MID-TERM REVIEW

Maldives: Renewable Energy Technology Development and Application Project (RETDAP)

Republic of Maldives

United Nations Development Programme

Global Environment Facility

FINAL VERSION

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LIST OF ABBREVIATIONS

ADEME	French Environment and Energy Management Agency
CO_2	carbon dioxide
CDM	Clean Development Mechanism
EU	European Union
FRESA	Fund for Renewable Energy System Applications
GEF	Global Environment Facility
GFF	Guaranteed Fiberglas Fabrication
GHG	greenhouse gas
LPG	liquefied petrol gas
MEEW	Ministry of Environment, Energy and Water
MHAE	Ministry of Home Affairs, Housing and Environment
MoAD	Ministry of Atolls Development (MoAD)
MoFT	Ministry of Finance and Treasury
MPND	Ministry of Planning and National Development
PV	photovoltaic
RE	renewable energy
RET	renewable energy technology
Rf	Maldivian Rufiyaa
RETDAP	Maldives Renewable Energy Technology Development and Application Project
SMILES	Strengthening Maldivian Initiatives for a Long-term Energy Strategy (EU project)
STELCO	State Electricity Company
STO	State Trading Organization
SWM	solid waste management
TTF	UNDP Thematic Trust Fund
UNDP	United Nations Development Programme
UNFCCC	UN Framework Convention on Climate Change
UNIDO	UN Industrial Development Organization
UNOPS	UN Office for Project Services
US$	US dollar
USD	US dollar

Exchange rate: 1 US$ = 12 Rufiyaa (2007)

EXECUTIVE SUMMARY

Maldives mainly uses fossil fuels for generating electricity and in the transportation sector, in the forms of fuel oil, diesel, gasoline, kerosene and LPG:

- The majority of Maldivians live in locations with full day availability of electricity. The State Electric Company (STELCO) provides 24-hour electric power to some 24 of the 199 inhabited islands (including Male'), while generators operated by island communities (with the financial assistance of the Ministry of Atolls Administration, MAA) serves an additional 50 islands and private providers serve 6 islands with 24 hours of electricity each day. The remaining islands have at least 5-12 hours electricity service.
- The main source of energy for domestic purposes in the outer islands has been biomass. However, with the depletion of wood resources and subsequent restrictions on tree cutting, more households use kerosene and LPG for cooking instead of biomass materials (shrubs and coconut husks).
- Diesel and gasoline are used to fuel automobiles and marine outboard engines in the transportation sector, while fuel oil is used in industry.

Maldives has no conventional energy resources (e.g., oil and gas) that it can utilize to meet its energy needs. Basically, the country utilizes imported petroleum fuels to meet all of its energy needs. Some renewable energy (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.

Currently, renewable energy technology applications are limited to some application of solar photovoltaics in navigation lights and outer island telecommunication systems and the modest use of solar water heaters in Male' and in resorts. The following RE options have been identified as potentially feasible:

- Hybrid systems (wind and/or solar and/or diesel generators) on larger islands in the windy belts;
- Capturing and utilization of landfill gas for heat and/or electricity from the biologically degradable waste from Male' (Thilafushi island landfill);
- The use of household or village bio-digesters to produce biogas out of kitchen garbage;
- Use of thermal solar technology in water heating in the households and on the resorts;
- Combined heat-power (CHP) from biomass, if suitable islands with sufficient biomass can be found.

However, a number of barriers hinder unlocking the potential of the before-mentioned RE technologies:

- Lack of information and essential data on the availability of renewable energy sources
- Lack of information on appropriate options of RE technologies and their financial viability in the Maldivian context;
- Limited capacity and capability of key players in the government sector in the design, development, implementation and management of RE activities;
- Lack of a framework of the national policy on energy and limited institutional mechanisms to support the development, implementation and management of RE application activities;
- Limited involvement of entrepreneurs and lack of financial and economic incentives to undertake RE ventures;
- Lack of visibility in terms of technical demonstration of RE applications and of established financial viability of RE project ventures;
- Lack of financing and financing mechanisms for RE applications;
- Non-availability of reliable RE technology hardware in the local market.

The **Renewable Energy Technology Development and Application Project (RETDAP)** is designed to address the above-mentioned barriers and to lower them in order to facilitate the widespread utilization of RE resources in the country. The project is co-financed by the Global Environment Facility (GEF) with the United Nations Development Programme (UNDP) as the implementing agency and the Ministry of Environment, Energy and Water (MEEW) as the national executing agency. The Project Document mentions as **development goal** "the growth rate of greenhouse gas emissions from fossil-fuel-using activities, such as power generation and process/water heating, is reduced through the the removal of the major barriers to the development and application of renewable energy (RE)-based systems that can supplant part of the fossil fuel use in the Maldives".

The Project Document states six **outcomes**:

1. *RE advocacy and awareness* (to create awareness of the benefits among the citizens of Maldives of utilizing RE to meet their energy needs and to sustain national development);
2. *RE resource assessment* (to conduct a RE resource survey to assess the potential and feasibility of utilizing RE resources available in Maldives);
3. *RE policy development and institutional strengthening* (involving the design, development and implementation of appropriate policies, strategies and interventions addressing the fiscal, financial, regulatory, market, technical and information barriers to RE development and utilization);.
4. *RE technical capacity building* (involving capacity building activities for enhancing the country's capability in establishing workable and viable schemes for supporting RE applications with emphasis on the design, development, financing, implementation and management of such RE projects);
5. *RE Project Financing Schemes (*private and government financial institutions, commercial banks and private entrepreneurs are trained on RE technology business, financing and economic feasibility evaluation. A RE Fund is established, and a clearly defined financing scheme for utilizing the fund is designed and implemented. A RE "one-stop-shop" service at the Energy Department of MEEW is to provide eligible financing assistance to applicants);
6. *RE System Project Development* (techno-economic feasibility of RE-based energy projects in selected demo sites, including the necessary implementation requirements from the MEEW, financing institutions and the national power utility are completed. Baseline performance data and operating performance targets for the planned demo projects are established. Demo plants are constructed and commissioned. Evaluation of operating and economic performances are conducted and documented for dissemination.

Key **accomplishments** of the project so far have been:

Given the fact of a baseline of 'almost zero activities on RE in Maldives', the project has started focussing on establishing the basis first necessary for RE development.

1. *Outcome 1:* Various advocacy and awareness raising activities have been implemented, including on-the-job training, seminars, study tours and awareness programmes in the atoll islands
2. *Outcome 2:* A detailed assessment of wind, solar and biomass resources was carried out, accompanied by in-house training of relevant government officials and a least-cost assessment of RE technologies;
3. *Outcome 3:* The first energy supply and demand balance was constructed for Maldives and the first National Energy Policy was drafted, which is currently considered by the President's Office.
4. *Outcome 5:* A setup and guidelines for the Fund for Renewable Energy System Applications (FRESA) have been designed
5. *Outcome 6:* Installation of the demonstration solar-diesel hybrid system on Mandhoo Island, after a survey was carried out on six islands.

Now that these 'preparatory and demonstration' activities have been carried out, the project enters a next phase of organising a more focussed technical capacity building for the most promising RE technologies, setting up financial support mechanisms and supporting the installation of appropriate RE systems on the atoll islands.

The Evaluation Team assesses that about 55% of activities of the entire project (as mentioned in the Project Document) have been implemented and in this sense the project *has performed satisfactorily so far.*

Until recently, energy planning was in essence not more than the island electrification with diesel generators undertaken by government agencies. Lack of essential information on energy demand and supply, renewable energy resources and lack of trained staff hampered the ability to perform a true energy policy formulation, let alone the ability to develop a RE strategy. Over recent years, the Government of Maldives has been stressing more and more environmental and climate change related issues, including the planning of sustainable energy options. It has been proposed to include a target of 10-12% share by RE in the energy mix by 2015 in the forthcoming 7th National Development Plan.

Thus, RETDAP has arrived in a time-critical way coinciding with the Government's attempt to formulate the first national energy policy. The project has been catalytic in laying the groundwork for renewable energy promotion and development and in mobilising other sources of funding.

Regarding project design and execution, the evaluation team has nonetheless the following major **observations:**

- The logical framework of outcomes and outputs (as given in the UNDP Project Document) seems to implicitly assume that the private sector or private end users will play a large role in acquiring RE technology, but without really explaining what the (current and future) role of the Government, private sector and end-users in acquiring RE technologies in Maldives could be and without distinguishing between target group, type of technology or scale of application. In general, it is not clear on what analysis the targeted values of certain indicators in the framework are based. Maybe this is a reason why the logical framework of the project (with its elaborate list of performance indicators and verifiers) is not really being used as a monitoring and evaluation tool for the project's impacts, outcomes and outputs

- While RETDAP has been quite successful in raising awareness amongst government, private sector and beneficiaries about RE, at this point in time, it might be useful to learn more about the perceptions and attitudes of stakeholders on RE and opinions after having had the first experiences with RE implementation.

- Regarding financial sustainability, some RE technologies will be cost-effective, while others will require subsidy, depending on their application, target group and cost, and this should be strongly taken into account when developing future RE projects in the islands. The RETDAP project includes setting up of a financing mechanism to promote and support the application of RE technology, but the project's replicability will depend on a concerted effort to set up a technology and delivery support system with involvement of the private sector. This implies not only enhancing and developing adequate technical capacities in the Maldives but also capacity strengthening at the national and local level to be able to provide services for installation and maintenance

One important **lesson learned** regarding the installation of solar/wind/diesel hybrid systems in Maldives is the following:

- Many of the electrical appliances are unique to the manufacturer and thus making it difficult to service by a technician not specifically trained in the technology; future project should consider regional providers of appliances in order to avoid extended shipment time and expenses.
- Future RE application projects should be delivered in a running-and-testing scheme and should include a check-up by the manufacturer 6 months or so after installation;
- Lightning control measures should be considered when installing RE installations;
- Power demand (present and future) should be determined as precise as possible, so that the diesel / wind / hybrid system can be sized accordingly.

Important **recommendations** coming out of the evaluation study are:

- With economic growth on the islands (especially those whose villagers find employment in nearby resorts), demand for electric appliances and thus electricity rises rapidly. This asks for a good power demand survey to be undertaken before installing RE systems. At the national level, the data in energy supply and demand balance, constructed under RETDAP/Energy TTF, should be updated annually, if possible.

