Maldives Climate Change In-Depth Technology Needs Assessment - Energy Sector

Ministry of Environment, Energy and Water
Republic of Maldives

Submitted by:

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CONTENTS

ACRONYMS AND ABBREVIATIONS

DFO	Diesel Fuel Oil
EONCON	Energy Conservation
GHG	Green House Gases
MoAD	Ministry of Atolls Development
MEEW	Ministry of Environment, Energy and Water
MoFT	Ministry of Finance and Treasury
MPND	Ministry of Planning and National Development
SIDS	Small Island Developing States
STELCO	State Electric Company Ltd
TNA	Technology Needs Assessment

PREAMBLE

In the Maldives energy usage has been concentrated in Male'. It is believed in the absence of an integrated planning approach for the electricity sector, the peak electricity demand in Male' is likely to double in the next 7 years, requiring major investments, incurring high operating costs associated with the imported fossil fuels, and contributing to local and global GHG emission. Climate change associated with GHG emissions coupled with the realisation that the world oil reserves will run out has given strong impetus for the Government to explore alternative energy sources while putting strong emphasis on energy conservation.

Maldives is blessed with abundant renewable energy resources. But the ongoing energy programmes in Maldives have a substantial focus on electricity generation through diesel-run generators. As a result, little attention is given to promoting renewable energy for enabling decentralized access to remote islands to meet their energy needs. Thus, starved of funds, most renewable energy technology programmes have not advanced beyond the pilot stage.

The past energy conservation, efficiency and renewable energy technology programmes failed to have any continuity because the financing mechanism in place for such projects solely depended on donor assistance. This is complete contrast with the country's stated policy that includes commitments to reduce dependency on imported fuel by exploring sustainable energy sources in the country. It was also observed specific regulatory interventions and awareness programmes for the introduction of the renewable energy and energy conservation had been mission or inadequate.

Since electricity is considered a basic necessity, under pressure for quick results, the past electrification policy in Maldives had ignored system optimization by ignoring the promotion of efficient technologies. As a result of these inefficiencies coupled with high oil prices, power providers including STELCO are finding it increasingly difficult to supply power without Government subsidy. However, there is no transparent subsidy mechanism in place. This acts as a major deterrent for the new entrants. Thus, putting more pressure on the Government, as provision of electricity has become exclusive responsibility of the Government, while it does not have the funds and technical expertise to provide and manage power infrastructure in all islands.

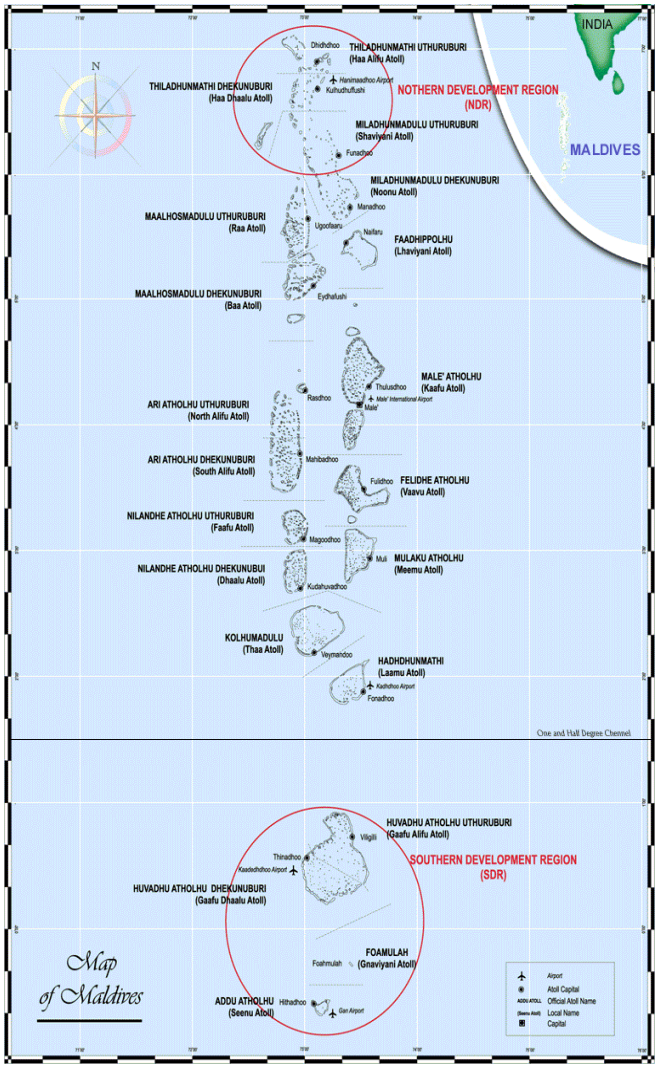
It is understood to bring continuity and much needed optimism into the energy programmes including energy conservation and renewable energy technology programmes certain prerequisites conditions had to be in place. Firstly, a market conducive for private sector participation need to flourish. Secondly, a financing mechanism for projects had to be in place one which is not dependent on donor funds. Therefore, it is recommended to establish an Energy Conservation Fund (ENCON) fund to play a proactive role in taking these project beyond the feasibility studies and pilot projects.

1. INTRODUCTION

This paper identifies the priority technologies, policies and options that the Maldives could implement in the energy sector to reduce Green House Gas (GHG) emissions to enhance the ability to adapt to climate change in order to achieve sustainable development.

As a small country composed of 1,190 tiny islands dotting the Indian Ocean, the Maldives is among the most vulnerable and least defensible countries to the projected impact of climate change and associated sea level rise. Maldives was the first to sign the Kyoto Protocol and ratify it in 1998. The country is a party to the United Nations Framework Convention on Climate Change (UNFCCC). As a non-Annex I party to the UNFCCC, Maldives is not obliged to implement GHG measures but the current national environmental policies are based on the need to take an integrated approach to environmental management and to work towards the goal of sustainable development. The 1190 islands that make up the Republic are grouped into 26 natural atolls that together form a chain 820km in length and 130km in its widest point, set in an area of more than 90,000km2 of the Indian Ocean.

According to the census conducted by Ministry of Planning and National Development in 2006, the total population of the Maldives had reached 300,000. This is growing at 1.96% annually. The entire population is distributed among 200 inhabited islands. Malé is the urban centre and the capital of Maldives, where over a quarter of the country's population resides.



In the Maldives there are about 20 islands that have a population of more than 2000, 50 islands between 1000-2000, 80 islands less than 1000, but more than 500, and 50 islands with a population less than 500. In addition to these 200 inhabited islands, additional 100 islands have been developed exclusively as tourist resorts. A one-resort-per-island policy separates guests from locals and from other tourists, giving a sense of isolation that is one of the Maldives' main selling points.

Central to this strategy is that each island is self-sufficient, generating power, waste management and water supply. Because of this geographical distribution each island has their independent power houses and electricity distribution networks.

In the context of energy, dependence on imported fossil fuel remains a major issue. This overwhelming dependence poses two major credible threats for the sustainable development. Firstly, this high dependence puts the security of energy supply at a risk. It is unlikely the world oil prices will go down because of the realisation that the world oil reserves will run out in a near future. The high and volatile oil prices have already started creating serious economic and financial difficulties for the Maldives. Secondly, the vast majority of the world's leading scientific experts agree that GHG affect climate by increasing the "greenhouse effect." Activities such as the burning of fossil fuels are increasing the greenhouse gases in the Earth's atmosphere and accelerating global climate change.

Climate change and sea-level rise have dramatic implication for coastal communities, and the increasingly intense nature of destructive weather systems will hit the islands particularly hard. There is not much that Small Island Developing State (SIDS), like Maldives can do about the energy consumed elsewhere, but the one way in which Maldives can protect themselves, or at least limit the damage, is to diversify and develop its economy by utilising the renewable energy resources at the same time putting more effort on energy conservation.

The Maldives national implementation strategy to mitigate GHG emissions and enhancing energy security encompasses both demand and supply side objectives. In the supply side, although it is expected that the country will rely on imported fossil fuel for most of its energy needs in the coming years, renewable energy sources, such as solar, wind and biomass are recognised as potential energy alternatives and can supplant part of the imported conventional energy forms and work towards the goal of sustainable development. However, experience has shown a mere focus on introduction of renewable energy technologies along will not lead to energy security. It has to go hand in hand with energy conservation and energy efficiency programme.

Identified demand side actions include promoting energy efficiency and conservation through standards, regulations, pricing policies and public awareness; enhancing the use of energy efficient technologies and efficiency of present technologies; and promoting environment friendly technologies for household, industrial and business appliances. Activities identified in the supply side include introducing more efficient technologies in energy production, and converting conventional sources of energy to more environment friendly sources, in electricity generation.

