of emissions, followed by CH_4 and N_2O emissions, as 3.8% and 0.96%, respectively. Figure below presents the contribution of various gases under the energy sector.

Figure 10: GHG Emissions by Gases under Energy Sector, 2000



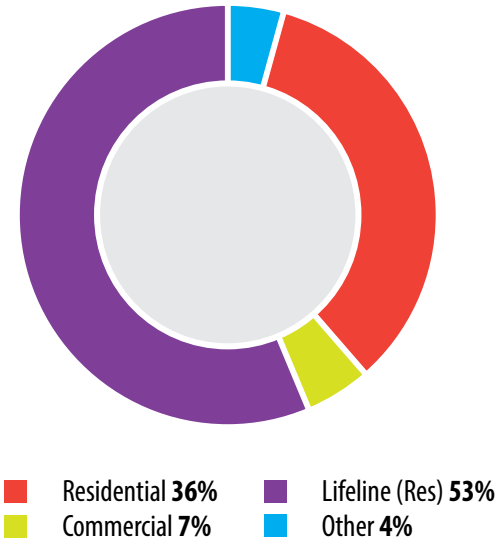
Source: RMI GHGI 2000

Electricity Generation

Energy industries is the first bigger emitter under energy sector accounting for 70.99% of emissions. Electricity generation is the major source of GHG emissions from the energy industries in RMI. The significant growth in emissions from energy industries reflects increased demand for electricity in the country.

Electricity generation in 2000 year was in the order of 84 GWh per year with MEC generating approximately 69 GWh and KAJUR (Kwajalein) 15 GWh next to power generation on the main island of Majuro, with a peak demand of 9.97MW. The consumption per typical residential consumer is estimated to be more than 700 kWh per month, among the highest of all PICs. Generation has grown 6.6% per year from 1999, the number of customers 3.8% annually and peak demand by around 8%.

Figure 11: Average Electricity Consumption in Majuro 1995 – 2000



Source: RMI GHGI 2000

MEC also operates 550 kW diesel generators on Jaluit and 60 kW generators in Rongrong which accounts to only 5% of demand. The local governments of Bikini/Kili

and Enewetak have similar size generators operating independent of MEC. The second largest power system is KAJUR on Ebeye. The 1999 census shows that at least 1,089 households (90%) had access to electricity. In 2002 KAJUR generation was 16.2 GWh, only 84% of the 1990 figure.

In year 2000, about 68% of households nationally were electrified but no breakdown by island group was made available. However, it is assumed that this number has grown to around 70% during the reference year due to the remote island RE electrification programs.

There is also some private generation, particularly on the islands such as Mili, Enewetak, Namu, Wotje, Arno, Maloelap, and the availability of detailed fuel consumption data for those remains the biggest problem. Considering the problems of electricity generation in the outer islands, it is envisaged that the need to exploit affordable renewable energy sources such as solar and wind energy is vital for the improvement of the quality of life and development.

Table 14: National Power Summary, By Station in 2000

Characteristics	Majuro	Ebeye	Jaluit	Bikini/Kili	Total
Gross Generation (GWh)	69.24	14.99	NE	3.74	87.97
Sales (GWh)	36.81	NE	NE	NE	36.81
Peak Demand (kW)	9.97	NE	NE	NE	9.97
System Own Use & Losses	32.43	NE	NE	NE	32.43
ADO Consumption (kl)	19,074.38	4,129.48	NE	1,030.30	23,200.00
Lubricants Used (kl)	NE	NE	NE	NE	210.01

Source: RMI Statistical Year Book 2004

Table 15: Sectoral Electricity Consumption (%)

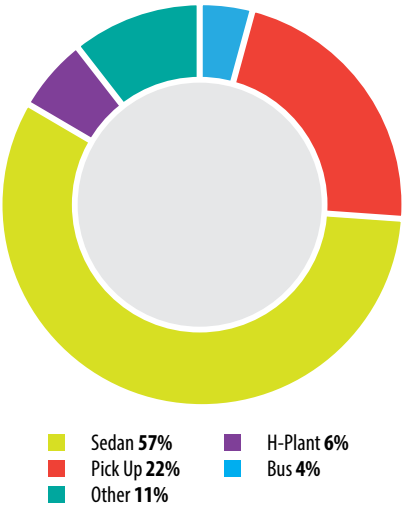
	1995	1996	1997	1998	1999	2000	AVG
Commercial	6.86	6.86	6.94	7.12	7.16	7.93	7.29
Government	3.19	2.94	2.88	2.92	2.77	2.46	2.80
Current Inactive	0.51	0.41	0.37	0.70	0.63	0.31	0.43
Resident	35.03	34.33	33.69	32.41	31.74	37.09	35.45
Lifeline	53.77	54.65	55.21	55.76	56.48	51.56	53.27
Other	0.61	0.81	0.91	1.09	1.24	0.65	0.76
Residential Flat Rate	0.02	0.00	0.00	0.00	-0.01	0.01	0.01
Commercial Flat Rate	0	0	0	0	0	0	0
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Stattistical Abstract 2002

Transport

It is observed that the share of GHG emission from transport sub-sector (under energy sector) is the second largest, accounting for 19 % of GHG emissions. The majority of emissions from this sector is CO_2 emissions resulting from the combustion of gasoline and automotive diesel oil (ADO) used in internal combustion engines.

Figure 12: Registered Motor Vehicle in Majuro 2000



Source: RMI GHGI 2000 and RMI Statistical Year Book 2004

Just about all services to outer atolls originate from Majuro. Most outer island atolls are serviced by ships mostly on a monthly basis and once a week by small passenger planes.

Outer atoll communities receive supplies on a regular basis, but it is not unusual for ships and planes to be delayed for longer periods. Communications to the outer atolls is limited.

The most common technologies are two way solar powered radio telephones and one way radio messages.

Emissions from transportation sub sector are the single biggest source of direct and indirect GHG emissions in RMI. The consumption of gasoline (mainly used for smaller passenger sedans "small gasoline engines") contributes most to emissions, with "four stroke diesel engines" accounting for almost the same fraction.

The CH_4 emissions from vehicles are a function of the methane content of the motor fuel, the amount of hydrocarbons passing un-burnt through the engine, the engine type, and any post-combustion controls. In uncontrolled engines the proportion of methane emissions is highest at low speeds and when the engine is idle. Poorly tuned engines may have a particularly high output of CH_4 and obviously regularly servicing of vehicle would reduce CH_4 emissions.

Manufacturing Industries and Construction

There are no major manufacturing industries in RMI and no detailed activity data is available for this sector, therefore this sectoral activity is not estimated.

Other (Residential and Commercial & Institutional Sector)

Other (residential and commercial & institutional sector) sub-sector in RMI is the third source of GHG emissions and constitutes 6.10 Gg CO_{2e} i.e.7 % of energy sector emissions in year 2000. Dual Purpose Kerosen (DPK) and LPG is fuel to be used in residential and commercial sub-sector, for lighting and cooking. Fuel wood and coco residue has been used for domestic purpose in householdes in thr RMI.

In 2000, 66% of households used electricity for lighting, 29% used kerosene and the rest relied on solar systems. Nearly 90% of urban households had electric lighting compared to 13% in outer islands, 71% of whom used kerosene. Households which reported using wood as their main cooking fuel increased from 14% in 1988 to 30% in 1999 nationally, with rural wood use increasing dramatically from 36% to 79% of all households. If accurate, this may have been due to low copra prices, a key source of income, in the late 1990s.

Below table shows the fuel consumption and associated GHG emissions in the residential and commercial sub-sector:

Table 16: Fuel consumtion and emissions in residential & commercial category

Year	Fuel (in MT)	Sub-Sector		Total emissions in Gg $CO_{2\ eq.}$
		Residential	Commercial	
2000	DPK	432.77	-	6.10
	LPG	173.92	173.92	
2005	DPK	541.38	-	7.45
	LPG	214.72	214.72	
2010	DPK	786.22	-	12.17
	LPG	274.04	274.04	

Source: RMI GHGI 2000

As biomass consumption and associated emssions is estimated and reported in this inventory as memo items, following table shows the biomass consumption and associated GHG emissions in RMI

Table 17: Biomass consumption and emissions

Year	Biomass (Fuel Wood + Coco) in MT	Gg CO2eq. Emissions
2000	35439	53.134
2005	42713	64.04
2010	77184	115.72

Source: RMI GHGI 2000

CO2 Emissions from the Energy Sector Using Reference Approach and Sectoral Approach

The GHG Emissions from the energy sector were estimated using reference and sectoral approaches using IPCC Tier 1 analytical framework. Under the reference approach, GHG emissions were estimated using only the fuel consumption data for each type of fuel. The results of estimated CO_2 emissions for the year 2000 using reference approach was 80.922 Gg and 80.923 Gg usng sectoral approach, the difference between reference approach and sectoral approach is about 0.00124 %, mainly attributed to uncertinilty and availability of detailed sectoral data. Table below represents the calculation results using reference and sectoral approach.

Table 18: Energy Sector CO_2 Emissions using Reference and Sectoral Approach, 2000

Sector	Approach	Gg CO_2	% difference
Energy	Reference Approach	80.9220	0.00124%
	Sectoral Approach	80.9230	

Source: RMI GHGI 2000

Industrial Processes

This sector covers GHG emissions from major industrial processes as an output of non-energy related activities. In RMI this sector is negligible except Copra and associated products production and processing. Hence GHG emissions from this sector are not estimated and reported in this report.

Solvents and Other Products Use

This sector comprises emissions (primarily Non Methane Volatile Organic Compounds) from solvents and other products use containing volatile compounds. There are no calculations and emissions factors in the revised 1996 IPCC guidelines to estimate GHG emissions from this sector. However in RMI there are no solvents and other products use industries and process; hence GHG emissions from this sector are not estimated.

Agriculture

Althoguh the agriculture sector (livestock) is one of the contributors of GHG emissions in RMI, emissions associated with this sector is not estimated due to unavailability of relevant data for the reference year 2000.

Land Use Change and Forestry Sector

With only 182km^2 (70 sq. miles) of land and a small proportion of this being suitable for settlement, land is the most prized possession in the Marshall Islands and forms the basis of Marshallese culture. A major difference between the Marshall Islands and other Pacific Island areas is that soil was thought to be stabilized and beginning to be colonized by plants and animals for only a very short time before people arrived. So when people came here and established food crops and other useful species, they probably had more of an influence shaping the land environment than almost anywhere else on earth. Since the land the ancestors found here was so limited and accessible, they were also able to influence a greater proportion of the natural environment than most other places. So humans can be seen to be an integral part of the land ecosystem here in the Marshalls. The Marshallese people retain a tremendous knowledge of native forests and plants, and strong skills in agro-forestry. In fact the maintenance of much of the forest and vegetation relies on humans for propagation and management

Total dry land area is only about 70 square miles. All the Marshall Islands are low in elevation; the average height of land above sea level being 7 feet.

Mapping and forest inventory conducted for the first time in 2008 shows that forest, including agro-forest and coconut plantations, covers about 70% of the Marshalls' land area.12% of the landscape was classified as urban land.

All forest land is privately owned under complex forms of land tenure.

The only Federal (US) land management agency is the US Department of Defense, which occupies and manages most of Kwajelein atoll, under the terms of the Compact of Free Association between the U.S. and the Republic of the Marshall Islands. This military relationship is highly sensitive; especially as consultations concerning land also involves chiefs (see explanation of "tribal representatives" under Forest Stewardship Committee).

Majuro Atoll strongly maintains and practices its traditional leadership system called the "iroij" for man, the "leroij" for woman, "alap" land owner and "ri-jerbal" the worker. An iroj traditionally has the authority for distribution of land, water and forests claimed under his or her title. An iroj decides which piece of the land each household will use. The use of an assigned area of land with permission for farming and dwelling marks the establishment of a more or less permanent right to land ownership. Under traditional law, custom and decree protect the undeveloped forestlands of the village.

Majuro Atoll is facing the same problem as many of the other small islands in the Pacific:

- A fixed and very limited arable land base.
- A high percentage of the land base in fragile ecosystems
- A rapidly expanding population.
- Isolation from the mainstream of ecosystem management concepts
- Susceptibility to sea level changes (i.e. global climate changes) Soils are most susceptible to erosion along coastal areas, especially during storms and storm surges without proper coastal protection.

The rapid population expansion is creating more subsistence farmers, and accompanying urbanization is forcing those new subsistence farmers onto fragile sites such as coastal areas and forests which lead to deforestation. This land use activity can only exacerbate the existing environmental problems of non-point source pollution and degrade both terrestrial and marine ecosystems.

Much of the vegetation in the D.U.D. area has been cleared for households and commercial development. Lack of protective vegetation along the ocean-side of Rita village in particular has exposed inland vegetation to salt spray burn. Overall reduced ground cover and consistent canopy cover in Rita also decreases rainfall recharge to the underground freshwater lens.

Due to unavailability of appropriate data the Land Use Change and Forestry sector has not been estimated and not reported in this inventory.

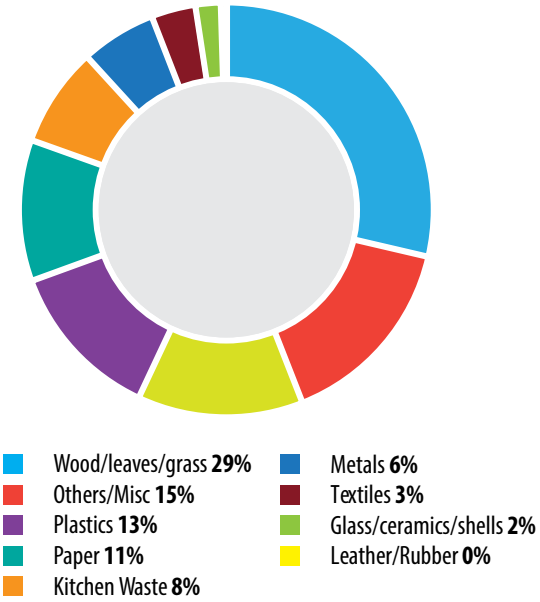
Waste

Waste management is among one of the top priorities for action in the RMI. As the RMI develops, the amount of waste generated will likely increase and the nature of the waste will change and will include increasing quantities of toxic elements such as electrical and electronic wastes, chemical wastes, and used oil.

As an atoll nation, the RMI lacks the suitable land space to accommodate environmentally sound disposal facilities for these changing waste streams and simply cannot afford to increase its waste generation. Any suitable and available land requires large investment in infrastructure and environmental protection systems to preserve the integrity of the coastal marine environment and potential underground water resources.

Residential waste accounted for 7.2 tons per day, with commercial waste amount to 13.2 tons per day. The composition of residential waste (household) and landfilled waste are shown in the charts below. Significant waste types that must be addressed are organic wastes, diapers, plastics, paper, and metals.

Figure 13: Residential waste composition (wt %)



Source: Republic of the Marshall Islands - National Waste Management Strategy 2012-2016 and Action Plan

Key performance Indicators of Waste sector in RMI, as per National Waste Management Strategy 2012-2016 and Action Plan, is as follows:

Table 19: Key performance indicators of waste sector in RMI

Key Performance Indicators	Baseline Value	Source
Amount of waste generated per capita	0.9 kg/person/day	**Waste characterization studies**
Amount of total waste landfilled	20.3 tons/day	**MAWC records**
Percentage of total waste diverted from landfill (includes 4R activities)		**MAWC records**
Percentage of population receiving at least once per week collection service	66% (20,000)	**Majuro 2011 Infrastructure Survey Report**
Number of unauthorized dumpsites		MAWC, community inspections, EPA reports
Number of pollution incidents and license breaches at authorized waste handling, storage, treatment and disposal facilities.		EPA reports

Source: Republic of the Marshall Islands - National Waste Management Strategy 2012-2016 and Action Plan

GHG emissions from the waste sector in RMI are estimated for following subsectors:

- Solid Waste Management and Disposal
- Domestic and Commercial wastewater handling

Waste management sector emissions has been estimated using data from open source and National Waste Management Strategy 2012-2016 and Action Plan, due to lack of reliable data on waste generation. Population for 2000, 2005 and 2010 has been considered from open source i.e. www.indexmundi.com

The emissions from waste sector were estimated to be 37.558 Gg CO_2e i.e. 30.65% of RMI's total GHG emissions in the reference year 2000.

Table 20: CO_2 Emissions from Waste Sector in RMI (Gg CO_2e), 2000 - 2010

	2000	2005	2010
Waste (Waste Disposal on Land and Waste Water Handling)	37.56	32.57	36.31

Source: RMI GHGI 2000

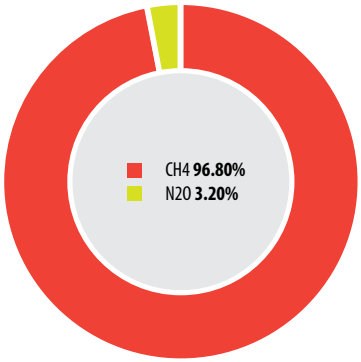
Table and figure below represents emissions of different gases from waste sector in RMI. Methane is the most prominent gas emitted from the waste sector. Unmanaged solid waste (SW) and waste water sites, lead to methane emissions. The methane emissions so emitted are estimated using the quantity of waste generated, management of the waste, the proportion of carbon that may be transformed into methane etc.

Table 21: GHG Emissions from Waste Sector in RMI (Gg), 2000

GHG Sources & Sinks	Waste Sector Total GHG emissions in Gg			
	(CO_2,CH_4 and N_2O), CO_2-equiv	CO_2	CH_4	N_2O
Waste (Waste Disposal on Land and Waste Water Handling)	37.564	0	1.731	0.004

Source: RMI GHGI 2000

Figure 14: Gas by Gas Emissions from Waste Sector in RMI, 2000



Source: RMI GHGI 2000

Solid Waste Management and Disposal

The key source of methane emissions under the solid waste management and disposal include emissions from anaerobic decomposition of waste.

In RMI, common methods of disposal include open backyard dumpsites, disposal at sea or on unused land, and burning. The management and control of the landfill has been, and continue to be a challenge. RMI lacks national environmental and health laws to regulate the dumping of hazardous waste and general rubbish.

Approximately 20.3 tons of rubbish is produced and dumped at the Majuro landfill per day. There is only one waste disposal site in Majuro. Development of the site has involved land filling a former reef inlet over a 4-acre area. It is estimated that over 2 million cubic feet of rubbish has been disposed of at the site. The disposal site is subject to flooding and there are no controls or management of the leachate generated by the site. The site is currently at full capacity and a new site is urgently required along with stabilization and remediation of the current disposal site.

The existing dumpsite was closed by the EPA temporarily in 2011, but was forced to re-open due to lack of other waste disposal options and an increase in littering. One temporary landfill site with a 9-month capacity (1547.11 m^3) has been identified and approved in Rankan, Rairok, Long Island in a swamp area, which the community wants filled in due to mosquito breeding to eliminate the dengue fever risk.

Two other long-term landfill sites have also been tentatively identified in the vicinity of Jenrok, for which MAWC has finalized the land negotiations, however MAWC needs to submit application and scoping study for using the site to EPA. It is estimated that an area of approximately 13 acres is necessary to provide a landfill lifespan of at least 10 years. (as per National Waste Management Strategy 2012-2016 and Action Plan, RMI)

Domestic and Commercial Wastewater Handling

There is no appropriate information available for sanitation system in RMI, however common practice would be decentralized system, consisting of privately managed household and commercial septic tanks for the collection of human waste. These allow the decomposition of the waste but the process leaves sludge as a by-product. Emissions from incineration and open burning of waste have not been estimated in the current inventory due to lack of data.

Memo Items

In accordance with 1996 IPCC guidelines, CO_2 emissions from International Bunkers and burning of biomass are not included under the national items, International Bunkers i.e. aviation and biomass have been estimated and reported separately as memo items in the inventory.

International Bunkers

International bunkers include aviation and navigation. Emissions from marine transportation are not estimated due to lack of data. CO_2 emissions from international aviation for the year 2000 were estimated to be 73.52 Gg CO_2, while emissions from other gases were insignificant. These emissions are not counted under national total GHG emissions.

Below table shows the GHG emissions from aviation:

Table 22: GHG Emissions from Aviation, 2000

International Bunkers	(CO_2,CH_4 and N_2O), CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Aviation	73.52	72.87	0.0005	0.0021	0.31	0.10	0.05	0.000013

Source: RMI GHGI 2000

Biomass

The country in the year 2000, was still overwhelmingly dependent on imported petroleum for its commercial needs but indigenous biomass still accounts for about 11.09% of gross national energy usage.

The volumes of petroleum fuel consumption have increased by approximately 59.56% compared to 1995, while a major reduction on biomass consumption was expected on the same year. Biomass for cooking has increasingly been replaced by kerosene and LPG; therefore its utilization is believed to have been fallen over the recent years. Although biomass remains important source of energy for cooking and crop drying energy.

Table 23: GHG Emissions from Biomass, 2000

Year	Biomass (Fuel Wood + Coco) in MT	Gg $CO_{2eq.}$ Emissions
2000	35439	52.6
2005	42713	63.4
2010	77184	114.6

Source: RMI GHGI 2000

Key Findings

To diversify away from nearly total dependence on diesel for power generation will require the development of domestic, renewable energy resources. To achieve a significant contribution of renewable energy for grid supply will likely require an element of subsidy to avoid raising tariffs relative to projected average costs estimated for continued diesel-based electricity supply. Even with a subsidy contribution, a substantial amount of investment will be required to develop and operate new renewable energy systems. This implies that private sector participation will be an important element of achieving significant reduction in the use of diesel for power generation. The different options have very different cost structures. The sector structure as defined in the policy, legal and regulatory instruments should facilitate and encourage private participation in the electricity sector.

Very aggressive efforts in applying energy efficiency measures and renewable energy development could result in a total reduction of the overall GHG emissions in RMI. Achieving that level depends strongly on the development of biofuel as a replacement for diesel fuel. It is also anticipated that a very aggressive efforts in implementing a large scale biofuel, solar and ocean energy technologies electrification programs over a ten year period plus there is an overall improvement in energy efficiency, a total reduction in GHG emissions of over 20% could be the result.

To implement the required measures to reduce GHG

emissions, RMI will need to put in place policy, measures and regulatory aspects to provide strong leadership, coordination and oversight of the energy and other sectors activities. Efficiency improvements are the least cost option for reducing dependence on imported petroleum and should be pursued aggressively.

RMI has several potentially feasible options for domestic sources of electricity generation but existing data are insufficient to assess their viability. Adopting a portfolio approach will help provide RMI with the flexibility to quickly adjust to developments in the energy sector occurring at both the international and national levels. This implies that where existing information or experience is inadequate for firm decision making, steps should be taken to collect and interpret the information required, including through proof-of-concept projects.

Principles to be followed to improve the performance, sustainability and security of the energy sector are set above which include focusing on a least cost approach, managing risks, financial sustainability, social and environmental sustainability and clear, appropriate and effective definition of roles for Government, MEC and private sector.

Perhaps the biggest gap in the GHG inventory is the lack of accurate and reliable data. The following recommendations are made to strengthen RMI's GHG inventory in coming years:

- Establish a system and a more detailed database to update all activity data required for the GHG inventory on an annual basis. This will greatly speed up the inventory process and should allow for annual monitoring of GHG emissions in the sectors.
- Investigate options for improving the detail of activity data used for all sectoral GHG inventory. This will allow for more accurate estimates to be made and reduce the uncertainty associated with the inventory in all sectors.
- Mainstream the GHG inventory as an annual activity to allow regular monitoring of emissions. This will allow accurate and meaningful measurement of progress made in GHG abatement efforts.

GHG inventory serves as a baseline for country to measure its progress towards reduction of greenhouse gases. It also serves as an integral tool in designing countries climate change policies and to measure the success of such policies. The current GHG inventory provides comprehensive information about all emissions and removals in RMI for the base year 2000 and also reflects the GHG emission trend since 2000 till 2010. The key findings of this inventory development exercise include:

- There is insufficient documentation of methods and data sources used for data collection, this in turn adversely impacts the reliability of the data.
- There is lack of country-specific emission factors and hence IPCC default values are generally used in estimating the GHG emissions.
- It is also observed that there is lack of detail in the activity data as is case with other SIDCs.
- There are no industrial activities in RMI except for copra products production and processing and emissions from this sector are not estimated due to non-availability of required data.
- There is need of data readiness from private parties for fuel import and consumption pattern in the country.
- There is very limited quality land for farming activity in RMI and hence limited use of fertilizers in the country, the data of fertilizer usage is not currently available. It can be included in the subsequent GHG inventory report under Third National Communications.
- There is a lack of support for GHG estimation activity initiatives resulting in small teams under different departments working with multiple responsibilities and limited resources. More resources (financial and human) are required to integrate GHG estimation with other sustainable and business as usual activities.
- Difficulties retaining capacity and expertise developed during the preparation of previous National Communications are leading to draining of resources.

CHAPTER 3

Vulnerability And Adaptation Assessment

Background

The Republic of the Marshall Islands is one of four countries that consist entirely of low lying atolls and islands, and which face perhaps the most urgent and daunting of climate change challenges in the world. The main climate change threats of immediate concern for the Marshall Islands include sea level rise in combination with storm surges causing flooding, accelerated coastal erosion and saline intrusion into freshwater lenses; periodic droughts associated with El Ni.o Southern Oscillation (ENSO) events and coral bleaching resulting from increased temperature and ocean acidification in combination with extreme low tides.

There are currently nine operational observation stations in the Marshall Islands. Multiple observations within a 24-hour period are taken at Majuro, Utirik, Ailinglaplap, Jaluit, Wotje, Mili, Amata Kabua International Airport and Kwajalein, and single daily observations at Laura and Arno. The primary meteorological stations are located at Majuro (the capital) on the southern end of the Ratak chain and at Kwajalein near the centre of the Ralik chain. Observations began at Majuro in 1951 and at Kwajalein in 1945.

Meteorological data for Majuro and Kwajalein atolls from the mid-1950s to present are available from the National Weather Service. Less comprehensive historical weather data are also available for Ailinglaplap, Arno, Eniwetok, Jaluit, Likiep, Mili, Utirik, and Wotje station. Tidal data for Majuro from May 1993.present are available through the South Pacific Sea Level and Climate Monitoring Project (SPSLCMP) maintained by the Australia Bureau of Meteorology, as well as the University of Hawaii Sea Level Center (UHSLC) from October 1968 to December 1999.

Climate Scenario

This section provides a brief description of climatic scenario for RMI including its past and present climate as well as projections for the future, and is derived from the collective work of RMI and Australian climatologists under the Pacific Climate Change Science Joint Program[2] (PCCSP- a collaborative research partnership between Australian Government agencies, East Timor and 14 Pacific Island countries). Observed trends and analysis of air temperature, rainfall, extreme events (including tropical cyclones), sea-surface temperature, ocean acidification, mean and extreme sea levels are presented and projections for air and sea-surface temperature, rainfall, sea level, ocean acidification and extreme events for the next century are provided.

The wind-wave climate of the Marshall Islands shows spatial variability between the northern and southern Islands. Surface wind-wave driven processes can impact on many aspects of Pacific Island coastal environments,

2 www.pacificclimatechangescience.org

Table 24: Mean wave height, period and direction from which the waves are travelling near RMI

		Hindcast Reference Data (1979–2009), Kwajalein (northern Marshall Islands)	Climate Model Simulations (1986–2005) (northern Marshall Islands)	Hindcast Reference Data (1979–2009), Majuro, (southern Marshall Islands)	Climate Model Simulations (1986–2005) (southern Marshall Islands)
Mean wave height (feet)	December–March	4.3 (2.8–5.9)	8.0 (6.8–9.2)	4.7 (3.3–6.3)	6.9 (5.6–8.3)
	June–September	2.8 (1.8–4.1)	4.0 (3.3–4.9)	3.7 (2.6–4.9)	3.8 (3.2–4.7)
Wave Period (seconds)	December–March	7.5 (6.3–9.4)	8.2 (7.6–9.0)	7.8 (6.4–10.3)	8.0 (7.3–8.9)
	June–September	7.6 (6.0–9.8)	7.1 (6.2–8.0)	8.5 (6.6–10.6)	7.4 (6.5–8.2)
Wave direction (degrees clockwise from North)	December–March	60 (40–80)	50 (40–70)	60 (30–100)	50 (40–60)
	June–September	110 (70–200)	90 (70–120)	130 (90–180)	100 (80–140)

Source: Pacific Climate Change Science, Government of Australia

including: coastal flooding during storm wave events; coastal erosion, both during episodic storm events and due to long-term changes in integrated wave climate; characterisation of reef morphology and marine habitat/species distribution; flushing and circulation of lagoons; and potential shipping and renewable wave energy solutions.

In the south (south-east coast of Majuro), the wave climate is characterised by trade wind generated waves from the north-east and south-east. A northerly component of swell propagated from storm events in the north Pacific is observed in December–March, with swell from Southern Ocean storms in June–September. Some southerly waves which may be associated with cyclones are also observed. In the north (sheltered east coast of Kwajalein), waves are characterised by variability of the Northern Hemisphere trade winds.

No suitable dataset is available to assess long-term historical trends in the Marshall Islands wave climate. However, inter-annual variability has been assessed with the hindcast data. The wind-wave climate displays strong inter-annual variability at both Majuro and Kwajalein, varying with the El Niño–Southern Oscillation (ENSO). During La Niña years, wave power is greater than during El Niño years in June–September at both locations.

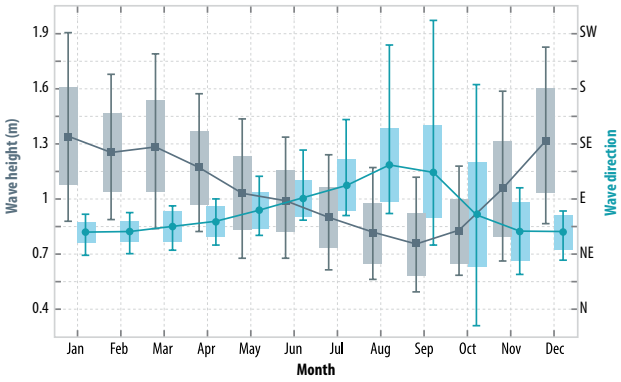
Waves are directed more strongly from the east year round near Majuro in La Niña years, and from the east rather than south-east in June–September at Kwajalein with no change in direction in December–March in La Niña years. The location of the Inter-Tropical Convergence Zone (ITCZ) can also have an impact in this area, reducing locally generated wind waves.