- After official approval of the draft National Energy Policy, the next step is to come up with a concrete set of measures in an 'Action Plan' to be able to implement the policy guidelines. RETDAP should support drafting such an Action Plan.

- Persistent understaffing is one capacity problem the MEEW faces in recent years as staff goes to 'greener fields' or for higher study abroad. To have recently graduated people that work at MEEW, go to specialist workshops or short courses abroad may not be effective, while tailor-made training of a few individuals would be too expensive. To ensure sustainability in capacity building in the longer term, establishing some sort of 'permanent' training course with a Maldivian higher education centre should be considered. In the short term, project management should consider using national or international consultants more to fill capacity gaps and to carry out project tasks.

- A 'baseline/mid-term' study should be performed as soon as possible to quantify the indicators as given in the project framework design in the original Project Document and the annual project implementation review sheets (APR-PIRs). At the end of the project, a similar study should be carried out to be able to measure the project's achievements and impacts.

- Such a study would also provide a quantitative basis to develop a sound Work Plan for the remaining period 2007-2008, which needs to urgently be developed with a revised budget attached to it. In this budget perhaps a larger amount of money could be dedicated to RE project development as in the original budget, by supporting the initiatives undertaken by Maldive Gas, Guaranteed Fiberglas Fabrication (GFF) and other actors. In any case the budget should be carefully re-allocated according to needs of the activities under the various outcomes.

- It is anticipated that the FRESA will be set up as a 'revolving fund'. The Work Plan should also include an exit strategy for FRESA, i.e., how the Fund would function and be replenished after RETDAP ends in 2008. For example, rural electrification is highly subsidised in Maldives, whether diesel or RE technology is utilised. Usual practice is that the power generation equipment is provided with government funds to the community. While FRESA can play an obvious role in financially supporting individual-level RE systems (such as biogas digestors and solar water heaters), it should be carefully looked at what role the proposed Fund for RE Systems Applications (FRESA, component 6) can play in community-level activities (such as island electrification).

- Activities have slowed down recently due to lack of managerial guidance. A new Project Manager should be appointed as soon as possible. Unfortunately, the Project Steering Committee has not met since November 2004. Its role, mandate and composition should be reconsidered, because it is vital to have such a decision-making body. It should continue to support RETDAP management by meeting *at least twice a year*. Perhaps ts membership should be expanded to include entities (apart from MEEW) that are involved in the implementation of RE technology, both state-owned companies, such as Maldive Gas as well as private sector (e.g. the solar water heater importers), if not in a voting, at least in an advisory capacity.

- The original project document often refers to 'RE technologies' in general, but actually this is masking the fact that RE technologies form quite a diverse group of technology in terms of maturity, financial viability, scale of application and type of application. With RETDAP going now more towards actual implementation and financing of RE applications, it is better to subdivide 'RE technologies' into certain *product-market clusters*. Each cluster faces different barriers and has different needs in terms of capacity building, technology support infrastructure (sales and after-sales) and financial support and requires different approaches by the government and other institutions involved. We can distinguish for example between individual applications on the islands (e.g. biogas digesters) and in the resorts (e.g., solar water heaters), community-level applications (such as island power generation by solar/wind/diesel hybrids or biomass-fuelled systems) and industrial applications (e.g., a waste-to-energy facility on Thilafushi Island). The above-mentioned RETDAP work plan for the remaining 2007-2008 should reflect the differences in issues and options between the product-market clusters.

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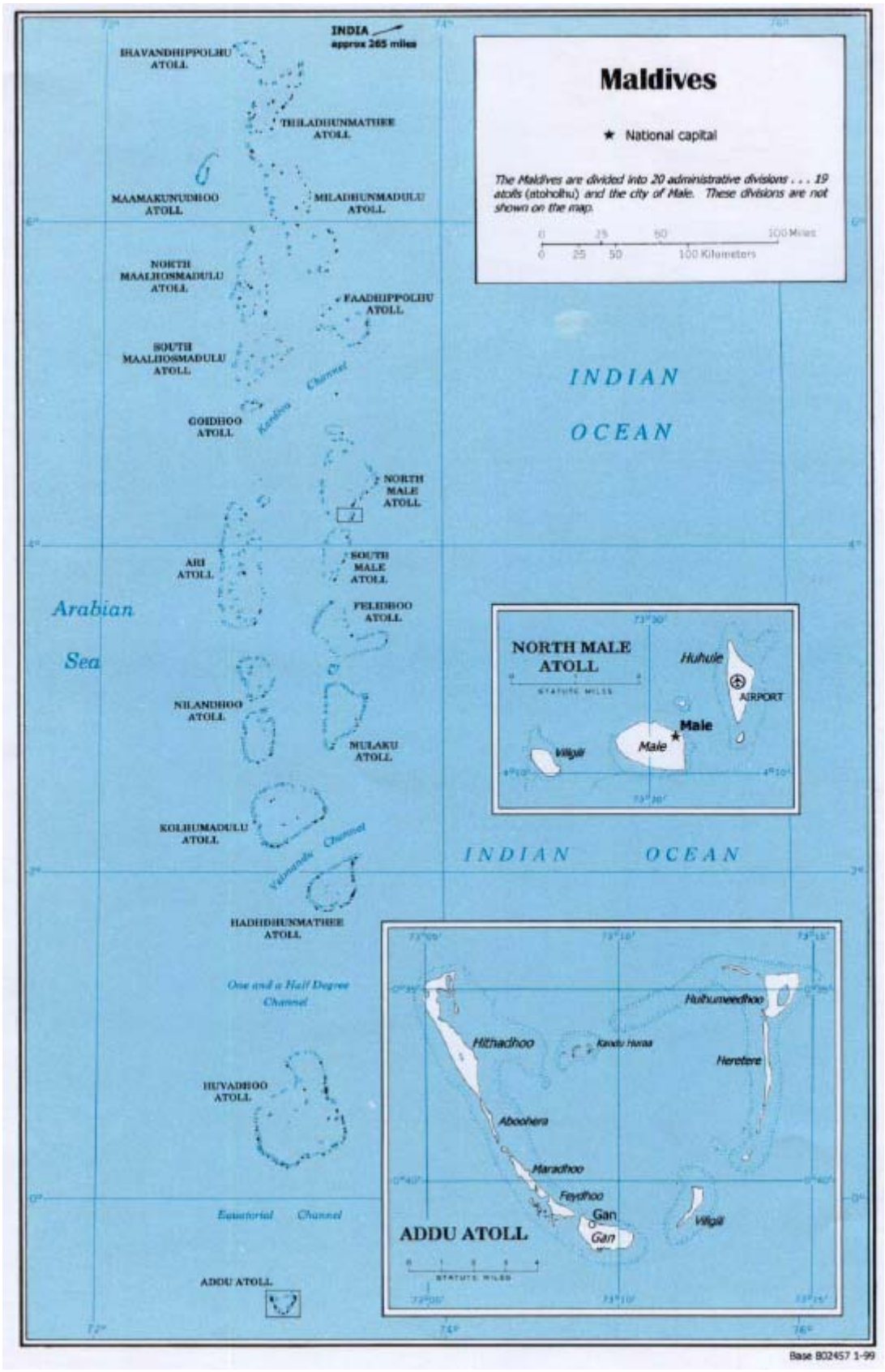
MAP OF MALDIVES



1. INTRODUCTION

1.1 Background

The Republic of Maldives is an archipelago consisting of about 1,190 tiny low-lying islands dotting the Indian Ocean, grouped into 26 natural atolls, stretching some 820 km from north to south. The sea forms 99% of the Maldives, leaving a total land area of 298 km^2. About 199 islands are inhabited. The country has a small and homogenous population of some 299,000 people (based on the 2006 Census), of which about 103,700 live on the capital island Male'. The land areas of the islands vary considerably, some of them having approximately 5 km^2 whilst other islands are as small as 0.2 km^2. Maldivians, all of whom are Sunni Muslims, share a common history, culture and a common language, Dhivehi.

The Maldives has achieved considerable economic and social progress since the 1970s when it began to diversify its economy from one that was agricultural-based to a services economy. The economy has grown by about 8-10% annually over the past decades, propelled by the growth of the tourism sector and associated industries, including construction and transportation. Tourism now accounts for about 20-30% of GDP and more than 40% of the government's budget. Also, the fishing industry remains vital as it accounts for two-thirds of exports and employs nearly 20% of the workforce. The continuing growth of tourism, largely financed by foreign capital and to a lesser extent, fishing, has helped improved social conditions. GDP per capita was US$ 2,500 in 2003, the highest in South Asia.

The tsunami disaster in December 2004, for example, badly affected the mainstay of the Maldivian economy, the tourist resorts. By June 2005, bed capacity was still more than 20 percent below that in the two previous years. The tsunami also affected the fisheries industry and thousands of people had to leave their homes. However, people returned fairly quickly to employment and by end of 2006, most of the displaced had permanent residences again. In 2006, tourist flows were the same as in 2004. In short, the country has steadily recovered from the tsunami disaster that temporarily decelerated the growth trend.

However, the lopsided dependence on tourism and fisheries implies that a decline in these industries could have a serious impact on the cost and the standard of living, development activities, provision of public services, the level of domestic economic activity and employment in the Maldives. In addition, the country is also heavily dependent on imports, particularly oil, to meet all its energy needs. This reflects the country's lack of natural resources and limited domestic market. Consequently, the Maldives runs a persistent merchandise trade deficit.

Maldives mainly uses fossil fuels for generating electricity and in the transportation sector, in the forms of fuel oil, diesel, gasoline, kerosene and LPG:

- The majority of Maldivians live in locations with full day availability of electricity. The State Electric Company (STELCO) provides 24-hour electric power to some 24 of the 199 inhabited islands (including Male'), while generators operated by island communities (with the financial assistance of the Ministry of Atolls Development, MoAD) serves an additional 50 islands and private providers serve 6 islands with 24 hours of electricity a day[1]. The remaining islands have at least 5-12 hours electricity service, leaving 4 islands without electricity. Electricity is generated by the burning of fuel oil and diesel. Organizationally, STELCO is a wholly state-owned company. STELCO and the over 200 private and community power providers are regulated by the Maldives Energy Authority (MEA)[2].