2. THE MALDIVES ENERGY SECTOR

2.1 Energy in the Maldives

The Maldives almost entirely dependent on petroleum fuels for power generation, transportation, lighting and food preparation. These include diesel fuel oil (DFO), gasoline, aviation fuel, kerosene and LPG. DFO is used mainly for power generation. Together with gasoline, DFO is also used as fuel for automobiles and marine outboard engines in the transportation sector. It is also consumed by ocean-going ships calling at Male'. Most urban households use LPG and kerosene for cooking. In the outer islands, the main source of energy for domestic purposes has been biomass. But recently more outer island households have started using kerosene and LPG for cooking instead of biomass materials. The energy supply mix in the country is as follows:

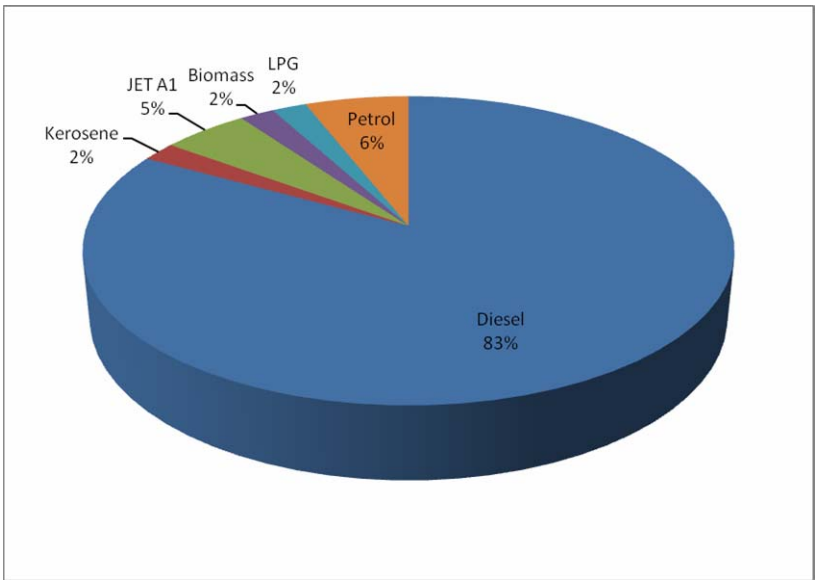


FIGURE 1: Total Final Energy Consumption by Energy Carriers, (Source: MEEW, National Energy Policy)

As depicted in the graph the dominant final use of energy is diesel primarily for fishing and sea-based transport to and from inhabited islands and resorts.

The import of diesel in 2005 is 178,109 metric tonnes. The import is diesel is growing at a rate of 20% per annum.

Diesel				
	2003	**2004**	**2005**	
Import	165,233	202,530	178,109	Metric Tonne
Export	20,394	16,169	16,743	Metric Tonne

TABLE 1: Import of Diesel 2002-2005, (Source: MEEW, National Energy Policy)

Almost 56% of the diesel oil used for electricity production is used in the resorts, 29% is used for electricity production by STELCO, and the remaining 15% is used in the islands and for industrial purposes.

Rising world oil prices in the mid-2000s have added to the burden of imports and have the potential to be a serious constraint on future growth. The oil prices in the local market have increased tremendously over the past few years. Diesel prices have gone

up by approximately 80% with the period January 2003 – October 2005, while Kerosene prices have gone up by 84% during the period April 2002 – October 2005. Additionally, the petroleum prices have also increased by 68% during January 2002 (UNDP, 2005)

The extreme dependence on fuel oil has been both expensive (Maldives must accept whatever price changes occur in the market) and detrimental to both the balance of trade and the balance of payments.

Increases in the use of air conditioning in recent years and the number of modern multi-story buildings have added further to the increasing demand for electricity and thereby to the demand for fuel oil.

2.2 Electricity in the Maldives

The most significant energy conversion process is converting diesel to electricity. According to MEEW close to a 100% of the population is provided with 24 hour electricity produced by diesel generators. The electricity production is decentralised, and based on production units of various size. For the purpose of National Energy Balance complied by MEEW, the supply of electricity has been divided into the following major segments:

a) STELCO operation of power systems in Male and Vilingili, Hulhumale'
b) STELCO operation in 21 other islands in the Atolls
c) Power system in Hulhule International Airport
d) Islands covered by other public or private operators in the Atolls (Non-TELCO Atolls)
e) Power production (auto-production) in the desalination plants
f) Electricity production in industries (auto-producers)
g) Electricity production in tourist resorts

Reliable and consistent data on electricity generation and consumption in the Maldives are limited to that of STELCO power plants, which collectively account for about a little more than a third (34.9%) of the total installed power generation capacity of the country.

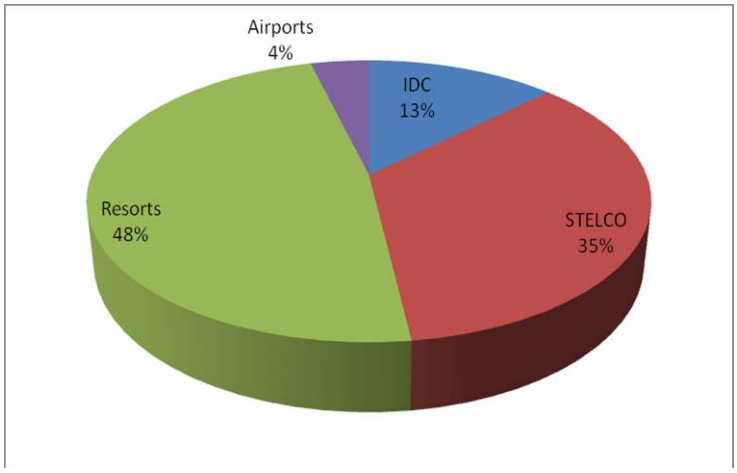


FIGURE 2: Total Installed Capacity of the Country, (Source: MEEW, National Energy Policy)

The total installed power generation capacity in the country is 106.2 MW, bulk of which, are in the resort islands (48.3%). Those in the outer islands operated by the Island Development Committee (IDC)s and some private generators account for 13.2% of the total power generation capacity. The rest are those installed in airports (3.5%).

With the exception of tourists resorts, energy use has been concentrated in Male' and at the International Airport in Hulhule. The success of improving energy access is shown by the fact that the percentage of the national population with access to electricity has gone from two-thirds with access 100% with access in less than a decade. Few smaller and more isolated islands have less then 24-hour access, but a majority of Maldivians now live in locations with 24 hour electricity.

The electricity sector of the capital island of Malé has witnessed an annual double-digit growth over the last decade, with an accompanying increase in the maximum power demand. The annual average growth rate is expected to rise at an annual rate of 12% percent up to 2010, mainly due to the construction boom in Malé and the rapid growth

in the ownership of household and office electrical appliances. In the absence of an integrated planning approach for the electricity sector, the peak electricity demand is likely to double from in the next 7 years, requiring major investments, incurring high operating costs associated with the imported fossil fuels, and contributing to local and global GHG emission (SMILES, 2005)

2.2.1 Expansion of Energy Services within the Atolls

In the Maldives, the Government has found it difficult to develop adequate power infrastructure in all the 200 inhabited islands. The development of the energy sector in the islands has been hampered by the physical smallness of the vast majority of inhabited islands which create a system of "minigrids," not one national power grid. Islands have their independent power houses and electricity distribution networks.

The power supply systems in most of the outer islands have been developed on an adhoc basis and unprofessionally by the island communities with some form of assistance from the Government. These systems, although appeared adequate at the time are no longer suitable for the island communities with the increase in demand for electricity.

FIGURE 3: STELCO Power Plant in Male', (Source: MEEW)

FIGURE 4: A Powerhouse Managed by IDC, (Source: MEEW)

The cost of electricity generation is relatively high compared to other developing countries in the region because of transportation costs, small-scale generating systems and low-density, scattered populations and total dependence on imported expensive fossil fuels. Additionaly, one constraint for the affordability of electricity services was the setting up of inappropriate schemes, either through the non-use of low cost options or through the use of schemes that did not serve the priority need of the majority of the population. For instance, under pressure for quick results, the electrification policy in Maldives had ignored system optimization by ignoring the promotion of efficient technologies when it is proven that in long run system optimization could reduce both supply and consumption costs.

Because of equity considerations, and due to the inability to achieve cost-recovery for electricity through tariffs, it was felt subsidy is inescapable fact of life. In many instances, the past subsidy schemes created perverse incentives leading to an inefficient use of scarce public resources. Inefficient operation of utilities for electricity provision had led to misallocation of about MRF 155 Million in 2006 alone.

In addition to this in since June 2006 – to June 2007 Government had give given about MRF 25 Million worth of assistance to island communities to sustain their power systems.

Following Tsunami Maldives has received assistance for power system rehabilitation projects from the following agencies. 4 Islands are being developed under Asian Development Bank (ADB)'s Tsunami Emergency Assistance Project (TEAP), 5 Islands already being developed under Japanese Government Grant Aid, and 6 Islands are being developed under United Sates Aid for International Development (USAID). In addition to this tsunami related assistance, one of the most ambitious power sector development project is underway loan assistance from Asian Development Bank (ADB)'s Outer Island Electrification Project (OIEP). This project include electrification of 40 islands of the by the year 2009.

FIGURE 5: New Generator Sets Installed under the Project, (Source: MEEW/OIEP)

FIGURE 6: Excavation of Trenches for Laying New Distribution Network, (Source: MEEW/OIEP)

FIGURE 7: New Powerhouses Constructed under the Project, (Source: MEEW/OIEP)

FIGURE 8: New Fuel Storage Systems Developed Under the Project, (Source: MEEW/OIEP)

The successful completion of these projects will help to alleviate some burden on the government but the majority of the outer islands will still be left without proper power supply system. Even though this huge investment would make life lot easier for the island communities in terms of capital investment but the operational cost would still

remain as major burden on the power providers as wells as the Government since the systems provided are completely dependent on diesel fuel.

Recent studies conducted by MEEW have confirmed the generator sets in some islands are oversized or are undersized and there exist technical and non technical losses which could be minimised to a great extent. A resource assessment survey has also found that renewable energy technologies can be a viable option for the smaller remote islands. Therefore, a structured system optimisation programme has to be devised to make current systems more efficient and sustainable.