Warming trends in annual and half-year mean temperatures at Majuro since 1955 and Kwajalein since 1949 are statistically significant at the 5% level. Maximum and minimum temperature trends at Kwajalein are much stronger compared to Majuro. The warming temperature trends at both sites are consistent with global warming trends.

Notable inter-annual variability associated with the ENSO is evident in the observed rainfall records for Majuro since 1954 and Kwajalein since 1945 in the above figures. The negative trend in Majuro annual rainfall is statistically significant at the 5% level. This implies either a shift in the mean location of the Inter-Tropical Convergence Zone or a change in the intensity of rainfall associated with the ITCZ.

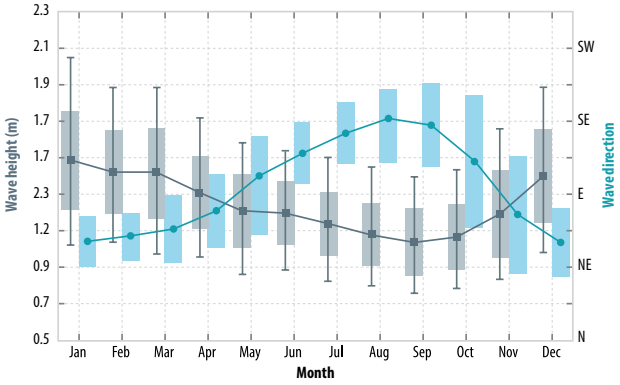
When tropical cyclones affect the Marshall Islands they tend to do so between June and November. The tropical cyclone archive of the Northern Hemisphere

Figure 15: Mean annual cycle of wave height and mean wave direction (Hindcast) Majuro, Marshall Islands



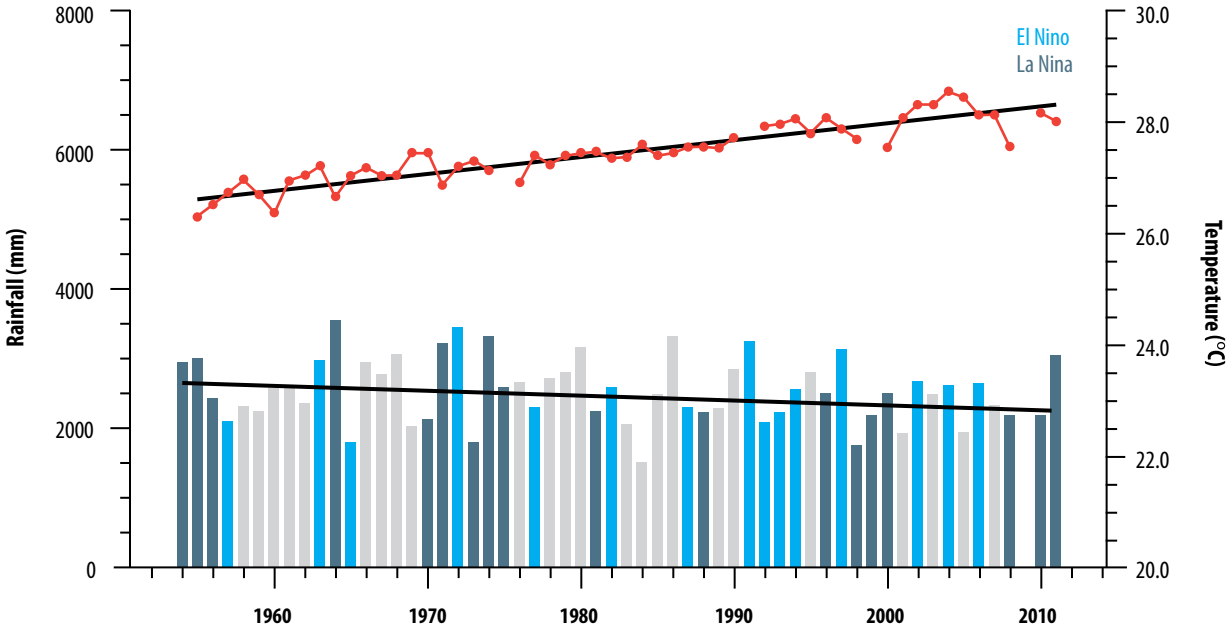
Source: Pacific Climate Change Science, Government of Australia

Figure 16: Mean annual cycle of wave height and mean wave direction (Hindcast) Kwajalein, Marshall Islands



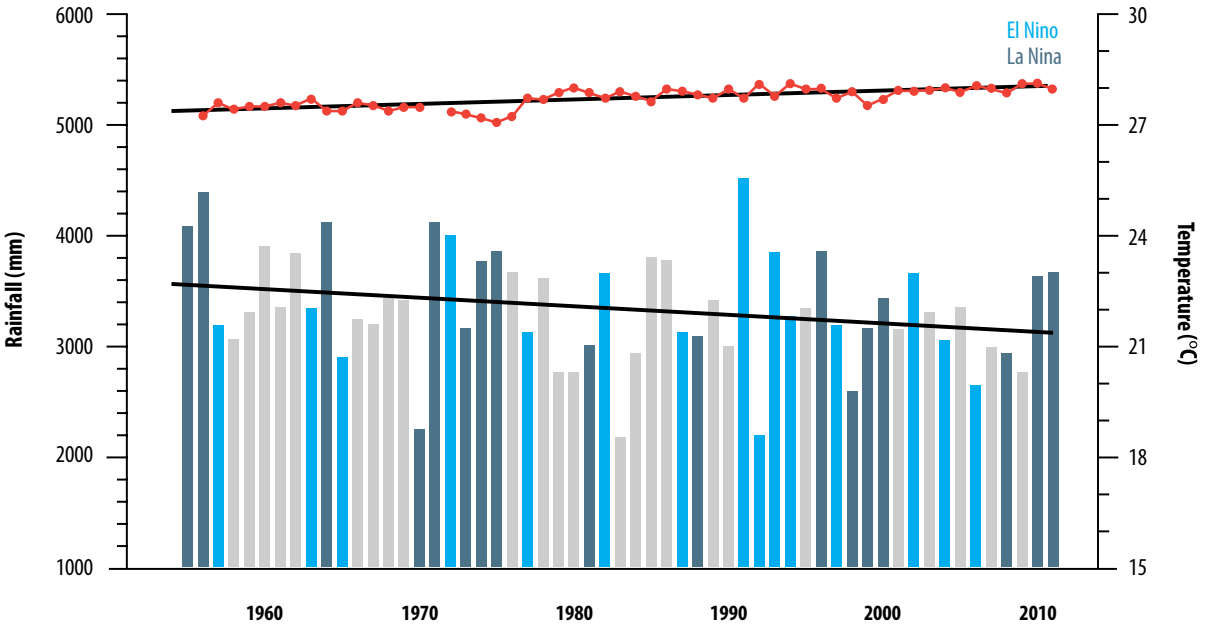
Source: Pacific Climate Change Science, Government of Australia

Figure 17: Observed time series of annual average values of mean air temperature at Majuro



Source: Pacific Climate Change Science, Government of Australia

Figure 18: Observed time series of annual average values of mean air temperature at Kwajalein



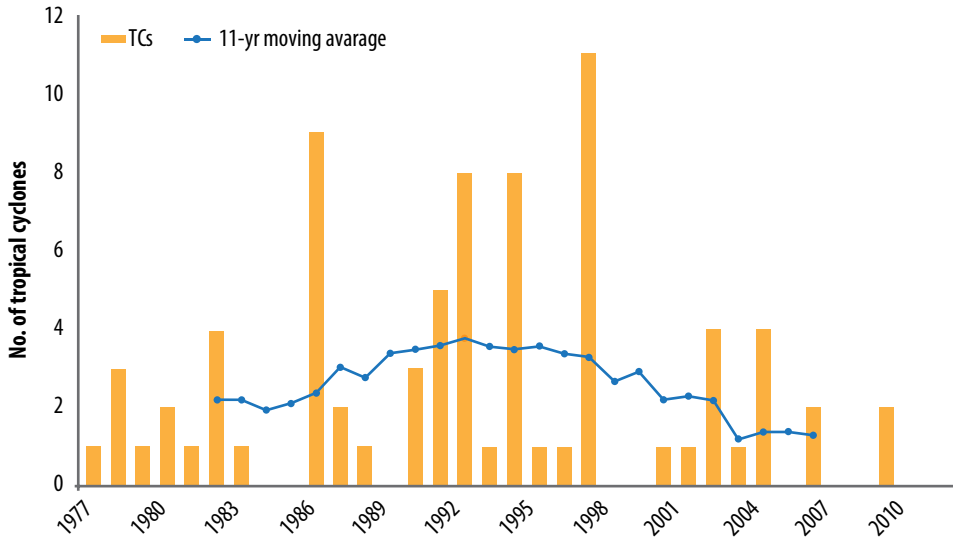
Source: Pacific Climate Change Science, Government of Australia

indicates that between the 1977 and 2011 seasons, 78 tropical cyclones developed within or crossed the Marshall Islands EEZ. This represents an average of 22 cyclones per decade. The inter-annual variability in the number of tropical cyclones in the Marshall Islands EEZ is large, ranging from zero in some seasons to 11 in 1997. Tropical cyclones were most frequent in El Niño years (50 cyclones per decade) and least frequent in La Niña years (3 cyclone per decade). The neutral season average is 18 cyclones per decade. Thirteen of the 71 tropical cyclones (18%) between the 1981/82 and 2010/11 seasons became severe events (Category 3 or stronger) in the Marshall Islands EEZ.

To summarize the current climate scenario in Marshall Islands:

- Warming trends are evident in both annual and half-year mean air temperatures at Majuro (southern Marshall Islands) since 1955 and at Kwajalein (northern Marshall Islands) since 1952.
- The frequency of Warm Days has increased while the number of Cool Nights has decreased at both Majuro and Kwajalein. These temperature trends are consistent with global warming.
- At Majuro, a decreasing trend in annual rainfall is evident since 1954. This implies either a shift in the mean location of the Inter-Tropical Convergence Zone (ITCZ) away from Majuro and/or a change in the intensity of rainfall associated with the ITCZ. There has also been a decrease in the number of Very Wet Days since 1953. The remaining annual, seasonal and extreme rainfall trends at Majuro and Kwajalein show little change.
- Tropical cyclones (typhoons) affect the Marshall Islands mainly between June and November. An average of 22 cyclones per decade developed within or crossed the Marshall Islands Exclusive Economic Zone (EEZ) between the 1977 and 2011 seasons. Tropical cyclones were most frequent in El Niño years (50 cyclones per decade) and least frequent in La Niña years (3 cyclones per decade). Thirteen of the 71 tropical cyclones (18%) between the 1981/82 and 2010/11 seasons became severe events (Category 3 or stronger) in the Marshall Islands EEZ. Available data are not suitable for assessing long-term trends.
- Wind-waves in the Marshall Islands are influenced by trade winds seasonally, and the El Niño Southern Oscillation (ENSO) inter-annually. Wave heights are greater in December–March than June–September. Available data are not suitable for assessing long- term trends.

Figure 19: Time series of the observed number of tropical cyclones developing within and crossing the Marshall Islands EEZ per season



Source: Pacific Climate Change Science, Government of Australia

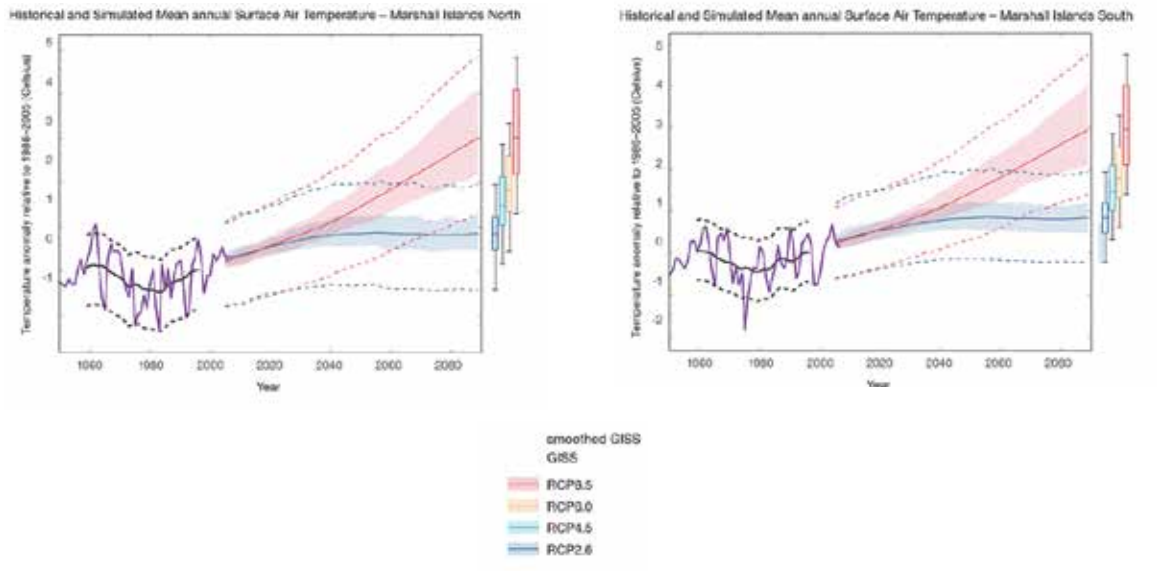
Future Climate Projections

According to the Coupled Model Inter-comparison Project (Phase 5) (CMIP5) climate models further warming is expected over the northern and southern Marshall Islands. Under all IPCC Representative Concentration Pathways (RCPs) the warming is up to 1.1..C by 2030, relative to 1995, but after 2030 there is a growing difference in warming between each RCP.

In the northern Marshall Islands by 2090, a warming of 2.2 to 4.2..C is projected for RCP8.5 (very high emissions) while a warming of 0.5 to 1.2..C is projected for RCP2.6 (very low emissions), with a similar range in the southern Marshall Islands. While relatively warm and cool years and decades will still occur due to natural variability, there is projected to be more warm years and decades on average in a warmer climate.

The long-term average rainfall in the northern and southern Marshall Islands is projected by almost all models to increase. The increase is greater for the higher emissions scenarios, especially towards the end of the century. Most models project an increase in rainfall in both the wet and dry seasons. The year-to-year rainfall variability over Marshall Islands is much larger than the projected change, except in the upper range of models in the highest emission scenario by 2090. There will still be wet and dry years and decades due to natural variability, but most models show that the long-term average is expected to be wetter. The effect of climate change on average rainfall may not be obvious in the short or medium term due to natural variability.

Figure 20: Historical and simulated surface air temperature time series for the region surrounding the northern (top) and southern (bottom) Marshall Islands



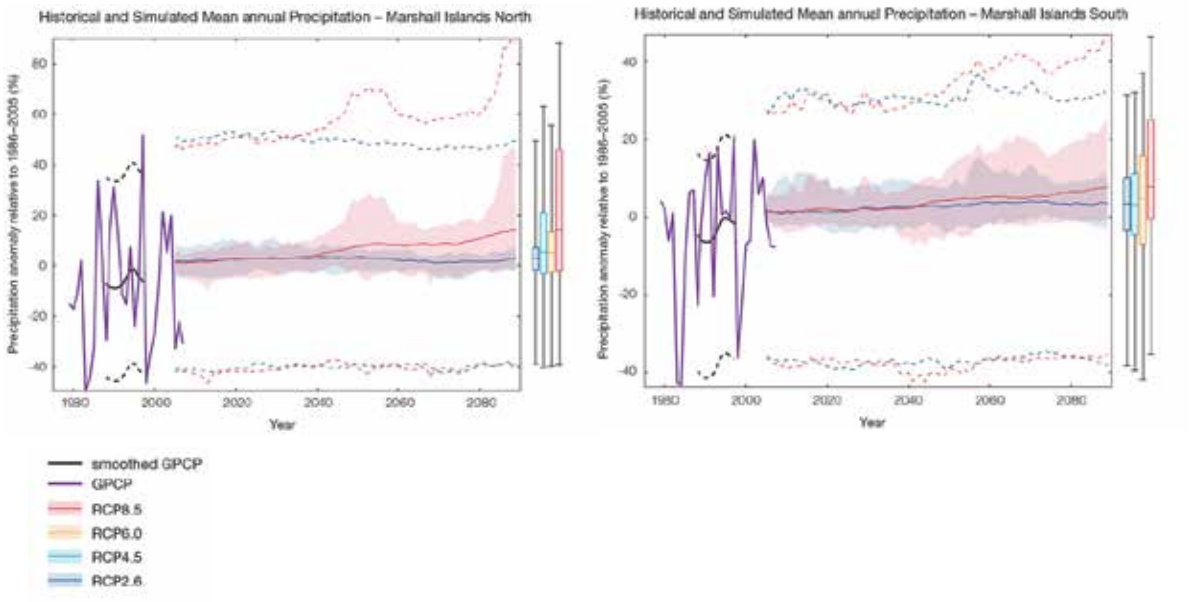
Source:Pacific Climate Change Science, Government of Australia

The temperature on extremely hot days is projected to increase by about the same amount as average temperature. For the northern Marshall Islands the temperature of the 1-in-20-year hot day is projected to increase by approximately 0.7 .C by 2030 under the RCP2.6 (very low) scenario and by 0.8 .C under the RCP8.5 (very high) scenario. By 2090 the projected increase is 0.8 .C for RCP2.6 (very low) and 3.3 .C for RCP8.5 (very high). For the southern Marshall Islands the temperature of the 1-in-20-year hot day is projected to increase by approximately 0.7 .C by 2030 under the RCP2.6 (very low) scenario and by 0.8 .C under the RCP8.5 (very high) scenario. By 2090 the projected increase is 0.8 .C for RCP2.6 (very low) and 3.1 .C for RCP8.5 (very high).

The frequency and intensity of extreme rainfall events are projected to increase. For the northern Marshall Islands current 1-in-20-year daily rainfall amount is projected to increase by approximately 1 mm by 2030 for RCP2.6 and by 7 mm by 2030 for RCP8.5 (very high emissions). By 2090, it is projected to increase by approximately 6 mm for RCP2.6 and by 32 mm for RCP8.5 (very high emissions).The majority of models project the current 1-in-20-year daily rainfall event will become, on average, a 1-in-8-year event for RCP2.6 and a 1-in-5-year event for RCP8.5 (very high emissions) by 2090. For the southern Marshall Islands the current 1-in-20-year daily rainfall amount is projected to increase by approximately 4 mm by 2030 for RCP2.6 and by 11 mm by 2030 for RCP8.5 (very high emissions). By 2090, it is projected to increase by approximately 9 mm for RCP2.6 and by 30 mm for RCP8.5 (very high emissions). The majority of models project the current 1-in-20- year daily rainfall event will become, on average, a 1-in-9-year event for RCP2.6 and a 1-in-6-year event for RCP8.5 (very high emissions) by 2090.

For both the northern and southern Marshall Islands the overall proportion of time spent in drought is expected

Figure 21: Historical and simulated annual average rainfall time series for the region surrounding the northern (top) and southern (bottom) Marshall Islands



Source: Pacific Climate Change Science, Government of Australia

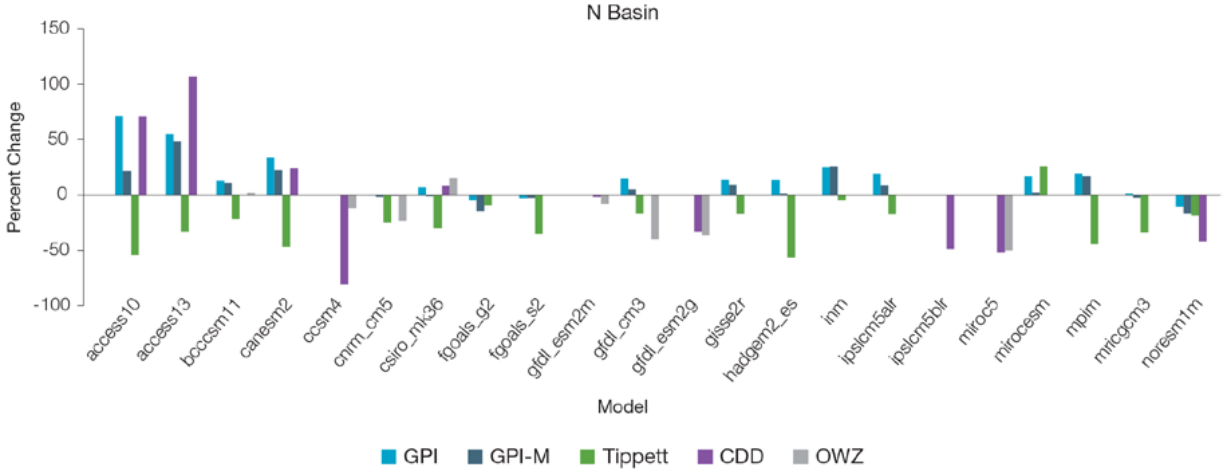
to decrease under all scenarios. Under RCP8.5 the frequency of drought in all categories is projected to decrease and the duration of events in all drought categories is projected to stay approximately the same. Under RCP2.6 (very low emissions) the frequency of moderate, severe and extreme drought is projected to decrease while the frequency of mild drought is projected to remain stable. The duration of events in all categories is projected to stay approximately the same under RCP2.6 (very low emissions).

There is a growing level of agreement among models that on a global basis the frequency of tropical cyclones is likely to decrease by the end of the 21st century. The magnitude of the decrease varies from 6%..35% depending on the modelling study. For Marshall Islands, the projection is for a decrease in tropical cyclone genesis (formation) frequency for the northern basin. However the confidence level for this projection is low. The GCMs show inconsistent results across models for changes in tropical cyclone frequency for the northern basin, using either the direct detection methodologies (CVP or CDD) or the empirical methods. The direct detection methodologies tend to indicate a decrease in formation with almost half of results suggesting decreases of between 20 and 50%. The empirical techniques assess changes in the main atmospheric ingredients known to be necessary for tropical cyclone formation. About four-fifths of results suggest the conditions for tropical cyclone formation will become more favourable in this region. However, when only the models for which direct detection and empirical methods are available are considered, the assessment is for a decrease in tropical cyclone formation.

As atmospheric CO2 concentrations continue to rise, oceans will warm and continue to acidify (Ocean Acidification). These changes will impact the health and viability of marine ecosystems, including coral reefs that provide many key ecosystem services. In the Marshall Islands the aragonite saturation state has declined from about 4.5 in the late 18th century to an observed value of about 3.9..0.1 by 2000 (Kuchinke et al., 2014).

All models show that the aragonite saturation state, a proxy for coral reef growth rate, will continue to decrease as atmospheric CO2 concentrations increase (very high confidence). Projections from CMIP5 models indicate that under RCPs 8.5 (very high emissions) and 4.5 (low emissions) the median aragonite saturation state will transition to marginal conditions (3.5) around 2030. In RCP8.5 (very high emissions) the aragonite saturation state continues to strongly decline thereafter to values where coral reefs have not historically been found (< 3.0). Under RCP4.5 (low emissions) the aragonite saturation plateaus around 3.2 i.e. marginal conditions

Figure 22: Projected percentage change in cyclone frequency in the northern basin

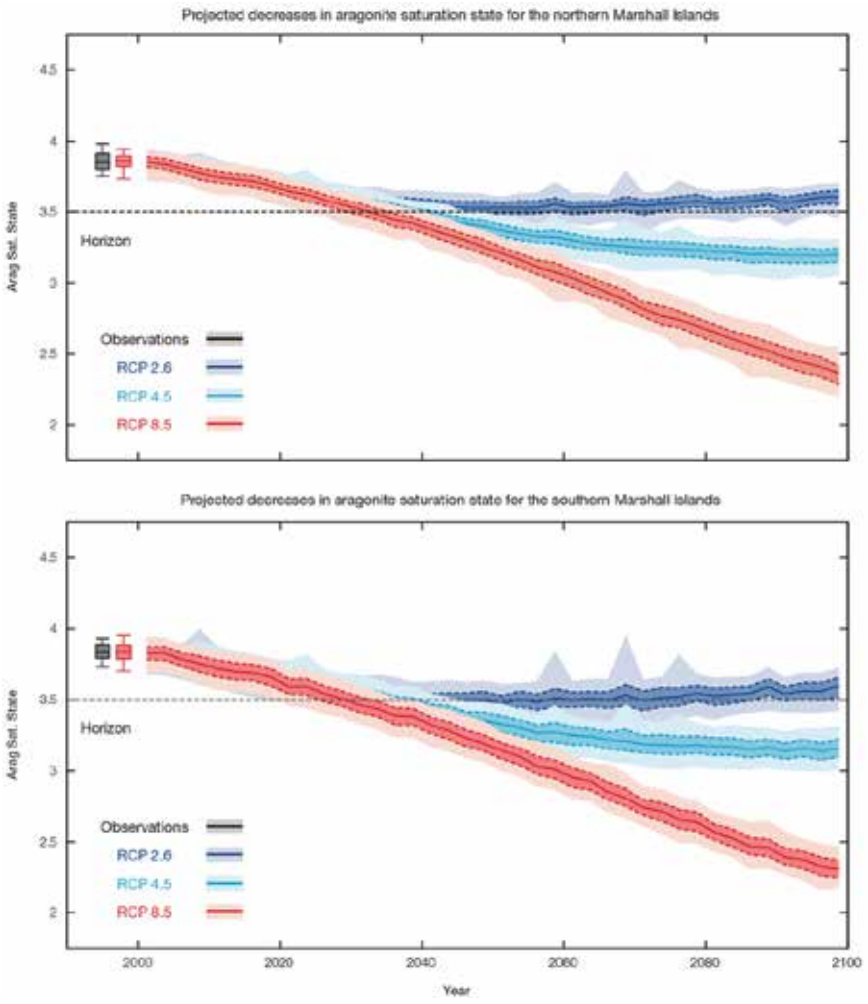


Source: Pacific Climate Change Science, Government of Australia

for healthy coral reefs. While under RCP2.6 (very low emissions) the median aragonite saturation state never falls below 3.5, and increases slightly toward the end of the century suggesting that the conditions remains adequate for healthy corals reefs.

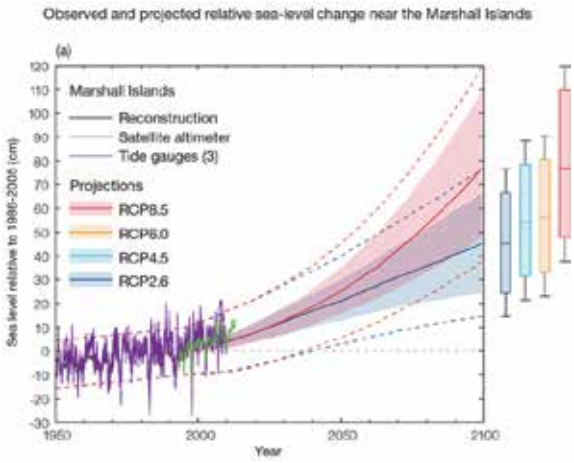
Mean sea level is projected to continue to rise over the course of the 21st century. There is very high confidence in the direction of change. The CMIP5 models simulate a rise of between approximately 7..19 cm by 2030 (very similar values for different RCPs), with increases of 41..92 cm by 2090 under the RCP8.5. There is medium confidence in the range mainly because there is still uncertainty associated with projections of the Antarctic ice sheet contribution. Inter-annual variability of sea level will lead to periods of lower and higher regional sea levels.

Figure 23: Projected decreases in aragonite saturation state in the northern (upper panel) and southern Marshall Islands (lower panel) from CMIP5 models under RCP2.6, 4.5 and 8.5



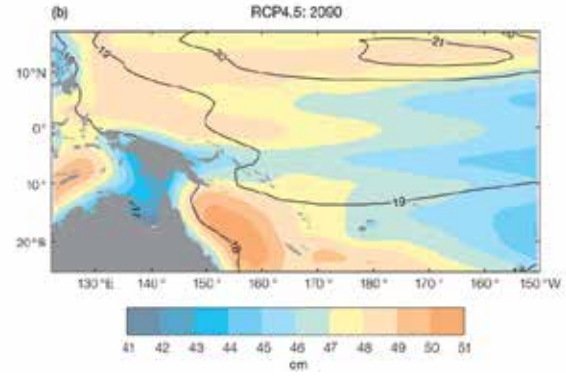
Source: Pacific Climate Change Science, Government of Australia

Figure 24: Observed and Projected Relative Sea Level Rise near the Marshall Islands



Source: Pacific Climate Change Science, Government of Australia

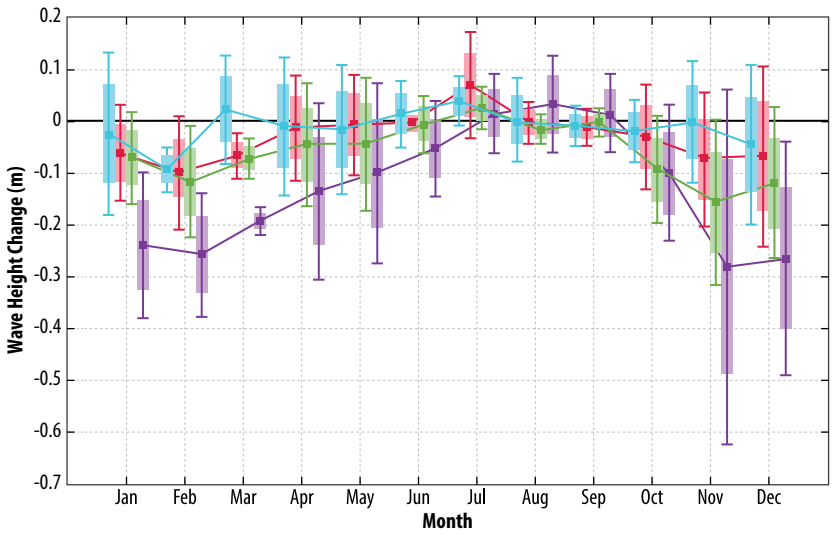
Figure 25: The regional distribution of projected sea level rise under the RCP4.5 emissions scenario for 2081–2100 relative to 1986–2005



Source: Pacific Climate Change Science, Government of Australia

The projected changes in wave climate vary across the Marshall Islands. In the northern Marshall Islands, there is a projected decrease in December..March wave height (significant under RCP8.5, very high emissions, by 2090 across the season, and also in February under RCP4.5 in 2035 and 2090, and March under RCP8.5, very high emissions, in 2035 and RCP4.5 in 2090) consistent with a decrease in northern trade winds, with a suggested decrease in wave period, and no change in direction (low confidence). In the wet season (June… September) there is no projected change in wave height or period but a strong clockwise rotation toward the south is suggested under RCP8.5, very high emissions, in 2090 and in all scenarios in September, possibly as a result of increased projected numbers of westerly and south-westerly waves from monsoons or typhoons, or southern storm swell (low confidence). Storm wave heights are projected to decrease by around 1' (30 cm) by the end of the 21st century in December - March (low confidence).