[1] Of the total installed capacity of 106 MW, 48% is in the resort islands, 35% is operated by STELCO in Male', Vilingili and Hulhumale'and 21 other islands, 13.5% is operated by Island Development Committes and some private operators and 3.5% at the airports (CDE, 2007a)

[2] The former Maldives Electricity Bureau (MEB)

- The main source of energy for domestic purposes has been biomass. However, with the depletion of wood resources and subsequent restrictions on tree cutting, more households use kerosene and LPG for cooking instead of biomass materials (shrubs and coconut husks).
- Diesel and gasoline are used to fuel automobiles and marine outboard engines in the transportation sector, while fuel oil is used in industry (e.g., sea water desalinization on Male' and the cement and LPG bottling industry on Thilafushi island near Male').

Maldives has no conventional energy resources (e.g., oil and gas) that it can utilize to meet its energy needs. Basically, the country utilizes imported petroleum fuels to meet all of its energy needs. Although the country is expected to continue to rely on imported fuels, 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:

Currently, renewable energy (RE) technology applications are limited to some application of solar photovoltaics in navigation lights and outer island telecommunication systems, modest use of solar water heaters in Male' and in resorts. A recent report[3] has identified the following potentially feasible RE options:

- Hybrid systems (solar and/or wind and/or diesel generators) on larger islands (more than 400 people) in the windy belts;
- Capturing and utilization of gas from the Thilafushi island landfill for heat and/or electricity from the biologically degradable waste (from Male' and other islands);
- The use of household or village bio-digesters to produce biogas out of kitchen garbage;
- Use of thermal solar technology in water heating in the households and on the resorts;
- Combined heat-power (CHP) from biomass, on islands with sufficient biomass resource.

Wind-solar-diesel hybrid systems on the smaller islands in the windy belts and solar PV as stand-alone systems on the resorts are mentioned as options, but would need substantial subsidy.

At the time of writing the RETDAP proposal, a number of barriers hinder unlocking the potential of the before-mentioned RE technologies:

- Lack of information and essential data on the availability of renewable energy sources;
- Lack of information on appropriate options of RE technologies and their financial viability in the Maldivian context;
- Limited capacity and capability of key players in the government sector in the design, development, implementation and management of RE activities;
- Lack of a framework of the national policy on energy and limited institutional mechanisms to support the development, implementation and management of RE application activities;
- Limited involvement of entrepreneurs and lack of financial and economic incentives to undertake RE ventures;
- Lack of visibility in terms of technical demonstration of RE applications and of established financial viability of RE project ventures;
- Lack of financing and financing mechanism for RE applications;
- Non-availability of reliable RE technology hardware in the local market.

1.2 Project description and objectives

The RETDAP is designed to address the above-mentioned policy, institutional, information, financing and technical barriers, seeking to remove them in order to facilitate the widespread utilization of RE resources in the country. This is in line with the Government's aim of utilizing

[3] Energy Consulting Network (2004c)

RE resources for national sustainable development, as mentioned in the 6th National Development Plan (2001-2005).

The Project Document mentions as **development goal** "the growth rate of greenhouse gas emissions from fossil-fuel-using activities, such as power generation and process/water heating, is reduced through the the removal of the major barriers to the development and application of renewable energy (RE)-based systems that can supplant part of the fossil fuel use in the Maldives".

The above-mentioned goal and project objective will be achieved through the following **components**:

1. Advocacy and awareness
2. Renewable energy (RE) resource assessment
3. RE policy development and institutional strengthening
4. RE technical capacity building
5. RE project financing schemes
6. RE project development

1.3 Evaluation methodology and structure of the report

The Ministry of Environment, Energy and Water (MEEW) started project activities in 2004 which are planned to go on until 2008. RETDAP is funded by Global Environment Facility (GEF) with other co-financing coming from the UNDP Nordic Fund (implemented by the UN Office for Project Services, UNOPS) and the UNDP Energy Thematic Trust Fund (TTF). Some co-funding is also available for different activities of the project from South Asian Regional Initiative (SARI) - USAID, the UN Economic and Social Commission for Asia and the Pacific (ESCAP), the European Union (SMILES project) and the French Environment and Energy Management Agency (ADEME).

In accordance with regulations of the UN Development Programme (UNDP) and the Global Environment Facility (GEF), a "mid-term evaluation" has to be carried out under the responsibility of the GEF implementing agency, i.e. UNDP, of which the results are presented in this report. The purpose of the evaluation is to analyse and assess the achievements and progress made, identify factors that have facilitated or impeded the achievement of outcomes and the effectiveness, efficiency, relevance, impact and sustainability of the project. The evaluation is expected to result in recommendations for the remaining period of the project as well as lessons learned and recommendations in general.

For this purpose, an Evaluation Team, consisting of two independent evaluators, Mr. Johannes (Jan) van den Akker (ASCENDIS, Netherlands) and Ms. Mariyam (Marie) Saleem (Male'), was fielded to the Maldives from 12-28 August 2007 to undertake the mid-term evaluation. During the mission, extensive discussions were held with representatives from UNDP Maldives and MEEW as well as with other stakeholders, including community beneficiaries.

Before undertaking the mission, the Evaluation Team drew up a table of contents that covers the issues to be addressed as mentioned in its Terms of Reference (see Annex A) and follows the structure of this report:

- Introduction (project description and evaluation method)
- Findings on project progress
  - Project's performance in terms of results (achieving objectives and outputs by means of realised activities and inputs used) and impacts, quantitatively and qualitatively measured by indicators (as defined in the project document)
  - Description of project impacts
  - Evaluation Team's assessment of the project design and execution
- Conclusions and recommendations
  - Conclusions taken into account sustainability and replicability issues

- Lessons learned and recommendations

The Evaluation Team adopted the following methodology of evaluation:

i) Review of project reports (project documents, budget revision sheets, quarterly financial and progress reports, steering committee minutes of meeting) as well as background information on the energy sector in Maldives,
ii) Meetings with the main project partners and stakeholders in Maldives at the national level (UNDP Country Office, MEEW, other government entities and private sector),
iii) Field visit to Mandhoo Island to discuss with island authorities and with beneficiaries).

The report is divided into three sections. This first section provides general background information, purpose of evaluation, project implementation setup, partners/stakeholders and evaluation methodology. The next section dwells on findings from the reports and from interactions with stakeholders. These findings are described within the logical framework design of the project, as given in the Project Document. Conclusions from the observations and findings are discussed in the context of project objectives. These also pertain to sustainability and replicability of project. The third section ends the report with lessons learnt and recommendations for the further direction of RETDAP. A list of people met and interviewed is given in Annex B.1 and the list of documents reviewed is given in Annex B.2.

1.4 Project set-up and stakeholders

The Ministry of Environment, Energy and Water (MEEW) is the project-executing agency according to the national execution (NEX) modality. Originally the Ministry of Communications, Science and Technology (MCST) was the Government executing agency of RETDAP, but after a Government restructuring this responsibility passed to MEEW. The Deputy Minister for Energy is the Project Director for the project[4]. Day-to-day management is the responsibility of a full-time Project Manager[5], assisted by the two Assistant Project Managers[6]. The UNDP Country Office at Male' carries out project implementation oversight. The organizational chart for decision making in RETDAP is given in Figure 1.

The Project Steering Committee consists of UNDP, MEEW, State Electricity Company (STELCO), Ministry of Planning and National Development and Planning (MPND), Department of External Resources (DER) of the Ministry of Finance and Treasury (MoFT), Ministry of Atoll Development (MoAD) and the Ministry of Home Affairs[7]. Its main role is to take major decisions regarding the project activities and direction as well as to integrate project results into the decision making of the respective sectors involved. The Steering Committee has met only three times (July 2004, August 2004, November 2004), but has stopped meeting after the government reshuffle in which responsibility for the project passed to MEEW.

Apart from the PSC members, important key players/stakeholders include:

- Organizations involved with energy supply (STELCO, STO, VILLA, Maldive GAS, private operators and the Island Development Committees in the atoll islands)
- Agencies who are responsible for sectors/areas that create demand for energy:
  - Ministry of Construction and Public Infrastructure (MCPI)
  - Ministry of Fisheries, Agriculture and Marine Resources (MoFAMR)
  - Ministry of Housing and Urban Development (MHUD)
  - Ministry of Tourism and Civil Aviation (MTCA)

[4] Mr. Abdul Razzak Idris

[5] There have been two Project Managers, Mr. Firag (who left 2006 to do his Ph.D) and Mr. Waheed (who also left in 2006).

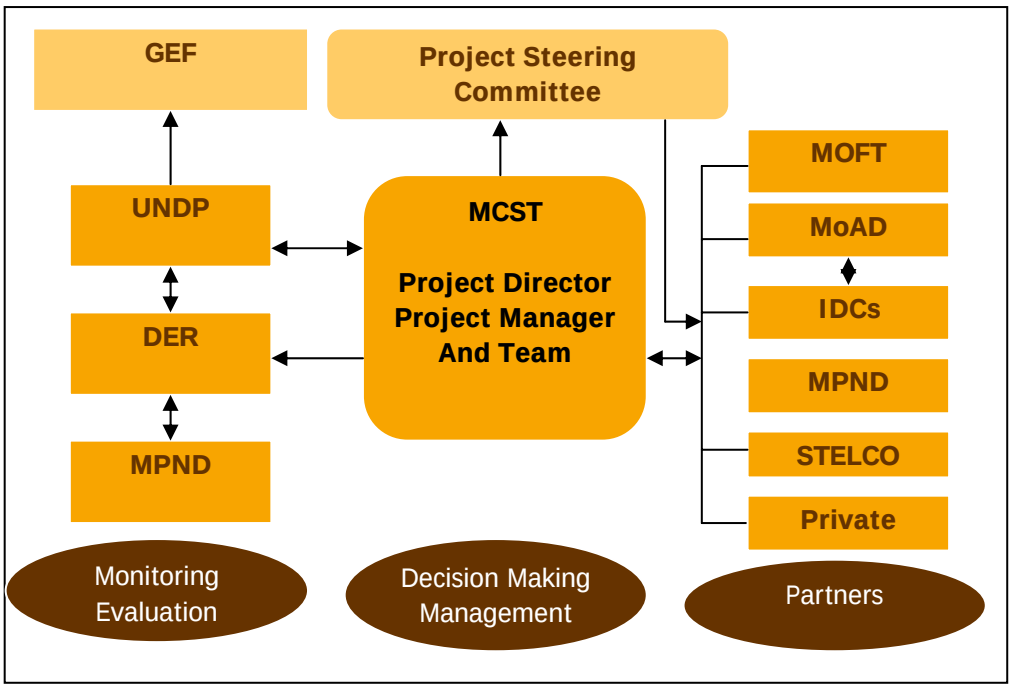
[6] Mr. Haikal Ibrahim and Mr. Jadulla Jameel

[7] Before the recent Government restructuring, known as Ministry of Home Affairs, Housing and Environment

- Ministry of Trade and Industries (MTI)
- Ministry of Transportation and Communications (MTC)
- Ministry of Atolls Development (MoAD)

- Agencies who facilitate financing of the energy sector (Ministry of Finance and Treasury, Ministry of Atolls Administration, Bank of Maldives)
- Intermediaries (Maldives Chambers of Commerce and Industry, Maldives Association of Tourism Industry, NGOs and CBOs) and the private sector.