The disparities in tariff among the urban and rural islands are also a growing concern. It was felt the people who could least afford pay a higher tariff for power. This causes equity problems and various other social issues which has almost become a high political burden on the Government. Tariff harmonisation has become a priority but because of its complexities no studies has yet been commissioned to address this important issue.

To partly address these issues, the recently formulated National Energy Policy calls for the greater involvement of private sector in the provision of power to island communities. In line with this policy, the Government has opened the market for private parties to bid for provision of electricity in the Islands. Despite this move, it is now understood private parties would not invest in smaller islands where they cannot find sufficient market.

Government policy has now been made clearer and it's widely accepted within the government that it is not practical to provide large social infrastructure investments to such small population. "Focus islands" are being identified where a core set of public services, such as education and health, will be provided. In addition, economic infrastructure in the forms of telecommunications, energy, harbour and harbour support activities will be financed for such locations. Government also is providing significant resettlement investments in the form of homes and even shops for those who move to more central locations.

It is envisaged this policy would have direct implication for the provision of electricity to the islands in future. Population reconsolidation would allow for greater efficiency in electrical generation and use.

2.3 Electricity Provision with Renewable Energy Technology

Maldives is blessed with abundant renewable energy resources, but depends overwhelmingly on petroleum imports for their electricity generation. This creates serious economic and financial difficulties and puts the security of energy supply at risk.

There is an urgent need to look for alternatives to slow down the need for expanding the power generating capacity and importing greater quantity of fossil fuels. There is a clear potential for using renewable energy sources such as solar energy, wind energy and biomass.

Developing appropriate measures now will secure the constant supply of energy and serve the long term goal of reducing GHG emissions and improving the standard of living of the Maldivians.

2.3.1 Renewable Energy Resource Assessments

The following gives resources assessment study presented in the National Energy Policy.

2.3.1.1 Biomass

FIGURE 9: Landfill at Thilafushi- a Source of Power, (Source: MEEW)

The total accessible biomass potential resource has been established as almost 20,000 toe. If the difficult-to-access resource at the un-inhabited islands is left out, then the remaining resource potential is equivalent to 10-15% of the primary energy requirement.

The present utilization represents 4,626 toe, which is 24% of the known and accessible potential, or 2-4% of the total primary energy requirement in the Maldives. It is only the solid agro / wood fuel type of waste and biomass which is presently used. This represents an easy accessible resource, which could be further utilized. The second easy accessible resource is related to the landfill at Thilafushi, where solid waste and household waste is burnt in open air, providing an unnecessary air pollution and energy waste.

A source of biomass material is municipal solid waste. According to the Municipality Waste Management Section in Male', the typical composition of municipal solid waste is: paper and cardboard (33%); kitchen waste (15%), and construction waste (industrial/scraps) (52%). About 15% of the construction waste is wood. Daily solid

waste generation in Male's is on the average 140 tons. Biodegradable waste (mainly food waste) is about 25 tons/day.

The solid waste is sorted prior to transporting to the island of Thilafushi. Only the biodegradable and combustible materials (i.e., organic) are dumped in the pits. The combustible materials are burned first before the ashes (plus unburned matter) are dumped into the pit. The landfill area is already 10 years old. Previously it was just a reef and now it has now a reclaimed area of 100,000 m2. Some industries now exist in the area such as a cement packing plant and a LPG refilling plant. Landfill gas from the area can be recovered and utilized for power and heat generation for use by the industries located in the area.

Planting of energy crops and trees is also a possibility especially in islands that are of marginal values and are suitable for these plants for energy purposes. Coconuts, sugar cane, oil palm and other similar crops can provide steady source of biomass-derived fuels or bio-fuels that are already proven and accepted in the market as substitute for diesel oil and ethanol for gasoline. At present there is no estimate of potential for this bio-fuels sourced from planting these trees and crops in the Maldives.

2.3.1.2 Wind

FIGURE 9: Maldives Enjoys Wind Speeds Sufficient for Power Generation, (Source: MEEW, National Energy Policy)

The GIS data, made by National Renewable Energy Laboratory (NREL) of United States of America, indicate 3 wind zones on the Maldives, South, Middle and North. The highest annual average wind speed should be in the upper middle of the Maldives 4.5 ºN to 6.5 ºN, from the GIS measurements the annual average wind speed in this region should be 6.5 to 6.7 m/s measured at 50 m height. There is a tendency that maximum wind speeds occur at night. The Northeastern monsoon is weaker than the Northwestern monsoon.

Results of measurements of wind speed and direction in potential sites have been evaluated which indicate that the wind energy potential could be at the range that can be tapped for power generation purposes.

2.3.1.3 Solar

FIGURE 10: Maldives Enjoys Sun throughout the Year Sufficient for Power Generation

The annual global radiation is 2,054 kWh/m². The direct solar radiation at the airport in Hulhule, measured during 3-month period (September-November 2004), has a peak close to 1,000 W/m^2, and the annual daily average is around 200 W/m2. Tapping this potential energy depends on the application to be used which could either be for solar heating or solar photovoltaic (PV) power generation. The term solar heating is normally referred to heaters used for production of hot water, but also heaters used for drying of wood and heaters for drying of fish, meat and fruit are in operation in different parts of the world. On the other hand, for instance, typical design parameters for solar PV systems for small island communities would need around 3.5 m^2 of PV for each household.

2.3.2 Renewable Energy Technology Applications in Maldives

The ongoing energy programmes in Maldives have a substantial focus on electricity generation through diesel-run generators. As a result, little attention is given to promoting renewable energy for enabling decentralized access to islands to meet their energy needs. Thus, starved of funds, most RET programmes have not advanced beyond the pilot stage. This is complete contrast with the country's stated policy that includes commitments to reduce dependency on imported fuel by exploring sustainable energy sources in the country.

According to various national policy statements it appears Government is committed to promoting sustainable energy in the country and has mandated MEEW to formulate policies and plans on for the introduction of RETs. MEEW has also been designated as focal point for RE development in the country and is now actively pursuing several inter-related initiatives to overcome the existing barriers to the widespread development and application of RETs.

There were very few activities that were carried out in the country in the past in the field of RE development and applications. Most of these were projects supported by the UNDP. These are mainly pilot projects, which test the technical viability of solar and wind energy utilization. Most programmes receive technical assistance from international bodies as the Maldives lacks a local human resource pool to meet its programme formulation and planning needs.

Although the country is expected to continue to rely on imported fuels to meet its energy needs, some RE resources are recognized as potential alternatives, being indigenously available, having minimal environmental impacts and contributing to the balanced provision of services to dispersed island communities. The potential RE applications being tested in the Maldives are:

2.3.2.1 Solar photovoltaic and wind power systems used in hybrid systems with diesel generators in the (outer) islands;

FIGURE 11: Installation of Solar-Diesel Hybrid System in Adh. Mandhoo (12kWp)

FIGURE 12: Solar-Diesel Hybrid System installed in Adh. Mandhoo

FIGURE 13: Solar PV System installed in B. Goidhoo and R. Fainu (8 kWp)

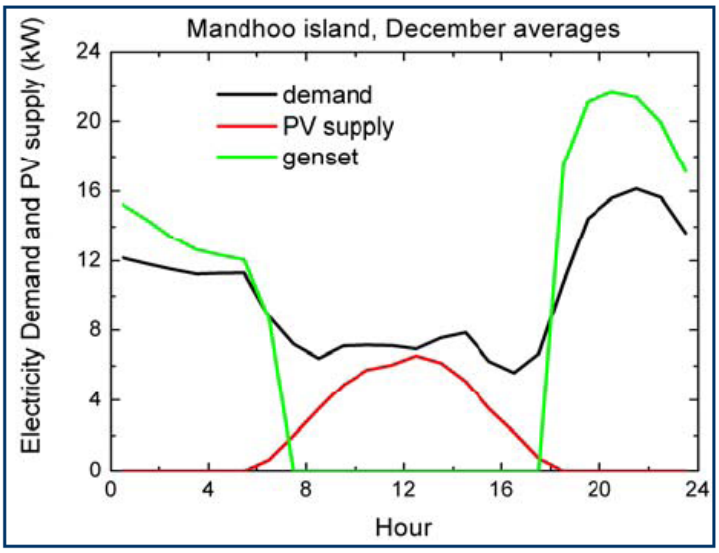
FIGURE 14: Wind Generator installed in B. Goidhoo and R. Fainu

FIGURE 15: Solar PV System in L. Gan Multipourpose building (30kWp)

FIGURE 16: Solar PV System in L. Fonadhoo office building

After reviewing a number of islands and assessing their suitability, Adh. Mandhoo, R.Fainu, B.Goidhoo Island has been selected for installing a pilot hybrid solar-wind-diesel hybrid systems. These projects will serve as an interesting learning experience for the Maldivian before setting up similar installations in future.

The solar PV system is installed in Adh. Mandhoo island is designed to supply power to the network during daytime, with the objective of avoiding the use of a diesel generator during that period and lowering the fossil fuel use. Also, since the solar system is designed to operate during the sunshine hours, the size of the storage batteries can be minimized, thus limiting the investment on batteries and their replacement costs. When the electrical demand of the island becomes quite low between midnight and early morning, there is provision to charge the batteries by using the excess capacity of the diesel generator, thus helping to improve the generator efficiency. With an average solar radiation of 5 kWh/m2 per day, the The solar PV system is sized to be 12 kWp and the total battery storage capacity is a little over 100 kWh.