Figure 26: Mean annual cycle of change in wave height between projection scenarios and historical models in the northern Marshall Islands



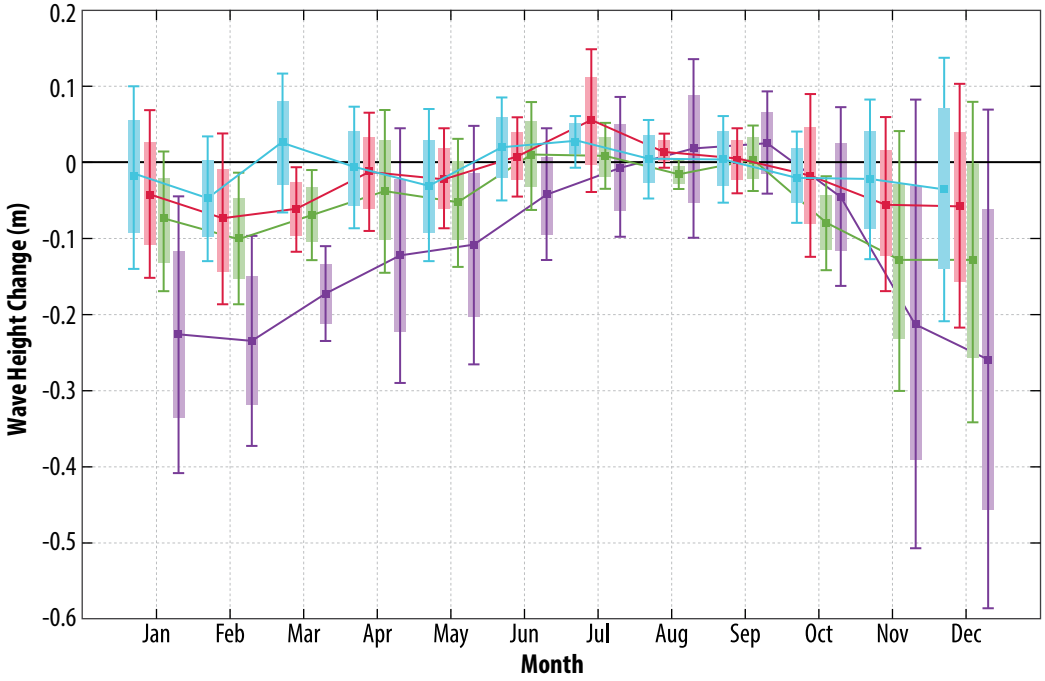
Source: Pacific Climate Change Science, Government of Australia

In the southern Marshall Islands, projected changes in wave properties include a decrease in wave height (significant in January-March under RCP8.5, very high emissions, by 2090, in February under RCP4.5 in 2090 and in March in all scenarios except RCP4.5 in 2035) consistent with a decrease in northern trade winds, with an associated decrease in wave period and no change in direction during the December–March dry season (low confidence). During June–September, no significant changes are projected to occur in wave height or period (low confidence), while a large but non-significant clockwise rotation of direction is projected by 2090, due to more southerly and south-westerly waves resulting from monsoons or typhoons, or perhaps swell from southern storms (very low confidence). A decrease in the height of storm waves by around 8" (20 cm) is suggested in the dry season (low confidence).

To summarize the climate projections in Marshall Islands, for the period to 2100, the latest global climate model (GCM) projections and climate science findings indicate:

- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency;
- Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence);
- Average rainfall is projected to increase (high confidence), along with more extreme rain events (high confidence);
- Droughts are projected to decline in frequency (medium confidence);
- Ocean acidification is expected to continue (very high confidence);
- The risk of coral bleaching will increase in the future (very high confidence);
- Sea level will continue to rise (very high confidence); and
- Wave height is projected to decrease in the dry season (low confidence) and wave direction may become more variable in the wet season (low confidence).

Figure 27: Mean annual cycle of change in wave height between projection scenarios and historical models in the southern Marshall Islands



Source: Pacific Climate Change Science, Government of Australia

Vulnerable Sectors

Climate change impacts are already being felt across the Republic of the Marshall Islands, including increased intensity and frequency of extreme events and droughts. Already, some of the country's northern atolls are suffering more frequent drought conditions, and much of the archipelago is under threat from storm surges and flooding. The major climate-related natural hazards impacting the Marshall Islands are sea level rise, droughts, and tropical storms and typhoons.

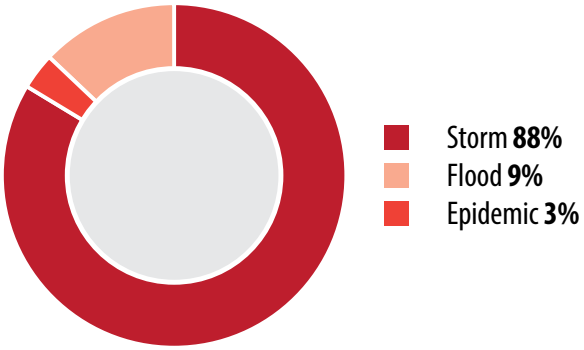
Sea level rise: Shoreline erosion caused by sea level rise is already a significant problem across the Marshall Islands. According to a study conducted in 1992 of Majuro atoll by the National Oceanic and Atmospheric Administration of the United States (NOAA), a three foot rise in sea levels would completely inundate the atoll, and defense mechanisms to protect the atoll from a one-in-fifty year storm event would be impossible. It is recommended that a "full retreat of the entire population of the Majuro atoll and the Marshall Islands must be considered in planning for worst-case sea level rise scenarios.

Droughts: Wet season rainfall supplies the majority of freshwater to the RMI. However, EL Ni.o conditions in this part of the Pacific can shift rainfall patterns, bringing significantly less rainfall than in normal years and leading to drought conditions. Droughts are especially damaging in the atolls lacking sufficient rain-water harvesting/storage capacity to withstand dry periods, as is the case with most of the outer atolls of the dry North (Utrik, Ailuk, Likiep, Wotho, Lae, and Namu). The El Ni.o event of 1997/98 was one of the most pronounced drought periods in RMI, bringing only 8% of normal rainfall in a four month period and leading the government to declare the entire archipelago a disaster area, and severely impacting Laura atoll's fresh-water lens. More frequent El Ni.o events could increase the intensity and occurrence of these drought events, with important implications for disaster management and response in the RMI.

Photo 14: Drought during 2013 in Ailuk Atoll

Tropical storms and typhoons: Strong winds, wave run-up, and overtopping of beach berms and protective structures are significant sources of flooding and damage across RMI. Such was the case in 2008, when one of the worst recorded disasters in the nation's history took place. A combination of factors, including three major storms in two weeks and high tides, together flooded (via storm surges) a large part of the Majuro atoll, damaging more than 300 homes and forcing 10% of the population to temporary shelters.

Figure 28: Percentage of affected people reported by disaster type in the top 10 natural disasters



Source: Pacific Climate Change Science, Government of Australia

Photo 15: Flooding in Majuro

The impacts of natural hazards in the Republic of the Marshall Islands are exacerbated by the underlying conditions of vulnerability noted in a GFDRR, World Bank, and SOPAC assessment. The conditions noted in the assessment included:

- extremely high population density, especially on the two urban islands of the archipelago (Ebeye and Majuro);
- high levels of poverty (20% of the population lives on less than US$1/day);
- low elevations. average elevation of most islands is approximately two meters above sea level, with the highest recorded point on the atoll at 10 meters above sea level (Likiep), and the majority of the population living along the coastline;
- dispersed archipelago (the islands are spread across three quarters of a million square miles) making administration, communications, and operations challenging;
- limited and fragile island ecosystems and fresh-water resources (vulnerable to over-use, contamination, and droughts);
- a weak economic base heavily dependent on donor support

Climate variability and change has and will continue to affect the Republic of the Marshall Islands. Vulnerability is a key factor that needs to be considered to identify the differential impacts of climate. The poor and those farther away from government services have limited access to services necessary to make them resilient to adverse climate effects, and their living conditions are often affected by laws, policies, and economic forces over which they have little or no control. Although it

Photo 16: Major Erosion at Majuro airport and catchment, caused by Upwelling during the February 2011 King Tide

is by no means clear whether vulnerable groups, with their pressures to survive, or affluent groups, with their pressures to consume, ultimately lead to the impacts which continue to drive vulnerability, it is clear that poor people will be vulnerable to the growing demands of a changing climate if this requires looking beyond their immediate needs.

The RMI's hazards and vulnerabilities are linked to both physical and social characteristics of its islands and people, in addition to ongoing unsustainable development practices. Key drivers of the RMI's vulnerability include:

- Rapid population growth and over-population in urban centres
- Environmental degradation and unsustainable development
- Localized pollution (including contamination of water supply) and waste management
- Potential climate change impacts including accelerated sea level rise, which may increase vulnerability and exposure to shocks and stresses, as well as increase uncertainty and unexpected events
- Limited resources (particularly food, water and fuel)
- Limited economic potential due to small size and remoteness
- High exposure to external market shocks (demonstrated by the State of Economic Emergency declared in 2008 following unprecedented increases in costs of imported food and fuel)
- Sparse and scattered nature of islands and atolls, making communication and transportation to outer islands more difficult, with infrequent and at times unreliable transport links

Additional challenges include pollution and waste management, including sanitation. Outbreaks of disease via contamination of water is not uncommon ..an issue that is exacerbated by the high population densities of the urban centres.

Table 25: RMI's Natural and human induced hazards

Key Natural Hazards	Key Human-Induced Hazards
Tropical storms and typhoons Sea swells Drought Tsunami	Fire Contamination of water supply Outbreak of epidemic diseases

Tsunamis have not been recorded as having a significant impact on the Marshall Islands in living memory. However, recent research on similar atoll islands in the Pacific also thought to be at minimal risk (such as in Wallis and Futuna) have revealed inland soil deposits caused by significant tsunamis. The tide gauge in Majuro has recorded 14 tsunamis since 1993, with the largest being 4.3 inches (11cm), caused by a 8.3 Mw earthquake in the Kuril Islands in 1994. While the likelihood of a major tsunami occurring during an extremely high equinox tide (or even coinciding with waves arriving from a distant storm, are very low, such an event could have disastrous consequences for RMI. With increasing sea levels, the likelihood of a tsunami coinciding with high water level will increase.

Table 26: RMI's sectoral vulnerabilities

Sector	Climate change vulnerabilities
Water resources	Changes to precipitation patterns are likely to further exacerbate existing pressure on limited water resources. Any rise in sea level also puts freshwater resources at risk of contamination of sea water into freshwater lenses
Agriculture	It is likely that sea level rise will result in salinization of agricultural land, which in the RMI is very low lying and already vulnerable to high seas and storm surge. Land loss via erosion is also likely, further reducing the availability of land to grow crops.

Human Health	Climate change is likely to enhance the risks for the potential of outbreaks of vector-borne diseases such as dengue fever, due to an increase in mosquito breeding sites associated with a warmer climate and potentially higher rainfall conditions, particularly given the increasing trends of urban settlement and corresponding higher population densities. Higher temperatures may also lead to increased transmission of water borne diseases; for example, prolonged periods of high temperatures can enhance the conditions favourable to some types of diarrheal diseases and gastroenteritis. Conversely, there is an enhanced risk of outbreaks of diseases such as typhoid and cholera with contaminated water during and after flooding.
Infrastructure	Sea level rise and associated impacts such as coastal erosion and inundation threatens infrastructure of RMI's low lying atolls and islands. An increase in frequency and/or intensity of tropical storms or typhoons also poses a risk to infrastructure, much of which is built with little/no regard for construction standards
Fisheries, Coastal Ecosystems and biodiversity	Substantial negative impacts on coastal and marine ecosystems are likely. Rising ocean temperatures and ocean acidification (via increased concentration of carbon dioxide) may have significant adverse impacts upon coral reefs such as coral bleaching, coastal ecosystems, and migratory fish stocks such as tuna, which represent a substantial economic resource for RMI.
Energy	RMI's vulnerability to external fluctuations in global prices of food and fuel was exposed in 2008 via the State of Economic Emergency. Despite stabilising somewhat, global fuel prices remain volatile in a time of increased concern over existing energy reserves and the transition globally to focus more on renewable energy. Climate change increases this uncertainty, meaning an unstable platform upon which the energy sector is situated in the RMI.

Source: Republic of the Marshall Islands Joint National Action Plan for Climate Change Adaptation & Disaster Risk Management 2014-2018

Impact on land use

Agriculture, including the subsistence production of taro, coconuts, breadfruit, pawpaw and the commercial production of copra are highly dependent on fresh ground water supplies. Similarly, a significant proportion of water used for domestic purposes is taken from ground water aquifers. Any change in ground water resources would have a significant impact on land use in the RMI. Since subsistence agriculture has a more limited role in the Marshall Islands than in most atoll states, the result would not be severe as elsewhere. Nevertheless, although atoll plant species are generally resistant to some salt intrusion, there are unlikely to be any crop or plant species that would benefit from a greater level of salinity.

Most of the settlements in the Marshall Islands are necessarily located near the coast. Increased coastal erosion would threaten some of these settlements and make relocation necessary. Unfortunately, this would be virtually impossible in Ebeye and Majuro where the urban areas are almost completely filled-up and where private land tenure prevents some kinds of relocation. Elsewhere, central depressions, and mosquitoes discourage residence at a greater distance from the coasts. Only a few areas, such as Laura, can relocation be possible, albeit to a very limited extent.

Impact on coastlines

Increased wave height and increased storminess are both likely to cause erosion of unstable coastlines in the RMI as they have in the past. In some islands coastline stability is greater than on other atoll islands because of the extensive fringe sandy or conglomeratic beach rock, and the existence of natural beach rock accumulations. These deposits will offer temporary resistance to the erosion likely to be caused by rising sea level, but in time is envisaged to succumb to this erosion. Few atolls, except where mangrove exists, the will erosion are less significant.

Erosion of the coastline of Majuro is occurring at a considerable rate as coconut trees and coastal vegetation fall over as the soils are washed away from underneath them. This situation is not helped by the amount of dredging and sand mining that is happening especially around the airport area.

Photo 17: Coral Bleaching in Majuro

Impact on water supply

In the northernmost islands of the RMI, the ground water lens usually becomes saline following drought periods. In the southern islands including Majuro and Kwajalein, adequate rainfall prevents this from occurring except on the small atoll islets. Warmer periods in the tropical Pacific are associated with positive Southern Oscillation Index values or anti-El-Nino movements, and drier

climatic conditions. Should this association of lower rainfall with higher temperatures persist with global warming, the ground water resources of these atolls would decrease, with less rain-fed recharge, increased evaporation and increased water demand. However, should sea level rise, the fresh water lens which floats above a mixed salt water base will be elevated, and its slope and head increased.

This is likely to result in increased lateral saline mixing, increased evaporation through taro pits and wells, increased loss of fresh water by coastal leakage, saline water being brought within the reach of coconut and other tree crop roots or well and pump intakes, and generally a loss of the fresh water resource. If sea level rise is accompanied by increased storm surges, which will favour island building, such wash processes will render groundwater saline until a state of stability returns. Such stability is possible only when sea level rise ceases.

Impact on Fisheries

The tuna fishery of the EEZ of the RMI is the mainstay of the nation's economy. However, there are limiting factors to the continuing viability of the sector including the sustainable yield of the fish stock, the world markets for the products and the effects of climate phenomena such as El Nino and ENSO. It is not known how increased ocean temperatures will affect the tuna fishery industry but it is acknowledged that the tuna fishery is a risky and costly business for Mashallese. Hence, despite the fact that only about 5% of the potential fisheries revenue is retained in the RMI, the government will continue to look at foreign fishing vessels and companies for the utilization of its tuna fisheries for some years to come.

Subsistence fishery is particularly important and includes reef and lagoon, as well as oceanic fisheries. There is concern that the current rate of damage to the corals and coral reef systems from land based pollution activities is having negative effects on the life cycle of many coral and fish species. Dredging, sand mining and beach erosion are having detrimental effects on the corals and reefs and these are in turn having negative impacts on fisheries resources of the country.

Yellowfin and bigeye tuna stock are reported to be nearing full exploitation. El Nino conditions in 2002-2003 resulted in the principal tuna stock moving out of RMI waters and congregating more in the western hemisphere around Papua New Guinea and its neighbouring countries. This led to decreased catch and less trans-shipments occurring in the RMI. This situation is expected to reoccur under similar conditions in future.

Impact on agricultural crops

Prolonged periods of drought over the past twenty years have been observed to have adverse effects on the agricultural productivity of the atolls. Both taro and breadfruit production have been affected by the changes to the water table under adversely dry conditions and this situation can only be expected to worsen with future climate change events such as reduced rainfall and more frequent and intensive droughts.

Although there is still not a clear understanding of whether increasing temperatures will directly affect subsistence crops in the RMI, observations seems to suggest that subsistence crops will indeed be affected. The scenarios of future temperature change for the middle of the next century indicate a rise of 1.6 ..2.9..C, implying a climate regime that is considerably different from that of the present. Crops like taro and arrowroot are already showing signs of stress under present conditions and are doubtful to survive further increases in temperature.

On the other hand, there is strong evidence that rainfall variations directly affect crop yields and production in the RMI. The scenario of higher rates of sea level rise and increased incidence of extreme events such as droughts and tropical cyclones could result in increased salinity of the soils and fresh water lens, thus impairing food security.

National Adaptation and Disaster Risk Management Priorities

This Joint National Action Plan (JNAP) for Climate Change Adaptation and Disaster Risk Management (2014-2018), endorsed by cabinet in 2014, provides a detailed strategy for holistically and co-operatively addressing risk in the Republic of the Marshall Islands (RMI). The JNAP is the result of extensive national consultations with relevant stakeholders and is built upon the strong foundations of the RMI's Disaster Risk Management National Action Plan (DRM NAP). The incorporation of actions to address the crucial issue of climate change, which is likely to severely and negatively impact upon livelihoods in the RMI, provides an updated action plan which does not differentiate between the source of risk, whether it be climate driven or otherwise. The RMI has been able to effectively plan for mainstreaming risk reduction across all sectors via activities detailed in this JNAP.

The JNAP draws upon and is informed by existing policies and frameworks at the national, regional and international level. At an international level, the RMI is committed to the principles outlined in the Mauritius Strategy for Sustainable Development of Small Island Developing States 2005. The RMI's National Strategic Development Plan: Vision 2018 (currently under review) provides an overarching framework for sustainable development. Containing ten sustainable development goals, Vision 2018 contains several strong linkages to disaster risk management and climate change

The climate change related sectoral policies and plans the JNAP takes into account include: RMI Energy Policy and Action Plan; Agriculture and Food Security; National Water Resource Management Framework, and outcomes of 2011 National Water Summit and EPA Coastal Management Framework.

The JNAP also links in with existing strategies, both nationally and donor led, e.g. the UNDP supported Action for the Development of Marshall Islands Renewable Energies (ADMIRE), the FAO supported Food Security and Sustainable Livelihoods program, the UNDP funded and SPREP coordinated Pacific Adaptation to Climate Change (PACC) Program, Pacific IWRM implemented by SOPAC, International Climate Change Adaptation Initiative (ACCAI), Pacific-Australia Climate Change Science and Adaptation Planning Program (PCCSAP), Pacific Adaptation Strategy Assistance Program and the IOM funded PREPARE and CADRE programs …among others.

The six JNAP goals are the result of combining the aims and priorities of the DRM NAP and the NCCPF. They also address the key sector vulnerabilities.

Table 27: JNAP Goals and Expected Outcomes

Goal	Outcomes
Goal 1: Establish and support an enabling environment for improved coordination of disaster risk management /climate change adaptation in the Marshall Islands	Strengthened coordination and effectiveness of DRM/CCA decision making processes and institutional arrangements including government, traditional leaders, private sector, NGOs and civil society Natural hazard risk considerations (climate-related, geophysical and others) are mainstreamed in all relevant processes of development and budgetary planning at all levels and in all relevant sectors, resulting in an integrated response to building resilience to climate change and disasters Key organizations are adequately resourced and avenues for sustainable financing are secured through improved policies, capacities and institutional arrangements (incl. National Trust Fund)

Goal 2: Public education and awareness of effective DRM/CCA responses from local to national level	Technical, scientific and management skills and expertise for climate change and DRM are improved and retained in the RMI Effective climate change and disaster communication strategies are tailored for the RMI both in urban centres and Outer Islands Increased discourse on climate change and DRM in planning for sustainable development at national, local and community levels Awareness of the causes and impacts of climate change and disasters in the RMI is improved, including what constitutes an effective adaptation response Development planning and budgeting increasingly reflects understanding higher level of investment in climate change and disaster risk information, traditional knowledge and science as the basis for decision making
Goal 3: Enhanced emergency preparedness and response at all levels	Appropriate governance arrangements and resources are in place to provide enabling environment for disaster preparedness and response and coordination at all levels and for all agencies and organizations People focussed early warning systems and emergency communications are effectively implemented and maintained, including between Majuro, Ebeye and the Outer Islands Needs of vulnerable groups are given priority in emergency preparedness and response planning and implementation External support from partners complements and enhances national arrangements and mechanisms for disaster response preparedness
Goal 4: Improved energy security, working towards a low carbon future	Effective implementation of the RMI National Energy Policy and Action Plan (2009), in part supported through access to international finance for emissions reductions, technology transfer and capacity development Improved resilience of the Outer Islands by increasing the availability of on-island renewable energy sources
Goal 5: Enhanced local livelihoods and community resilience	All households have reliable access to clean, fresh water The resilience of community livelihoods (including health and wellbeing) and vulnerable groups including youth and children are strengthened Vulnerability to water and food related hazards and shortages resulting from hazards and climate change impacts is reduced Reduced vulnerability to coastal hazards Effective management of coastal resources including land and marine biodiversity
Goal 6: Integrated approach to development planning including consideration of climate change and disaster risks	All land use policies and settlement planning processes reflect DRM/CCA RMI has an updated building code for disaster and climate-proofing that is backed by appropriate legislations Improved national and local capacity to undertake vulnerability and adaptation assessments and planning Key stakeholders are integrated into the planning and implementation of adaptation programmes at all levels

Source: Republic of the Marshall Islands Joint National Action Plan for Climate Change Adaptation & Disaster Risk Management 2014-2018

Key Vulnerability Reduction and Adaptation Initiatives

Table 28: RMI's Key Vulnerability Reduction and Adaptation Initiatives

Vulnerability Reduction and Adaptation Initiatives	Description
Micronesia Challenge (MC)	Sub-regional conservation initiative which enhances community resiliency by using traditional knowledge and ecosystem strategies to conserve vulnerable coastal land resources by 2020; goals are to effectively conserve at least 30% of near shore resources and 20% of terrestrial resources. The MC includes the Micronesians in Island Conservation Network (MIC), Pacific Islands Managed and Protected Area Community (PIMPAC), Locally Managed Marine Area Network Micronesia Node (LMMA), and Micronesia Challenge Young Champions. Agencies responsible: Micronesia Chief Executives (Guam, Mariana Islands, FSM, Palau and RMI), The Nature Conservancy (TNC) NOAA, Micronesia Conservation Trust (MCT).
Micronesia Conservation Trust (MCT)	MCT was formally established by TNC in 2002 as a charitable and irrevocable corporation organized to manage and provide funds for the accomplishment of the following mission: "to support biodiversity conservation and related sustainable development for the people of Micronesia by providing long term sustained funding." In 2006, MCT was selected as the financial mechanism for the MC and has since fully regionalized its Board and organizational structure and services.
Pacific Adaptation to Climate Change (PACC) Project	The PACC Project is designed to promote climate change adaptation as a key pre-requisite to sustainable development in Pacific Island countries. Its objective therefore is to enhance the capacity of the participating countries to adapt to climate change and climate variability, in key development sectors. Mainstreaming, demonstration and communications are implemented at the community and country levels. The PACC Project is working to increase water storage in the country and to improve existing water systems to conserve the limited water that they have. This will better equip people to withstand future droughts caused by climate change. Agencies responsible: UNDP (implementing agency), GEF, AUSAID (funding agencies), SPREP(implementing partner), RMI OEPPC

Implementing Sustainable Water Resources and Wastewater Management in Pacific Island Countries (Pacific IWRM)	Pacific IWRM is developing "Ridge to Reef Community to Catchment" integrated water resource management (IWRM) activities in the 14 participating Pacific Island Countries. Agencies responsible: Global Environment Facility (GEF), SPC Applied Geosciences and Technology Division (SOPAC)
European Union B-Envelope water supply	The project aimed at improving reliability of dry-season and drought-period water supply to urban and rural areas through rainwater harvesting and management, and protection of groundwater resources. Agency responsible: European Union, RMI Chief Secretary's Office
Coping with Climate Change in the Pacific Island Region (CCCPIR)	CCCPIR covers 12 Pacific Island Countries and six components ranging from regional and national mainstreaming of climate change, implementation of adaptation activities on the ground, and climate change related to tourism, energy and education. In RMI CCCPIR focuses on the water and sanitation sector. Overall available funding is 17m EUR with up to half a million USD available to RMI. The project is focusing on adaptation in the water sector with technical support being placed in RMI EPA... Agencies responsible: German Ministry for Economic Cooperation and Development (BMZ, funding), GIZ, implementing agency. SPC (regional partner). RMI OEPPC
Pacific - Australia Climate Change Science and Adaptation Planning Program (PACCSAP)	PACCSAP: supporting the government of RMI to develop improved climate change projections and adaptation planning activitiess. 2012-2013. FSM and 14 other Pacific countries are part of this A$32 million project which builds on the foundation of the Pacific Climate Change Science Programme and the Pacific Adaptation Strategy Assistance Programme. Agencies responsible: AUSAID; Australian Department of Climate Change and Energy Efficiency (DCCEE); Australian Bureau of Meteorology, CSIRO, RMI National Weather Service Office
Global Climate Change Alliance: Pacific Small Island States (GCCA:PSIS)	The overall objective of the GCCA:PSIS is to support the governments of nine Pacific smaller island states, including RMI, in their efforts to tackle the adverse effects of climate change. Overall available funding is 11m EUR. In the RMI the key adaptation activity focus has been proposed in the coastal sector, along with initiatives on mainstreaming climate change adaptation and climate change financing. Agencies responsible: European Union (EU), SPC (Implementation), SPREP, RMI OEPPC, EPA
Coastal Community Adaptation Project (C-CAP)	This project aims to build the resiliency of vulnerable coastal communities in the Pacific region to withstand more intense and frequent weather events and ecosystem degradation in the short-term, and sea level rise in the long-term. The project has three components: (1) rehabilitating or constructing new, small-scale community infrastructure; (2) building capacity for community engagement for disaster prevention and preparedness; and (3) integrating climate resilient policies and practices into long-term land use plans and building standards Responsible Agencies USAID Implementing Organization: Development Alternatives, Inc. (DAI), University of the South Pacific (USP); Kramer Ausenco Papua New Guinea Limited, RMI OEPPC

Asia Climate Change Adaptation Support Facility (ADAPT Asia-Pacific)	Will provide capacity building and governance support for adaptation planning and implementation in 13 Asian countries including Timor-Leste, and 14 Pacific Islands countries in the region. This program aims to: (i) strengthen human and institutional capacity to prepare high-quality climate change adaptation investment proposals; (ii) accelerate and ensure sustained access to financial resources for climate change adaptation investment projects; and (iii) support and strengthen a regional knowledge platform to share and replicate best practices. Responsible Agencies USAID/RDMA program under IAA with State/OES AECOM
Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)	Aims to provide the Pacific Island Countries (PICs) with disaster risk modeling and assessment tools to help them better understand, model, and assess their exposure to natural disasters, and to engage in a dialogue on integrated financial solutions for the reduction of PICs financial vulnerability to natural disasters and to climate change. The initiative is part of the broader agenda on disaster risk management and climate change adaptation in the Pacific region. Responsible Agencies: SPC, WB and ADB, Japan, Pacific Disaster Centre, with technical inputs from GNS Science, Geoscience Australia, and AIR Worldwide
Pacific Islands Climate change Assistance Programme (PICCAP)	A multi-country regional enabling activity project funded by the GEF, implemented by UNDP, and executed by SPREP to assist participating countries to prepare their initial communications under the UNFCCC.
Schools of the Pacific Rainfall Climate Experiment (SPaRCE)	The Schools of the Pacific Rainfall Climate Experiment (SPaRCE) is a cooperative field project involving elementary, middle school, high school, college, and trade school students along with local meteorological services from various Pacific islands, atolls, and the U.S. Mainland. SPaRCE provides environmental education and enhancement of Pacific Island science programs. In turn, the students collect important data to be used for climate research. Besides gaining a better understanding of basic concepts, these students become an integral part of the study of weather patterns in the Pacific. The rainfall data collected by participants is entered into the Comprehensive Pacific Rainfall Database (PACRAIN). PACRAIN also contains rainfall data reported from the Pacific New Zealand Meteorological Service.
Regional Program for Food Security in the Pacific Islands (RPFS)	In addition to many other programs and projects supported by FAO in the region, this RPFS program, endorsed at the Sixth and Seventh FAO South West Pacific Ministers of Agriculture Meetings, aims to address agriculture trade, food quality and safety, and climate change focusing on the urgent need for preparedness, and putting in place adaptation and mitigation strategies and actions. The Sub-Program 2.3 (Natural Disasters and Climate Change Preparedness, Adaptation and Mitigation) has four components dealing with (i) Agriculture Diversification; (ii) Integrated Coastal Management; (iii) Land and Water Management and Use; and (iv) Technical Coordination Support. Interventions of the expanded program will target: Enhancing food production; Rural infrastructure development; and Strengthening agriculture trade and policy, climate change adaptation and mitigation and support for project planning and program development. FAO has supported pig development and improved home gardening in the RMI under this project.