Figure 1 RETDAP organizational setup



Source: Inception Report RETDAP (November 2004). Note that MCST has been replaced by MEEW as national project executing agency

2. FINDINGS

2.1 Implementation: outcomes, outputs and accomplishments

For each of the six outcomes, as mentioned in paragraph 1.2, this section assesses the progress in the implementation of the project's outcomes and outputs, following the format as given in the 'project framework design' (as given in Annex II of the UNDP Project Document).

2.1.1 Component 1 Renewable energy (RE) advocacy & awareness enhancement

Table 1 Outputs and indicators of outcome 1

Outcome:	Provision of adequate, affordable, accessible and up-to-date information services, continuing education, and awareness improvement on the application of RE resources.
Indicator:	A sustainable and continuously evolving program of providing RET information services, continuing education, and awareness enhancement, covering the energy applications of RE resources is established & implemented by 3rd yr.

Outputs	*Indicators*
1.1 Establishment of a RE Information Center in MCST	• RE Information Center established at the MCST and functioning by yr2. • An average of about 100 guests are served by the RE Information Center each year starting yr2.
1.2 Design and conduct of a RE Technology Education Program	• In-house RE technology training course for MCST staff started by yr1. • Study tour/fellowship program on RE system design and applications for selected relevant government and private sector personnel starting yr2 • Trained government personnel (particularly the MCST staff) are actively involved on RE development activities in the country starting yr2. • About 50 % of the trained private sector personnel engaged in RE-based project development and implementation activities in the country starting yr3. • Comprehensive annual training course (1st quarter of each year) on RE technology for Outer Island and Atolls (OIA) Development personnel successfully conducted. • At least *50%* of the trained personnel in the OIAs are managing, operating and maintaining RE-based energy systems starting yr3.
1.3 Establishment and implementation of an Integrated RE Information Exchange Service	• A fully functioning information exchange services program is operationalised by yr2. • Publication and circulation of a quarterly newsletter containing information gathered through the information exchange service (local/regional) starting 4th quarter of yr1. • Around 10 RE-based energy projects or installations in the country monitored each year by MCST starting yr 2. • Profiles of monitored RE-based energy projects / installations in the country prepared and updated annually by MCST starting yr2. • Information materials on RE technology incorporated in the MCST database starting yr2. • Subscription of scientific journals on RE Technology is received regularly by the Information Center starting yr1. • Abstracts/Information Notes on relevant articles on RE Technology are

	annually prepared by MCST, printed in the newsletter and incorporated in theNEO database starting yr3.
1.4 Conduct of Information Campaigns on RE Technology Applications in Outer Islands and Atolls (OIAs)	• Printed information materials on RE technology promotion produced and disseminated quarterly starting yr2. • Production of multi-media campaign materials on RE technology applications starting mid-yr1. • Applicable RE technologies are demonstrated through one product exhibition at yr3 and four demonstration schemes during the duration of the project. • An annual average of 100 RE-based energy projects is proposed by the IDCs and individuals starting yr3. • An annual average of 20 replication projects are developed and implemented in country starting mid yr4.
1.5 Introduction of a "one-stop-shop" service for RE market services	• RE "one-stop-shop" service is established in NEO to cater to the provision of RE market services by yr3. • RE "one-stop-shop" services provided to an average of about 40 clients each year starting yr3.

Output 1.1

The RE Information Centre is not yet in function because the Ministry of Communication, Science and Technology (MCST) changed to Ministry of Environment, Energy and Water (MEEW) and until 2007 MEEW has not been operational in any permanent place. These temporary movements and subsequent lack of physical space as well as staff shortage at MEEW are delaying the implementation of the RE Information Centre, which is planned for 2007/08

A renewable energy webpage linked to MEEW website was launched in July 2007. The website can be found at www.meew.gov.mv/retdap

Output 1.2

The following activities were organised:

- On the job training on RE technology, i.e., operation and maintenance (for 5 personnel) was done during implementation of the first pilot project (solar-diesel hybrid) participant;
- Two personnel from MEEW and the State Electric Company (STELCO) were sent for an energy efficiency and renewable energy seminar in Malaysia;
- Study tours to Malaysia and Thailand including 2 private sector and 5 government participants on options and methods in energy efficiency, conservation and renewable energy (April-May 2005);
- Seminar on Energy Efficiency and Renewable Energy conducted with partnership with UNIDO. Participants were from government, private sector and resorts. There were 10 participants from the ministries, 10 from private sector and 20 from tourism sector;
- Workshop on Eco-Friendly Buildings and RE with participation of 90 engineers and designers
- Awareness programmes conducted in 6 atolls in which 243 power house operational & administrative staffs participated.

Output 1.3

Activities implemented:

- Field trips of senior staffs of MEEW including the Minister
- Leaflets and stickers on RE & energy efficiency distributed
- Fieldtrip arranged for Bank of Maldives senior staff including its Chief Executive Officer (CEO) to see the demonstration of biogas digester in Thilafushi.

Output 1.4

The following activities were carried out:

- Several meetings with the private sector, public companies and government ministries with regards to use of renewable energy.
- Presentation on energy efficiency and renewable energy given in Seenu atoll Hithadoo and schools
- A leaflet on renewable energy was prepared and distributed for the general public to create awareness among them regarding the renewable energy options available in the Maldives and activities that are on-going to promote renewable energy in the Maldives
- A leaflet on electrical energy efficiency and conservation was prepared and distributed. The target groups of the leaflet are households and private and government offices
- The final report of the consultant, *The Maldivian Renewable Energy & Energy Efficiency Media & Communication Action Plan 2005-2007: Re-Map* was prepared describing detail activities that need to be carried out in awareness campaign. The report also highlights energy newsletter and energy website components.
- The Maldives Association for Construction Industry has also distributed awareness materials on RE.

Output 1.5

The activities are still pending.

2.1.2 Outcome 2 RE resource assessment

Table 2 Outputs and indicators of outcome 2

Outcome: Establishment of the availability and appropriate uses of RE resources in the country. *Indicator:* A comprehensive assessment and database of RE resources in the country completed by end of yr2 and utilized by the government and private sector for RE research, energy policy development and planning and RE project investments by end of project.	
Outputs	*Indicators*
2.1 Conduct of RE resource survey	• RE resource (wind, solar, biomass, landfill gas, etc.) surveys in selected areas in the country where the RE resource potentials are significant completed by mid yr2. • Comprehensive assessment results on the technical requirements wind/solar and other relevant technology applications (e.g., wind velocities and solar radiation intensities) compiled and analyzed by end of yr2.
2.2 Development of a RE Resource Assessment Methodology	• A suitable methodology for RE resource assessment agreed by Q2 of yr1. • Methodology for RE resource assessment is used and improved each year.
2.3 Design and development of a RE resource database	• Comprehensive RE resource database covering selected island/atoll groups developed by end of yr2, and subsequently maintained by MCST. • RE resource database is updated by MEEW annually.
2.4 Development of a RE monitoring and simulation methodology	• Suitable methodology for monitoring and simulation of wind, solar and other relevant energy resource completed by Q2 of yr3. • Results derived from RE monitoring and simulations are used in energy planning and policy making starting yr3.
2.5 Conduct of capacity building program on RE resource assessment for relevant government agencies	• In-house training for relevant government agencies (e.g., MCST, Dept. Meteorology) on RE resource data gathering, interpretations and analysis completed by yr1. • In-house training for relevant government agencies (e.g., MCST, DMet) on RE monitoring and simulation completed by end of yr3. • About *30%* of the trained personnel of RE resource assessments/monitoring and evaluation are providing training to other relevant MCST, DMet, OIA personnel each year starting yr3.

Outputs 2.1 - 2.4

Most of the activities have been carried out under the co-financing by the Danish through the Nordic Fund (implemented by UNDP-UNOPS) and by the UNDP Energy Thematic Trust Fund (TTF):

A methodology was developed to collect RE resource data. The solar and wind resource assessment was carried out during 2003-2004 by means of wind measurements at 3 stations (B. Eydhafushi, K. Villingili and M. Meedhoo) and solar radiation measurements at Hulhule' airport. The analysis shows that the country has; an average wind speed of about 5.8 metres per second (m/s) at a height of 40 m above the sea level, average annual solar irradiation of 2054 kWh/m2 and annual average sunshine hours of 2891. The results from the measuring stations confirms an earlier study by NREL that the northern region of Maldives has a moderate-good potential, while the southern part has a fair-moderate potential, although the measurements show lower average wind speeds than the NREL study[8].

In Thilafushi, a landfill gas production cell was manufactured to measure the landfill gas production from the waste collected. The gas produced is analyzed by a gas analyzer and found that the gas produced consists of about 60% of CH_4 and 40% of CO_2. Monitoring is being carried out to test the production capacity of a cell of this size.

A biogas digester, constructed by Guarantee Fibreglass Fabrication (GFF), was put under test during February 2005 with the help of a UNEP consultant. Several other attempts have been made to test the biogas digester as well.

Comprehensive assessment results and the technical requirements on wind, solar and biomass are compiled by the consultants financed through the UNOPS/Energy TTF. These documents include:

- *Final Report, Assessment of Least-Cost, Sustainable Energy Resources, Maldives* (Energy Consulting Network, 2004c)
- *Design and Specifications of Pilot Hybrid Systems* (Energy Consulting Network, 2003)
- *Final Report: Landfill Gas* (Energy Consulting Network, 2004b)
- *Biomass Survey, Technical Report* (Energy Consulting Network, 2004a)

In addition to these co-funded activities, the following tasks have been implemented *with GEF funding:*

- The energy resource assessment measuring equipments was handed over to the Department of Meteorology;
- Data from the measuring stations were given to the Red Cross, Australia and Red Cross, Canada for preparing a feasibility study for the use of wind and solar energy electricity in Duvaafaru Island as part of the Tsunami recovery efforts. Additional data were given to Maldives Gas, a subsidiary company of STO public company, for developing a study on renewable energies.
- Questionnaires were sent to resorts to collect data on the use of renewable energy (11 resorts responded with a completed questionnaire)
- RE resource data have been collected from Baa Eydafushi and Daravandhoo (with an Australian expert on renewable energy).