Out of all these pilot projects only the Wind-Solar-Diesel Systems installed in R. Fainu is successfully operational. All other systems are lying idle and work is underway to fix the problems. But with limited technical know-how and expertise this work is moving with a slow progress.

2.3.2.2 Landfill gas recovery and utilization in the island of Thilafushi where the biologically degradable waste from Male' are disposed;

FIGURE 17: Landfill gas recovery plant construction

FIGURE 18: Landfill gas recovery plant

At the moment, the only realistic application is at the Thilafushi landfill site. Feasibility studies conducted by MEEW shows that the landfill gas site project is financial viable and may be implemented without subsidies. This depends largely in the sustained annual gas yield from the landfill gas system to fuel the operation of gas engine/genset producing both electricity and heat. The co-generation of heat and electricity could be utilized for industrial purposes. However, after some experimentation this project was abandoned because of lack of technical capacity and financial constraints.

2.3.2.3 Possible use of household or village bio-digesters to produce biogas out of kitchen waste and other agricultural waste; and,

FIGURE 19: Bio-digester plant in operation in Thilafushi

FIGURE 20: Bio-digester plant manufactured by GFF in Thilafushi

The potential use of household biogas digesters could be concentrated on smaller islands – i.e. islands with less than 2,000 inhabitants. The reason for this is that such a

system requires space and access to organic biomass. With the technical assistance from MEEW-RETDAP Guarantee Fibre Glass has successfully manufactures and tested a bio-digester. According to their feasibility studies a digester could be able to provide enough cooking gas for a family of 6. Despite its technical and financial viability because of lack of marketing and awareness on the potential use and access to funds this project is moving a slow pace with very limited progress.

2.3.2.4 Passive solar technology in water heating, fish and crop drying, seawater desalination and other applications.

Solar powered water desalination plant capable of producing 500 liters a day would be installed in R. Fainu and B. Goidhoo. This project is implemented by MEEW. If successful this technology would be an ideal solution for the expensive RO plants run on diesel. The plant is expected to be commissioned in September 2007.

2.4 Energy Efficiency and Conservation

It is generally recognized that the energy including electricity plays a significant role in economic development mainly because it enhances the productivity of capital, labour and other factors of production. Many studies have shown that the energy consumption is positively correlated with economic growth where, for example, countries with high per capita GDP have shown to have high per capita energy consumption (Gohsh 2002, Jumbe 2004).

Electricity does not yield utility itself, but, rather, is desired as an input for other processes or activities that do yield utility. All such processes utilize a capital stock, and electricity provides the energy input. The demand for electricity is therefore a derived demand, derived from the demand for the output of the processes in question.

Energy efficiency makes perfect economic sense at user level because when an appliance is bought, the user commit to paying both the first cost and the operating cost for as long as he owns it. And over the life of an appliance, the energy cost to run it can be many times greater than the first cost. So it pays to buy an energy-efficient appliance. However, because of the lack of general awareness and the high initial cost of such appliances, Maldivian normally shy away from such products.

In the Maldives there is an acute need to look for ways to slow down the need for expanding the power generating capacity and importing greater quantity of fossil fuels. There is general consensus that the oil supply would peak soon, resulting in continued upward pressure on the energy prices. At the same time it is becoming clear that the emissions from burning fossil fuels have a strong effect on the global climate. One of these effects is the sea level rise, which is threatening the mere existence of low lying countries such as the Maldives.

Energy management initiatives can help in partially overcoming the above problems because their objective is to provide the same energy services with a lesser quantity of primary energy consumption, thus achieving three important results: slowing down the growth of fossil fuel demand, lowering of atmospheric pollution, and reducing the need for investment in new power generating capacities.

One of the most notable activities on energy management in the Maldives was conducted by the Strengthening Maldivian Initiative for a Long-Term Energy Strategy (SMILES) project implemented by the MEEW. Three energy-related topics were dealt with in order to provide support for the development of a long-term energy strategy in the Maldives. The first topic involved options to slow down the rapid growth in the electricity demand in the capital island of Malé. The second topic involved search for niche areas to introduce a wider use of renewable energy sources and reduce the dependence on commercial fossil fuels in outer islands. The third topic involved developing policies and strategies to introduce public transport in the capital island of Malé. All three studies have profound implication on energy but for the purpose of this study only the demand side management study conducted for Male' is analysed in detail.

2.4.2 The Cause of Electricity Demand in Male'

FIGURE 21: Male' Island- the Most Crowded City in the World

Development process of the Maldives took flight in the late 1970s (MPND). In the early stages of this process, much of the effort was centralised in Male' for many reasons. Male, being the capital of the Maldives hosts about quarter of the inhabitants. Male' is adjacent to Hulhule' island, the first point of contact for every visitor coming to Maldives from overseas.

For obvious reasons the scattered nature of population distribution often made investments cost-inefficient in many islands. However, Male' already had a population which gave economy of scale for vital services such as secondary education. This created the environment for people from the atolls to gradually migrate to Male' in search of these services. As more people settled in Male', commerce, and employment opportunities expanded.

The introduction of tourism in the mid-seventies and its growth has a strong bearing on this issue. The first resorts were built within easy reach of Male'. By default Male' became the ideal location which could centrally service these resorts. Hence the support services for the resorts were also centred around Male', creating more employment in and around Male'. Recent studies shows that Male' is one of the most crowded city in the world.

The recent development of Hulumalé Island in the medium-term, which will create new needs for power generation. The artificial island was reclaimed to establish a new land mass required to meet the existing and future housing, industrial and commercial development demands of the Malé region. When all things considered Male' region will remain the only true urban area in future.

2.4.3 The Growing and Uncontrolled Demand in Male'

FIGURE 22: Construction Boom of Male'- High Rise Building Creating More Demand for Electricity.

With the increase in the number of high-rise buildings in Malé, all equipped with air-conditioning, and the growing use of electrical appliances in households and commercial enterprises, the demand for electricity has been rising steeply in the recent years. In Malé, the electricity consumption crossed the 100 million kWh mark in 2003, and still continues to increase by about 11% per annum. (Mohanty, 2005).

To meet this demand plans are ready for large investments in new power generating capacities. Since 1994, Malé has been experiencing an annual average growth of 11.3%. The rate of growth in consumption is not very steady, reflecting the impact of the commissioning of various projects (construction of new offices, hospitals, etc. as well as the addition of new power generating capacities) on the level of consumption. (Mohanty 2005)

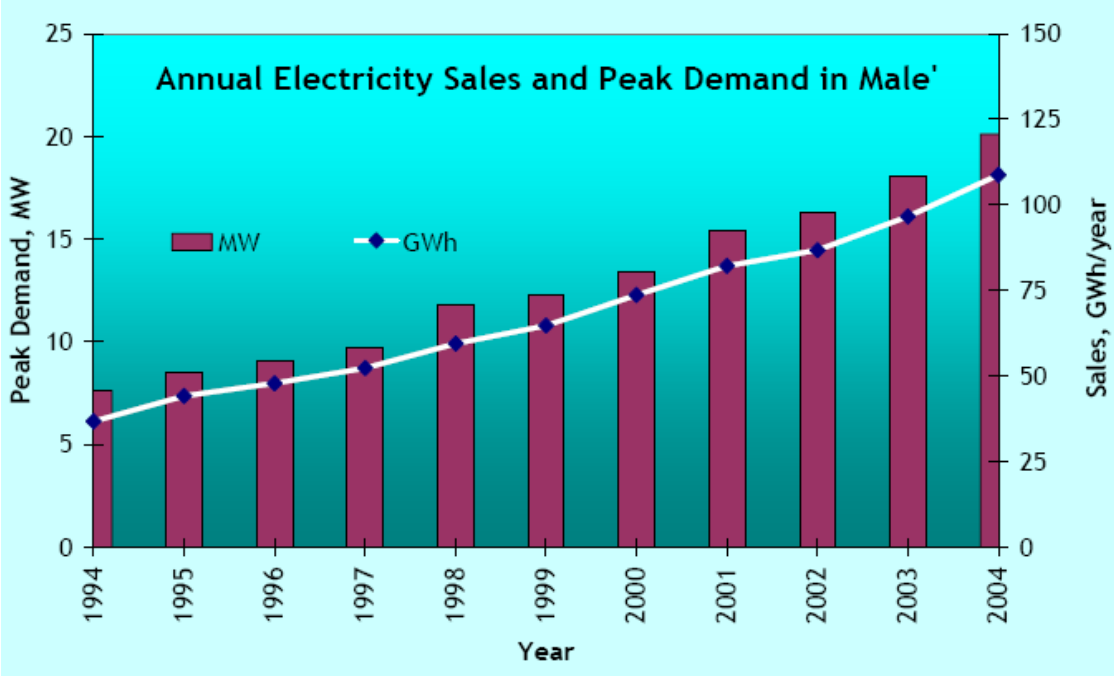


FIGURE 23: Annual Electricity Sales and Peak Demand in Male'. (Source: SMILES project DSM study)

The non-residential buildings are the principal electricity consumers, representing over 52% of the total consumption in 2003. The residential sector accounts for the remaining 48% of the total electricity consumption. Under the non-residential buildings, the highest consumers are the government buildings and those falling under the category that includes private economic activities, such as offices and trade/commerce. (SMILES, 2005)

The SMILES study also found that the growth of the electricity consumption by the different sectors is quite uneven. Among all sectors they have observed, government buildings are presently leading the way, with 36.1% growth within 4 years, providing a very strong leverage to promote activities favouring energy conservation: government should be the first to lead the way by adopting the energy efficiency policy it defines.