A Framework for Action 2005 - 2015: Building the Resilience of Nations and Communities to Disasters	The 2005-2015 Framework for Action was prepared by the SPC (formerly SOPAC) in response to increased national and regional commitments to disaster risk reduction and disaster management. It also directly supports the development and implementation of policies and plans for the mitigation and management of natural disasters, which is one of the key initiatives of the Kalibobo Roadmap, which reinforces the objectives of the Pacific Plan. The framework also complements other relevant regional frameworks, declarations and policies including those relating to climate change, ocean resources, freshwater, health, HIV/AIDS and agriculture.
Pacific Hydrological Cycle Observing System Program.	The program focuses on (a) working with the RMIEPA and Majuro Water and Sewer Company on several management issues and capacity building; (b) providing equipment for water quality management; (c) assisting with the rehabilitation of the Laura lens and groundwater monitoring; and (d) supporting outer Pacific Islands for water quality and assessment.
Rongelap Atoll local government, conservation, and sustainable development project	The project is taking a holistic approach to sustainable development of the island, which has a pristine marine environment and from which the inhabitants have temporarily been relocated. The activities include a marine research center, a marine sanctuary, aquaculture, and ecotourism. Thisincludes breeding of marine species.

Source: Republic of the Marshall Islands Joint National Action Plan for Climate Change Adaptation & Disaster Risk Management 2014-2018

Marshall Islands Pacific Adaptation to Climate Change Project

The Marshall Islands is an atoll nation with half of the population live on the main island of Majuro. With limited groundwater supplies, the islands rely heavily on rainfall for their freshwater. Drought is therefore a major threat to water security. The low-lying islands are also highly vulnerable to rising sea level, storm surges, and flooding.

Reservoir renovation on Majuro

To address the key issue of water security, the PACC demonstration project focused on improving the catchment and reservoir system on the main island of Majuro. The island uses its largest paved area the airport runway to collect rainwater, and then diverts it to a series of storage tanks where it is treated and piped to communities. However, increasing population and outdated infrastructure, compounded by unpredictable and challenging weather, meant that the system was becoming inadequate.

The project carried out a vulnerability and adaptation assessment of the water sector in Majuro, and cost… benefit analysis, to identify the best options for PACC investment. Following recommendations from these analyses, PACC activities focused on repairing the reservoir, including relining the tanks and installing a cover to reduce evaporation. The renovated reservoir was officially opened on 2 April 2014. The reservoir is now able to hold up to 36.5 million gallons, compared with 31.5 million gallons prior to the improvements. The higher capacity means greater water security for the people of Majuro.

Solar water purifiers for the outer atolls

The PACC demonstration project is benefiting the communities of Majuro, but the other islands are also vulnerable to drought. Witnessing the success in the Nauru PACC project with solar-powered water purifiers, which convert saltwater or contaminated water into clean drinking water, the Marshall Islands PACC team realised that communities on their outer islands could also benefit from this technology. They put in an order to the Australian manufacturers, and

Photo 18: Reservoir in Majuro

168 units were delivered to health centres on the outer islands and formally commissioned by RMI President Chris Loeak in early June 2014.

Mainstreaming achievements

The PACC project team has also contributed to mainstreaming of climate change into some key strategic documents, including the National Water and Sanitation Policy (endorsed in March 2014), National Climate Change Policy, and the country's Joint National Action Plan for disaster risk management and climate change.

Barriers and Opportunities

The Republic of the Marshall Islands, like all small island states, faces a unique set of challenges in dealing with climate variability and change. While a number of adaptation activities are ongoing, the assessments point to significant gaps that will need to be addressed in light of projected changes in climate. Vulnerability to natural and human-induced hazards, inherently high in the RMI due to its fragile island environment, appears to be increasing. This is a consequence of modernization, urbanization, and unsustainable development processes that have not taken current and future risks into account.

The potential for catastrophe in RMI is very large and growing. While the list of hazards is relatively small, the potential for catastrophic damage and loss of life from several hazards is very high. Disease, epidemic, and fire are potential hazards, but typhoons top the list. The land has low elevation (less than two meters) and is narrow. Housing and most buildings are generally of poor construction, not well maintained and tightly packed. There are no established agreed means of evacuation or identified shelters to seek refuge. The airport would be unusable. Climate change is likely to increase the intensity, frequency, path, and other characteristics of typhoons.

Current efforts to deal with underlying risk issues appear to be under-resourced and not well organized or managed. Despite having been identified as long-standing priority issues, solid waste disposal, inadequate sanitation, and issues related to water quality and quantity remain largely unmitigated problems. These severe problems have negative consequences for human health, settlements, and sustainable development in both urban and rural atolls. The RMI capacity to manage the patterns of population growth, land use, and environmental impacts in order to reduce the risks is subject to some severe constraints. This includes: Inadequate waste management systems; Poor sanitation; Coral reef and beach degradation; Unregulated coastal development; Poor settlement planning and lack of building Codes; Isolation, lack of emergency infrastructure and high dependency, especially in the outer islands.

The GFDRR assessment has identified the following 6 priority areas where appropriate interventions, consistent with the JNAP goals, could prove especially effective in removing obstacles and promoting DRR and CCA objectives: Strengthening the capacity of the National Emergency Management and Coordination Office; Developing an information management system; Enhancing community-based awareness and education to change attitudes and behaviour toward effective risk reduction; Climate-proofing new water supply developments; Reviewing and revising draft building codes and Testing early warning response.

RMI's JNAP identifies the strong synergies and commonalities in the DRM NAP and the NCCPF. It ensures all risks, threats and priorities are covered, by incorporating the NCCPF's five strategic goals and national priorities with the DRM NAP's ten goals. It allows for partnerships between government ministries and agencies, local governments, the non-government sector (NGOs, private enterprise, communities, traditional leaders), the donor community and regional and international agencies and organizations.

CHAPTER 4

Mitigation Measures And Analysis

Background

Mitigation of climate change refers to actions that reduce greenhouse gas emissions and enhance carbon sinks, generally by promoting technologies such as renewable energy, energy efficiency, carbon capture and storage, or by promoting land-use practices that sequester CO2. Technological methods of climate change mitigation may include improvements that reduce final energy use (e.g. buildings, industry, transportation), improve efficiency or otherwise reduce emissions in secondary energy production (e.g. electricity generation), or reduce fugitive emissions from primary energy production and transport (e.g. natural gas handling and piping). Within the energy sector, the two biggest sources of emissions are "Transportation" (mainly road transportation in RMI) and "Energy Transformation" (electricity generation) sectors.

The IPCC calls for governments to incorporate mitigation measures into commercial sectors which include energy supply, industry and transportation. In RMI, the sector with the greatest capacity to stabilize atmospheric concentrations of greenhouse gas emissions is the energy sector. Thus transition from fossil fuels to climate-friendly energy sources will entail the following strategic approaches:

- Reducing the amount of energy required through energy efficiency and energy conservation measures and;
- Meeting the energy needs with renewable energy sources

Measures that improve energy efficiency reduce the amount of energy input required to produce a unit of output. Transitioning to renewable energy is another key strategy for reducing carbon emissions. Renewable energy is generated from resources that do not deplete the stock of energy found on the earth, such as sunlight, wind, tides, OTEC and biofuel. Most forms of renewable energy generate no or low levels of greenhouse gas emissions.

There are a number of policies, legal and regulatory updates required putting in place which would mitigating GHG in RMI. Pursuant to the Republic of Marshall Islands 2009 National Energy Policy and Energy Action Plan, the 2011 National Climate Change Policy Framework and Joint National Action Plan (for climate change adaptation, energy security and disaster risk reduction), and the Green Energy Micronesia initiative, a 40% reduction in CO_2 emissions below 2009 is envisaged.

Data availability was a major issue in the energy sector as detailed analysis will only be possible when appropriate data are available. However, analysis based on the currently-available information indicate:

Efficiency improvements in electricity supply and on the demand side measures could significantly reduce the use of diesel by up to 18% or more relative to a situation with no efficiency improvements without raising and lower the cost of electricity supply to be passed through in lower tariffs.

The only renewable energy option for grid supply with sufficient resource data to determine viability and launch an investment project in the near term is solar PV and maybe ocean energy.

The two options for achieving a significant level of renewable energy in the grid supply, are electricity generated from coconut products ((CNO and coconut waste) or from an intermittent (e.g. solar or ocean energy) source combined with battery storage option. Both would likely require some form of subsidy to compete with electricity from diesel generation.

As discussed in the GHG inventory chapter, the total GHG emissions by source for RMI for the reference year 2000 was 133.53 Gg CO_2equivalent (excluding removals). This includes the sector wise contribution from Energy (88.66 Gg CO_2e) 66.40% and Waste (44.873 Gg CO_2e) 33.60% respectively. The contribution of individual GHGs include Carbon Dioxide (CO_2) 66.046 %; Methane (CH_4) 32.308 %; Nitrous Oxide (N_2O) 1.646 %. Emissions from per fluorocarbons (PFCs), hydro fluorocarbons (HFCs) and sulphurs hexafluoride (SF_6) in RMI are negligible, as the products containing these gases are not produced in the country. The primary sources for CO_2 emissions are from combustion of fossil fuels for power generation and transportation; CH_4 and nitrous oxide (N_2O) emissions are primarily due to waste disposal.

RMI is committed to formulating strategies, national policies and best practices for addressing GHG emissions and making a practical contribution towards global mitigation efforts, while at the same time pursuing its national and regional development priorities. The country plans to achieve this by integrating GHG abatement efforts with other social, environmental and economic priorities.

This chapter outlines RMI's contribution towards global climate change mitigation efforts, including effectiveness of potential greenhouse gas abatement actions for long-term sustainable development. The chapter also outlines priority climate change mitigation areas that require international support.

Potential Climate Change Mitigation Sectors

The following section includes the mitigation assessment of the main GHG emission sectors, various technologies, national and sectoral policies and practices with an aim to present RMI's capacity to mitigate climate change including long-term mitigation scenarios.

Energy Sector

Energy is one of the crucial development indicators in any country and like the other Pacific Island Countries, RMI's primary energy needs are met by imported petroleum fuel. Imported, refined petroleum fuel is the primary energy source in RMI.

The RMI is strongly dependent on imported petroleum fuels. Although there are no recent data on biomass consumption, it is estimated that about 92% of energy use in 2011 is from petroleum, biomass remaining significant but declining to about 2%, with on-grid and off-grid solar totalling around 6% (as per IRENA report). The main petroleum imports are gasoline, diesel fuel, dual-purpose kerosene (used as aviation turbine fuel and household kerosene), and liquefied petroleum gas (LPG). Mobil and MEC both provide products in Majuro, with Mobil supplying most outer islands with products except for distillate where MEC has a price advantage due to its large storage capacity. Mobil also provides aviation fuel. Despite the lack of price control, fuel prices (excluding duties and taxes) are about average for Pacific island countries.

In 2011, the RMI imported 56 million litres of petroleum fuel. Most of the storage facilities are owned by the overseas supplier although MEC also has its own large storage facility and imports diesel fuel for its own use and for selling to fishing vessels. From 2003 to 2011, the RMI lost 14% of its export volume, 26% of its marine bunker volume, to fuelling ships on the high seas and to the FSM. Until 2011, MEC purchased fuel outright, which often caused cash flow problems. However, in 2011 MEC secured a new supplier who was willing to deliver on a consignment supply basis, thus reducing MEC cash flow exposure and subsequently increasing diesel sales volume. Based on information for the years 2007 to 2011, 48% of imports are used for transportation and 52% for electricity generation. Kerosene demand is almost nil in RMI with increasing numbers of people using LPG for cooking and solar energy for lighting.

Table 29: Petroleum Fuel Consumption in RMI

Fuel (in MT)	2000	2005	2010	Average
ADO	20526	25245	32220	25997
Motor Gasoline	4195	4540	5795	4843
Jet Fuel (DPK)	23520	29423	42729	31891
LPG	348	429	548	442
Lubes & Cres	284	348	445	359

Source: RMI Statistical Year Book 2004

Electricity generation and demand:

Approximately 75% of the RMI population has access to grid electricity; 92% in the urban areas of Majuro and Ebeye and 32% in the rural outer islands. Some outer islands have central power plants, some of which run during limited hours of the day, and other remote populations receive electricity services from photovoltaic-battery systems provided by international donors and maintained by the central utility.

There are two utility companies. Both are state-owned enterprises operating under a board appointed by the president's cabinet. The current cost of electricity for utility customers in the RMI is $0.50/kWh for government, $0.49/kWh for commercial, and $0.43/kWh for residential customers. Roughly 60% of residential customers receive a subsidized "lifeline" rate which is slightly less, $0.41/kWh for consumption less than 500 kWh/month. Outer-island homes with off-grid solar systems pay a $5/month lease to MEC's for maintenance.

One important factor contributing to the high cost of electricity is that the RMI's small, remote, and dispersed population means that there are virtually no economies of scale in electricity production.

Additionally, the power sector is challenged by the following:

- **Aging infrastructure** Generators, transmission and distribution systems, and other infrastructure are outdated and in need of upgrades. Inefficiencies in generation and line losses are examples of the challenges this creates.
- **Corrosive environment** - The RMI's low elevation, absence of wind barriers, and narrow land areas make electrical equipment highly vulnerable to ocean spray, which is highly corrosive.
- **Inadequate maintenance** - The capacity and funds are not always readily available to address maintenance requirements.
- **High fuel costs** - The RMI's remote location adds significantly higher transportation costs to the price of fuel, and the lack of economies of scale prevents the RMI from taking advantage of bulk fuel purchases.
- **Revenue shortfalls** - Electricity rates do not cover total costs, and the landowner's electricity concession results in extra costs of about $1.8 million/year.

Two public electric utilities sharing a single oversight board operate in the RMI. Both are semi-autonomous state-owned enterprise of the RMI government. The Marshalls Energy Company (MEC) operates six districts with average loads ranging from 15 kW on Rongrong Island to 7 MW on Majuro. Kwajalein Joint Utilities Resources (KAJUR) serves only Ebeye in the Kwajalein Atoll and has an average load of 1.7 MW. Virtually all power generation is from diesel reciprocating engine-generators, common in small power systems. Electricity tariffs are uniform across all districts and range from $0.41/kWh for residential customers to $0.50/kWh for the government.

In addition to these centralized plants, MEC owns and operates photovoltaic-battery systems on less-populated, rural islands. All of these systems were provided through grants or were fully funded by international donors but MEC is responsible for maintaining them and collecting monthly usage fees. There are approximately 1,500 residential solar systems and three PV systems on rural schools ranging in size from 6 kW-DC to 9 kW-DC.

In addition to electricity, MEC provides sewer and wastewater services on Majuro, and KAJUR provides freshwater, saltwater (for toilets), and sewer services on Ebeye. There is no independent body regulating the utilities in the RMI. The president and his cabinet are the regulatory authority for all utilities in the RMI.

MEC supplies electricity on Majuro, Jaluit and Wotje and expects to eventually provide power to 28 other atolls. On some atolls, a local island committee operates generators and acts as a local utility company. On Majuro, before a power plant fire, MEC had 28 MW (nameplate rating) of diesel capacity de-rated to 18.2 MW. Maximum demand was about 8.5 MW in 2011.

Table 30: Electricity sales 2005 - 2008

Year	Sector	Sales In MWh
2005	Residential	27 517.26
	Commercial/Industrial	22 195.16
	Government	11 021.66
2006	Residential	26 997.36
	Commercial/Industrial	21 599.52
	Government	8164.21
2007	Residential	26 087.05
	Commercial/Industrial	21 387.46
	Government	9521.29
2008	Residential	22 852.11
	Commercial/Industrial	21 337.84
	Government	8194.68

Source: IRENA RMI Report 2013

MEC customers on other islands account for only 5% of demand. In the fiscal year 2011, MEC generated 62 639 MWh of electricity, used 4 098 283 US gallons (15 513 689 litres) of fuel for an overall fuel efficiency of 15.24 kWh/US gal (4.038 kWh/litre). The peak load during that period was 8.75 MW. The actual electricity generation and fuel use between 2005 and 2008 are shown in below table.

Table 31: Actual generation and fuel use 2005-2008

Year	Actual Generation (MWh)	Fuel used (litres)	Station losses (MWh)
2005	82 366	21 337 034	5684
2006	79 077	20 602 327	5304
2007	77 469	19 303 004	6173
2008	70 696	17 623 641	7726

Source: IRENA RMI Report 2013

In 2011, MEC had 2,629 standard residential meters and 462 residential pre-paid meters. Commercial meters numbered 462 and government meters numbered 145. The plan is to convert all residential meters to the pre-paid type as soon as possible. A new “scratch card” system is being introduced so that pre-paid meter customers can purchase payment cards at retail outlets, some of which are open 24 hours a day. Streetlights are unmetered and

therefore show up as non-technical losses. Free electricity is provided to those persons whose land is used for transmission lines but this is metered and not considered part of non-technical losses.

The second-largest power system in the RMI is KAJUR on Ebeye. Recent data were not readily obtainable for KAJUR but available information indicates that it has an installed capacity of 4.8 MW and a peak demand of 2 MW. It has about 1,300 metred customers and generates 15.6 GWh of electricity per year using 4.2 million litres of fuel.

Table 32: All public utility grids operating in the Marshall Islands in 2011

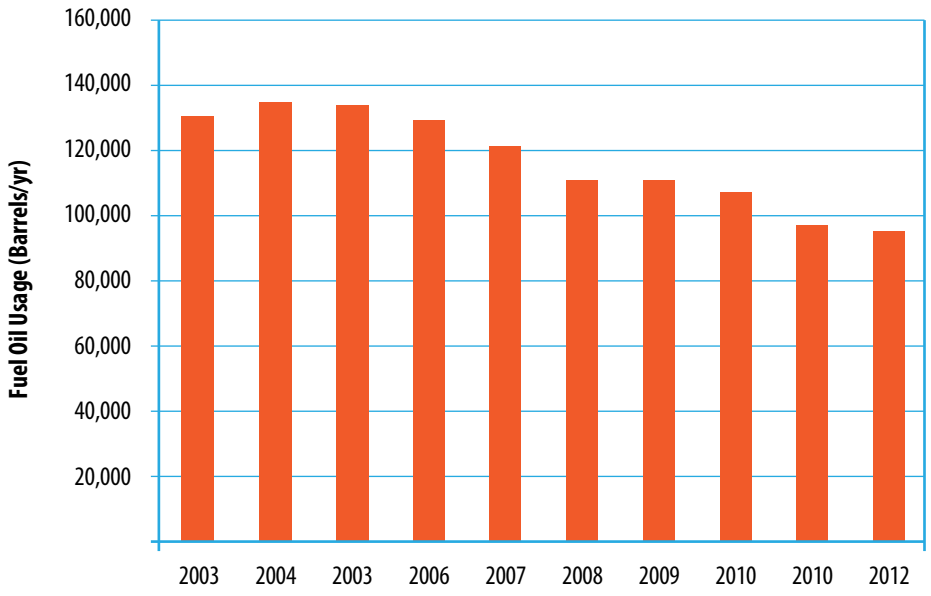
Location	Operator	Customers	Hours per day	Peak load time	kW peak	kW capacity	Generation source
Majuro	MEC	3916	24	20:00	8 500	18 200	Diesel
Ebeye	KAJUR	1300	24	20:00	2 000	4800	Diesel
Wotje	MEC	115	24	20:00	80	525	Diesel
Jaluit	MEC	110	24	20:00	90	525	Diesel
Rongrong	MEC	35	24	20:00	15	65	Diesel
Kili	KBE1	130	24	20:00	NA	1500	Diesel
Rongelap	RALGOV2	NA	NA	NA	NA	NA	Diesel

Source: Provided through communication by MEC (2012) and MEC website for KAJUR.

1 KBE=Kili/Bikini/Ejit Government

2 RALGOV=Rongelap Government

Figure 29: Downward trend in fuel consumption at Majuro power plants



Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Historical fuel usage by MEC on Majuro is shown below for years 2003 through 2012. The figure shows the number of barrels of #6 fuel oil used in the power plants. Consumption in 2012 is down 29% from the maximum consumption in 2004. This reflects the fact that the total annual electricity demands at the plant are down 26% from the high in 2004. The annual average load in 2004 was 9.4 MW while in 2012 it was down to 7.0 MW.

Declining fuel consumption is speculated to be the result of declining electricity demand due to three primary factors: increased cost of electricity from increasing fuel costs, introduction of prepaid meters, and increased enforcement against theft. Historical data for Ebeye and Jaluit could not be secured but it seems reasonable to assume these districts showed similar trends as they were, in general, subject to the same set of forces. KAJUR reported that peak loads in excess of 3 MW to 3.5 MW occurred regularly ten years ago while peak loads currently are 1.9 MW. This reduction was attributed to the introduction of a prepaid meter program. Prepaid meters now account for about 95% of all meters on Ebeye.

Conventional fossil fuel generators in the RMI are all reciprocating compression-ignition diesel engines. The diesel generation assets are listed by island district in table below.

Table 33: Diesel Generation Plants by Island District

District	Installed Generation and Date Installed
Majuro	10 MW (1982) 3.3 MW (1992) 12.8 MW (1999) 26.1 MW total
Rongrong Island, Majuro Atoll	0.12 MW (2003)
Ebeye	3.6 MW (2012)
Jaluit	0.55 MW (1991)
Wotje	0.55 MW (2003)
Kili Island	1.8 MW (1990)
Bikini Atoll	0.73 MW (date unknown)

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Power plant heat rate is a figure that describes how much fuel, in units of British thermal units, a plant is consuming to generate each unit of electricity. Plants with lower heat rates have higher efficiencies. Heat rates in the table are expressed using the fuel's higher heating value (HHV), the convention used in United States.

Table 34: Power Plant Heat Rates for Majuro, Ebeye, and Jaluit for 2012

	Weighted Average	Majuro	Ebeye	Jaluit
Heat Rate, HHV (BTU/kWh)	9,769	9,823	9,481	11,244

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

An analysis funded by the US department of internal affairs identifies excessive energy consumption within the power plant on Majuro. That report estimates that almost 8.5% of all electricity generated by the plant is consumed within the plant to operate pumps, fans, other peripheral equipment, and plant facilities. Station use would typically be expected to be less than 5%. With 6.4% losses in electrical distribution and rates of electricity theft exceeding 11%, overall system losses are in excess of 25%.

Transport Sector

As described in the GHG inventory, the transport sub sector has the largest share (19 % 15.923 Gg CO_2e) of GHG emissions for the reference year 2000. This includes emission from road transportation contributed by the CO2 emissions from combustion of fossil fuel (Gasoline and Diesel) used in internal combustion engines. Road transport under transportation category which is dominated by cars and other light multi utility vehicles. Under international bunkers, only DPK fuel has been considerd for international aviation and national navigation and international marine transport is not estimated due to unavailability of data.

The Ministry of Transport and Communications is responsible for the overall regulation, promotion and development of transportation and communications in the Marshall Islands. The country has international airports at Majuro and Kwajalein and airstrips all inhabited atolls and islands. Besides Majuro, there are other three designated international ports of entry: Enewetak, Ebeye and Jaluit. The Ministry contracts with private ship operators to make voyages into 5 designated shipping regions, namely: Lower Northern, Upper Northern, Central Eastern, Southern and Western. There are 4 vessels involved in inter-island shipping under this arrangement, three are government owned and one is private. Intra-atoll shipping is conducted mainly by small boats with diesel engines, often ranging from 14 feet to 30 feet in length, called "bumbums".

Several International shipping lines service Marshall Islands calling in at Majuro and Ebeye. The ships are mainly container carriers with some multipurpose container and break-bulk carriers. The bulk of the shipping is from the US West Coast, by the Matson and PM&O Lines. The remainder is from East Asia and Australia. Shipping services for the various carriers range from bi-weekly to monthly.

Table 35: No. of Vehicles Registered in Majuro: 1986,1991, 1996, and 2001-2004

Type	1986	1991	1996	2001	2002	2003	2004
Car	525	806	567	1,614	1,647	1,602	1,531
Jeep	20	24	28	80	89	74	55
Station wagon	0	0	34	72	97	100	66
Mini Pick-Up	0	43	12	19	37	15	8
Mini Van	0	0	30	60	40	54	34
Scooter/ Motor cycle	10	42	16	38	32	41	20
Pick-up	258	498	369	530	566	452	415
Van	65	38	126	115	117	119	62
Bus	4	4	7	48	58	36	28
Truck	50	33	48	80	135	113	97
Heavy Equipment	0	0	70	93	101	94	88
Total	932	1,488	1,307	2,749	2,919	2,700	2,404

This total is inclusive of government vehicles.

Source: Traffic Investigation Division Department of Public Safety, Majuro, RMI

Table 36: No. of Vehicles Registered in Ebeye 2001-2004

Type	2001	2002	2003	2004
Car	68	27	30	24
Jeep	3	4	5	6
Station Wagon	2	2	3	0
Mini Pick-up	0	3	4	3
Mini Van	14	4	5	2
Motor Cycle/Scooter	9	3	6	2
Pick-up	81	80	78	64
Van	0	6	4	8
Bus	6	6	7	5
Truck	8	6	2	29
Heavy Equipment	3	14	9	13
Total	194	155	153	156

Table 37: No. of Government Vehicles Registered in Majuro: 2001-2004

Type	2001	2002	2003	2004
Car	67	55	94	87
Jeep	4	4	3	3
Station Wagon	6	1	4	0
Mini Pick-up	2	2	0	0
Mini Van	3	1	5	4
Scooter/ Motor Cycle	1	0	2	3
Pick-up	62	41	72	68
Van	33	11	43	15
Bus	21	18	40	20
Truck	7	15	22	13
Heavy Equipment	8	6	2	9
Total	**214**	**154**	**287**	**222**

Source: Traffic Investigation Division, Department of Public Safety, Majuro, RMI

Table 38: Number of Taxies and Buses in Majuro and Ebeye: 1995-2004

	\Majuro		Ebeye	
Year	Taxies	Buses	Taxies	Buses
1995	-	-	6	0
1996	-	-	13	0
1997	-	-	19	0
1998	-	-	24	0
1999	-	-	45	0
2000	288	6	53	0
2001	391	8	67	0
2002	444	10	75	0
2003	259*	11	61	0
2004	369	6	62	0

**Figures are for year 2003 to May 2004. Significant decrease in number of taxis is due to implementation of improved monitoring measures*

Source: Local Government, Majuro and National Police, Ebeye

The Marshall Islands has 32 airfields located on 24 atolls and islands. Two of these- Majuro and Kwajalein are international airports capable of handling regular service by airliners up to the size of a 757. Kwajalein airport is operated by the US Military. The government owned Airline of the Marshall Islands is the sole air service provider to the outer islands operating two Dorniers 228-19 seat turboprop aircraft. AMI recently added a larger Dash 8 aircraft to service the busier routes. Service is available at least once a week to most of the outer islands from Majuro. There are also international air services provided by Aloha and Continental Airlines.

Table 39: Fuel Consumption in Road Transportation

Fuel (in MT)	2000	2005	2010	Average
ADO	868	1010	1363	1080
Motor Gasoline	4195	4540	5795	4843
Lubes & Cres	100	122	156	126

Source: RMI Statistical Year Book 2004

Table 40: Fuel Consumption in International Aviation

Fuel (in MT)	2000	2005	2010	Average
Jet Fuel (DPK)	23087	28881	41943	31304

Source: RMI Statistical Year Book 2004

The Marshall Islands is a very "air travel minded" nation. In the US and Canada the average number of flights per person per annum (fpppa) is two and 1.8 fpppa for New Zealand. It is one fpppa for Australia, 0.5 for Japan and Malaysia, 0.2 for Taiwan, 0.02 for Indonesia and 0.6 for Saudi Arabia. For the Marshall Island's the number of flights per person per annum is about 0.7, significantly more than Japan and more than Australia's both of whose GNP per capita is significantly higher than the RMI's. On this basis we can conclude that the Marshall Islands is a leading nation in terms of its use of air travel whether for business or pleasure.

Agriculture, Forestry & Other Land Use

The Republic of the Marshall Islands is a sprawling Micronesian archipelago that includes 29 coral atolls and 5 table reefs, all essentially flat and composed of coral limestone. Land area is 181 km2, but the islands are scattered across 2,000,000 km2 of ocean. Because they are spread 1 150 km from north to south, there is a marked moisture gradient, from semiarid in the north to very humid in the south. The vegetation is conditioned by moisture availability and salt spray exposure, and has been affected by occasional severe hurricanes, several thousand years of human occupation, and more recently, World War II activities, nuclear testing and conversion of land to coconut plantations, resulting in a highly altered landscape.

Forests, as such, are virtually non-existent although a wide variety of trees and plants are present. Mangrove is one of the main forest types. Woody vegetation communities are restricted to mixed broadleaf forests and a variety of mono-dominant tree and scrub communities. Around 60 percent of the Marshall Islands land area is covered by coconut palms and breadfruit. Other dominant species include Pandanus tectorius (screwpine) and Terminalia spp. No endemic species of vegetation are known. There are no large-scale forest industries in the Marshall Islands. Small quantities of wood and paper products are imported.