[8] Vilingili: 244 W/m^2, 5.9 m/s; NREL wind map: 300-325 W/m^2. Meedhoo: 201 W/m^2, 5.6 m/s; NREL: 275-300 W/m^2. Eydhafushi: 184 W/m^2, 5.3 m/s; NREL: 325-350 W/m^2. The NREOL study mentions wind speeds of 6.4-6.7 m/s for the northern part of Maldives and 5.8-6.4 for the southern part.

A study on the potential use of marine currents to produce energy will be undertaken by Robert Gordon University. Also, meetings were held with Tsunami First Relief Foundation on the possibility of conducting a study on Ocean Thermal Energy Conversion (OTEC).

Output 2.5

Under this output, the following has been achieved so far:

- As part of the before-mentioned *Energy TTF/UNOPS co-financed activities*, staff was trained on the basic maintenance of wind and solar measuring equipment and on the retrieval of data. Also, an appropriate fellowship programme (on solar and biomass) was chosen and a candidate was selected through formal government procedures. The candidate started his M.Sc programme at the Asian Institute of Technology (AIT) in October 2003[9];
- A seminar was conducted for 11 staff of government stakeholder agencies on wind and solar measurements

2.1.3 Outcome 3 RE Policy Development and Institutional Strengthening

Table 3 Outputs and indicators of component/outcome 3

Outcome: Strengthening and improvement of the policy and regulatory framework to encourage feasible RE-based energy projects *Indicator:* Government policy and accompanying implementing rules and regulations on the utilization of feasible RE resources for electricity and non-electricity projects is established by end of yr2.	
Outputs	*Indicators*
3.1 Strengthening of the newly established national energy office (NEO) that will be responsible for all energy matters.	• Adequately staffed with trained personnel in National Energy Office (NEO) by Q4 of yr2.
3.2 Formulation and implementation of a national energy policy incorporating RE development, utilization and pricing	• A clear government policy on the promotion, development and utilization of RE both for electricity and non- electricity applications is established • Policy study concerning the provision of incentives (e.g., financial, fiscal) to prospective RE project developers completed by end of yr2. • Study on RE-based OIA electrification and on electricity pricing completed by end of yr2 and yr3 respectively. • RE-based OIA electrification policies including policy support activities and guidelines recommended to government by end of yr2. • Proposed policy and regulations on the production and sales of RE electricity recommended to, and considered by, the government by yr4. • NEO personnel are doing energy policy formulation and review starting yr2 and formulation and recommendation of energy policies & framework starting mid-yr2.
3.3 Conduct of RE promotion workshops focusing on the relevant policies, policy instruments and policy	• National workshops on RE promotion and RE utilization for electricity and non-electricity applications conducted semi-annually until last year of project implementation. • About 10 local groups in the OIAs propose policies and policy support activities on RE applications each year starting yr1.
3.4 Conduct of a study on RE-based Livelihood and	• Study of potential livelihood support and productivity projects that will utilize electricity from RE systems (stand-alone or hybrid) completed

[9] It should be noted that the activities co-financed by the UNDP Energy TTF and UNOPS/Danish Fund started already in 2003, i.e. before RETDAP's activities were started (in 2004)

	Productivity Projects Support Policy	by yr1. • A total of 20 potential livelihood support and productivity projects are proposed and evaluated each year starting yr3.
3.5	Conduct of a detailed study on energy supply and consumption in Maldives	• An initial detailed evaluation report on the energy supply and end-use consumption in Maldives, including energy demand and energy trends / profiles completed by yr2 and reviewed annually. In-house training for relevant government agencies (e.g., MCST, DMet) on RE monitoring and simulation completed by end of yr3. • The national energy office (NEO) updates and reports on the energy balance of the country annually starting yr3.
3.6	Conduct of an Integrated National Energy Planning	• NEO personnel are capable of conducting least-cost integrated energy planning by yr2. • Planners from relevant government agencies are capable of doing energy-integrated planning by yr2. • The Initial National Energy Plan of Maldives is prepared and completed by yr2.
3.7	Evaluation of the National Energy Policy Implementation	• Annual growth of fossil based energy consumption is reduced by *2.2%* by the end of the project. • Annual production of RE electricity is increased by *2.1%* by end of project.
3.8	Conduct of a review of the RE Policy	• Revised policy and implementing guidelines covering pricing, incentives, etc. issued and enforced by yr4.

Output 3.1

The proposed 'NEO' has been incorporated into the recently formed Ministry of Environment, Energy & Water (MEEW) which has a designated Department for Energy, in which some 12 staff are planned to be working. However, understaffing continues to pose a big problem (about 6 staff are currently employed), a problem not uncommon in many governmental entities, as the Evaluation Team was told during its mission. It is difficult to attract qualified persons who prefer other jobs or go for studies abroad. To strengthen the Energy Team of MEEW, staff has been sent abroad for M.Sc studies in energy-related fields (one supported under the UNDP Energy TTF, see Output 2.5; another on energy management, supported by IDB).

Outputs 3.2 – 3.4

With *Energy TTF / Danish Fund (UNOPS) co-financing,* a draft National Energy Policy was compiled[10], then translated in Dhivehi and is currently under discussion in the President's Office. Similarly, the Energy Balances for 2003, 2004, 2005 and the detailed energy supply & demand studies were finalised[11]. However, no annual revision of the national energy balance has taken place yet. Recently, a letter went to the President's Office requesting to free imported RE technology of customs duty.

Outputs 3.4 and 3.6 – 3.8

Most activities are still pending. A meeting was held recently with the Ministry of Planning and National Development (MoPND) to include RE in 7th National Development Plan, aiming at a 10% contribution of RE by the year 2015.

[10] *National Energy Policy – Maldives – Final draft* (Aldover, 2006)

[11] *Energy Supply and Demand, Technical Report* (Energy Consulting Network, 2003) *and Maldives, Energy Balances and Indicatotrs 2003-2005* (Energy Consulting Network, 2006)

2.1.4 Outcome 4 RE Technical Capacity Building

Table 4 Outputs and indicators of component/outcome 4

Outcome:	(a) Establishment of the potentials and requirements for the energy applications of RE resources, as well as the support provisions for such initiatives; (b) Continuous promotion and support of the development and application of RE resources for outer islands (electricity and non-electricity applications) supporting socio-development in OIAs.
Indicators:	a. Assessment of the needs and potentials for applications of RE resources are completed and provisions for support are in place by end yr3; b. The RE-based energy system owners, and private entrepreneurs in OIAs commit *10%* of their gross revenues each year for supporting RE technology development starting yr 3; c. The GoM commits a percentage of its annual gross revenues for promotion and support of RE starting yr3.

Outputs	*Indicators*
4.1 Assessment of Other Value-added Applications of RE Resources Assessment of the needs and potentials	• Assessment of other value-added applications of RE resources completed by end of yr2. • Recommendations on the development and implementation of other value-added applications of RE resources promoted &disseminated by end of yr2.
4.2 Evaluation of the viability and the requirements for the development of a local RE Consultancy Service Industry	• Assessment of the viability of a local RE consultancy service industry, completed by yr3. • A total of approx. 5 entities expressed interests and initiated plans to provide RE consultancy services by end of the project.
4.3 Assessment of Local Capabilities for the Provision of RE Services	• Evaluation report on the capabilities of local engineering and consulting services in the area of RE completed by mid yr4.
4.4 Assessment of the Viability of Local Manufacturing of RE System Equipment and/or Components	• Assessment of the viability of local manufacturing of RE system equipment and/or components completed by end of yr3. • Investors from within and outside the country used the study findings for possible investments in RE equipment manufacturing in the country by end of the project.
4.5 Design and conduct of Training Course on the Design, Feasibility Evaluation, Operation and Maintenance of RE Systems for potential local engineering consultants and RE system suppliers.	• Comprehensive training course on the design, feasibility evaluation, maintenance and operation of RE systems for local engineering consultants completed by end of yr4.
4.6 Design and initiation of a Sustainable RE System R&D Program	• Sustainable RE system (wind, solar, biomass) R&D program designed by mid yr4. • Sustainable RE system R&D program approved and initiated by the GoM by end of the project.
4.7 Formulation of Plans for RE-based Power Generation Projects in OIAs.	• Proposals for RE-based power system projects completed by end of project.

Output 4.1-4.4 and 4.6, 4.7

These activities are a still pending

Output 4.5

Activities implemented:

- Guaranteed Fiberglass Fabrication (GFF) staff was trained to manufacture, operate and maintain biogas digesters
- R. Fainu residents were trained to operate and maintain the solar-wind hybrid system

2.1.5 Outcome 5 RE Project Financing Schemes

Table 5 Outputs and indicators of component/outcome 5

Outcome:	Encouragement of the government and private sectors to provide financial assistance to the development and implementation of RE-based energy projects, as well as livelihood and productive use initiatives that will utilize energy from RE-based projects.
Indicators:	Financing assistance program for RE-based energy projects, as well as RE-supported livelihood and productive use projects are established and availed of by project developers and island communities by end of yr3

Outputs	*Indicators*
5.1 Design and conduct of a Training Course on RE Projects and RE-based Livelihood / Productivity Projects Financing	• A total of 3, one for each group, training courses conducted for: (1) private and government financial institutions; (2) commercial banks; and, (3) private entrepreneurs, by end Q2 of yr3. • RE-based projects and productivity projects are being considered for financing by private and government financial institutions; commercial banks; and, private entrepreneurs starting yr4.
5.2 Design and establishment of a Fund for RE System Applications (FRESA) in OIAs	• FRESA established by the GoM by mid-yr3.
5.3 Design and development of FRESA Financing Schemes	• Clear and well-defined mechanics of the FRESA financing scheme, including the financing eligibility criteria, available and enforced by mid yr3. • Legal status of IDCs (if necessary) for availing of financing from FRESA is established and secured by the end of yr2.
5.4 Provision of Assistance Services to FRESA Financing Applicants	• RE "One Stop Shop" in the NEO processing an average of 40 applications per year starting mid-yr3.