FIGURE 24: Air condition load contributes to the peak demand in Male' (Source: SMILES Project).

The predominance of electricity consumption in the non-residential buildings leads quite naturally to a high day peak (i.e. maximum electricity demand). As much as 84% of the peak utility demand is contributed by the non-residential sector, a great share of which can be attributed to the air conditioning loads. (See Figure 25)

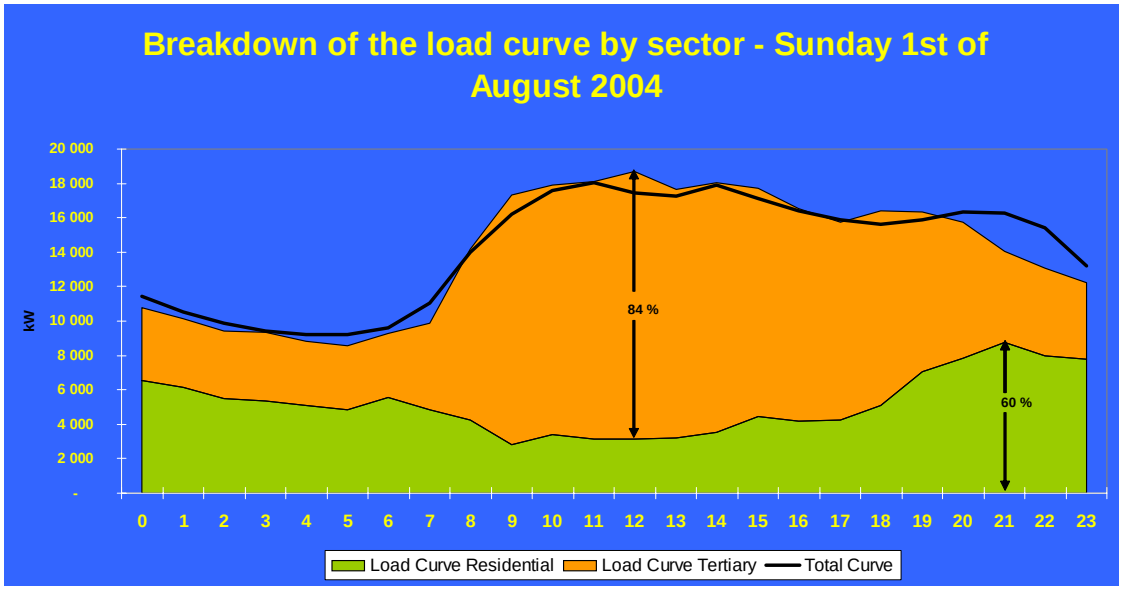


FIGURE 25: Breakdown of the Load Curve by Sector (Source: SMILES Project).

From these observations it is easy to draw parallel with other islands. It is observed even the other islands the same conditions and trends prevail but with less intensity as the high energy consuming appliances such as air conditioners are still not common in the islands. However, due to the increased demand for lighting and the penetration of more electrical appliances, the demand quickly exceeds the installed capacity and every few years, new generators are commissioned to cope with the demand. In general, the peak demand coincides with the need for lighting in the evenings; during the rest of the time, the demand is poor and the generators are being operated at low loads burning expensive fossil fuels putting economic burden at the same time contributing unnecessarily to GHG.

Due to this phenomenal growth, it is anticipated that the power requirements of Malé may reach twice the currently installed capacity within the next 5-7 years. However, possibility of expanding the power station to cater for this growth on the congested Malé island is very limited. Hence the only possible alternative is to explore the possibility of housing a power generation system off Malé that could extend the supplies to Malé and nearby islands, and make the whole system economically more viable.

FIGURE xx: Male' Urban Region (Source: Google Earth).

2.5 Impact on the Environment

The efficiency of power generation using diesel engines is quite low: around 35% of energy supplied is converted into electricity. Only a fraction of the remaining energy is used for the water desalination plant of STELCO, the majority amount being rejected to the sea and the surrounding air.

The RETDAP project implemented by the MEEW, conducted studies to understand the amount of CO2 contribution from power generation. Under the business-as-usual scenario, the annual growth rate of CO2 emissions from diesel based power generation is 7.4% (2001- 2010). In 2002, the total CO2 emission from power generation was about 199,617 tons CO2. In the RE scenario, the annual growth rate of CO2 emissions is estimated at 5.8%. Figure 26 shows the comparison of the CO2 emissions trend in the business-as-usual and RE scenario.

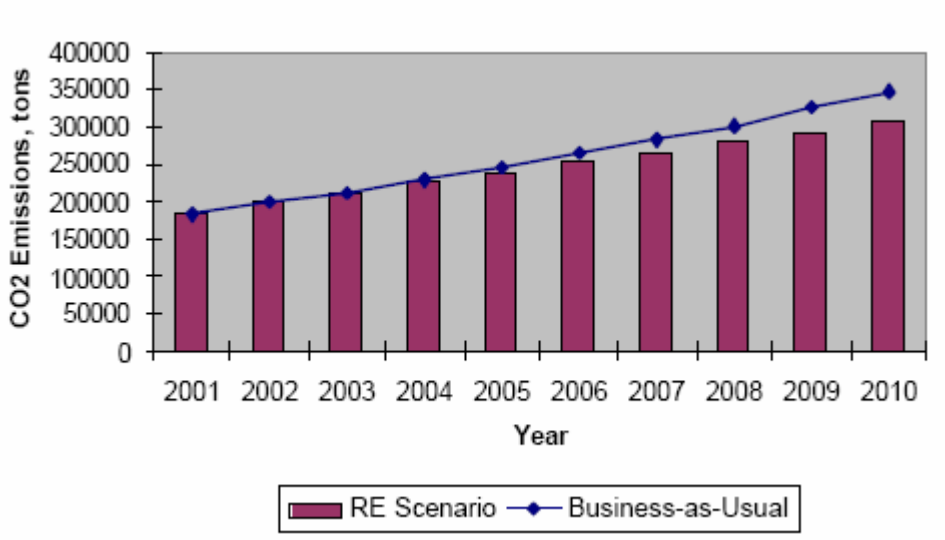


FIGURE 26: Forecast of CO2 Emission from Power Generation (Source: RETDAP).

The project document concludes the at the end of the project, when the identified barriers would have been removed (particularly the technical and economic feasibility of RE-based energy systems), a wider utilization of RE resources is expected in the country. The resulting reduction in demand in fossil fuel consumption (especially diesel generated electricity) would bring about a reduction in GHG emissions by at least an average of 2.2% per year.

The SMILES project also concluded that an adoption of an ambitious energy policy, with a dual objective of influencing the behaviour of the users (by awareness raising and sensitization, and modifying the electricity tariff structure) and taking action on the characteristics of the buildings and appliances will allow to slow down considerably the growth in energy demand between 70 and 161 GWh in terms of energy and between 13 and 37 MW in terms of electricity demand. This results in less emissions of greenhouse gases and traditional pollutants (NOx, CO, SO_2, etc.), no emissions linked with the use of the fluorocarbon refrigerants.

3. Identification of the Major Stakeholders

The major stakeholders of the energy sectors were identified as follows. There are several entities, both from the government and the private sector, whose activities are linked directly or indirectly to the energy issues. The different categories include:

i. Organizations involved with energy supply (STELCO, STO, VILLA, Private Operators and Communities in atoll islands, Tourists Resort Owners…)

ii. Agencies who are responsible for sectors/areas that create demand for energy (Ministry of Construction and Public Infrastructure, Ministry of Housing and Urban Development, Ministry of Tourism and Civil Aviation, Ministry of Atolls Development)

iii. Agencies who facilitate financing of the energy sector (Ministry of Finance and Treasury, Ministry of Atolls Administration, Bank of Maldives)

iv. Organization mandated for developing energy policy (Ministry of Environment, Energy and Water)

v. Organisation mandated to regulate energy sector (Maldives Energy Authority)

vi. Intermediaries (Maldives Chambers of Commerce and Industry, NGOs, civic societies)

The Government organizations that are considered as major stakeholders in view of their crucial role as political decision makers are covered more in detail below. The first two are the major players on the energy supply side whereas the last four are involved in creating or fuelling the energy demand.

3.1 Ministry of Environment, Energy and Water

The Ministry of Energy, Environment, and Water (MEEW) was established in July 2005 in to oversee the energy, environment and water sector. Prior to its institution, the energy sector mandate was fragmented across multiple ministries, leading to low effectiveness of the isolated attempts made by individual ministries to encourage energy efficiency and alternative energy use within the Maldives. The MEEW is assisted in its efforts by the Energy Advisory Committee (EAC).

MEEW is an important stakeholder because in addition to looking after the energy sector it is also mandated to regulate activities affecting the protection and conservation of the environment. The Ministry has experience of coordinating with a wide range of other ministries whose activities are related to the environment. The MEEW is the national focal point for both the Global Environment Facility (GEF) and the United Nations Framework Convention on Climate Change (UNFCCC).
Over the years, the MEEW has built up capacity to assess the sources of greenhouse gas emissions and to identify potential mitigation measures. Based on the conclusions of the study undertaken by the MEEW, “mitigation of GHG emissions could be based

on lowering the demand on the imported fossil fuel by increasing the efficiency in generating and utilizing energy and improving the efficiency of the transportation mechanisms". This study has also identified several appropriate energy demand side and supply side measures to mitigate greenhouse gas emissions.