The key issues faced by the forestry sector include:

- limited land area and natural resources;
- vulnerability to environmental disasters, such as cyclones and hurricanes;
- high species endemism but low occurrence of individual species, leading to high risk for loss of biological diversity;
- high human population density, usually concentrated in lowland areas, which increases pressure on already limited resources;
- economic constraints due to relatively small scale;
- institutional constraints (including high levels of migration, particularly of skilled human resources).

The agriculture sector mainly remains subsistence-based. While most production figures have remained about the same, there remains potential to increase production to replace imported products as well as add to employment and local private sector development.

The Marshallese people's agricultural economy is based on copra. Coconut is the main crop followed by breadfruit, pandanus, banana, taro and arrowroot. Minor crops planted are pawpaw, sweet potato, limes and vegetables. There is a strong cash economy on Majuro and Ebeye, while a subsistence economy prevails on the outer islands. The Marshall Islands is heavily reliant on imports, mainly from the United States and has a large trade deficit. Tuna fishing by foreign vessels in Marshall Island waters is a source of revenue.

The climatic conditions are similar to those in other islands of Micronesia, except that the northern Marshalls have rainfall as low as 152 mm while the southern parts

has a high 4,000 mm per annum. Several of the northern islands are uninhabited due to lack of rain. The rainfall is seasonal, December to March being the drier months; and May to August the wetter months. Rainfall in any one atoll varies greatly from year to year. Due to the porosity of the soil, the rainwater soon disappears from the soil surface.

Sandy soils of low fertility and the topography are typical of most of the atolls. The poor atolls support only a limited range of plants and the growth of vegetation is hampered also by salt spray water which sweeps over the islands during the season of the northeast trades, killing or seriously inhibiting plant growth. Soils on coral islands or atolls are poor, requiring much persistence for production of even basic crops. Since they are either atolls or raised coral Islands, elevation is slight. Highest point in the entire group is Likiep, 10 metres above sea level. The lagoon reef offers a great variety of marine life.

Other agriculture production includes fruits and vegetables including: bananas, breadfruit, pandanas, coconut and taro. Meat production includes pigs and chickens. Production numbers between these items fluctuates. However, there is potential to increase production for more than subsistence production.

Due to the nature of the soil and its vegetation, ruminant livestock production based on pasture is very limited. The subsistence system of production is practiced in Marshall Islands. In past years a few goats were kept tethered during the day under coconut plantations that have little undergrowth. Presently there are no cattle or goats and the main livestock kept are pigs and chickens.

The poor atoll soils that prevail support only a limited range of plants and the growth of vegetation is hampered also by saltwater spray which sweeps over the islands during the season of the north-east trades, killing or seriously inhibiting plant growth. By atoll standards the vegetation of the Marshall Islands is poor.

Several factors affect the development of pasture based livestock in Marshall Islands, and these are:-

- People are used to the keeping of the traditional livestock poultry and pigs that are raised on the free-range system, and not ruminant livestock. Therefore, very few small ruminant livestock are found in Marshall Islands.
- Rainfall pattern of the islands does not sustain the growth of most common grass and legume species.
- The salt spray factor is constant and this affects crops.
- The sandy nature and low fertility of the soil does not permit the growth of most grasses and legumes. Besides, the soils are unprotected salt water spray.
- The strict rules and principles that governed the traditional land tenure system are also a constraint. Therefore there is insufficient land for the cultivation of food crops let alone land for pasture development (IPS, 1987).

Subsistence farming and fishing are the major focus of the majority of the people.

Shrubs form an outstanding part of the vegetation in Marshall Islands. The weedy undergrowth in the coconut plantations has in the past served as pasture for grazing animals (a few goats). The dominating vegetation of these coral islands is made up of the coconut palm (Cocos nucifera) followed by pandanus, breadfruit (Artocarpus artilis), Piosonia grandis, Messerschmidia argentea, Morinda citrifolia and Premna obtusifolia. Shrubs that form an outstanding part of the vegetation are Scaevola sericia and Pemphis acidia.

The GHG emissions from the Agriculture and Land Use, Land Use Change & Foresty sectors is not estimated due to unavailability of sector specific data.

Waste Sector

The GHG emissions from the Waste sector include, emissions from (a) solid waste management and disposal and (b) domestic and commercial wastewater handling. The GHG emission from waste sector in RMI for the reference year 2000 was 37.56 Gg CO2e (30.6% of total emissions). The key source of methane emissions under the solid waste management and disposal include emissions from anaerobic decomposition of waste. Background information on the waste sector in RMI has been discussed in the GHG inventory chapter.

Whilst there is limited data available on waste generation in RMI, it is believed that chemical and

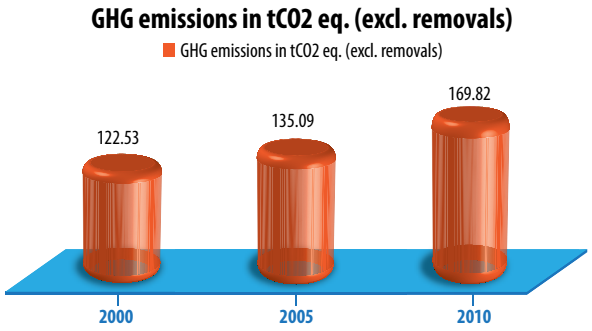
hazardous waste are being illegally dumped and are likely to be adversely affecting the environment in the Marshall Islands. Buried chemicals are reported to be present at Place Arno Coconut Research Farm and bitumen drums have been reported to be present on Kwajalein Atoll. There are conflicting reports about the number of transformers contaminated with PCBs remaining in RMI. The estimates range from 1 in Jaluit (S. Wakefield) to 8 in Ebeye (Roney Arelong). There are no reports of significant quantities of asbestos present in RMI. E-waste is currently collected at the landfill and separated and stored for eventual export.

The hospital has no infection control plan and workers handling medical waste are provided with protective equipment. There is no management plan for medical waste management. The existing dumpsite was closed by the EPA temporarily in 2011, but was forced to re-open due to lack of other waste disposal options and an increase in littering. One temporary landfill site with a 9-month capacity (1547.11 m^3) has been identified and approved in Rankan, Rairok, Long Island in a swamp area, which the community wants filled in due to mosquito breeding to eliminate the dengue fever risk. Two other long-term landfill sites have also been tentatively identified in the vicinity of Jenrok, for which MAWC has finalized the land negotiations, however MAWC needs submit application and scoping study for using the site to EPA. It is estimated that an area of approximately 13 acres is necessary to provide a landfill lifespan of at least 10 years.

RMI's GHG Emission Scenario

The total GHG emissions for RMI calculated for the SNC reference year 2000 and for years 2005 and 2010 are presented beow:

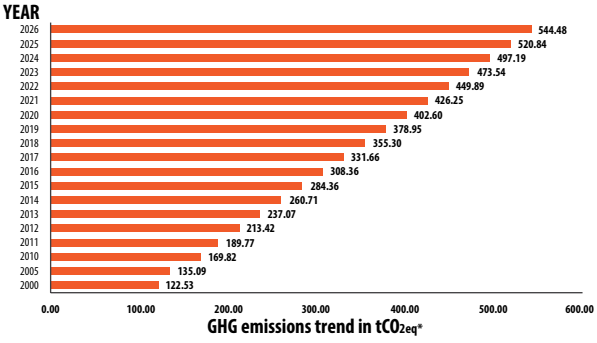
Figure 30: Total GHG Emissions (excluding removals) $GgCO_2e$, 2000-2010



Source: RMI GHGI 2000

Based on the available data and the observed trend for the years 2000, 2005 and 2010, GHG emission profile (excl. removals) for RMI has been prepared for year 2025 (below figure). Under the business as usual scenario, RMI's total GHG emissions (excluding removals) were projected to increase by 77.50 % between 2000 and 2025, with an average increase of 8% per year. The GHG emission profile of RMI is presented in the figure below:

Figure 31: Projected Total GHG Emissions (excl. Removal) $GgCO_2e$, 2000-2025



Source: RMI GHGI 2000

The projected GHG emissions do not include sinks and removals. Further, the projected emissions could be reduced with appropriate GHG mitigation interventions through current and planned renewable energy and energy efficiency initiatives.

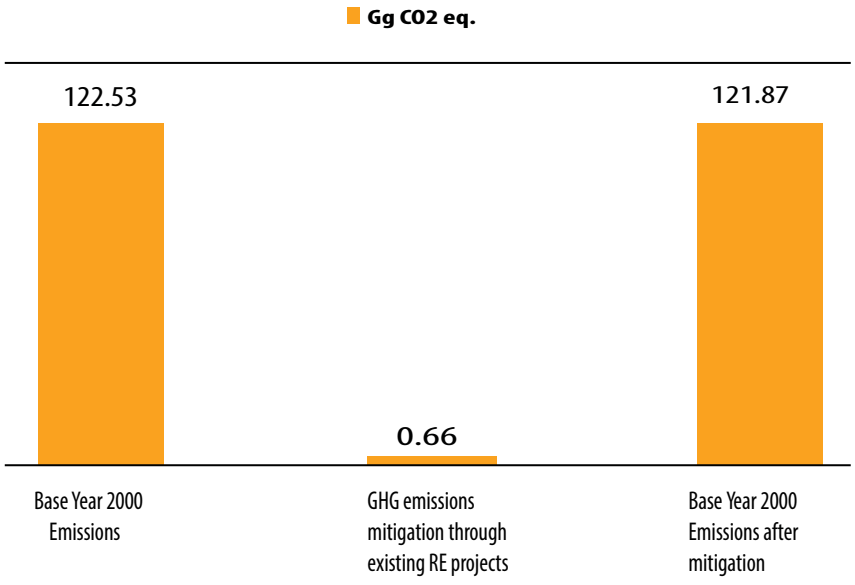
The emissions scenarios illustrate that without intervention, emissions are projected to rise sharply over the next decade due to increased fossil fuel consumption. It is important, however, to note that even with this growth RMI's emissions will still be small compared to other developing countries, in both absolute and per capita terms. There is significant potential for RMI to reduce the GHG emissions by implementing renewable energy technology in the energy sector and energy efficiency in supply and demand side. This investment is largely beyond RMI's financial capacity and is only achievable with support from development partners. New breakthroughs will be needed to tackle other sectors' emissions. This will also depend largely on progress made in developing viable options for the reduction of emissions from other sectors.

Table 41: GHG emissions and mitigation through existing intreventions, 2000

Case	Gg CO2 eq.
Reference Year 2000 Emissions	122.53
GHG emissions mitigation through exisitng RE projects	0.66
Base Year 2000 Emissions after mitigation	121.87

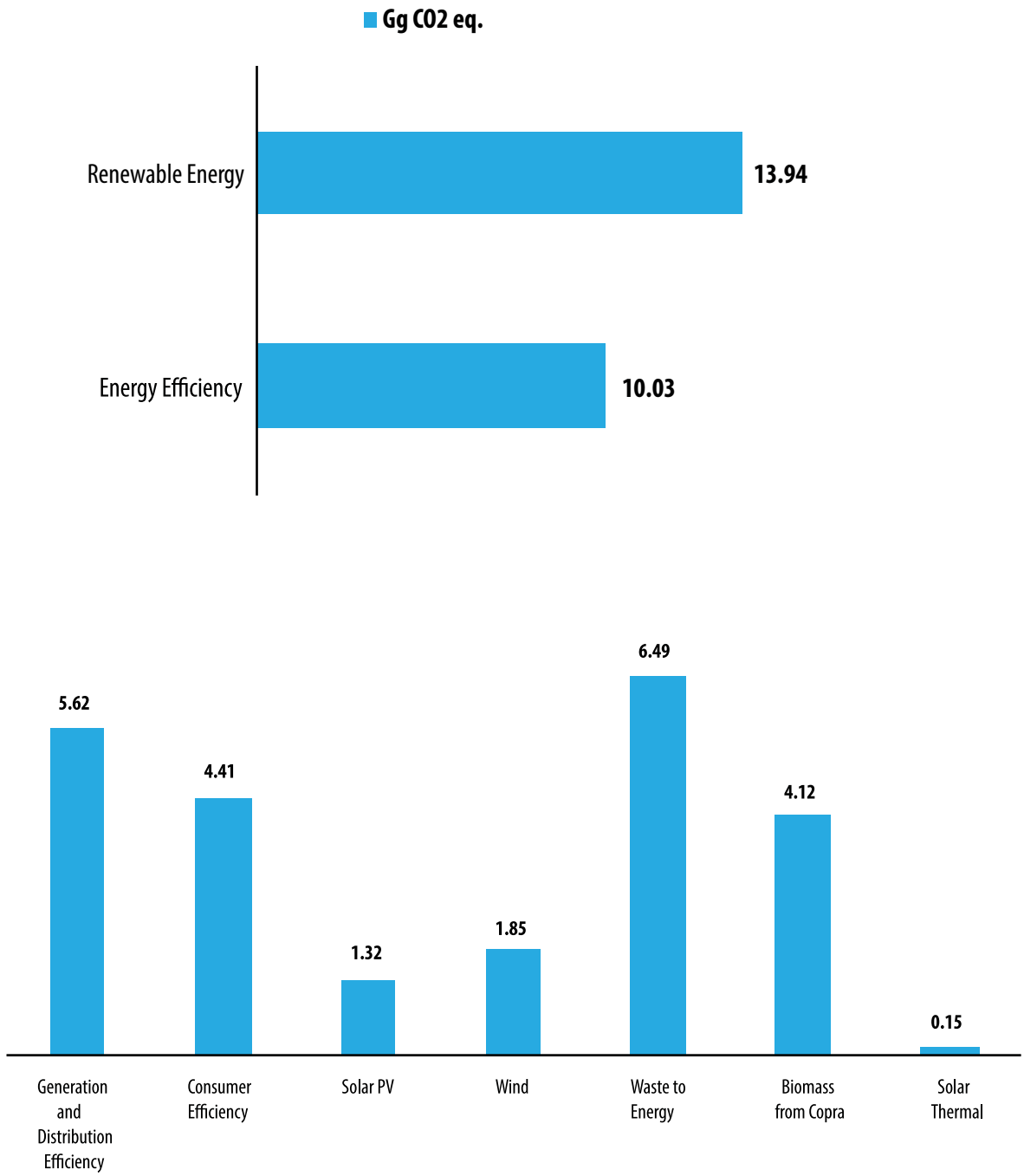
Source: RMI GHGI 2000

Figure 32: GHG emissions and mitigation through existing intreventions, 2000



Source: RMI GHGI 2000

Figure 33: Potential for GHG Mitigation by year 2032 through planned Intreventions (Gg $CO_{2\ eq.}$)



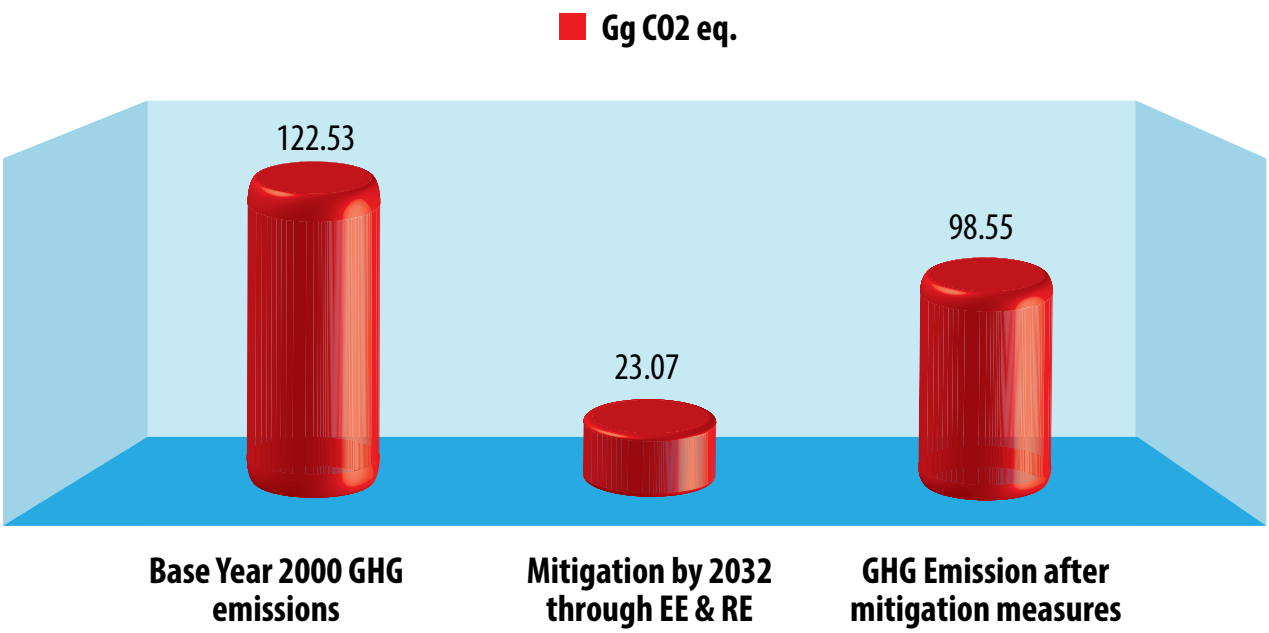
Source: RMI GHGI 2000

Table 42: Planned Mitigation Intreventions and GHG reduction potential

GHG Emissions and Mitigation Measures by 2032		
Scenario		**Gg CO2 eq.**
Reference Year 2000 emissions		133.53
Mitigation by year 2032 through Various EE & RE Technologies (in Gg CO2 eq.)	Generation and Distribution Efficiency	5.62
	Consumer Efficiency	4.41
	Solar PV	1.32
	Wind	1.85
	Waste to Energy	6.49
	Biomass from Copra	4.12
	Solar Thermal	0.15
GHG emissions after considering all mitigation measures (EE & RE) by 2032		109.56

Source: RMI GHGI 2000

Figure 34: GHG emissions and mitigation scenario 2000 – 2032 (Gg $CO_{2\ eq.}$)



Source: RMI GHGI 2000

Mitigation Related Policies and Programs

In accordance with the principles of common but differentiated responsibilities and capabilities; it is crucial that Annex I countries take the lead in the global mitigation efforts. RMI is committed to making a practical contribution to global climate change mitigation efforts and has taken up various policies, legislations and program based initiatives towards climate change mitigation and GHG emission reduction with the support of various development partners and agencies. The main mitigation policy and programs pursued by RMI government are discussed in the following section.

Pursuant to the Republic of Marshall Islands 2009 National Energy Policy and Energy Action Plan, the 2011 National Climate Change Policy Framework and Joint National Action Plan (for climate change adaptation, energy security and disaster risk reduction), and the Green Energy Micronesia initiative, the below goals are set:

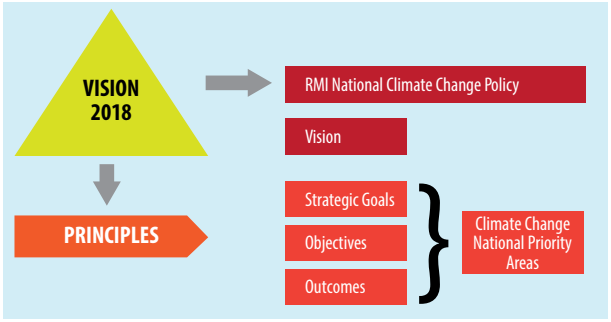
- 40% reduction in CO2 emissions below 2009 levels by 2020;
- Electrification of 100% of urban households and 95% of rural outer atoll households by 2015;
- Provision of 20% of energy through indigenous renewable resources by 2020;
- Improved efficiency of energy use in 50% of households and businesses, and 75% of government buildings by 2020;
- 20% efficiency improvement in transportation sector fuel use by 2020;

The NCCPF aims to foster and guide action to address current and short, medium and long term effects of climate change, ensuring to the greatest possible extent that the quality of life of the people of the Marshall Islands and opportunities for sustainable development are not compromised. The five strategic goals of the NCCPF are to: strengthen the enabling environment for climate change adaptation and mitigation, including sustainable financing; adapt and reduce risks for a climate resilient future; ensure energy security and a low-carbon future; ensure disaster preparedness, response and recovery; and provide education, awareness-raising and community mobilization whilst being mindful of culture, gender and youth.

Recognising that a successful response to climate change cannot be achieved in isolation from other development objectives and programs, this policy is informed by the goals of RMI's Vision 2018 Strategic Development Plan and contributes to achieving the global Millennium Development Goals. In this context, the vision of RMI NCCPF is Building the Resilience of the People of the Marshall Islands to Climate Change.

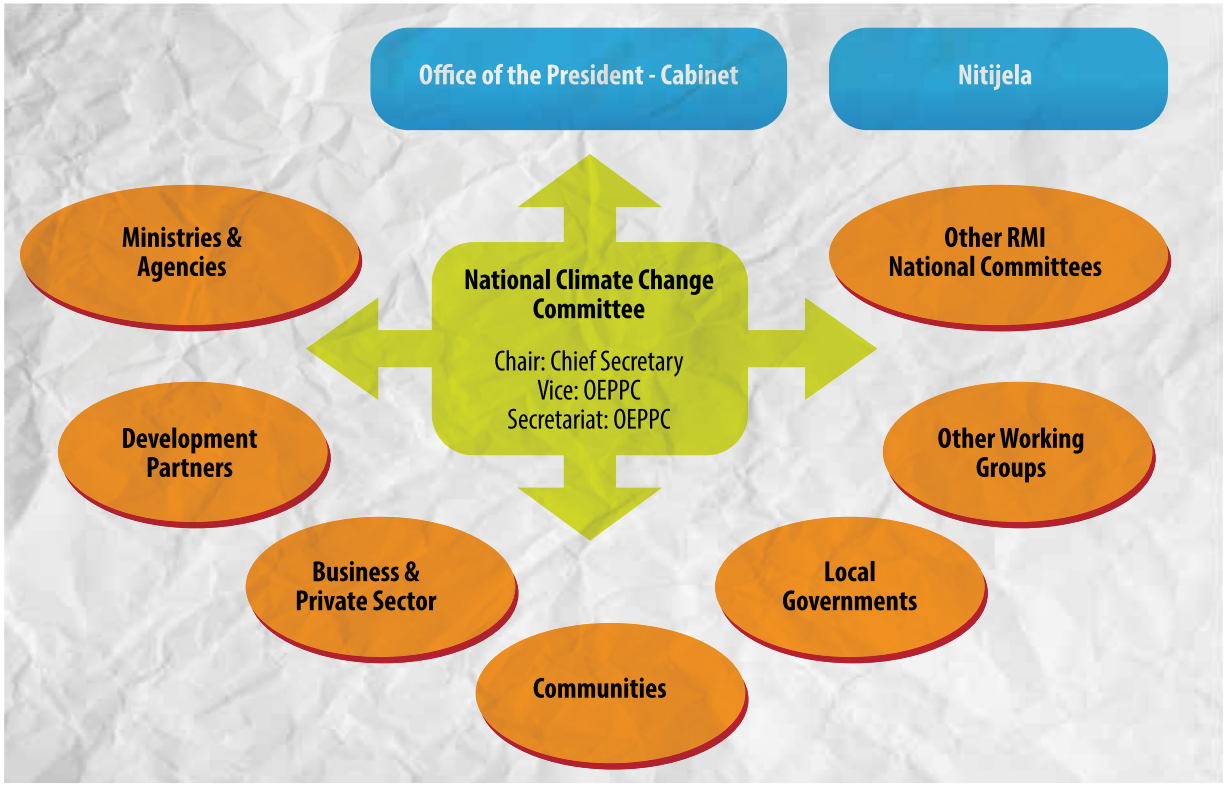
To prepare for these impacts, the RMI Climate Change Policy Framework presents five strategic goals that provide a pathway to an integrated, whole of Marshall Islands response. Objectives and outcomes are identified for each goal. The framework also aims to foster and guide a national plan of action to address current and short, medium and long term effects of climate change, ensuring to the greatest possible extent that the quality of life of the people of the Marshall Islands and opportunities for sustainable development are not compromised.

Figure 35: Overview of RMI National Climate Change Policy Framework



Source: Republic of the Marshall Islands National Climate Change Policy Framework, 2011

Figure 36: Institutional Framework for Managing the National Climate Change Policy



Source: Republic of the Marshall Islands National Climate Change Policy Framework, 2011

The RMI National Energy Policy was developed with the vision of an improved quality of life for the people of the Marshall Islands through clean, reliable, affordable, accessible, environmentally appropriate and sustainable energy services. The broad goals include:

- Electrification of 100% of all urban households and 95% of rural outer atoll households by 2015;
- The provision of 20% of energy through indigenous renewable resources by 2020;
- Improved efficiency of energy use in 50% of households and businesses, and 75% of government buildings by 2020 and

  Reduce 20% supply side energy losses from MEC by 2015.

Five specific areas identified as keys to shifting toward more sustainable energy development and include: Petroleum and Liquid Fuels; Electric Power; Transport and Energy Use; Energy Efficiency and Renewable Energy.

The key objectives under the policy are: Energy Planning Division develops the level of skills necessary to review, update and implement the energy policy framework; The Energy Planning Division uses its limited human and financial resources effectively, concentrating on important, practical and achievable goals; MRD influences key energy decisions, shifting RMI toward more sustainable and rational energy use; National energy database adequate (for analysis and policy development) is developed and regularly updated; Consistent management and financial mechanism is developed and implemented for all solar PV and other renewable energy initiatives; There is investment in renewable energy and energy efficiency as part of all energy initiatives where appropriate; RE/EE, not considered as stand-alone activities or special interests and Improved cooperation on energy within Micronesia and the wider Pacific region

The Energy Planning Division (EPD) is part of the Ministry of Resources and Development (MRD) and has full responsibility over the entire national energy

policy framework and its associated action plans, overseeing: renewable energy; energy efficiency in both power supply and demand sides; petroleum reform towards energy efficiency; and the push towards an energy security plan linked to both national disaster management and energy supply security/management.

Some of the key laws and regulations which directly or in-diretly relate to energy sector activities include:MEC Regulations designate Majuro as MEC's sole supply area, although there is no Electric Power Act to regulate either MEC or KAJUR and no formal policy framework for national electrification; The Retail Price Monitoring Act provides powers to monitor and regulate retail prices but regulations have never been promulgated and there is no price control over petroleum fuels; The Unfair Business Act could in principle be used to monitor electricity and fuel prices but has not been used for this purpose; The Consumer Protection Act protects against unfair or deceptive business practices and could be used to regulate some aspects of renewable energy; The Bulletin Boards and Price List Act could be used to control fuel prices in outer islands but it is not enforced; The Alternative Energy Fund Act established a revolving fund for development, marketing and operation of alternative energy, but this no longer is active; The Import Duties Act specifies tax rates on all commodity imports (several energy efficient appliances and renewable energy components are exempted) and the environmental protection act provides powers regarding land use, pollution control and emissions.

Existing and Identified Mitigation Options

RMI has identified and is implementing various GHG mitigation projects in the energy sector. The key GHG mitigation options including current and identified potential mitigationprojects and opportunities are discussed below:

Existing Mitigation Activities

Small rural solar photovoltaic systems have been used on the outer islands in the RMI for a decade or more to provide basic electrical services to remote homes and clinics. An RMI rural electrification program continues to add additional off-grid PV-battery systems for outlying communities. The RMI's NEP projected that a total of 2800 rural, stand-alone PV installations would be deployed by 2015. These systems are generally financed by international donors and deployed in partnership with MEC.

On Majuro, there are two grid-connected PV systems of significant size, one on the roof of the Majuro Hospital (205 kW) and the other on top of buildings on the campus of the College of the Marshall Islands (57 kW). The hospital system was funded by Japan and installed in 2012. The combined size of these two systems is 262 kW, representing about 2.2% of Majuro's current total electrical load. A single 10 kW wind turbine is operating on Majuro. It is an off-grid system using battery storage and provides power to a moored boat. In addition, a few small solar water heating (SWH) systems are located on the campus of the College of the Marshall Islands.

Table 43: Partial List of Existing Renewable Energy Systems in RMI

Atoll/Island	Technology	Type*	Details
Majuro	PV	Grind connected	205 kW Majuro Hospital (2012)
	PV	Grid connected	57kW College of the Marshall Islands (2010)
	Wind turbine	Off-grid battery	10kW
	Solar water heat		Approximately 40 of collector College of Marshall Islands
Mejit	PV	Off-grid battery	9.2kW-DC on Mejit elementary school (2009)
Amo	PV	Off-grid battery	6.12kW at the Ine primary school (2009)
Namo Atoll	PV		6.12 kW at Majkin primary school (2009)
Throughout the RMI	PV		Approximately (1500) 80 Watt to 300 Watt residential systems installed under various donor programs over the last decade
Throughout the RMI	PV powered street lights	Off-grid battery	At least 6,088 units

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Planned Mitigation Initiatives

A number of activities have been planned, which are likely to reduce GHG emissions in RMI. This section provides the details of these activities. It is important, however, to note that most of the planned activities remain heavily dependent on continued international support.

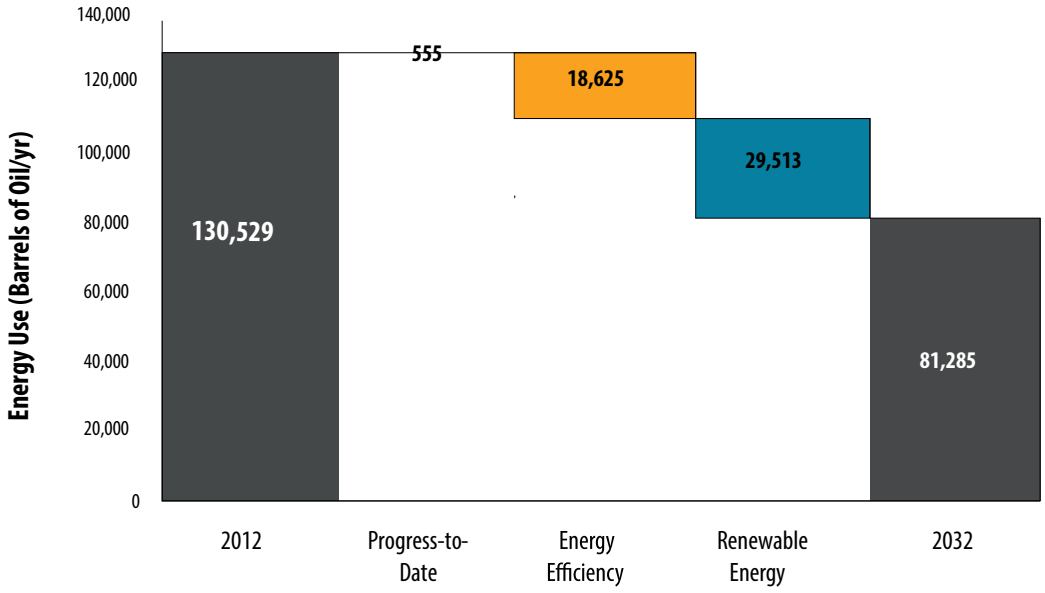
High energy costs, isolation from large electrical grids, and access to local indigenous renewable resources are driving small island communities to explore alternatives to imported fossil fuels. Many island communities have set ambitious goals for reducing fossil fuel usage and increasing renewable energy generation. In the RMI, the goals in the National Energy Plan (NEP) include 20% renewable energy generation by 2020 and improved efficiencies in generation, distribution, and end-user equipment. In addition to the national government's goals, system reliability and the cost of energy are high-priority issues to RMI citizens and businesses, which are bottoms-up drivers for energy sector changes.