Output 5.1

Activities:

- A training session was held early 2005 on “Economic Analyses and Design of Sustainable Energy Projects and Programme” with funding from the European Union SMILES project
- Training on RE project finance was given to financial institutes & entrepreneurs in February 2007.

Outputs 5.2 and 5.4

Activities are still pending.

Output 5.3

A report on the the setup, guidelines and operational plan of the FRESA has been written (Salomon-Dealino, 2006 and 2007). A MoU on setting up the FRESA and providing financial services is currently under discussion between MEEW and the Bank of Maldives. The FRESA can provide loans for RE technologies to individuals (up to Rf. 50,000) and to enterprises and cooperatives.

2.1.6 Outcome 6 RE Project Development

Table 6 Outputs and indicators of component/outcome 6

Outcome:	a) Demonstration of the techno-economic viability, design, development, financing and sustainable operation & maintenance of RE-based energy projects; b) Facilitation of the effective demonstration of the techno-economic viability, design, development, financing and sustainable operation & maintenance of livelihood and productive use initiatives supported by RE-based energy projects.
Indicators:	a. Techno-economic feasibility of RE based energy projects in selected demo sites, including the necessary implementation requirements from the MCST, financing institutions and the national power utility established by yr3. b. Rural-based small to medium scale enterprises (SMEs) are operating profitably utilizing the energy from RE-based project by yr4.

Outputs	*Indicators*
6.1 Conduct of Techno-economic Feasibility Analyses of Potential RE-based Systems in IAs	• Report on the techno-economic feasibility analyses of potential RE--based energy systems in OIAs completed by yr3. • An average total of 4 feasible RE-based energy systems in OIAs each year.
6.2 Finalization of the demo sites, identification and evaluation of RET Application Demo Requirements	• Final list of demonstration sites approved by Q3 yr2. • Report on the feasibility and implementation requirements for the demonstration schemes completed by end of yr2.
6.3 Identification and implementation (in conjunction with Item 6.2) of courses of actions for the removal of barriers to the successful implementation of RE technology application demonstration schemes.	• Barriers to, and other necessary requirements for, the implementation of the demonstration schemes are eliminated / mitigated by the end of yr3. • Verified and confirmed availability and magnitudes of RE resource potentials in the selected demonstration sites completed by the end of yr2. • Financing assistance mechanism for financing of RE supported livelihood/productive use projects in the demo sites is set-up and implemented by Q1 yr3.
6.4 Provision of Assistance Services to FRESA Financing Applicants	• Electricity consumption and demand surveys at the demonstration sites and baseline performance data established by the Q2 yr2. • Operating performance targets for the planned RE systems are defined by Q2 yr2.
6.5 Finalization of the design of the RE system that will be implemented in the demonstration schemes.	• RE system basic engineering design for each demo site completed by Q3 yr2. • Comprehensive technical and economic feasibility evaluations of demo RE systems completed by end of yr2. • Detailed engineering designs of each demo RE systems completed and approved by Q2 of yr3.
6.6 Implementation of RE	• Equipment procurement and delivery at each site completed well

	demonstration projects	within project time line. • Civil engineering, electro-mechanical equipment and support facilities construction completed well within project time line. • Installation and commissioning of each demo RE system completed well within project time line. • Demo site owners are satisfied with the technical assistance provided during start-up of the facilities.
6.7	Monitoring and Evaluation of the performance of each demonstration scheme	• An evaluation report for each demo RE system highlighting the operating and economic performances completed midway of project implementation. • RE-based energy system project implementers are reporting bi-annually the energy and GHG reduction impacts of their respective projects. • Survey of energy savings from RE-based system (non-electricity) projects conducted annually starting yr4.
6.8	Evaluation and dissemination of the results of the demonstration Program	• A national workshop presenting the results of the demonstration program • Documented comments about the operation of the demonstration program by end of project. • Increased installed capacity of RE-based power systems in the country bringing up the total to 100 kW by end of project.
6.9	Design of sustainable follow-up program for RE development	• Financing scheme is in place for supporting a follow up program for RE technology applications by end of yr4.

Outputs 6.1-6.3

Activities carried out so far:

- Six islands A. Dh. Mandhoo, V. Thinadhoo, Lh. Olhuvelifushi, R. Rasgetheem, R. Fainu and R. Hulhudhufaaru were selected to survey for solar and wind hybrid demo projects. Surveys to find baseline data were conducted in these listed islands and feasibility studies were done by the project staff for each of 6 islands surveyed;
- At the first Project Steering Committee meeting a potential site for the solar-diesel pilot project and a potential site for the wind-diesel hybrid pilot project was selected. A. Dh Mandhoo was selected for the site for the solar-diesel pilot project.

Outputs 6.2, 6.5, 6.6

Installation of the solar-diesel pilot system started by the end of December 2005 in Mandhoo Island (Ari Atoll) with support from the EU-SMILES project and ADEME. The purpose of the system is to study the solar RE systems and convince the general public the potential of solar in supplying power to the islands. After 8 suppliers sent in their bids, the company BP Solar was selected and an order was placed for equipment (12.8kWp PV panels, 108kWh battery bank and other necessary equipments) of value around € 96,600. The solar array of 12.8 kWp supplements the existing island power plant consisting of two 32 kW diesel generators (one operational during the day, the other during the evening and night). Total cost of equipment and installation was around US$ 180,000, supported by the French agency ADEME and with a UNDP contribution of US$ 50,000. Installation was completed by August 2006. The idea was that the solar array could replace day-time diesel operation. It turned out however that even during the day demand outstrips the solar facility's capacity[12] and the solar system has never been in operation.

[12] The survey estimated peak demand in Mandhoo at 6 kW only and the solar array was thought to be safely 'oversized' at 12 kW. However, many islanders found employment in the nearby Hilton resort on Rangali Island. The resulting rise in living standards has led to the use of electric appliances, such as colour TV, refrigeration, fans, etc. Peak demand is now an estimated 20 kW (early evening peak), reaching 25 kW or more during holiday (when children look TV during the day) and the Ramadan, which is met by the two 32 kW diesel gensets (each working in 12-hour shifts), consuming about 110 litres of diesel per day. There are about 400 people living on Mandhoo (about 40 households). The current electricity tariff is Rf 4.5 per kWh.

Two solar-wind systems have been installed with UNIDO support in B. Ghoidhoo (8 kW, to mpower the community centre) and R. Fainu (8 kW, providing power for about 130 villagers) and which are operational. Some solar PV systems have been installed in office buildings, e.g. in L. Ga and L. Fonadhoo (CDE, 2007).

Maldive Gas[13] has installed solar-wind-diesel hybrid system in Ha. Uligam and in M. Raimandhoo (which are currently in its testing phase)I and is constructing a 23 kW system on GA. Konday.[14] A MoU has been agreed upon between MEEW, Maldive Gas, STO and the Singaporean company Daily Life to install solar-wind-diesel hybrid systems in another 100 islands.

One pilot domestic biogas plant of GFF is operational with the assistance of RETDAP in Thilafushi Island and another biogas digester has been installed to R.Fainu with UNIDO support, while another is planned to be shipped to another island. In addition, GFF is planning to donate three pilot plants to three atolls.

Outputs, 6.4, 6-7 - 6.9

These activities are still pending.

2.2 Project implementation: impacts of the project

This paragraph provides an overview of the project impacts, as far as quantitative and qualitative data are available. The potential impacts are summarised in Table 7 below.

Table 7 Potential impacts of the project

Impacts	***Indicators***	***Estimated value (as mentioned in APR-PIR 2007)***
1. **Development goal:** The growth rate of GHG emissions from fossil fuel using activities, such as power generation and process/water heating, is reduced through the removal of the major barriers to the development and application of renewable energy (RE)-based systems that can supplant part of the fossil fuel use in the Maldives.	• Annual greenhouse reduction due to RE replacing fossil fuels (in power generation) in tCO_2 per year • Cumulative CO_2 reduction that can be directly and indirectly attributed to the project • Energy (MWh/year) produced annually • Installed capacity (kW, MW) of RE energy technologies	• 50 tonnes due to solar and wind projects directly associated with the RETDAP project • Currently implemented are Mandhoo, PV-diesel, 12.8 kW; Fainu: 8 kW solar-wind and some other projects
2. Productive and social uses of energy	• Number of people or businesses with improved income and income generated • Energy expenditure • Savings on avoided fossil fuel • Impact on social services (health, education,	To be determined

[13] A subsidiary of the State Trading Organisation (STO)

[14] In Uligam, a combined capacity of 45 kW of solar and wind (approximately double the peak power demand) backed up by a 32 kW diesel generator to provide power to the 450 islanders. The system is owned by STO that put up the investment. Local people have been trained and will be employed by Maldive Gas to operate the system. On M. Raimandhoo, a 40 kW solar-wind hybrid system has been installed.

	communication) • Impact on social organization and relation with local government	
3. Development of sectoral policies, laws and regulations that support the project goal	• Adoption/creation/enactment of new policies and regulations	• The first National Energy Policy was developed; the country has a commitment to produce 10-2% of its energy demand in 2015 with 8.5 MW of RE.
4. Expansion of business and supporting services for RE	• Number of additional businesses with project-related purposes	
5. Increase in finance and financing mechanisms	• Amount of financing disbursed • Financing modalities developed	• Microfinance facilitated by the RE fund with a volume of $ 250,000

The proposed energy policy aims at a 10-12% share of renewable energy in energy supply. Assuming a more conservative estimate of 8% RE in the energy mix, this would imply:

- Substitution of petroleum fuels of 28,000 tonnes of oil equivalent (toe) by the year 2015;
- Total investment in RE of about Rf 1,000 million (including subsidies of Rf 250 million)
- Job creation of about 100 jobs
- Net national cost over the period 2005-2015 of Rf 250 million
  - Increased imports of equipment and services, Rf 670 million
  - Reduced oil imports of Rf 420 million
- Net national benefit from 2015 onwards of Rf 42 million[15].

Regarding the 50 tCO_2 at the end of the project as mentioned in the APR-PIR (2007), the Evaluation Team has that RE equipment needs not only to be installed, but to be operational to be able to claim real CO_2 emission reduction.