3.2 Maldives Energy Authority

Besides the MEEW, the other important Government agency dealing with energy is the Maldives Electricity Bureau (MEB) recently restructured and renamed as Maldives Energy Authority (MEA). While the MEEW still formulates energy policies, the regulation of the energy sector falls under the purview of the MEA.

The MEA regulates the national electricity sector including the largest utility company, State Electric Company Ltd (STELCO). MEA is responsible for regulating the generation, distribution and utilization of electricity, including tariff setting. Though MEA has a broad mandate to regulate the electricity sector, set standards and conduct awareness programmes, its activities have been limited so far to activities of technical nature, such as setting technical standards for improving the quality of electricity supply and resolving conflicts between electricity providers and customers.

3.3 Ministry of Planning and National Development

The Ministry of Planning and National Development (MPND) has been playing a key role in developing 5-year national development plans with "an aim to move the country through sustainable economic growth and social development, while meeting the unique environmental challenges of our island communities".

The plan is formulated in co-ordination with several organizations that are engaged in economic, infrastructure and social development activities. Considering the important role of the MPND in laying down the Government's development policies and strategies, this Ministry is considered as an important stakeholder. Due to the lack of reliable data, MPND has not been able to correlate the impact of the growth in energy demand and the energy pricing on the economic development and inflation trends. Once such data are available MPND will benefit considerably from such data to improve the overall planning process.

3.4 Ministry of Finance and Treasury

On the energy supply side and demand side, the Ministry of Finance and Treasury (MoFT) is certainly an important stakeholder as three major energy players are presently affiliated to this Ministry. The State Trading Organization (STO) has traditionally been the sole importer of fossil fuels into the country. Very recently, policies have been revised to allow other entities to import fossil fuels such as diesel, gasoline, LPG, kerosene and aviation fuel. However, STO still has a very major share of the fossil fuel imports. In addition, STO has the license to import and re-export products. In addition to being the sole importer of goods for government projects and government needs, the STO is involved in importing household and commercial electrical appliances into the country.

The State Electricity Company (STELCO) affiliated to the MoFT has the mandate to find the cheapest way to produce electricity for the citizens. STELCO provides electricity round-the-clock to some 27 of the 199 inhabited islands designated by the Government, including the capital of Malé where the users are prohibited to produce electricity from their own power generators. STELCO's installed capacity is about 35% of the whole country.

The Government raises loans for STELCO to increase its generating capacity. STELCO is expected to generate profit for investors by trading, producing and distributing electricity. According to the Government guidelines, STELCO is mandated to introduce new technology to suit Maldivian environment, and produce electricity with least environmental impacts. But STELCO has so far not made any investments on generating power from renewables such as solar and wind energies. Interestingly, the STELCO is also allowed by the Government to sell by-products while producing electricity, thus opening an avenue for diversifying provision of energy services (cogeneration, for example).

Currently the Ministry of Finance is the de facto regulator of the sector and price leadership set by STELCO's prices has distorted pricing by IDCs. The Ministry of Finance has no formal regulatory methodology. There are a number of alternative approaches that need to be investigated – cost based rate of return regulation, performance based price cap regulation, light handed regulation. Serious questions remain about which agency should be administering the economic regulation of the Power Sector. Economic pricing and setting of targeted subsidies required would seem to be primarily policy and regulatory issues not ownership issues.

In the context of energy conservation MoFT can play a vital role as its responsible for approving the budget of all government ministries and other institutions which is the largest contributor to the peak demand in Male'.

3. 5 Ministry of Atolls Administration

Another important player as far as electricity supply is considered is the Ministry of Atolls Development (MoAD). Under this Ministry, the Island Development Committees (IDC) are grass root institutions for development of outer islands. With the financial assistance of the MoAD, the IDCs play an important role as suppliers of electricity to islands not covered by the STELCO systems.

While striving to satisfy the ever-increasing energy needs of the population in the outer islands, the IDC could be instrumental in creating awareness, providing advice as well as introducing suitable techniques and technologies that could help to reduce the rapid growth in energy consumption while meeting energy services needed by the population. The IDCs, however,

While the Ministry of Atolls Development plays a crucial role of ensuring adequate supply of energy to satisfy the needs of the population in the outer islands, it could also be instrumental in supporting them to adopt energy efficient approaches and practices.

3.6 Ministry of Housing and Urban Development

The Ministry of Housing and Urban Development (MHUD) has two main overall responsibilities. That is to oversee and regulate the physical development for the whole country and to facilitate housing delivery through development projects. It is also the ministry's mandate to establish and execute land development regulations for all parts of the country.

3.7 Ministry of Construction and Public Infrastructure

Ministry of Construction and Public Infrastructure (MCPI) is the government ministry responsible for the development and regulation of the construction sector of the country. It is also the agency which oversees the development of public infrastructure of the country. Hence, MCPI has a vital role in influencing energy demand.

Taking the case of Malé, one can see new structures coming up in all parts of the island. The climatic condition of the Maldives is such that in a good part of the year, comfort conditions cannot be attained by natural means due to the very high humidity combined with relatively high ambient temperature. Therefore, the new commercial constructions are systematically adopting artificial air conditioning, without considering building features for solar protection during sunshine hours or natural ventilation during periods of low temperature and humidity. MCPI has introduced codes and guidelines for buildings but so far mandatory energy efficiency measures in these buildings are missing in these guidelines and regulations.

In the case of Maldives, establishing a regulation on construction guidelines will allow to not only improve the energy performance of buildings but also limit the energy demand for air conditioning and lighting.

3.8 Ministry of Home Affairs

Though the Municipality has a reduced role, it can be a important partner to improve the management of energy use in areas such as public buildings and public lighting, thus reducing the operating costs in the process.

3.9 Ministry of Tourism and Civil Aviation

The Ministry of Tourism and Civil Aviation (MTCA) is in-charge of all aspects related to tourism development in the island. The Ministry is an important stakeholder because tourism sector is vital for the Maldivian economy while it remains at the same time very much resource-intensive. It is estimated about 60% of the energy is consumed in the resorts.

Adequate measures for environmental protection are crucial for this sector to ensure sustainable tourism. The recently formulated Tourism Master Plan has put reasonable emphasis on energy conservation measures. Tourist resorts are to greatly benefit from innovative adoption of sustainable energy and resource management techniques and

technologies such as cogeneration, renewable energy applications, water and waste management, etc. in the resort islands.

The Maldives Tourism Promotion Board can launch awareness campaigns for both the staff as well as their guests to familiarize them with resource management concepts and sensitize them about the long-term benefits of their adoption.

President of Maldives Green Resort Award is a prestigious award specially designed to the tourism industry. The award aims to generate environment consciousness and reward good practices of the resort hotels Energy conservation- Measures taken to conserve energy, such as on electricity, water, fuel etc. will assist to cut costs.

While tourism sector has no reservations in energy efficiency and conservation they have shown reservation in introducing RET in the resorts because of aesthetic reasons. Several consultative meetings with the tourism sector official including the minister have confirmed their stand.

3.10 Associations, NGOs, Civic Societies and Private Sector

Apart from the government entities, there are several major private organizations, civic societies and associations whose involvement, contribution and partnership with MEEW will help to spur the sustainable growth of the energy sector. For example, the Maldives National Chamber of Commerce and Industry (MCCI) and the Maldives Association of Tourism Industry (MATI) are strong representations of their constituents. In stead of addressing directly a large number of concerned organizations, the MEEW could interact with them closely and strengthen their capacities so that they in turn can interact effectively with their members in matters concerning energy generation and use awareness campaigns.

The larger issue is that of non-recognition of non-governmental organizations (NGOs) as potential partners in local development planning processes, and thus the failures to harness non-governmental expertise and capacities.

Public–private partnerships have been restricted to the transportation and distribution of fuel alone rather than being allowed to enhancing access, efficiency and development of energy services.

There are no collaborations of note between STELCO and IPP to expand electricity access to the other inhabited islands not covered by STELCO. At the decentralized level, local administrative bodies do not have a significant influence over energy generation and distribution.

It is disappointing to see lack of initiatives and interest from private sector for energy conservation and efficiency measures. Careful review of various literatures published by electrical goods suppliers such as SONEE Hardware shows no effort to promote energy efficient technologies. SONEE do sell OSRAM energy efficient lights, but they do not market the company as environment friendly company.

4. Evolving Policy and Regulatory Frameworks

The formation of the MEEW has initiated institutional reforms that could lead to an integrated approach to energy. The additional duties of regulating the environment and water sectors have placed the MEEW in a better position to harmonize the country's energy agenda with its sustainable development agenda. The Ministry has also been able to resolve institutional conflicts between different stakeholders to a great extent. Further, policies such as the Seventh National Development Plan (NDP) (2005–2010), the Sustainable Energy Plan (June 2004), and the National Energy Policy (Draft 2005, draft) have been introduced/proposed to harness and enable programme coordination in the energy sector.

In view of the under-representation of IPPs in the sector, the National Energy Policy (Draft 2005) has committed to encourage private power producers, and recommends tapping of the inherent synergies between these producers and STELCO. Additionally, the Seventh NDP (2005–2010) has woven public–private energy partnerships into its broader socio-economic vision for the country, urging the exploration of sustainable partnerships to enable the achievement of national development goals.