There are many energy efficiency and renewable energy opportunities for the RMI. However, there is no single opportunity or simple means to reach the NEP's 20% renewable energy by 2020 goal. The seven years remaining until 2020 are likely to be insufficient to accomplish the full suite of necessary projects. Energy sector transformation will require significant investment in infrastructure. Political and regulatory bodies will need to adjust to facilitate change and the electrical system operators will need to develop the necessary institutional capacity to manage more complex systems.

According to the National Renewable Energy Laboratory (NREL) report on RMI renewable energy and energy efficiency, summary results of the analysis and report are presented here while detailed discussions follow in subsequent sections. Below figures show results of the what-if analysis using 2012 as a benchmark, assuming zero growth in energy consumption.

Figure below shows the potential contribution of energy efficiency and renewable energy by 2032 in units of barrels of oil equivalent (BOE). The BOE metric assumes that #2 diesel is used as the power-plant fuel and the analysis is based on current power-plant efficiencies. The baseline is established using electricity production data for Majuro, Ebeye, and Jaluit.

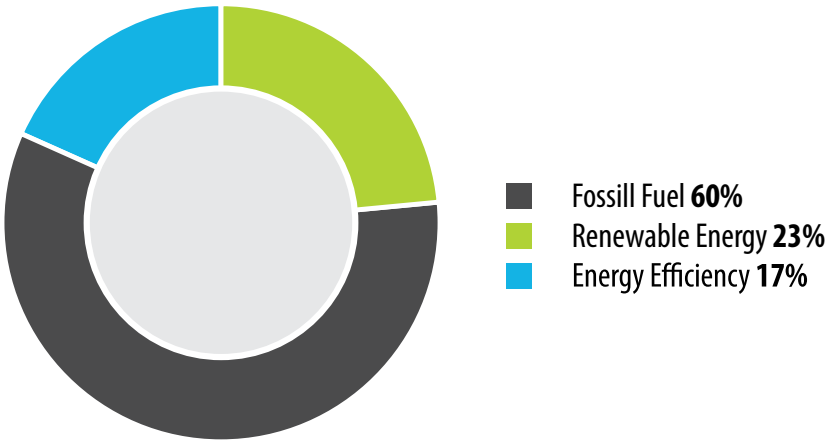
Figure 37: Waterfall presentation of the wedge analysis



Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Figure below shows the impact of the analysis scenario in year 2032 relative to the 2012 baseline: a 17% reduction in power-sector fossil-fuel usage as a consequence of energy efficiency measures and an additional 23% reduction from renewable energy technologies.

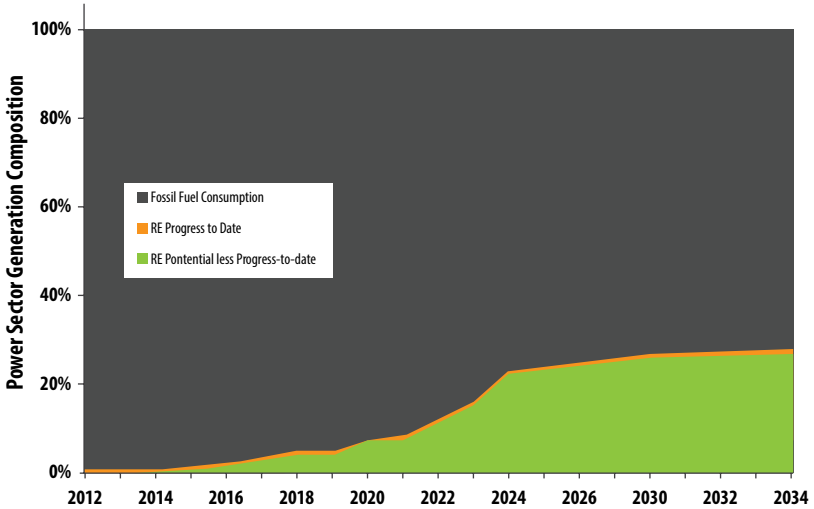
Figure 38: The RMI electricity sector in 2032 relative to the 2012 baseline



Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Figure below presents the model results to show power sector generation. Results are normalized to show the percentage of energy generation provided by oil and provided by renewable energy.

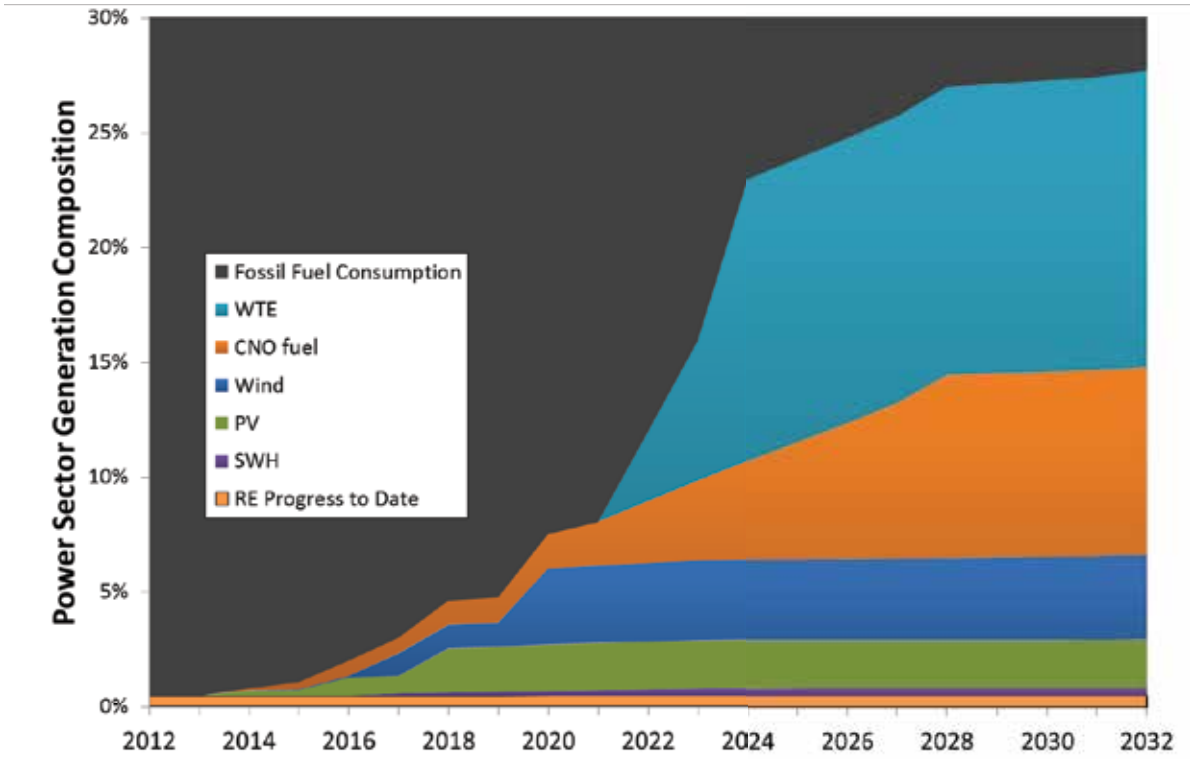
Figure 39: Analysis model power generation profile from 2012 to 2032



Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Figure below splits out the individual technologies that make up the RE wedge. Twenty percent renewable energy could be accomplished with the construction of a 1.2 MW waste-to-energy plant (12.9% contribution) and by diverting approximately 50% of the locally produced coconut oil from export to the local power sector for blending with diesel fuel (8.2% contribution). Both of these resources are limited by the amount of feedstock available, so reduction in total energy use through any gains in energy efficiency will reduce total fossil fuel imports and proportionally increase the potential contribution from renewable sources.

Figure 40: Analysis model power generation profile from 2012 to 2032



Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Under this scenario, potential fraction of electricity provided or offset by renewable energy would be 7% in 2020. This would require the installation of 1.3 MW of PV, 1.3 MW of wind, 1,400 ft2 of solar water heating collectors, and 160,300 gallons/year of CNO being used in power plant generators.

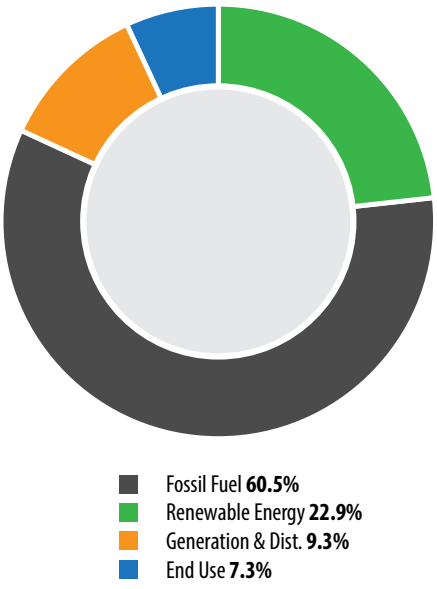
The model demonstrates that 28% renewable energy is possible, after efficiency gains by 2030 and includes a mixture of renewable energy technologies and resources: 1.2 MW waste-to-energy plant; 1.35 MW of PV ; 1.4 MW of wind ; 2,300 ft2 of solar water heating collectors. The current scenario lays out a path to achieve this by 2032. It could be possible to meet this level of renewable energy sooner, but the implementation of projects would need to be accelerated beyond typical project lead times especially waste-to-energy and CNO. It could also be possible to achieve this level of renewable energy if other baseload technologies (such as ocean thermal energy conversion (OTEC)) were found to be technically and economically feasible, and if they could be built in a reasonable amount of time.

Energy Efficiency And Conservation

The NREL analysis splits the energy efficiency gains by 2032 into two broad areas: power sector efficiency gains in generation and distribution and reduced energy use by utility customers through improvements in the efficiency of electricity-consuming equipment and building systems and implementation of conservation programs.

Figure below shows the relative contribution of these areas to the overall reduction in total fossil fuel usage in 2032: a 9.3% reduction in fossil fuel usage by improving utilities' generation and distribution and 7.3% through customer-side improvements. The figure shows the total fossil fuel usage can be reduced to 60.5% of current consumption rates if strategies for efficiency (both on the supply side and demand side) and renewable energy technologies are employed. (Renewable Energy contribution in this figure is 22.9% reduction from today's baseline total diesel fuel use.

Figure 41: Energy efficiency reductions attributed to improvements in demand and supply from today's baseline

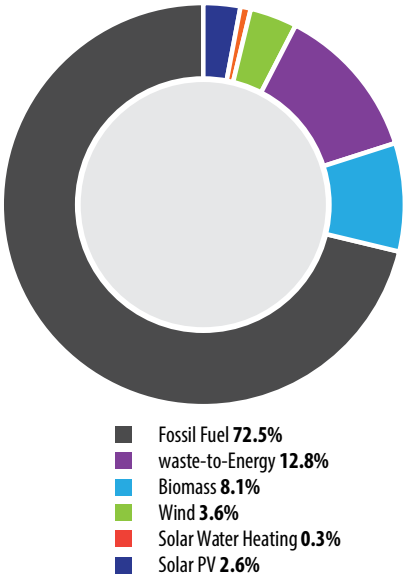


Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Renewable Energy

The technologies that have been considered under the analysis the RMI are solar photovoltaics, solar water heating, wind power, waste-to-energy, and liquid biomass (coconut oil) used as power plant fuel. The estimated relative contribution of each technology in 2032 is shown in below figure . The analysis indicates that the combined generation (from PV, wind, WTE and CNO) and generation offsets (from SWH) for these technologies is 28% in 2032, or approximately 30,000 BOE per year.

Figure 42: Contribution of each renewable energy technology to generation profile in 2032



Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

In this analysis PV and wind contribute a little over 6% of the total generation (energy in units of kW). Energy efficiency gains are an important part of achieving this renewable energy goal. For example, the 1.2 MW WTE plant generates 8,300 MWh/yr. in this model. This is 10.7% of the total 77,500 MWh produced in central power plants on Majuro, Ebeye, and Jaluit in 2012. However, if the efficiency gains are accomplished, total

annual demand of consumers will decrease and the same WTE plant would then meet 12.8% of the total. So the RE goal can be best accomplished by deploying both RE and improving electrical system and consumer efficiencies.

Solar Photovoltaics

Photovoltaic (PV) electricity generation is commercially available, economically competitive, and is well-suited to the RMI as it is a distributed generation technology that could be installed in small power clusters on existing rooftops and as ground-mounted systems on small areas of unoccupied or otherwise unusable land. PV-covered canopies over parking lots could also be installed for additional capacity potential at a modest price premium. As described in earlier sections, the RMI and MEC have experience on Majuro with grid-connected systems and with smaller off-grid battery-backed installations on the outer islands.

Off-grid systems can incorporate a combination of PV, wind, battery energy storage, and diesel backup generators to meet energy needs. The optimal choice of technologies depends on resource availability and load profiles at each site. Off-grid systems can be used in remote locations where the cost of extending power lines prohibits the system from being connected to the grid. Off-grid systems operate independently from the central electricity grid; grid-connected systems feed energy back into the grid.

A summary of the impact of PV energy on business-as-usual (BAU) diesel generation is shown in Table below. Energy generated and reported fuel savings assume that the PV system output degrades 0.5% per year and are reported for expected production in the year 2032. The timeline for implementation can certainly be accelerated should the RMI prioritize this effort.

Table 44: Photovoltaic Systems Size and Potential Impact by 2032

Total Installed Capacity	1.35 MW
Annual Energy Production	1,689MWh
Displaced Diesel	2,845 barrels/yr
Fuel Reduction from BAU	2.2%
Electricity contribution in the year 2032	2.6%

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Wind Power

Wind power is a mature technology that is likely to be cost effective in the RMI and it should be included as a viable technology in sustainability and energy diversification plans. Properly sited installations have exposure to the prevailing wind direction, which can be accomplished everywhere in the RMI with sufficiently tall towers. A summary of the impact of wind energy on business-as-usual (BAU) diesel generation is shown in Table below.

Table 45: Wind Power Total Systems Size and Predicted Impact by 2032

Total Installed Capacity	1.4 MW
Annual Energy Production	2,360 MWh
Displaced Diesel	3,975 barrels/yr
Fuel Reduction from BAU	3.1%
Electricity contribution in the year 2032	3.6%

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Waste to Energy

WTE is a commercially sound, widely deployed option that is considered to be a form of renewable energy by most countries and organizations around the world. In the NREL analysis, WTE is the largest renewable energy wedge with about 13% of RMI's 2032 total annual energy requirements produced from a hypothetical 1.2 MW plant. The model assumes that combustible waste on Majuro is used in a steam-powered generator operating at an annual average capacity factor of 79%. The figures are based on an analysis report published in 2010 and funded by the ADB78. The report authors visited Majuro to engage local stakeholders and gather data. It is a pre-feasibility study that includes sound estimates of total waste available, energy content, and power plant production. The report also discusses local factors including permitting, the challenges of finding operating expertise, raising capital, and the ownership options that are most likely to lead to project development and operational success. Financial feasibility is also addressed.

Table 46: Waste-to-Energy System Size and Predicted Impact by 2032

Plant Size	1.2 MW
Annual Energy Production	8,300 MWh
Displaced Diesel	13,980 barrels/yr
Fuel Reduction from BAU	10.7%
Electricity contribution in the year 2032	12.8%

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Biomass from Copra

Coconuts are a significant indigenous resource that has an important place in the RMI's economy and history. Coconuts are collected throughout the Marshall Islands and processed on Majuro at the Tobolar Copra Processing Plant, a state owned enterprise. Coconut oil (CNO) is a high-value commodity that is sold to international markets. The remaining copra cake has value as animal feed but accounts for 10% or less of operating revenue. CNO has been considered as an alternative fuel source that could reduce the amount of diesel imported by the RMI.The analysis assumes CNO is blended with diesel for use in existing diesel generators. The plant size in the table represents the approximate capacity of existing generation that would be fueled by renewable coconut derived biofuels.

Table 47: Coconut Oil as a Fuel Source and Predicted Impact by 2032

Plant Size	0.75 MW
Annual Energy Production	5,296 MWh
Displaced Diesel	8,874 barrels/yr
Fuel Reduction from BAU	6.8 %
Generation contribution in the year 2032	8.2 %

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Solar Water Heating

Solar water heating (SWH) systems are easy to install and cost-effective, particularly in areas like the RMI with high utility costs and a strong solar resource. New low-cost plastic-bodied units have further improved economics and may be a good fit to the RMI's mild climate and low temperature increase requirements (high cold water inlet temperature). The application of SWH and impact on total island energy used is minor because of low hot water usage. However, in niche applications in the RMI, such as hospitals, hotels, and in commercial and industrial kitchens, SWH is cost effective and an opportunity for these facilities to reduce utility costs.

Typical SWH systems will provide 40% to 70% of a water heating load; well-designed systems in the RMI would perform at the higher end of this range. Water heated by solar energy is stored in tanks. The temperature of the stored water is raised, as needed, with supplemental heaters that use electricity or fuel.

This analysis assumes SWH offsets electricity and that hot water usage in the RMI is modest and concentrated in hotels and hospitals. A summary of the impact of SWH on business-as-usual diesel generation is shown in Table beow. This analysis assumes the typical home and commercial building does not consume hot water. The estimate here considers modest hot water loads at hotels and the Majuro hospital are supplemented by solar heating.

Table 48: Solar Water Heating Total Installation Size and Predicted Impact by 2032

Total installed collector area	2300
Annual Energy Savings	197 MWh
Displaced Diesel	332 barrels/yr
Fuel Reduction from BAU	0.3 %
Electricity offset by 2032	0.3 %

Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

Ocean Energy

The potential energy available in the oceans is immense and holds significant promise for renewable power production and for energy efficiency gains by using large district cooling systems. Ocean power production technologies are divided into four categories: tidal, wave, marine current, and ocean thermal energy conversion (OTEC). Ocean power production systems would be a good fit for the RMI because of the proximity of the resource; however, only impounded tidal power systems similar to conventional hydroelectric dams are commercially available today. In this type of system, large dams open and close with tidal cycles to capture water in an estuary or impound structure to create sea elevation differences used to drive hydroelectric turbines. These impound or barrage systems are not feasible in the RMI because of the small changes in tidal elevation and limited land area.

Barriers for Mitigation Initiatives

Many remote island communities face a common set of barriers and challenges in implementing energy projects. The recent NREL assessment has listed below along with some obstacles that are particularly problematic in the RMI.

- Competing priorities - Similar to most island countries, energy is just one among many important development objectives in RMI. Priorities can change rapidly, which can lead to delays in energy project development. This results in higher-than-anticipated project costs, representing an inefficient use of local and donor resources and development targets not being met .
- Absence of an optimized project planning framework and standardized project development protocols - Each international donor has its own approach to project development and, as a result of varying donor experience with project implementation in remote communities, not all of these approaches address key project development fundamentals that are common to all energy

projects. This problem is exacerbated by the absence of strong local policies designed to promote energy project development and guide the actions of well-intentioned donors.

- Lack of detailed local information required to make informed decisions about which energy projects to pursue - It can be very difficult to gather basic information about local energy supply and demand and the likely cost of new projects. Without this information, it is difficult to know which projects are the most cost-effective and appropriate to the local situation.
    - In some cases, the lack of data results from the fact that local utilities may not have had an incentive to keep detailed records, something that can be addressed through a change in business practices and by applying some resources to long-term planning.
    - When very few comparable projects have been undertaken locally or nearby, one of the most reliable ways to ascertain likely project costs is to issue tightly specified RFPs for specific technologies. However, a lack of data regarding local energy markets, laws and regulations governing energy project implementation, potential site access issues, and available energy resources will reduce the reliability and number of RFP responses, as respondents typically add large contingencies to their estimates for any missing information that could increase their own project development costs and risks.
- Donor challenges - In addition to neglecting key project fundamentals during the planning phase, international donors sometimes fail to address other aspects that are critical to project success. Some of these issues are exacerbated by similar problems within the RMI.
    - Lack of coordination - The multitude of donors often have their own agendas and develop projects in a piecemeal fashion instead of leveraging each other's efforts by coordinating their activities.
    - Inadequate project oversight - Many donors are not intimately familiar with the local situation and some end up using the wrong vendor or contractor to supply and install equipment, hiring inexperienced local staff, not making sure their project funds are spent in ways that further the overall project goals, and not following standard project close-out procedures that are designed to capture "lessons learned" that can be used to develop a set of best practices that can be applied to future projects.

- Failing to address post-construction operations and maintenance needs - Many 'international donors are overly focused on project completion and do not pay sufficient attention to ensuring that the funds and a skilled workforce are in place to operate and maintain project equipment for the life of the project.

- RMI institutional challenges - The lack of independent utility oversight, some missing technical skills amongst the workforce, and the absence of energy policies and regulations in the RMI present significant challenges to project development .

- RMI utility financial challenges - The practice of providing free electricity to some landowners makes it difficult for the local utilities to balance their books.

- External risk factors - Some project challenges result from a lack of foresight on the part of the international donors or the local government, but others are more difficult to predict. Contingency planning can help to mitigate the impact of some of these risk factors.

  - A downturn in the local economy or a change in global markets can quickly shift local development priorities or the financial viability of a particular energy project. A rapid and sustained increase in global oil prices, for example, could immediately improve the economics of renewable energy projects as a whole, and the potential value of coconut oil, as an example, a diesel substitute in particular.

  - Natural disasters can switch local and donor priorities overnight from energy project development to infrastructure reconstruction, delaying the implementation of projects that are already under way. The remoteness of many island communities and their limited local resources can further exacerbate the effects of natural disasters by increasing both the cost and time required for reconstruction.

- Lack of stakeholder engagement - Education and outreach to local stakeholders, including landowners, ordinary citizens, municipal leaders and other influential members of the community, is an often-overlooked aspect of successful project development. It is important that stakeholders are not just informed about, but are fully engaged and personally invested in, the success of the projects.

The key barriers to renewable energy and energy efficiency in the RMI include: Limited capacity within the government to regulate, develop, implement and monitor renewable energy and energy-efficiency projects; Fragmented implementation of projects among government departments with little sharing of resources, information and experience; Lack of standards or certification for components and training; Irregular incomes on outer islands make it difficult for households to make regular cash payments; RMI's small size and its wide geographical distribution; Outer island villages are expensive to access; Loss of skilled people through emigration; Lack of good quality wind energy resource data; Donor-supplied equipment that is poorly designed for reliable operation in the tropical marine environment of the outer islands; Political interference that prevents full cost recovery for solar installations despite their being less costly than petroleum-based alternatives; Lack of confidence by users that the fees paid for service do result in good service; There is no programme for refresher training of technicians or for training of new technicians once installations are completed; MEC does not have a net-metering policy and current laws forbid generation by anyone but MEC, which makes it difficult for the private sector to participate; Lack of sustainability of the solar home systems provided by donors for the rural electrification projects; Maintaining a sustained copra supply for biofuel purposes; Lack of enforcement on fuel price regulation; Ageing petroleum infrastructure, which still represents over 90% of the RMI energy source; Need for local capacity development and Need for appropriate legislation to regulate energy security measures.

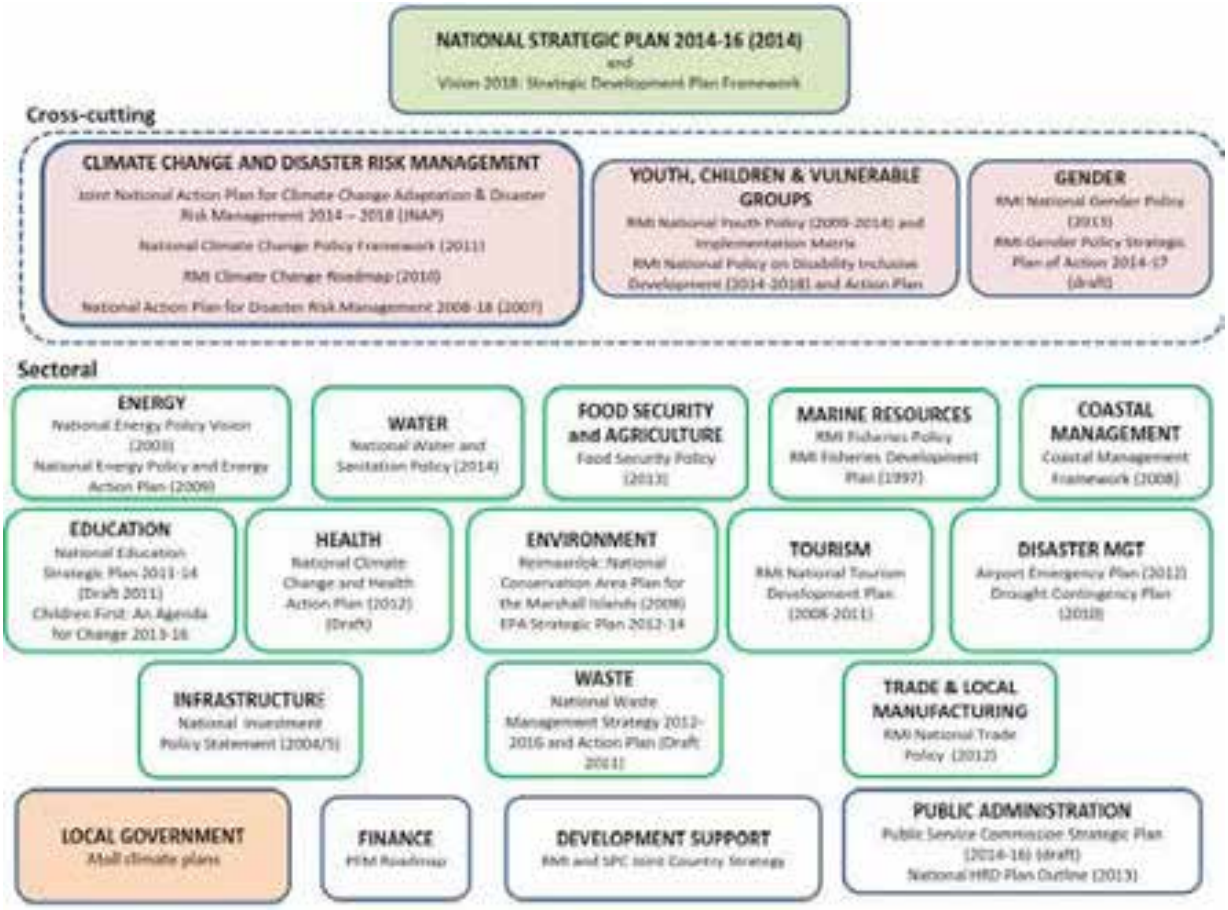
CHAPTER 5

Other Relevant Information

Policy Environment

The array of RMI plans and policies are summarised in the below figure. Several of these plans have been superseded, while others are still in draft form. The National Strategic Plan 2014-2016 (NSP), endorsed by the Nitijela (RMI Parliament) in April 2014, expands on the previous national development strategy, Vision 2018. Similarly, the Joint National Action Plan for Climate Change Adaptation & Disaster Risk Management 2014 - 2018 (JNAP) supersedes the National Climate Change Policy Framework (2011) and the National Action Plan for Disaster Risk Management 2008-18. Some of the relevant policies have been elaborated below.

Figure 43: Overview of RMI National Policies



Source: Pacific Climate Change Finance Assessment, RMI National Assessment, 2014

National Strategic Plan (NSP) 2014 and Vision 2018

The NSP, which builds on Vision 2018, was endorsed by the RMI Cabinet in early 2014. Both Vision 2018 and the NSP clearly articulate RMI's development efforts and priorities, and the significant development challenges they face. High external debt and import dependence, limited human and financial resources, and the threats of climate change are all identified as major development constraints. The NSP also highlights a range of social development issues and a need to address the different vulnerabilities across the community relating to gender, age, disability and income levels.

The National Food Security Policy (2013)

The Food Security Policy emphasises that vulnerability is the product not only of specific risks such as drought but also health (high NCD rates, exposure to contaminated food and water), the need to modernise agricultural production and take advantage of "value adding" opportunities (e.g. coconut production), unsustainable fisheries management, environmental degradation (including waste generation and disposal, biodiversity protection), and indirect risks due to price changes in the international market for imports. Such factors all have a significant influence on the capacity of communities in RMI to cope with stress and/or adapt to climate change. The Food Security Policy also highlights differing levels of vulnerability across the community, for example the way in which gender influences vulnerability and access to resources.

The Coastal Management Framework 2008 offers a hazard-focused response to climate change stating that "The Marshall Islands will be increasingly battered by storms that in lower sea levels would not have threatened the coastal defence", and that "There are only a few options for adaptation: build up shoreline defences and elevating structures, pushing development and construction away from the coastal zone (still possible in rural areas) and (worst case) evacuation of affected areas". Some of the issues covered in the Framework such as coastal dredging practices, waste management, the establishment of conservation areas and the enforcement of marine water quality regulations will play an important role in improving RMI's resilience to climate change.