2.3 Implementation: assessment of the evaluation team

2.3.1 Project relevance and country drivenness

By the start of the 21st century, RE technologies were limited to some applications of solar photovoltaics (PV) in navigation lights and outer island telecommunication systems and to modest use of solar water heaters in resorts and in Male'. Energy planning was in essence not more than island electrification with diesel generators. Lack of essential information on energy demand and supply, renewable energy resources and lack of trained staff hampered the ability to perform energy policy formulation, let alone the ability to develop a RE strategy. The lack of essential data on available wind, solar and biomass energy resources and on the appropriateness and viability as well as the lack of visible demonstration of RE technologies were major barriers for government and private entities alike to sustainable RE development.

Over recent years, the Government of Maldives has been stressing more and more environmental and climate change related issues and sustainable energy planning. For example, the 6th National Development Plan mentions 'to plan and manage the provision and utilisation of energy and the

[15] If all the CO_2 benefits could be sold under the Clean Development Mechanism at $ 10/tCO2, this would create additional benefits of US$ 7 million, or about Rf 84 million. Source of data: Energy Consulting Network (2004c) and Aldover (2006)

supply of electricity in the country' and 'to minimise the dependency on imported sources of energy for generating power'. RETDAP and the related Energy TTF/UNOPS activities have been instrumental in realising these policy goals. Currently, the draft National Energy Policy is under consideration at the President's Office. It has been proposed to include a 10-12% target share of RE in the energy supply mix in the 7th National Development Plan.

This clearly shows the commitment of the Government to a national renewable energy policy and the country's ownership in accordance with its development principles. In fact, RETDAP has arrived in a time-critical way coinciding with the Government's attempt to formulate the first national energy policy. The project has been catalytic in laying the groundwork for renewable energy promotion and development in a holistic manner and in attracting other sources of funding for RE development[16].

RETDAP has also managed to mobilise the interest of state entities that before were not interested in renewable energy, such as Maldive Gas and its parent company STO.

2.3.2 Project conceptualisation and design

The objectives and expected outcomes and outputs are indicated in the logical framework laid down in Annex II of the UNDP Project Document with success indicators and risk assumptions, based on the analysis of barriers, given in the same document. Tables 1-6 in section 2.1 provide a summary of outputs and indicators.

The project has recognized at the outset that, in order to remove these barriers, it was not sufficient to implement just technical solutions but also look at 'soft' options like capacity building, national RE strategy formulation, institutional strengthening and financial options to ensure long-term sustainability. The approach follows a logical sequence:

- First, make a detailed assessment of the available renewable resources (solar, wind, biomass) and organise the first ever gathering of data on energy consumption and supply;
- Second, support the Government-planned restructuring of the energy planning function in one entity (since recently the Energy department under MEEW) and the subsequent formulation of a national energy plan;

The Evaluation Team concludes therefore that *the problems that the project addresses are clearly identified. Regarding the approach followed to tackle the identified problems, the Evaluation Team has two observations:*

First, the logical framework of outputs (especially components 5 and 6) seems to implicitly assume a large role of the private sector in RE without explaining what the (current and future) role of the Government, private sector and end-users in acquiring RE technologies in Maldives could be and without distinguishing between target group (community, resort or household) and type of technology (solar PV, wind, solar thermal, biomass).

Second, the logical framework seems quite elaborated with an extensive and very detailed list of expected outputs and associated indicators. The Evaluation Team wonders a bit, however, on what existing data and analysis such a detailed framework is based, given the fact that when RETDAP was under formulation, very few data on energy was available, experiences with renewable energy was scant and also given the fact that no PDF B funds were applied for to do the basic analysis for the elaboration of the logical framework.

Take for example the indicator of 'development goal' in the project logical framework. It is assumed that the annual consumption of diesel fuel oil (DFO) in the RE (GEF) scenario will be

[16] Trough UNDP (Energy TTF, Danish Fund/UNOPS) and other donors (EU SMILES project and the French agency ADEME)

some 2% less than in the business-as-usual scenario and that the annual growth in RE installed capacity is also 2%, but it is nowhere substantiated why this should be 2%. Given the lack of energy data at the moment of project formulation, it is perhaps unavoidable that such 'guesses' had to be given, but it seems to suggest an exactness which is not there.

The objectives and outputs of the project are formulated in very much detail with observable success indicators and a logically articulated relationship between objectives, outputs and activities, although is not exactly clear on which analysis the whole framework and suggested CO_2 emission reduction is based.

The RETDAP project aims at building local capacities and raise awareness on RE technologies among the end users, private sector and decision makers in government. Regarding stakeholders identification, it must be noted that Maldives is a small country, so it is not too difficult to identify the key players on the 'energy scene' in Maldives. The list of stakeholders, as detailed in paragraph 1.4) seems to be complete to the Evaluation Team's opinion.

Another question is how these stakeholders' viewpoints are taken into account in the project design, given the fact that the design stage was 'short'. RETDAP has been quite successful in raising awareness amongst government, private sector and beneficiaries about RE. At this point in time, it might be useful to learn more about the perceptions and attitudes of stakeholders on RE and opinions after having had the first experience with RE implementation. This is all the more important now that the financial support scheme has to be set up and such a scheme can only function successfully if beneficiaries and private sector have an interest and confidence in RE.

The stakeholders and beneficiaries are clearly identified in the project design. With RETDAP being midway, some investigation should be done at this stage on the stakeholders' opinions and perceptions regarding RE (and RETDAP in particular) in order to be able to direct RETDAP's activities in its remaining project period.

2.3.3 Financial planning and delivery of counterpart inputs

Table 8 provides an overview of the original budget allocation per component and per budget item and of the actual expenditures until 30 June 2007. After 2½ years of project implementation, it appears at first look that the project's funds have been quite underutilised; only one-third of the available GEF funding has been used. However, it should be noted that a large part of the GEF funds, US$ 250,000 is a capital grant to set up the financial mechanism. Subtracting this amount from the total budget of US$ 750,000, we can derive that expenditure rate of the technical assistance activities is closer to 45%, which is normal also given the fact that project has met some delay (as will be explained in the next paragraph 2.3.4). The travel budget (US$ 176,800) seems extraordinarily high; if calculated as being 30% of international consultants' budget and 10% of national consultants' budget, this should be in the order of $ 60,000. Of the budgets for international consultants and travel only 8% has been utilised so far.

Table 9 provides an overview per component of the available co-financing and the estimated co-financing disbursements until end of June 2007. Co-financing expenditures have followed the implementation of the technical assistance activities. The UNDP contribution (US$ 5,000) and the ADEME-EU co-financing of US$ 180,000 has been used mainly to set up the Mandhoo solar-diesel pilot system (component 6). The UNDP Energy TTF and Nordic Fund co-financing of US$ 269,000 have supported the resource assessment and policy development activities (components 2 and 3). Apart from developing the Mandhoo solar-diesel pilot system, most of the project financing and project development activities are still pending (components 5 and 6), and so are the MoAD (formerly called MAA)[17] and STELCO contributions to investment in RE technology as well.

[17] MoAD: Ministry of Atolls and Development; MAA: Ministry of Atolls Administration; STELCO: State Electricity Company

Table 9 Planned UNDP-GEF budget and actual disbursements (per component and per budget line)

Component	Expenditures (US$)					Planned budget (US$) UNDP-GEF	Expenditure rate (%)
	2007	2006	2005	2004	TOTAL		
Project management and M&E	5,154	15,882	16,813	8,333	*46,181*	115,501	40%
1 RE Advocacy	93	5,275	21,169	1,912	*28,449*	56,501	50%
2 RE Resource Assessment	-	-	4,142	-	*4,142*	13,678	30%
3 RE Policy dvpt	-	-	4,318	-	*4,318*	44,063	10%
4 RE Techn Cap Building	6,725	15,702	-	270	*22,697*	116,443	19%
5 RE Project financing	1,616	-	-	-	*1,616*	256,601	1%
6 RE Project dvpt	1,711	20,959	79,529	881	*103,080*	122,213	84%
TOTAL	*15,298*	*57,817*	*125,971*	*11,397*	***210,483***	***725,000***	*29%*
Budget item							
Internat consultants	1,487	1,552	3,561	-	*6,600*	106,600	6%
Nat consultants and staff	4,413	14,987	13,561	6,335	*39,296*	70,410	56%
Travel	1,712	7,347	673	265	*9,997*	176,800	6%
Training & workshops	6,853	20,299	25,871	2,476	*55,500*	61,820	90%
Equipment	-	12,550	78,853	874	*92,278*	33,620	274%
Micro-finance						225,000	0%
Evaluation	-	471	-	-	*471*	29,000	2%
Miscellaneous	832	611	3,452	1,447	*6,341*	21,750	29%
TOTAL	*15,298*	*57,818*	*125,971*	*11,397*	***210,483***	***725,000***	*29%*

Source: compiled from project *Quarterly Financial Reports*, October 2004-June 2007

Table 8 Planned project co-financing and actual disbursements

Planned co-financing	In-kind (US$)	GOM	UNDP TRAC	UNDP TTF	UNOPS Nordic	MoAD	STELCO	GFF	ADEME	SMILE	Total cash (US$)
1 RE Advocacy	78,900	20,000		10,000							*30,000*
2 RE Resource Assessment	31,080			84,000	115,000						*199,000*
3 RE Policy dvpt	43,580				60,000						*60,000*
4 RE Techn Cap Building	18,570										-
5 RE Project financing	29,930		50,000			130,000					*180,000*
6 RE Project dvpt	128,720		50,000				1,160,000	4,000			*1,214,000*
TOTAL	***330,780***	*20,000*	*100,000*	*94,000*	*175,000*	*130,000*	*1,160,000*	*4,000*			***1,683,000***
Est.disbursements, mid-2007	***203,000***	*20,000*	*50,000*	*94,000*	*175,000*			*4,000*	*105,000*	*75,000*	***523,000***

Source: compiled from APR-PIR (2007)

2.3.4 Implementation and implementation approach

Performance of the project

Given the fact of a baseline of 'almost zero activities regarding RE', the project has correctly started focussing first on advocacy and awareness raising (components 1), carrying out the RE resource assessment (component 2), setting up a policy framework for (sustainable) energy (component 2) first and on having some demonstration of RE technology on the islands, e.g. the solar-diesel hybrid system at Mandhoo. However, the proof will be in the pudding now that the project enters a next phase of setting up financial support mechanisms and installing more RE technologies on the island.