The draft Energy Policy stress on the regulations aimed at improving the energy efficiency by imposing standards and norms

The recently formulated Tourism Master Plan also acknowledged the importance of energy efficiency and introductions RET to the resorts. This is a welcome change as without the support of tourism sector the RE and GHG targets of the country will be never able to meet.

Maldives Energy Authority has received funding from ADB to develop the power sector regulation. The consultation with MEA has highlighted the specific regulation to facilitate and encourage energy conservation will be incorporated in the new regulation.

These legislative changes underway will significantly change the general legal framework within which the Power Sector operates. There will be direct effects for the electricity providers from draft legislation currently before the Attorney General and scheduled for introduction in late 2007. STELCO as a public enterprise will be directly affected by the increased reporting requirements in the Public Enterprise Accountability Bill. The Island Development Committees (IDCs), that currently run the electricity system on virtually all the smaller islands not supplied by STELCO, will be affected by Local Government reform as it is to proposed to phase out IDC's altogether. This recognition would make the utilities more responsible and more efficient.

5. Key Challenges

5.1 Limited Institutional Capacities

As the Government's energy sector regulator, the MEEW is understaffed. The existing regulatory framework lacks uniformity at the national and local levels, and does not include the renewable energy sector.

Public–private energy partnerships have not been as successful as was hoped, perhaps due to the presence of state-owned monopolies combined with a lack of financial mechanisms and discriminatory policies on funding the private sector. IDCs are not backed by legal statutes, and hence are not unable to provide electricity as cooperatives.

Specific regulations for governing areas such as independent power generation, and the pricing and use of renewable energy technologies (RETs) are not currently in place.

Technical and managerial capacities in energy transmission and distribution are mainly confined to STELCO, with some involvement of private power producers servicing resorts. Technical skills are mostly limited to routine maintenance and operations, although even these have not been adequately transferred to the decentralized levels. There are no specific capacity-building initiatives for energy service delivery institutions that focus on synergizing the energy production and efficiency improvements.

There is a need to build up the capacities of other stakeholders in energy transmission and distribution. The Faculty of Engineering Technology in Male has been addressing this need by conducting a series of short-term courses for technicians, operators, and other staff. At the local level, IDCs and ADCs need to integrate energy issues into their short-term training courses on community development, credit management, and micro-enterprise development.

5.2 Limited Access to Modern Energy Services

Renewable energy sources have not been adopted widely in both urban and rural areas, and the use of solar dryers, solar cookers, and wind generators has been undertaken only on a pilot project basis. The Government has sought to increase the pace of renewable energy adoption by considering the introduction of a Renewable Energy Portfolio (REP), which would devise strategies to increase the share of renewable in the total energy generation to 12 percent by 2015 (Sustainable Energy Plan, June 2004).

Access to electricity has a strong urban–rural bias in the Maldives due to the absence of a uniform electricity tariff structure. Residents of Male pay considerably less for electricity than outer island households that spend a substantial 30–40 percent of the family income on electricity.

Lack of awareness about renewable energy, its applications, potential, and success stories contribute to the indifference in towards its adoption.

5.3 Limited Energy Entrepreneurship

Tourism and fisheries account for over 66 percent of the country's gross domestic product (GDP), yet the demands of these energy-intensive sectors only further highlight the glaring absence of a robust entrepreneurial energy network to offer energy services in the Maldives even when demand and an ability to pay are in place.

Large-scale entrepreneurship in electricity generation is hindered by the prohibitive costs of diesel and technical expertise. Efforts to encourage energy entrepreneurship are further hampered by a lack of both awareness and access regarding energy services, cost–benefit analyses, and available energy economics data.

Acknowledging the current scenario, the nation's policy-makers are committed to enabling a thriving industry on the generation and distribution of energy services. These commitments are visible in policies such as the recently expired Sixth NDP (2001–2005) and the Regional Development Plan.

A driving force developing energy sector can be created through the integration of SMEs in the energy programmes. As such, partnerships should be encouraged and efforts should be directed at developing a fair and competitive market. Eventually, this market could replace or complement monopolies such as STELCO and STO. The Government could also benefit by this on account of restrictions in the scope of subsidies and grants. To enable the formation of such a dynamic market, it is necessary to have a comprehensive National Policy and Action Plan aimed at market liberalization for fair and free competition.

The lack of Energy Service Companies (ESCos) also critical issues which needs to be addressed. In other countries where energy efficiency programmes are conducted ESCos generally act as project developers for a wide range of tasks and assume the

technical and performance risk associated with the project. Typically, they offer the following services:

a) Develop, design, and finance energy efficiency projects;
b) Install and maintain the energy efficient equipment involved;
c) Measure, monitor, and verify the project's energy savings; and
d) Assume the risk that the project will save the amount of energy guaranteed.

These services are bundled into the project's cost and are repaid through the monetary savings generated.

What sets ESCos apart from other firms that offer energy efficiency, like consulting firms and equipment contractors, is the concept of performance-based contracting. When an ESCo undertakes a project, the company's compensation, and often the project's financing, are directly linked to the amount of energy that is actually saved.

Briefly then, an ESCo is a company that provides comprehensive and integrated energy cost reduction services to its customers (mainly large energy users, but also utilities) on a guaranteed performance basis. An ESCo provides performance and savings guarantees, and its remuneration is directly linked to the measured energy savings achieved.

5.4 Limited Access to Finance

Funds for energy development projects undertaken by communities and private entrepreneurs range from some business loans extended by commercial banks to small credit schemes offered by international donors and local government bodies. Traditional sources of finance, such as commercial banks, have limited effectiveness on Maldivian rural islands. The inability of disadvantaged groups to provide collaterals against loans and a lack of high-return investment opportunities in the outer islands obstruct greater participation of the operations of commercial banks in the rural energy sector.

Government-supported micro-finance mechanisms such as the Atoll Development Fund (ADF) and the Revolving Electricity Fund (REF) have emerged as viable alternative sources of funds to enhance rural energy entrepreneurship and access to energy services. However, effectiveness of the national-level REF has been reduced by a short repayment period and limited credit ceilings. In the available credit mechanisms, the low credit limit in the Revolving Electricity Fund (REF) is partly a result of shortage of available seed capital, and demand often surpasses the funds available for disbursement. (UNDP, 2005)

Most micro-finance for renewable energy development is provided through the RETDAP, although the credit is not sufficient to meet the initial hardware costs of most renewable energy systems.

Energy project loans are given only to individuals who prove their capacity to pay back the loan by putting up collateral. This deprives a large segment of the rural

population of the necessary finances to implement micro-energy projects for household and productive use. In this context, it would be useful to study and adopt best practices from other countries in the region, such as Bangladesh and Nepal.

In all the above-mentioned financing-related suggestions, the MoAD and the Bank of the Maldives can together take the initiative. The Maldives Monitory Authority, the MoFT, supported by MEEW, can spearhead and coordinate the process.

Financial incentives constitute a powerful leverage for favouring the dissemination of efficient appliances. The principle is simple, it involves providing subsidies directly or indirectly (tax benefits) for the purchase or use of more efficient appliances. The level of financial incentive can be set to cover fully or partially the incremental cost associated with energy efficiency. From an economic point of view, this incentive should not be higher than the savings generated from the use of the efficient appliance over its economic life.

This type of tool is quite widely employed, especially to favour the creation of market for new products. It can be introduced by public authorities (for example, by providing tax incentives for the installation of a solar water heater or purchase of an efficient refrigerator) or by power utilities themselves on the basis of comparison of the cost of energy supply with the cost of energy saved.

5.5 Limited Access to Information

The most common form of knowledge sharing and transfer at the national level is through training workshops, seminars, and periodic interactions. In addition, reports of studies conducted by various agencies are available on the Internet and elsewhere. However, at the island and community levels, orientations, demonstrations, exhibitions, and audio-visual presentations are mostly lacking. Moreover, there is limited public access to studies, and information on assessments related to energy is not documented. (UNDP, 2005)

Awareness rising is meant to make the energy consumers more sensitive towards energy problems, to encourage them to adopt energy-saving behaviour and purchase energy efficient appliances. Awareness and sensitization campaigns are indispensable for the success of the electricity demand management programs, though it may be difficult to evaluate their impacts in the short term. Their targets are to upgrade the general awareness, to influence the behaviour and to achieve market transformation of high efficiency products.

The communication methods adopted may vary from one country to another and may depend on the expected outcomes: in some cases, the environmental considerations may be highlighted (importance of achieving energy savings for the preservation of the natural resources and for limiting greenhouse effects) whereas in others, financial benefits may be emphasized (lowering of the energy bill for the end-users).

The MEEW has made limited progress in extending access to information on renewables. However, deficiency of information in the electricity sub-sector prevents accurate assessment of the country's energy sector. Still the electricity generation and distribution information of the State Electricity Company STELCO is confined to the organization, and private power producers do not readily share such information.

Energy information centres could be set up, preferably at the MEEW, and the national library could be encouraged to create an energy section.

With respect to renewable energy information, the RETDAP has been able to address a few gaps, benefiting communities in remote and outer islands. It has achieved this through a pilot demonstration and publishing awareness material. However, to develop robust systems for energy, the MEEW should extend its experience of a one-stop information shop for all renewable energy information to the entire energy sector, particularly the electricity sub-sector. It should also consider replicating this resource centre elsewhere to generate community enthusiasm and promote participation in renewable energy programmes.