RMI's National Climate Change Policy

The RMI's people are among the most vulnerable to the impacts of climate change. RMI firmly believes it has no choice but to implement measures to build resilience, reduce disaster risk, and support renewable energy and energy efficiency, i.e. to adapting to the adverse impacts of climate change. Within the context of extreme vulnerability to climate change impacts, the RMI has developed the National Climate Change Policy Framework (NCCPF), to provide a blueprint to build resilience in partnership with our regional and global partners. The NCCPF was formally endorsed in 2011, and provides overarching national guidance and identification of priorities for tackling climate change challenges in the RMI.

The vision of the NCCPF is **"Building the resilience of the people of the Marshall Islands to climate change"**. The RMI has identified a series of priority climate change areas which represent targets for attention and, in some cases, urgent response. While efforts continue to understand the nature of future climate change, it is clear that the RMI faces major impacts on its communities' livelihoods and infrastructure from sea-level rise, sea surge, typhoons and rainfall intensity; water and food security issues from changing rainfall patterns and ocean acidification; health issues from rising temperatures and prolonged drought periods, as well as the potential for increasing peak wind speeds and changes to ocean circulation patterns. To prepare for these impacts, the RMI Climate Change Policy Framework presents five strategic goals that provide a pathway to an integrated, whole of Marshall Islands response. This includes: Strengthen the Enabling Environment for Climate Change Adaptation and Mitigation, including Sustainable Financing; Adaptation and Reducing Risks for a Climate Resilient Future; Energy Security and Low-Carbon Future; Disaster Preparedness, Response and Recovery; Building Education and Awareness, Community Mobilization, whilst being mindful of Culture, Gender and Youth.

The NCCPF also identifies nine national priority areas, which are addressed via the five strategic goals: Food and Water Security; Energy Security and Conservation; Biodiversity and Ecosystem Management; Human Resources Development, Education and Awareness;

Health; Urban Planning and Infrastructure Development; Disaster Risk Management; Land and Coastal Management, including Land Tenure and Transport and Communication.

Integrating Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA)

The RMI has a well-established Disaster Risk Management National Action Plan (DRM NAP), which was informed by extensive national consultations and stakeholder engagement over a period of several years. The DRM NAP describes in detail how to address risk in the RMI, including ten strategic goals and subsequent objectives and activities.

A review of the DRM NAP highlighted the need to further extend the scope of the DRM NAP to incorporate the impacts and risks associated with climate change. The DRM NAP therefore provides much of the groundwork for an action plan for climate change, as many of the impacts associated with climate change will be an enhancement of existing risks and threats (e.g. water and food security, coastal erosion). A Joint National Action Plan (JNAP) for both disaster risk management and climate change was envisaged as a practical and strategic way to address risk in the RMI holistically.

RMI's JNAP identifies the strong synergies and commonalities in the DRM NAP and the NCCPF. It ensures all risks, threats and priorities are covered, by incorporating the NCCPF's five strategic goals and national priorities with the DRM NAP's ten goals. It allows for partnerships between government ministries and agencies, local governments, the non-government sector (NGOs, private enterprise, communities, traditional leaders), the donor community and regional and international agencies and organizations.

JNAP Linkages and Implementation Strategy

The JNAP draws upon and is informed by existing policies and frameworks at the national, regional and international level. At an international level, the RMI is committed to the principles outlined in the Mauritius Strategy for Sustainable Development of Small Island Developing States 2005.

The Pacific Plan provides a regional policy approach to sustainable development. Reflecting elements of the Paris Declaration of Aid Effectiveness and the Pacific Principles of Aid Effectiveness, the Pacific Plan, calls on donors and development partners to work with national governments in providing a harmonized approach to development support in the Pacific. The recent review of the Pacific Plan notes the importance of addressing the region's vulnerabilities and dependencies, with the development and implementation of RMI's JNAP directly contributing to this approach.

The RMI's National Strategic Development Plan: Vision 2018 (RMI Government, 2001) provides an overarching framework for sustainable development. Containing ten sustainable development goals, Vision 2018 contains several strong linkages to disaster risk management and climate change. The JNAP fits in by providing a cross-sectoral action plan.

Figure 44: Vision 2018 and linkages to the JNAP

Source: Republic of the Marshall Islands Joint National Action Plan for Climate Change Adaptation & Disaster Risk Management 2014-2018

RMI acceded to the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and mostly aligns itself with the Alliance of Small Island States (AOSIS) in international negotiations for climate

change. As part of the UNFCCC, the Kyoto Protocol provides legally binding commitments for developed countries to reduce emissions of greenhouse gases by at least 5% of 1990 levels. Although the RMI has no required commitments to reduce emissions under the Kyoto Protocol, the government acceded in 2003 and continues to aim to transition to a reduced dependence on greenhouse intensive sources of energy, contributing to both mitigation and less reliance on imported fuels.

The Pacific Islands Framework for Action on Climate Change (PIFACC) 2006-2015 provides the regional policy driver for action on climate change. The JNAP is consistent with the six underlying principles of the PIFACC. The Micronesia Challenge is an agreement from governments of Palau, RMI, FSM, Guam and CNMI, and is a response to the Convention on Biological Diversity. The Micronesia Challenge commits participants to conserve 30% of near-shore marine resources and 20% of terrestrial resources by 2020. The Reimaanlok National Conservation Area Plan is RMI's approach in reaching its commitments to the Micronesia Challenge, providing a roadmap for conservation efforts.

Modelled after the Micronesia Challenge, the Green Energy Micronesia (GEM) incorporates RMI, FSM and Palau in attempts to transition more efficient energy use and to renewable energy in the region. The goals are to reach a 20% improvement in energy supply efficient; 30% improvement in energy use efficiency and 20% of electricity generated from renewable sources.

The National Climate Change Policy Framework was endorsed in 2011 and provides strategic priorities for scaling up the government's commitments to address climate change. By promoting a coordinated approach, the policy aims to address climate change issues across relevant sectors and also provides an entry point for donors to provide assistance in reducing RMI's vulnerabilities to climate change impacts. The climate change policy outlines national priority areas for action in addition to five strategic goals to address key vulnerabilities and areas requiring a boost in resilience.

At the international level, the Hyogo Framework for Action (HFA) 2005 - 2015 provides a strategy for reducing the impact of disasters, with a specific focus on risk reduction. Discussions are underway to design a post-2015 international framework for addressing risks, informed by lessons learned from the HFA. A regional approach to implementing the Hyogo Framework for Action was developed in 2005, with the Pacific Disaster Risk Reduction and Disaster Management Framework for Action 2005 - 2015.

Source: http://america.aljazeera.com/topics/topic/international-location/asia-pacific/marshall-islands.html

Mitigation

Climate change mitigation includes efforts to reduce the levels of greenhouse gases (GHG) in the atmosphere, either by limiting the sources or by enhancing the sinks. Examples include using fossil fuels more efficiently, switching to renewable energy sources such as solar energy and hydro-power, and expanding forests and other sinks to remove greater amounts of carbon dioxide from the atmosphere.

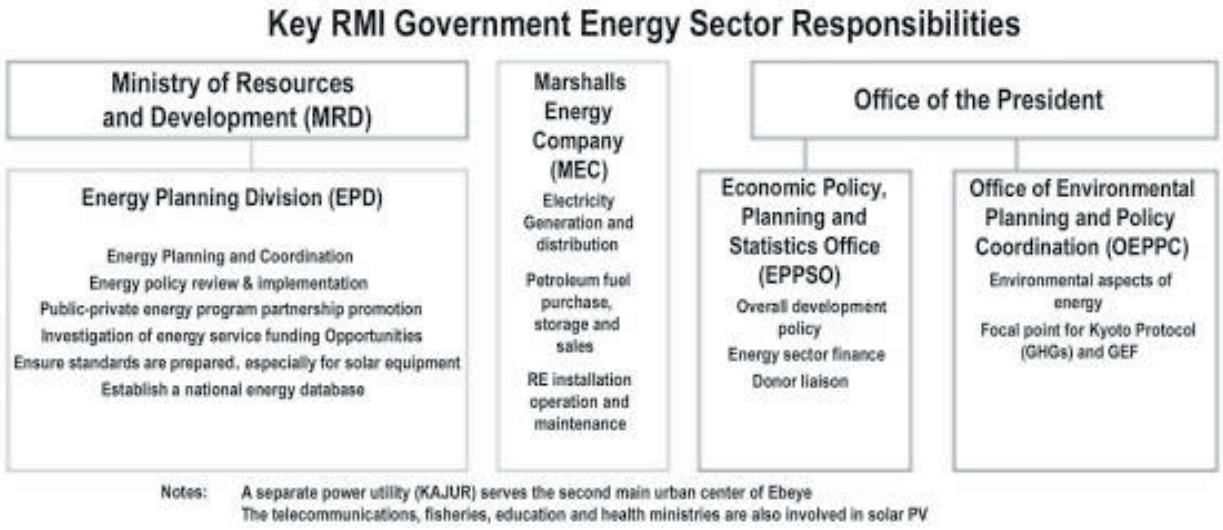
Table 49: RMI's Commitment during Majuro Declaration

Subject of Commitment	Target for Action	Where Reflected
Emissions Reductions **Renewable Energy** **Energy Efficiency** **Energy Access**	Pursuant to the Republic of Marshall Islands 2009 National Energy Policy and Energy Action Plan, the 2011 National Climate Change Policy Framework and Joint National Action Plan (for climate change adaptation, energy security and disaster risk reduction), and the Green Energy Micronesia initiative: • A 40% reduction in CO2 emissions below 2009 levels by 2020; • Electrification of 100% of urban households and 95% of rural outer atoll households by 2015; • The provision of 20% of energy through indigenous renewable resources by 2020; • Improved efficiency of energy use in 50% of households and businesses, and 75% of government buildings by 2020; • A 20% efficiency improvement in transportation sector fuel use by 2020; • Feasibility studies and internationally supported financing plans for innovative 'game-changing' renewable energy and sustainable development opportunities including Majuro atoll waste-to-energy • and Kwajalein/Ebeye atoll OTEC plants undertaken by 2015.	Barbados Declaration on Achieving Sustainable Energy for All in Small Island Developing States (SIDS),
Emissions reduction	40% reduction of CO2 emissions below 2009 levels by 2020, pursuant to the 2009 National Energy Policy and Energy Action Plan, and subject to the provision of adequate international support.	UN Document FCCC/AWGLCA/2011/INF.1, p. 30,

Source: Pacific Climate Change Finance Assessment RMI National Assessment, 2014

According to IRENA, during 2014, 94% of all electricity generated by grids operated by MEC was from diesel fuel, with solar accounting for about 6%. KAJUR relies entirely on diesel generation. Rural renewable energy installations in the RMI are mostly Solar Home Systems (SHS), in which each household has its own independent solar installation. Potential for renewable energy and energy efficiency interventions are envisaged to be good as discussed in the mitigation analysis chapter. Prospects for renewable energy development are also promising as the government has accepted the ADB framework developed for rural electrification through solar energy. MEC is also willing and able to manage renewable energy initiatives. An agreement exists between MEC and the government to promote renewable energy development throughout the country and carry out solar maintenance on the outer islands.

Figure 45: Institutional Structure for Energy Development



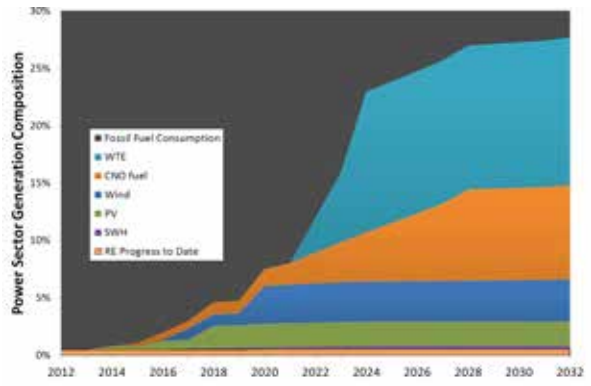
Source: Pacific Climate Change Finance Assessment RMI National Assessment, 2014

The National Energy Policy and action Plan's (NEP) development objective is, as stated in the plan, to achieve "an improved quality of life for the people of the Marshall Islands through clean, reliable, affordable, accessible, environmentally appropriate and sustainable energy services."

The NEP addresses energy policy and outlines numerous renewable energy and energy efficiency goals and projects including lays out project parameters, including the organization(s) responsible, project priorities, time frames, performance indicators, budget requirements, and potential funding sources.

The NEP goals include: Electrification of 100% of all urban households and 95% of rural outer atoll households by 2015; 20% indigenous renewable energy by 2020; 50% energy efficiency improvements of households and businesses, and 75% of government buildings, by 2020; 20% reduction of supply-side energy losses from MEC by 2015 and 40% reduction of fossil fuels used by the government by 2020.

Figure 46: NREL Analysis model renewable energy profiles from 2012 to 2032

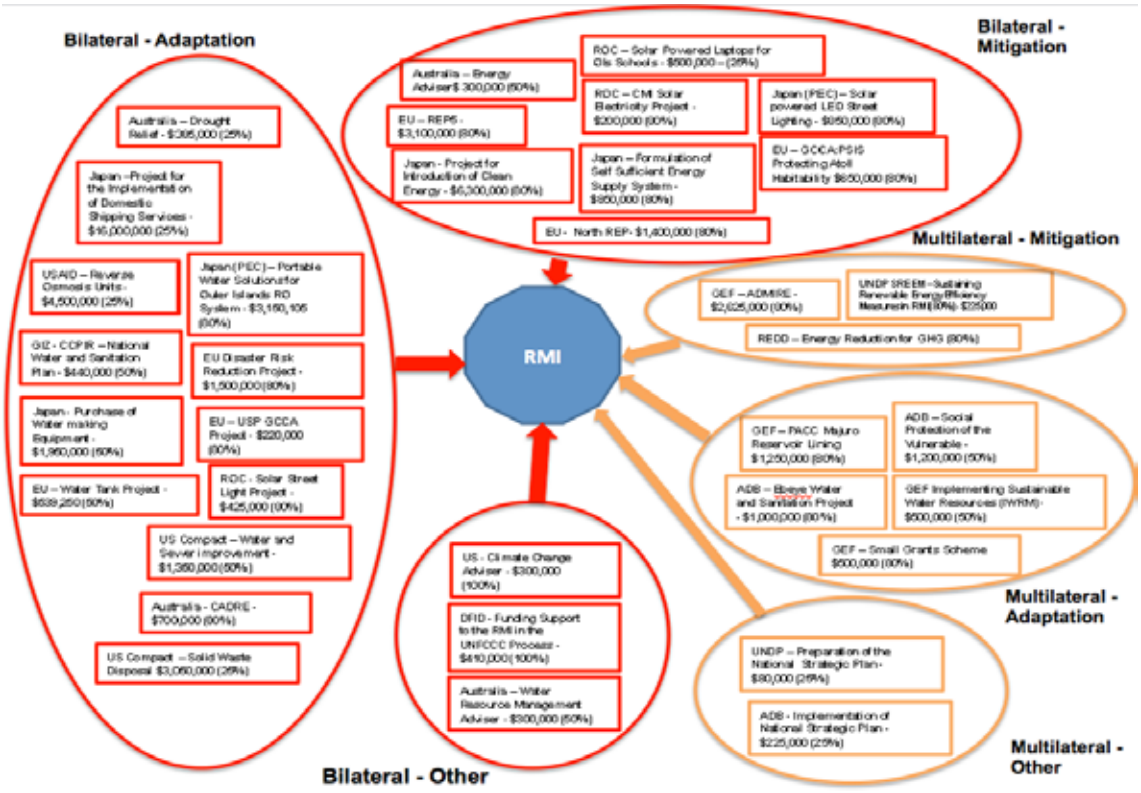


Source: RMI Initial Technical Assessment & Energy Project Implementation Options, 2013, NREL

The IRENA assessment also identified the key challenges associated with scaling up RE initiatives and came up with recommendations which include:

- To address the challenge of legislation and institutional co-ordination:
    - Reviewing existing acts relating to energy, and enact enabling legislation to create a national energy agency; legislating the responsibility and authority needed to establish and enforce standards for renewable energy systems generating electricity for public use.
    - Establishing an energy working committee. To co-ordinate renewable energy implementation and review any national design standards proposed for renewable energy installations. To propose training programmes supporting renewable energy development available at the College of the Marshall Islands or other educational institutions, and serve as a forum on renewable energy in the RMI.
- An articulated action plan using a systems approach should be adopted for grid-connected renewables development. The following actions should be taken:
    - Preparing a dynamic computer model of the grid to help MEC predict the effect of individual on-grid photovoltaic (PV) systems on the power quality of feeders and low voltage distribution lines.
    - Development and enforcing standardised technical design, installation and interconnection requirements.
    - Designing workable financing schemes following the model in Palau.
    - Designing effective capacity buildings programmes and also roll them out by training trainers. The training programme should be designed to meet local needs.
- The key challenges facing off-grid renewable energy still relate to long-term operation and maintenance (O&M). A customised approach is therefore recommended to ensure sustainable O&M through actions including the following:
    - Conduct a comprehensive survey of factors causing the failure of sustainable O&M (particularly for solar PV systems), and develop a remediation plan.
    - Develop an institutional arrangement for rural electrification to ensure it suitable for each individual outer island and sustainable in long-term operation.
    - Deliver training programmes using local knowledge and language to provide know-how in ways that can be understood by local villagers assigned with maintenance.
    - Develop and enforce design and installation standards for off-grid installations.
- Fuel drum leakage has been a serious problem for outer islands. Existing diesel powered mini-grids need to be converted to solar PV systems to eliminate this problem. Outer island diesel-to-solar energy conversions in other Pacific island countries need to be studied and followed by similar programme preparations for the RMI.
- Coconut oil looks promising if concerns about its supply, quality and price can be successfully addressed. It may be worth further exploring the solution provided by small-scale on-site coconut oil production capacity. This allows coconut oil to be extracted using small mills on site where the copra is harvested and still fresh.

Figure 47: Major Climate Projects and Funding Sources in RMI



Source: Pacific Climate Change Finance Assessment RMI National Assessment, 2014

Climate Change Institutional Coordination Structure

Office of Environmental Planning and Policy Coordination (OEPPC): OEPPC was established by the OEPPC Act (2003). OEPPC's role is to i) act as an advisory body to the Office of the President, Cabinet, the Ministries and government agencies on environmental planning and policy matters including issues related to climate change; ii) be the focal point in coordination, management and implementation of international environmental projects/programs and iii) act as the national point of contact in all negotiations with external partners and lending institutions on programs and/or projects of assistance. OEPPC also works in partnership with other government ministries and agencies, and the international community to prepare strategies to mitigate the negative impacts of climate change and prepare adaptation plans. It has the domestic climate change coordination role and is Secretariat to the National Climate Change Committee (NCCC) and provides technical support MoFA during international negotiations on climate change.

National Climate Change Committee (NCCC): NCCC is responsible for ensuring progress on adaptation and mitigation elements of the JNAP, and to ensure new and emerging climate change initiatives in RMI are linked and integrated into JNAP priorities. NCCC is chaired by the Chief Secretary with membership comprising mostly Secretaries, Head of Agencies. The Director of OEPPC is Vice-Chair the NCCC. Members often meet as the National Disaster Committee (NDC) during emergencies. OEPPC is Secretariat to this Committee with support of the Senior Climate Change Advisor.

Office of the Chief Secretary (OCS): OCS reports to the Office of the President and is responsible for the functioning of government ministries. OCS also houses the Disaster Office, which is responsible for disaster preparedness, risk reduction and response, and the National Disaster Committee (NDC). OCS also has administrative responsibility for OEPPC and the Economic Policy, Planning and Statistics Office (EPPSO). The Chief Secretary chairs the NCCC.

Ministry of Foreign Affairs (MoFA): MoFA is the political focal point for the international climate change negotiations together with the mission in New York and with bilateral partners and regional organisations. It works closely with OEPPC to coordinate international positions on climate change. Bilateral grants for projects are negotiated through MoFA (except for EU). The MoFA Secretary is a member of NCCC.

Ministry of Finance (MoF): MoF facilitates and handles funding from multilaterals (e.g. World Bank, ADB) as well as the European Union (EU). MoF also represents RMI on climate change issues at a range of other international and regional fora (e.g. Forum Economic Ministers Meeting) where climate change finance is discussed. MoF has no designated staff working on climate change issues. The Secretary of Finance is a member of NCCC.

National Disaster Committee (NDC): NDC was established under the Disaster Assistance Act (1994). The NDC is comprised of the Chief Secretary as Chair, with other Government Secretaries as representative members. The NDC's role is to ensure multi-stakeholder coordination and collaboration across government ministries for all disaster related management activities.

Economic Policy, Planning and Statistics Office (EPPSO): EPPSO reports through OCS to Cabinet on the development of sound economic policies and strategic planning, including developing and overseeing the implementation of the National Strategic Plan

Proposed Institutional Arrangements for Development of National Communications

As a party to the UNFCCC, RMI is fully committed to fulfill its commitments through a robust institutional and project management arrangement for development and submission of national communications on an ongoing basis. The strengthening of scientific, technical and institutional capacities of RMI in various aspects of preparation of national communications would enable the country to fulfill its obligations and commitments under the UNFCCC on a sustainable basis. It is envisaged that the institutional structure needs to be designed in order to fully engage participation by all relevant stakeholders in all aspects of national communication development.

A Project Steering Committee (PSC) is envisaged to be responsible for supervising project execution. The PSC could comprise representatives from various ministries and departments, as well as representatives from the private sector, local communities and NGOs. The PSC needs to ensure that the recommendations of the project are integrated into overall national development planning process. The responsibilities could also include evaluating project outputs to ensure that project activities are being carried out in a timely manner and to acceptable levels of quality, and reviewing the status and needs throughout project implementation.

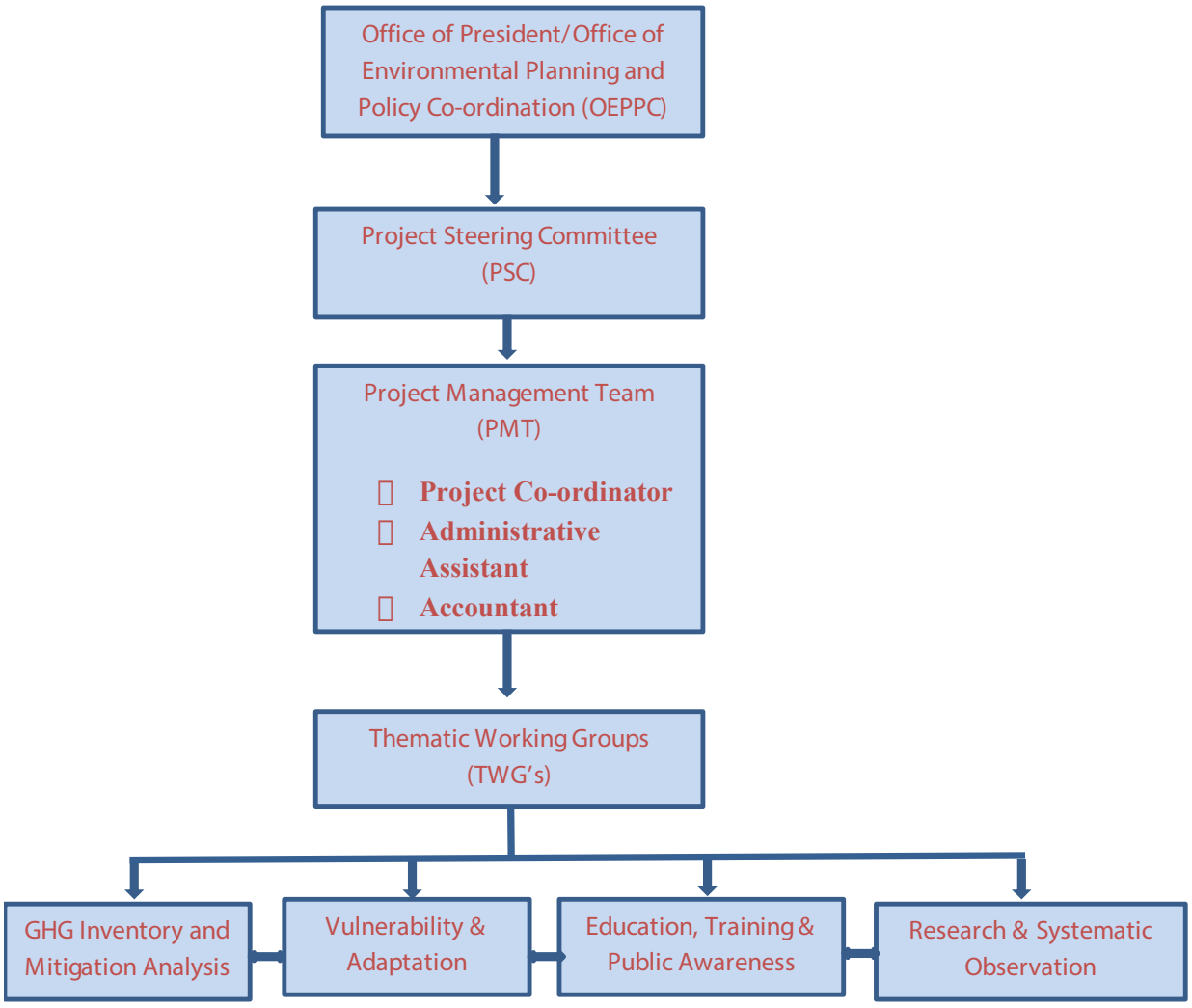
The Project Management Team (PMT) would be responsible for day to day management of project activities and is envisaged to include the national communication Project Co-ordinator (PC) administrative assistant and accountant. The PMT will work and undertake its tasks under the auspices of the OEPPC and in consultation with other relevant government departments, the private sector and NGOs.

The following thematic working groups could be formed to assist with the preparation of various components of the national communication: (i) National Greenhouse Inventory and Mitigation Analysis (ii) Vulnerability and Adaptation; (iii) Research and systematic observation; and (iv) Education, training, public awareness and information and networking and Capacity-building. Each thematic working group will comprise of a number of experts drawing both from public and private sectors, communities, and NGOs, as appropriate.

The OEPPC would provide technical and policy oversight to the project, facilitated by the PSC who could be assisted by the PC and project staff. The PMT can report to the Director of the OEPPC and be responsible for the operational programme of project implementation and will be located within the OEPPC. The PMT can also have adequate and appropriate computer and telecommunication facility, including Internet, to enable them to efficiently and effectively undertake their activities.

The national communications preparation project is envisaged to be executed by the OEPPC, with the support of various government ministries. Additional assistance could be provided to the project by regional and international organizations where appropriate. Public participation in certain aspects of the project activities needs to be encouraged where appropriate and possible. The outreach activities to be undertaken would also need the extensive support of not only the relevant ministries, but also local communities and NGOs in order for the activities to be effective and successful. Local communities, NGOs and the media can be invited to participate in all national workshops as appropriate.

Figure 48: Proposed Instituional Arrangement for National Communications



Barriers, Gaps and Constraints

Despite the improved national and international attention to climate impacts, the RMI still faces many of the same challenges and barriers identified in the Initial National Communications to the UNFCCC report, including severe financing challenges, the need for enhanced technical capacity and mainstreaming climate change considerations into development strategies and activities. While increased attention and direct funding is urgently needed for adaptation strategies, the RMI's geography creates physical limitations not easily addressed solely by infrastructure adaptation projects. While several plans are in place there is a lack of mechanisms to monitor and evaluate the progress towards climate change resilience.

Human Capacity

In RMI, the climate change agenda is well recognised and publicised by RMI Leaders at the national, regional and international fora. Despite this high profile, the stakeholders have stressed that the lack of human capacity as a key obstacle to RMI's effective access and management of climate change resources. The RMI NSP 2014-2016 recognises that human capacity needs to be strengthened across the board. The NSP also highlights this lack of technical capacity in relation to disaster risk reduction. The RMI JNAP also notes the need to build climate change and disaster capacity.

Currently, a significant proportion of RMI's climate change human capacity is locked into project specific, short term activities, often donor-funded. Much of this is infrastructure-focused, reflecting donor priorities and RMI's inability to have more ownership towards any climate change financing which becomes available. RMI therefore has few climate change finance resources devoted to long term, sustainable capacity building activity in climate change.

The magnitude of human resources devoted to climate change is, overall, low relative to the importance placed on climate change as a national priority. Only a handful of permanent staff are available to coordinate and manage climate change activities and the NCCC meets only intermittently. This is a major constraint to efforts to access more climate change finance.

RMI's NSP highlights the need to develop the nation's human capacity. The NSP delegates human resource capacity development to the Public Services Commission, and the National Training Council (NTC). Several initiatives are underway or planned, including the Public Service Commission Workforce Plan and the Human Resource Development (HRD) System Framework Development. RMI's JNAP also has a human capacity element that relates specifically to climate change and disaster risk management.

Institutional and Policy

The key gaps include: Limited integration of disaster risk reduction and climate change consideration into development activities; coordination among the country's relevant institutions, including the country's capacity for emergency preparedness and response at all levels; The technical and financial capacities of existing institutions especially to address the needs of the country's more remote islands, particularly in terms of maintenance of existing disaster risk management tools such as reverse osmosis units; Legislative policies and development activities need to include climate change. For example, existing infrastructure projects need to be properly climate-proofed to deal with projected climate risks.

Research and Data

In RMI, knowledge, data, and tools pertaining to biophysical, social, and technological elements of risk are not as advanced as with climate change data.

RMI also has limited databases on solid waste, coastal management, or water quality, and limited access to geographic information systems (GIS) for spatial, land use, and similar analyses. This is a major constraint to disaster risk assessment, reduction, benchmarking, monitoring, and enforcement. Overall, while there is a relatively solid base of knowledge, data, and tools for some sectors in the RMI, particularly in terms of climate data, there are some important gaps affecting mapping, monitoring, and related activities. Some of the key gaps include: Low level of assessment and development of tools to aid resource managers and decision makers; Inadequate data management tools and absence of a system for information sharing and exchange.