It would also be desirable to pursue collaborative knowledge partnership programmes with institutions and networks such as Asian Institute of Technologies, Bangkok; International Network for Sustainable Energy, Denmark; The Energy and Resources Institute, New Delhi. (UNDP , 2005)

6. TECHNOLOGY NEED ASSESSMENT

In light of the analysis presented in the paper, the following three project is recommended to address the problems in identified to encourage energy efficiency and conservation at the same time removing barriers for nation wide implementation of RET in the Maldives.

6.1 Project Profiles

PROJECT TITLE **RATIONAL AND JUSTIFICATION**	**Establish Energy Service Companies (ESCOS)** Substantial opportunities exist for energy efficiency improvement in public buildings. The Government has initiated a number of Energy Efficiency awareness programmes in the past but with no notable improvements. This is attributed to lack of dedicate persons to bring those valuable knowledge imparted in such seminars and workshops into action. Therefore it is important to start a project with the inclusion of dedicate ESCO's
GOAL	
OBJECTIVES	
ACTIVITIES	
OUTPUTS	

PROJECT TITLE	Establishing an Energy Conservation Fund (ENCON Fund)
RATIONAL AND JUSTIFICATION	It has long recognized that energy plays a crucial role in national and state economic development. Both government and industry have publicly stated the benefits of improvement in energy efficiency. Improving the efficiency of energy conversion, transportation, distribution, and utilization can lead to significant improvements in productivity, competitiveness, and job creation. Recent efforts to identify and address these barriers have concluded that there is a need for an Energy Efficiency Fund that will facilitate the development and growth of an energy efficiency (EE) infrastructure that includes energy service providers such as Energy Service Company (ESCO)s to help energy consumers develop and implement cost-effective EE projects. The past energy conservation, efficiency and renewable energy technology programmes failed because the financing mechanism in place for such projects solely depended on donor assistance. In the Maldives most of the RE projects in the energy sector have never gone beyond the pilot stage. **THE MAJOR FINANCIAL BARRIERS TO EE PROJECT IMPLEMENTATION INCLUDE THE FOLLOWING:** a) Most organizations in the SME, commercial and municipal market segments have limited capital resources b) Financial institutions have limited experience in lending to EE projects c) Project financing for EE projects is perceived to be highly risky by financial institutions d) The development and transaction costs for preparing and financing “investment grade” or “bankable” projects are relatively high. e) There are no qualified energy services providers such as ESCOs as there are accessible funds to set up such company’s.

To address this issue an Energy Conservation Fund (ENCON) fund has to be established.

INITIAL FUNDING SOURCES

There are many possible mechanisms to develop the initial funding for this Fund, including, for example:

a) levy on energy sales
b) special tariffs or taxes
c) general tax revenues
d) fees from certification
e) donor funds
f) funds from public and private financial institutions

These funds can be later augmented form other sources including venture capital funds, private equity capital, etc.

USE OF FUNDS

While some of the resources of the Fund may be used as grants to facilitate the financing of municipal or other government EE projects, it is anticipated that a majority of the fund will be set up as a :revolving fund" to provide loans, equity financing and/or loan guarantees to EE projects or to EE service delivery organizations.

Examples of financing mechanisms to be employed include:

a) Grants
b) Loans
c) Subsidies
d) Loan guarantees
e) Credit guarantees
f) Competitive bidding
g) Cooperative advertising and promotion of EC products

QUALIFICATIONS FOR PROJECT FINANCING

The Fund Manager (MEEW) will establish and publish the minimum qualifications for projects to receive various types of financial assistance from the Fund.

Examples of qualification criteria for projects receiving financial assistance may include:

a) Technically feasible.
b) Cost-effective from a societal perspective
c) Environmentally beneficial.
d) Financially sound
e) Having acceptable level of risk
f) Replicable
g) Contributing to the development of sustainable EE markets
h) Supported by an energy audit, or a detailed project report (DPR), prepared by an accredited energy auditor.

Generally, these are projects where the expected economic benefits are greater than the costs of the project. That is, the potential projects should be those where the total cost savings from reduction in energy usage are greater than the costs of implementing the energy efficient measure(s).

GOAL
OBJECTIVES

The primary purpose of the Fund will be to stimulate the market implementation of cost-effective energy efficiency projects. Such projects improve the efficiency of energy systems, reduce dependence on energy imports, improve economic well being, reduce environmental damage, and increase productivity.

THE FUND WILL ACHIEVE THIS OBJECTIVE BY:

a) Helping finance specific projects through debt or equity financing or by providing partial credit guarantees through financial institutions

b) Contributing to the development of energy efficiency service delivery organizations (such as ESCOs)

c) Developing and demonstrating model financial transactions

d) Developing typical financing agreements that can be used by the private sector

e) Involving local financial institutions in the transactions to build their knowledge, interest

	and capability for financing EE projects
ACTIVITIES	The ENCON Fund can be utilised to fund the following projects **FUND PROJECTS ON GOVERNMENT BUILDINGS** The objective of this project is to promote energy conservation in government buildings that do not fall into the designated building category in order to be examples for the general public in energy conservation as well as to save the government budget for energy consumption. **FUND PROJECTS ON FACTORIES AND BUILDINGS UNDER DESIGNING OR CONSTRUCTION** The objective of the project is to support the owners of factories or buildings, which are currently under designing or construction and the energy consumption of which, when the construction is completed, is expected to fall into the "designated" category, to improve the design with a view to energy conservation. **FUND PROJECTS ON NON-DESIGNATED FACTORIES AND BUILDINGS** The objective of the project is to support the owners of existing factories and buildings, which are not classified as "designated" who wish to implement energy conservation measures in their facilities. The implementation of this project has not started yet, awaiting availability of the responsible agency, which is currently dealing with the implementation of energy conservation in existing designated facilities to comply with the laws first. **FUND RENEWABLE ENERGY AND RURAL INDUSTRY PROJECTS** The project promotes utilization of renewable energy, which has less adverse impact on the environment, and energy conservation in agricultural and industrial activities in rural areas. Emphasis is placed on projects on renewable technology introduction, dissemination and transfer; projects on improvement of energy

consumption efficiency by using proven technologies.

FUND RESEARCH AND DEVELOPMENT PROJECTS

The project aims at developing new or improving existing technologies, information dissemination, and adaptation of proven technologies as well as small-scale demonstration projects.

HUMAN RESOURCES DEVELOPMENT PROJECTS

This project aims at supporting and developing human resources (HR) in the country with the right skills and knowledge in the energy field in order to increase manpower to facilitate effective implementation of the ENCON Program. Main activities of this project consist of the following: the development of curriculum on energy conservation and teaching materials, research grants, seminars, scholarship scheme, and financial support for educational institutes to provide courses related to energy conservation.

PUBLIC AWARENESS PROJECTS

The PA campaigns under am at changing consumers' behavior and attitude towards energy consumption with a view to achieving efficient use of energy.

OUTPUTS

PROJECT TITLE	**ENERGY EFFICIENCY IN PUBLIC BUILDINGS PROJECT**
RATIONAL AND JUSTIFICATION	In the Maldives the no-residential buildings are the principal electricity consumers, representing over 52% of the total consumption in 2003. The residential sector accounts for the remaining 48% of the total electricity consumption. Under the non-residential buildings, the highest consumers are the government buildings and those falling under the category include government offices, schools, higher education, hospitals, military facilities, and institutional buildings. For the electricity demand growth the Government buildings are presently leading the way, with 36.1% growth within 4 years, providing a very strong leverage to promote activities favouring energy conservation: government should be the first to lead the way by adopting the energy efficiency policy it defines.
GOAL OBJECTIVES	• Reduce energy consumption in public buildings • Showcase public buildings as demonstration case studies • Increase awareness of public building officials on available approaches to implement energy efficiency projects.
ACTIVITIES	The program will promote energy efficiency in public buildings by promoting the use ESCOs for the implementation of energy efficiency projects. MEEW will work with ESCOs and public building officials to identify contractual issues and mitigate them. MEEW will then work to recruit ESCOs to undertake demonstration projects that can be showcased to increase participation from public buildings. MEEW will work with legislators to enact laws to motivate public agencies to implement energy efficiency. **TARGERT MARKET SEGMENT** a) Government offices b) Schools c) Higher education d) Hospitals

	e) Military facilities f) Institutional buildings **END USERS TARGETED** a) Lighting b) Computing c) Cooling
OUTPUTS	100 public buildings energy efficiency projects in 10 years.

7. CONCLUSION

As a non-Annex I party to the UNFCCC, Maldives is not obliged to implement GHG measures but the current national environmental policies are based on the need to take an integrated approach to environmental management and to work towards the goal of sustainable development.

In the absence of an integrated planning approach for the electricity sector, the peak electricity demand is likely to double from in the next 7 years, requiring major investments, incurring high operating costs associated with the imported fossil fuels, and contributing to local and global GHG emission.

As observed from the various draft policy documents and there is general consensus within the Government, for the need for energy conservation and implementation of renewable energy technologies for our energy security and to do our share of reducing the global warming. However, as with everything else of this nature, political will and much needed support in terms of finance is not forthcoming. Instead, under pressure for quick results the on going energy programmes continue to have focus on diesel based power generation.

The project proposal identified in this study are carefully selected to address the shortfalls in the current systems and if implemented would bring the focus into energy conservation and efficiency and would reduce the GHG emissions and enable us a more energy secure future.

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