There is also a general lack of sector-specific data, especially on tuna fisheries and water demand. Responding to climate change in the water sector is hampered by a limited understanding of how water supplies will be impacted by rising temperatures. Detailed assessments of climate change impacts and risks across a variety of sectors are required in order to develop sound response strategies, in particular focusing on food security, water resources, and coastal resources.

The use of existing meteorological information is limited to specific agencies, and this information needs to be tailored to decision makers across a wider series of sectors, including water resources management. A very limited instrumental record makes extensive analyses of the natural variability of cyclones difficult. Overall applied research assistance is required to properly establish an island-specific and robust baseline from which to gauge projected changes and impacts. Research is required on the links between climate change and diseases in the context of small islands, including the collection of robust baseline data sets that offer a village perspective on current and potential impacts.

Another key challenge for RMI is to ensure that gender-sensitivity and disability inclusiveness is addressed in its climate change programmes, projects and activities. This has been helped to some extent by the active engagement of the Women United Together Marshall Islands (WUTMI), Island Youth Councils and other NGOs on climate change activities in RMI. Climate change affects communities and individuals in different ways and it is important to ensure that climate change activities are fully inclusive of these special groups.

Renewable Energy and Energy Efficiency

The key barriers to renewable energy and energy efficiency in the RMI include: limited capacity within the government to regulate, develop, implement and monitor renewable energy and energy-efficiency projects; fragmented implementation of projects among government departments with little sharing of resources, information and experience; lack of standards or certification for components and training; Irregular incomes on outer islands make it difficult for households to make regular cash payments; RMI's small size and its wide geographical distribution; outer island villages are expensive to access; lack of good quality wind energy resource data; donor-supplied equipment that is poorly designed for reliable operation in the tropical marine environment of the outer islands; political interference that prevents full cost recovery for solar installations despite their being less costly than petroleum-based alternatives; lack of confidence by users that the fees paid for service do result in good service; No programme for refresher training of technicians or for training of new technicians once installations are completed; No net-metering policy; lack of sustainability of the solar home systems provided by donors for the rural electrification projects; Maintaining a sustained copra supply for biofuel purposes; lack of enforcement on fuel price regulation and need for local capacity development.

Technology Transfer

According to the Intergovernmental Panel on Climate Change (IPCC) has defined technology as a piece of equipment, technique, practical knowledge or skills required to perform a particular activity. Technology transfer is defined as a process for exchanging of knowledge, money and goods amongst different stakeholders which enables the spreading and acquisition of technology for mitigating and adapting to climate change impacts. Technologies may be "soft" or "hard" technologies.

The Article 4.5 of the United Nations Framework Convention on Climate Change (UNFCCC) promotes the development and transference of environmentally sound technologies from developed countries to developing countries (non- Annex 1 countries under the UNFCCC) as means for enabling the international community to fulfil the requirements under the aforesaid convention.

Technology Needs Assessment (TNA) development is a key component of the Poznan Strategic Programme on Technology Transfer supported by the GEF.

The purpose of TNAs is to assist in identifying and analysing priority technology needs, which can be the basis for a portfolio of environmentally sustainable technology (EST) projects and programmes. This can facilitate the transfer of, and access to, ESTs and know-how in the implementation of Article 4.5 of the Convention. TNA includes: a set of country-driven activities that identify and determine the mitigation and adaptation technology priorities of developing country Parties; Involve different stakeholders in a consultative process to identify the barriers to technology transfer and measures to address these barriers through sectoral analyses and may address soft and hard technologies for both mitigation and adaptation, identify regulatory options and develop fiscal and financial incentives and capacity-building.

RMI envisages to carrying out a detailed TNA as part of the Third National Communication (TNC) with objectives going beyond the identification of technology needs. RMI envisages development of national Technology Action Plans (TAPs) to prioritize technologies, to recommend enabling frameworks for the diffusion of these technologies and to facilitate the identification of good technology transfer projects and their links to relevant financing sources. Nonetheless, the key mitigation and adaptation technologies identified under various past, current and planned climate change initiatives and assessments for RMI has been detailed in the below tables.

Table 50: Potential technologies for climate Change mitigation in RMI

Sector	Mitigation Technologies	Technology Needs
Energy Generation	• Solar Photovoltaics • Wind Power • Biomass from Copra • Solar Water Heating • Ocean Energy	Photovoltaic applications(lighting , heating, cooling and general power) Wind turbines Ocean power technologies Gasifiers Grid interconnection capacities Copra mills Human resources development Information technologies
Energy Efficiency	• Power sector efficiency gains in generation and distribution • Reduced energy use by utility customers through improvements in the efficiency of electricity-consuming equipment and building systems and implementation of conservation programs.	Efficient power generation technologies Minimum loss transmission and distribution network technologies Energy rating and Appliance labelling programmes technical trainings Human resource development
Transportation	• Improved vehicle efficiency • Alternative transport fuels(biofuels, natural gas)	Vehicles energy performance enhancing tools and techniques Human resource development General public awareness Biofuel and natural gas stations Human resource development Technical capacities
Waste	• Waste-to-Energy • 3Rs (reduce, reuse and recycle)	Anaerobic digestion (biogas) Landfill gas utilization Composting Feasibility studies Technical capacities Awareness programmes

Source: SNC study of RMI 2000

Table 51: Potential technologies/interventions for climate Change adaptation in RMI

Adaptation Priorities	Adaptation Technologies/ Interventions	Technology Needs
All households have reliable access to clean, fresh water. Reduced vulnerability to coastal hazards. Strengthened coordination and effectiveness of DRM/CCA decision making processes and institutional arrangements. Integrated response to building resilience to climate change and disasters. Resilience of community livelihoods (including health and wellbeing) and vulnerable groups including youth and children are strengthened. Vulnerability to water and food related hazards and shortages resulting from hazards and climate change impacts are reduced. Key organizations are adequately resourced and avenues for sustainable financing are secured through improved policies, capacities and institutional arrangements. Technical, scientific and management skills and expertise for climate change and DRM are improved and retained in the RMI.	Improved rainwater catchment systems Water Conservation plumping Measures Water leakage control Integrated Water Resource Management Plan & legislation Sea walls Establishing set back zones and legal agreements that restrict development on highly vulnerable coastal areas Building codes and climate proofing of all coastal infrastructural development Improved drainage systems Improved scientific data and information collection and analysis	Water storage systems Meteorological equipment Information technologies tools and equipment Water monitoring Equipment Most appropriate building materials Construction engineering tools & techniques Environmental engineering techniques and tools LIDAR survey Monitoring equipment Human resource development Technical capacities

Source: Republic of the Marshall Islands Joint National Action Plan for Climate Change Adaptation & Disaster Risk Management 2014-2018

Awareness and Capacity Building

The success of climate change initiatives including JNAP implementation in RMI will rely heavily on the ownership and support it receives not only from within the Marshall Islands Government but also from all sectors and levels of the community. This ownership and support is envisaged to be made possible through a mechanism that provides on-going and focused awareness and understanding on the critical nature of climate change adaptation, mitigation and disaster risk management to the longer-term sustainable development of Marshall Islands. In concert with awareness raising, there will continue to be a need to upgrade knowledge and skills for risk reduction.

As part of the GCCA:PSIS project, several kinds of training have been delivered in RMI which include: proposal preparation and log frame analysis ; Sub-regional North Pacific climate change and the media training; Sub-regional North Pacific training on utilising the Pacific Climate Change Portal and First National Climate Change Dialogue - September 2014.

The Pacific Islands Climate Education Partnership (PCEP), ongoing since 2011, educates students and citizens across the United States-affiliated Pacific Islands including RMI about the urgency of climate change impacts in ways that exemplify modern science and honour indigenous cultures and environmental knowledge so that students and citizens within the region will have the knowledge and skills to improve understandings of climate change and adapt to its impacts.

The Schools of the Pacific Rainfall Climate Experiment (SPaRCE) programme is increasing awareness of the younger generations on global environmental issues, such as climate change. Training and educational initiatives: students in the RMI are being educated with hands-on experience on an important environmental subject, climate change, by involving them in the data collection of rainfall.

According to JNAP and other relevant sector policies, an effective awareness raising and capacity building is therefore required to ensure the goals, objectives and activities within the climate change sector are understood by stakeholders from local to national levels. Some of the key activities envisaged include: bridging the gap between national and local levels, with a combination of awareness raising, education, and participatory engagement of local government and civil society in the process; inclusion of disasters risk reduction, climate change adaptation and mitigation in education and development of a strategy for effective capacity building to sustain risk reduction and to be resilient.

Further education and awareness regarding current and projected climate variability and change and associated risks are required, e.g. integrating climate change into formal education curricula, and community awareness programs. This needs to be implemented through a planned process, moving away from ad hoc approaches.

According to the RMI's SIDS 2014 report, in order to ensure that progress toward sustainable development is achieved, the RMI Government is focusing on setting priorities linked to measurable targets, developing partnerships, and allocating adequate resources to various sectors. In addition, there is recognition that voices at the local level need not only inform, but also drive sustainable development as much as possible.

The NSP links goals and objectives with measurable targets and indicators that are locally tailored and, at the same time, cognizant of international benchmarks. With a national plan tied to benchmarks in place, the RMI and its development partners will be able to engage in meaningful collaborations tied to measurable outcomes. Better coordination and integration of assistance, particularly compact funding, into national, regional and cross-regional strategies can thus be achieved. Partnerships are key to development, but partnerships and the assistance they can bring must be coordinated to maximize their impact. It should also be underscored that "bottom-up" approaches and mechanisms must be adopted to ensure that progress is made where is counts the most: the local level.

The key priorities that the RMI wants included in discussions of the post-2015 agenda include:

Enabling environment - Progress toward sustainable development depends on strengthened management systems that are attuned to local needs, are data-driven and have measurable outcomes. Local, national and international stakeholders must each work more closely to find and forge solutions for effective delivery of services and assistance.

Climate change - Climate change is a truly cross-cutting issue for the RMI and the Pacific as a whole. It is impossible to talk about development in the Pacific without considering the impact of climate change, which is an existential issue for many countries, particularly atoll states like RMI.

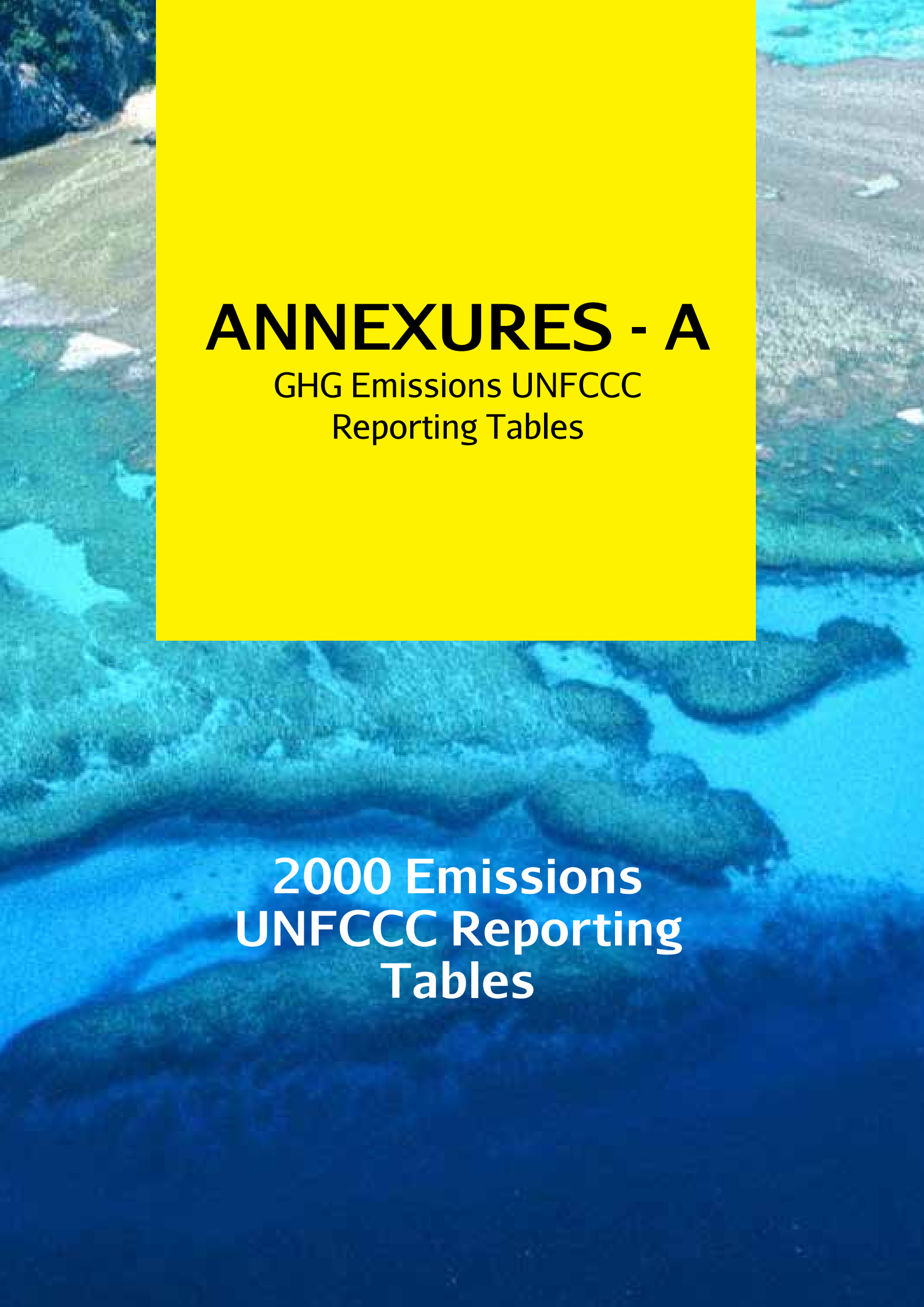
Fisheries/Oceans/Coastal Management - Ocean-based resource management (the so-called Blue Economy) is absolutely critical to development in the RMI and among its Pacific neighbors.

Education - The RMI cannot implement solutions to its problems if it does not have the human resources or capacity. The quality of education (rather than simply quantity) should be emphasized.

Health - The explosion in rates of NCDS represents a health crisis for the RMI and others in the Pacific. Health care systems must be strengthened to respond to this crisis as well as other concerns.

ANNEXURES - A

GHG Emissions UNFCCC
Reporting Tables



2000 Emissions UNFCCC Reporting Tables

UNFCCC Reporting Table 1: RMI's National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors (2000)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	80.92266	NE	1.88502	0.00651	0.36723	4.00255	0.58765	0.15055
1 Energy	80.92266	NE	0.15375	0.00263	0.36723	4.00255	0.58765	0.15055
A Fuel Combustion (Sectoral Approach)	80.92266		0.15375	0.00263	0.36723	4.00255	0.58765	0.15055
1 Energy Industries	62.72573		0.00258	0.00052	0.17184	0.01289	0.00430	0.06487
2 Manufacturing Industries and Construction	0.00000		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3 Transport	15.79833		0.00395	0.00014	0.14287	1.54121	0.28945	0.00748
4 Other Sectors	2.39859		0.14722	0.00198	0.05253	2.44845	0.29391	0.07820
5 Other (please specify)	0.00000		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO
1 Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO
2 Industrial Processes								
A Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO
B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO
C Metal Production	NO	NO	NO	NO	NO	NO	NO	NO
D Other Production	NE	NE	NE	NE	NE	NE	NE	NE
E Production of Halocarbons and Sulphur	NO	NO	NO	NO	NO	NO	NO	NO
Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
F Consumption of Halocarbons and Sulphur	NO	NO	NO	NO	NO	NO	NE	NO
Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
G Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
3 Solvent and Other Product Use	NO	NO	NO	NO	NO	NO	NE	NO
4 Agriculture	NE	NE	NE	NE	NE	NE	NE	NE
A Enteric Fermentation	NE	NE	NE	NE	NE	NE	NE	NE

B Manure Management	NE	NE	NE	NE	NE	NE	NE	NE
C Rice Cultivation	NE	NE	NE	NE	NE	NE	NE	NE
D Agricultural Soils	NE	NE	NE	NE	NE	NE	NE	NE
E Prescribed Burning of Savannas	NE	NE	NE	NE	NE	NE	NE	NE
F Field Burning of Agricultural Residues	NE	NE	NE	NE	NE	NE	NE	NE
G Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE
5 Land-Use Change & Forestry [(2)]	NE	NE	NE	NE	NE	NE	NE	NE
A Changes in Forest and Other Woody	NE	NE	NE	NE	NE	NE	NE	NE
Biomass Stocks	NE	NE	NE	NE	NE	NE	NE	NE
B Forest and Grassland Conversion	NE	NE	NE	NE	NE	NE	NE	NE
C Abandonment of Managed Lands	NE	NE	NE	NE	NE	NE	NE	NE
D CO_2 Emissions and Removals from	NE	NE	NE	NE	NE	NE	NE	NE
Soil	NE	NE	NE	NE	NE	NE	NE	NE
E Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
6 Waste			1.73127	0.00388	NO	NO	NO	NO
A Solid Waste Disposal on Land	NO		1.20908	NE	NO	NO	NO	NO
B Wastewater Handling	NO		0.52219	0.00388	NO	NO	NO	NO
C Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE
D Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
7 Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items								
International Bunkers	72.8701		0.0005	0.0021	0.3088	0.1029	0.0515	0.000013
Aviation	72.8701		0.0005	0.0021	0.3088	0.1029	0.0515	0.000013
Marine	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	52.5973							

UNFCCC Table 2. RMI's National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF6 (2000)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs	PFCs	SF6
Total National Emissions and Removals			
1 Energy			
A Fuel Combustion (Sectoral Approach)	NO	NO	NO
1 Energy Industries	NO	NO	NO
2 Manufacturing Industries and	NO	NO	NO
Construction	NO	NO	NO
3 Transport	NO	NO	NO
4 Other Sectors	NO	NO	NO
5 Other (please specify)	NO	NO	NO
B Fugitive Emissions from Fuels	NO	NO	NO
1 Solid Fuels	NO	NO	NO
2 Oil and Natural Gas	NO	NO	NO
2 Industrial Processes			
A Mineral Products	NE	NE	NE
B Chemical Industry	NE	NE	NE
C Metal Production	NE	NE	NE
D Other Production	NE	NE	NE
E Production of Halocarbons and Sulphur	NE	NE	NE
Hexafluoride	NE	NE	NE
F Consumption of Halocarbons and Sulphur	NE	NE	NE
Hexafluoride	NE	NE	NE
G Other (please specify)	NE	NE	NE
3 Solvent and Other Product Use	NE	NE	NE
4 Agriculture			
A Enteric Fermentation	NO	NO	NO
B Manure Management	NO	NO	NO
C Rice Cultivation	NO	NO	NO
D Agricultural Soils	NO	NO	NO
E Prescribed Burning of Savannas	NO	NO	NO
F Field Burning of Agricultural Residues	NO	NO	NO
G Other (please specify)	NO	NO	NO

5 Land-Use Change & Forestry [(2)]			
A Changes in Forest and Other Woody	NO	NO	NO
Biomass Stocks	NO	NO	NO
B Forest and Grassland Conversion	NO	NO	NO
C Abandonment of Managed Lands	NO	NO	NO
D CO_2 Emissions and Removals from	NO	NO	NO
Soil	NO	NO	NO
E Other (please specify)	NO	NO	NO
6 Waste			
A Solid Waste Disposal on Land	NO	NO	NO
B Wastewater Handling	NO	NO	NO
C Waste Incineration	NO	NO	NO
D Other (please specify)	NO	NO	NO
7 Other (please specify)	NO	NO	NO
Memo Items			
International Bunkers			
Aviation	NO	NO	NO
Marine	NO	NO	NO
CO_2 Emissions from Biomass	NO	NO	NO

2005 Emissions UNFCCC Reporting Tables

UNFCCC Reporting Table 1: RMI's National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors (2005)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	97.65570	0.00000	1.68607	0.00653	0.43234	4.63787	0.67339	0.18257
1 Energy	97.65570	0.00000	0.18492	0.00317	0.43234	4.63787	0.67339	0.18257
A Fuel Combustion (Sectoral Approach)	97.65570		0.18492	0.00317	0.43234	4.63787	0.67339	0.18257
1 Energy Industries	77.33089		0.00318	0.00064	0.21184	0.01589	0.00530	0.07998
2 Manufacturing Industries and Construction	0.00000		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3 Transport	17.34116		0.00429	0.00015	0.15705	1.67098	0.31386	0.00833
4 Other Sectors	2.98364		0.17745	0.00239	0.06345	2.95100	0.35424	0.09427
5 Other (please specify)	0.00000		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO
1 Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO
2 Industrial Processes								
A Mineral Products	NO	NO	NO	NO	NO	NO	NE	NO
B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO
C Metal Production	NO	NO	NO	NO	NO	NO	NO	NO
D Other Production	NO	NO	NO	NO	NO	NO	NE	NO
E Production of Halocarbons and Sulphur	NO	NO	NO	NO	NO	NO	NO	NO
Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
F Consumption of Halocarbons and Sulphur	NO	NO	NO	NO	NO	NO	NE	NO
Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO

G Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
3 Solvent and Other Product Use	NO	NO	NO	NO	NO	NO	NE	NO
4 Agriculture	NE	NE	NE	NE	NE	NE	NE	NE
A Enteric Fermentation	NE	NE	NE	NE	NE	NE	NE	NE
B Manure Management	NE	NE	NE	NE	NE	NE	NE	NE
C Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO
D Agricultural Soils	NE	NE	NE	NE	NE	NE	NE	NE
E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F Field Burning of Agricultural Residues	NE	NE	NE	NE	NE	NE	NE	NE
G Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
5 Land-Use Change & Forestry [2]	NE	NE	NE	NE	NE	NE	NE	NE
A Changes in Forest and Other Woody	NE	NE	NE	NE	NE	NE	NE	NE
Biomass Stocks	NE	NE	NE	NE	NE	NE	NE	NE
B Forest and Grassland Conversion	NE	NE	NE	NE	NE	NE	NE	NE
C Abandonment of Managed Lands	NE	NE	NE	NE	NE	NE	NE	NE
D CO_2 Emissions and Removals from	NE	NE	NE	NE	NE	NE	NE	NE
Soil	NE	NE	NE	NE	NE	NE	NE	NE
E Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
6 Waste			1.50116	0.00336	0.000000	0.000000		
A Solid Waste Disposal on Land			1.04838				0.000000	
B Wastewater Handling			0.45278	0.00336				
C Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE
D Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
7 Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items								
International Bunkers	91.1580		0.0006	0.0026	0.3863	0.1288	0.0644	0.000016
Aviation	91.1580		0.0006	0.0026	0.3863	0.1288	0.0644	0.000016
Marine	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	63.3924							

UNFCCC Table 2. RMI's National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF6 (2005)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs	PFCs	SF6
Total National Emissions and Removals			
1 Energy			
A Fuel Combustion (Sectoral Approach)	NO	NO	NO
1 Energy Industries	NO	NO	NO
2 Manufacturing Industries and Construction	NO	NO	NO
3 Transport	NO	NO	NO
4 Other Sectors	NO	NO	NO
5 Other (please specify)	NO	NO	NO
B Fugitive Emissions from Fuels	NO	NO	NO
1 Solid Fuels	NO	NO	NO
2 Oil and Natural Gas	NO	NO	NO
2 Industrial Processes			
A Mineral Products	NE	NE	NE
B Chemical Industry	NE	NE	NE
C Metal Production	NE	NE	NE
D Other Production	NE	NE	NE
E Production of Halocarbons and Sulphur Hexafluoride	NE	NE	NE
F Consumption of Halocarbons and Sulphur Hexafluoride	NE	NE	NE
G Other (please specify)	NE	NE	NE
3 Solvent and Other Product Use	NE	NE	NE
4 Agriculture			
A Enteric Fermentation	NO	NO	NO
B Manure Management	NO	NO	NO
C Rice Cultivation	NO	NO	NO
D Agricultural Soils	NO	NO	NO
E Prescribed Burning of Savannas	NO	NO	NO
F Field Burning of Agricultural Residues	NO	NO	NO
G Other (please specify)	NO	NO	NO

5 Land-Use Change & Forestry [2]			
A Changes in Forest and Other Woody Biomass Stocks	NO	NO	NO
B Forest and Grassland Conversion	NO	NO	NO
C Abandonment of Managed Lands	NO	NO	NO
D CO_2 Emissions and Removals from Soil	NO	NO	NO
E Other (please specify)	NO	NO	NO
6 Waste			
A Solid Waste Disposal on Land	NO	NO	NO
B Wastewater Handling	NO	NO	NO
C Waste Incineration	NO	NO	NO
D Other (please specify)	NO	NO	NO
7 Other (please specify)	NO	NO	NO
Memo Items			
International Bunkers			
Aviation	NO	NO	NO
Marine	NO	NO	NO
CO_2 Emissions from Biomass	NO	NO	NO

2010 Emissions UNFCCC Reporting Tables

UNFCCC Reporting Table 1: RMI's National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors (2010)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	124.93789	NE	2.00366	0.00905	0.58545	7.48831	1.04798	0.28294
1 Energy	124.93789	NE	0.33000	0.00530	0.58545	7.48831	1.04798	0.28294
A Fuel Combustion (Sectoral Approach)	124.93789		0.33000	0.00530	0.58545	7.48831	1.04798	0.28294
1 Energy Industries	98.46157		0.00405	0.00081	0.26973	0.02023	0.00674	0.10183
2 Manufacturing Industries and Construction	0.00000		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3 Transport	22.36766		0.00549	0.00019	0.20300	2.13586	0.40121	0.01087
4 Other Sectors	4.10866		0.32047	0.00430	0.11272	5.33222	0.64003	0.17024
5 Other (please specify)	0.00000		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO
1 Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO
2 Industrial Processes								
A Mineral Products	NO	NO	NO	NO	NO	NO	NE	NO
B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO
C Metal Production	NO	NO	NO	NO	NO	NO	NO	NO
D Other Production	NO	NO	NO	NO	NO	NO	NE	NO
E Production of Halocarbons and Sulphur	NO	NO	NO	NO	NO	NO	NO	NO
Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
F Consumption of Halocarbons and Sulphur	NO	NO	NO	NO	NO	NO	NE	NO
Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
G Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO

3 Solvent and Other Product Use	NO	NO	NO	NO	NO	NO	NE	NO
4 Agriculture	NE	NE	NE	NE	NE	NE	NE	NE
A Enteric Fermentation	NE	NE	NE	NE	NE	NE	NE	NE
B Manure Management	NE	NE	NE	NE	NE	NE	NE	NE
C Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO
D Agricultural Soils	NE	NE	NE	NE	NE	NE	NE	NE
E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F Field Burning of Agricultural Residues	NE	NE	NE	NE	NE	NE	NE	NE
G Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
5 Land-Use Change & Forestry [2]	NE	NE	NE	NE	NE	NE	NE	NE
A Changes in Forest and Other Woody	NE	NE	NE	NE	NE	NE	NE	NE
Biomass Stocks	NE	NE	NE	NE	NE	NE	NE	NE
B Forest and Grassland Conversion	NE	NE	NE	NE	NE	NE	NE	NE
C Abandonment of Managed Lands	NE	NE	NE	NE	NE	NE	NE	NE
D CO_2 Emissions and Removals from	NE	NE	NE	NE	NE	NE	NE	NE
Soil	NE	NE	NE	NE	NE	NE	NE	NE
E Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
6 Waste			1.67366	0.00375	0.000000	0.000000	0.000000	0.000000
A Solid Waste Disposal on Land			1.16885					
B Wastewater Handling			0.50481	0.00375				
C Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE
D Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
7 Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items								
International Bunkers	132.3850		0.0009	0.0037	0.5611	0.1870	0.0935	0.0000231
Aviation	132.3850		0.0009	0.0037	0.5611	0.1870	0.0935	0.0000231
Marine	NE	NE	NE	NE	NE	NE	NE	NE
CO2 Emissions from Biomass	114.5533							

UNFCCC Table 2. RMI's National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF6 (2010)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs	PFCs	SF6
Total National Emissions and Removals			
1 Energy			
A Fuel Combustion (Sectoral Approach)	NO	NO	NO
1 Energy Industries	NO	NO	NO
2 Manufacturing Industries and	NO	NO	NO
Construction	NO	NO	NO
3 Transport	NO	NO	NO
4 Other Sectors	NO	NO	NO
5 Other (please specify)	NO	NO	NO
B Fugitive Emissions from Fuels	NO	NO	NO
1 Solid Fuels	NO	NO	NO
2 Oil and Natural Gas	NO	NO	NO
2 Industrial Processes			
A Mineral Products	NE	NE	NE
B Chemical Industry	NE	NE	NE
C Metal Production	NE	NE	NE
D Other Production	NE	NE	NE
E Production of Halocarbons and Sulphur	NE	NE	NE
Hexafluoride	NE	NE	NE
F Consumption of Halocarbons and Sulphur	NE	NE	NE
Hexafluoride	NE	NE	NE
G Other (please specify)	NE	NE	NE
3 Solvent and Other Product Use	NE	NE	NE
4 Agriculture			
A Enteric Fermentation	NO	NO	NO
B Manure Management	NO	NO	NO
C Rice Cultivation	NO	NO	NO
D Agricultural Soils	NO	NO	NO
E Prescribed Burning of Savannas	NO	NO	NO
F Field Burning of Agricultural Residues	NO	NO	NO
G Other (please specify)	NO	NO	NO

5 Land-Use Change & Forestry [(2)]			
A Changes in Forest and Other Woody	NO	NO	NO
Biomass Stocks	NO	NO	NO
B Forest and Grassland Conversion	NO	NO	NO
C Abandonment of Managed Landsi	NO	NO	NO
D CO_2 Emissions and Removals from	NO	NO	NO
Soil	NO	NO	NO
E Other (please specify)	NO	NO	NO
6 Waste			
A Solid Waste Disposal on Land	NO	NO	NO
B Wastewater Handling	NO	NO	NO
C Waste Incineration	NO	NO	NO
D Other (please specify)	NO	NO	NO
7 Other (please specify)	NO	NO	NO
Memo Items			
International Bunkers			
Aviation	NO	NO	NO
Marine	NO	NO	NO
CO_2 Emissions from Biomass	NO	NO	NO

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