The latest quarterly progress monitoring form gives an estimate of the progress of the activities. The Evaluation Team concurs these estimates, although slightly adapting the figures mentioned in the progress monitoring form according to the Team's observations):

- Project management, 40%
- Advocacy and awareness, 50%
- Resource assessment, 85%
- Policy development and institutional strengthening, 90%
- Technical capacity building, 25%
- Project financing schemes, 35%
- System project development, 55%

Overall rating of the progress so far is 55% (of outputs achieved over the entire project period)

It should be noted that at the start of the year 2005, many activities scheduled in the project were delayed as a result of the 26 December 2004 Asian Tsunami. In addition to that, the change in government ministerial structure in July 2005 also contributed further delays to the project activities.

Given these constraints, the Evaluation Team concludes therefore that *the project has performed satisfactorily so far.*

Monitoring of project activities and performance

The progress in activities, budget disbursements and the project's achievements are regularly reported in the quarterly financial reports and the annual project report (APR-PIR[18]). A detailed progress report has only been made for the period 2004-2005, with less detailed progress reports for early 2007. Also, the activities of the Energy TTF / UNOPS activities are documented in two progress reports (2003 and 2004).

We noticed, however, that the elaborate framework of outcomes, indicators and verifiers, given in Annex II of the Project Document is not really used as a tool for monitoring project progress and impacts. Up to now, no baseline study has been done to quantify the indicators and such a study needs to be done urgently.

The Evaluation Team concludes therefore that *the progress of project activities is being monitored, but the logical framework of the project with its performance indicators and verifiers is not being used as a monitoring and evaluation tool for the project's impacts, outcomes and outputs,*

Role of management organizations, management arrangements and partnerships

The project is nationally executed by MEEW with UNDP as the implementing agency. As such management has apparently been smooth, especially also because a specific Department of Energy was formed under MEEW and with the Project Director, Mr. Abdul Razzak, now having the rank of Deputy Minister. A Project Steering Committee was formed and met regularly in the beginning. After the government restructuring the Steering Committee has not met again.

One problem that has hampered project implementation is the relative small capacity in terms of available qualified staff at the Energy Department of MEEW. Many government agencies in general have difficulty to attract and maintain qualified younger staff that in the end prefer to go abroad for advanced studies or be employed somewhere else. The project has had two Project Managers and the last left the project in February 2007. Project implementation therefore seems to have slowed down over the past year therefore.

[18] APR-PIR: annual project report – project implementation review

On the positive side, MEEW (and before MCST) has managed to attract a number of partners in the implementation of energy planning and renewable energy, including other donors (UNDP, ESCAP, EU and ADEME), other state entities (such as Maldives Gas and STO) as well as entrepreneurs (e.g. GFF) and financial institutions (Bank of Maldives) over a relatively short time period. RETDAP, being the largest initiative, has served as rallying point.

2.4 Project sustainability and replicability

Project sustainability

The project provides strong emphasis to develop local capacity through appropriate training, technical capacity building as well as advocacy and awareness creation. As part of RETDAP and the related Energy TTF activity, a National Energy Policy has been formulated and is under consideration by the President's Office.

RETDAP has played an important role as catalyst in jumpstarting the RE market from almost zero application (apart from a PV for telecommunications and some application of solar water heaters) to the first application of six solar/wind/diesel hybrid systems, the first indigenous production of household biogas digesters and raising the interest of various governmental and private sector entities as well as some of the resorts.

Regarding financial sustainability, some RE technologies will be cost-effective while other will (still) require subsidy, depending on their application and target group and on the international prices of fossil fuels. This fact should be strongly taken into account when developing other RE projects in the islands.

Replicability

The replicability of the project will depend on large part on how the barriers, mentioned in the Introduction chapter, are lowered. One positive factor is the possible commitment of the Government to 10-12% share target in the energy mix by 2015, which is under discussion to be included in the forthcoming 7th National Development Plan.

The RETDAP project includes setting up of a financing mechanism to promote and support the application of RE technology, but the project's replicability will depend on a concerted effort to set up a technology and delivery support system with involvement of the private sector. This implies not only enhancing and developing adequate technical capacities in the Maldives but also capacity strengthening at the national and local level to be able to provide services for installation and maintenance, including even some local manufacturing of parts of the RE equipment (a barrier this project addresses in its component 4).

3. LESSONS LEARNED AND RECOMMENDATIONS

3.1 Lessons learned

Installation of RE systems

The installation of the 12.8 kW solar-diesel systems at Mandhoo islands is probably an example of the problems with installing new technical hardware. Soon after installation, one of the two inverters of the system was malfunctioning, which was sent to the manufacturer for repair. Later lightning struck the system, destroying some of the electronic circuits. It took several months to get the French-made inverter replaced and the electronic cards repaired. Finally, when the system was put in operation, it was shut down again after 3 hours, because the demand could not be met by the system.

Some lessons learned for future renewable energy (RE) installations are:

- Many of the electrical appliances are unique to the manufacturer and thus making it difficult to service by a technician not specifically in the technology;
- Future RE application project should be delivered in a running-and-testing scheme and should include a check-up by the manufacturer 6 months or so after installation;
- Lightning control measures should be considered when installing RE installations;
- Future project should consider regional providers of appliances in order to avoid extended shipment time and expenses.
- Power demand (present and future) should be determined as precise as possible, so that the diesel / wind / hybrid system can be sized in such a way that the power demand can be met in a cost-effective way

Role of foreign assistance

Although hampered by understaffing, the 'energy group', first at MCST and now at MEEW, has managed to formulate an energy policy (draft, now under discussion at the President's Office) and within the policy's framework has embarked on the promotion of renewable energy as part of the country's environmental strategy.

In many countries, donors sometimes duplicate efforts in one area and leaving gaps in other areas. In the Maldives assistance by donors, at least in the energy field, seems to be part of a concerted energy planning and development effort. The Outer Island Electrification (OIE) project (facilitated by an USD 8 million dollar loan by the Asian Development Bank) has focussed on island electrification by means of diesel generators. Funding provided by GEF, UNDP and the Danish Government (Nordic Fund) has been channelled through UNDP to focus on energy policy formulation as well as on RE resource assessment, capacity building and technology demonstration. Smaller funds have been provided by USAID for solar and wind resource modelling[19], ESCAP on institutional strengthening[20] as well as the European Union and the French energy agency ADEME.

[19] South Asia Regional Initiative (SARI)

[20] See the report *Defining the Structure of a National Energy Agency for the Maldives,* by B. Mohanty (July 2003)

3.2 Recommendations for the project

3.2.1 RETDAP project

Energy supply and demand

As the experience with the installation of the solar-diesel hybrid system has shown, a lot of changes in electricity demand has taken place on many Maldivian islands due to economic growth on the islands. Earlier studies, such as the ADB report on electricity supply, distribution and demand[21] and the more recent energy demand and supply study by Energy Consulting Network (2003) should be updated on a regular basis, because variables such as power demand and price of fossil fuels tend to change quite a lot over time.

Policy making

If the draft National Energy Policy is approved by the President's Office, next step would be to 'translate' the policy guidelines into a specific National Action Plan, supported by RETDAP if the budget and RETDAP's timeframe allows so. Measures to be considered in such an action plan are:

- Fiscal measures (such as environmental taxation, tax exemption for RE);
- Financial mechanisms, for which the proposed Fund for RESA of RETDAP could function as a catalyst;
- Regulatory measures, e.g. the Island Development Committees (IDCs) are not backed by a legal status regarding energy supply; in fact, specific regulations for independent power generation and the pricing of RE technologies (perhaps a national framework for RE feed-in-tariffs) are not in place yet;
- Support for technology development, such as the locally produced biogas digesters;
- Awareness raising, information dissemination and capacity building.

Capacity building

Technical and managerial capacities in energy are mainly confined to STELCO and private power producers servicing the resorts. One problem voiced during the interviews with MEEW officials, is the difficulty to attract more senior staff, leaving positions to people that has recently graduated. In this context, having such junior staff to attend meetings or short courses abroad may not be effective, if their knowledge level is not appropriate enough. The alternative of having tailor-made courses on RE for selected MEEW staff in the Maldives would be quite expensive and may not be effective as the trained staff may not be retained anyway. This issue should be carefully considered when further implementing the technical capacity component of the project.

Maybe one option is to create some more permanent form of training courses on RE in Maldives, for example in cooperation with the Faculty of Engineering Technology of the Maldives College of Higher Education, which has conducted some short courses on energy transmission and distribution in the past. 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.

Table 8 shows that much less use has been made of international and national consultants than originally planned. Maybe more use could be made of subcontracted individuals on a temporary basis to fill the gap in capacity at MEEW.

[21] *Preparing the Outer island Electrification Study* (2000), by John Worall Pty Ltd for the Asian Development Bank, consisting of Volume I: Executive Summary and Recommendations, Volume 2: Main Report and Appendices, Volume 3: Sample Island Analysis, Volume 4: Renewable Energy

Baseline study and work plan

With 50-60% of activities implemented, RETDAP now goes from a first awareness creation, policy strengthening and data collection phase towards a phase of implementation of financial measures, targeted technical capacity building and development and implementation of RE projects. For example, Maldive Gas has agreed on a MoU with MEEW on the installation of hybrid systems on 100 islands; such activities should be supported by RETDAP and the experience with the operation of the systems will help RETDAP re-define its activities according to the lessons learned. To have ample time to make this possible, the Evaluation Team recommends extending the project until at least the end of 2008. A sound work plan should therefore urgently be developed by the new Project Manager for the remaining period 2007-2008 with a revised budget attached to it. In this budget perhaps a larger amount of money could be dedicated to RE project development as in the original budget, by supporting the initiatives undertaken by Maldive Gas, Guaranteed Fibergplass Fabrication (GFF) and other actors. In any case the budget should be carefully re-allocated according to needs of the activities under the various outcomes.

Since no real baseline study has been organised, it is important to urgently collect data in a combined 'baseline/mid-term impact' study, trying to quantify the indicators of the project results framework (Annex II of the Project Document) as much as possible. Such a study would also provide a more informed basis for making the above-mentioned Work Plan 2007-2008. In this respect, the Evaluation Team noted, for example, that the elaborate tables given in the Project Document are not used as a monitoring tool. The APR-PIRs use a smaller set of indicators than the original logframe. The study should therefore first check the indicators and verifiers about their usefulness and update was necessary. To facilitate this, the Evaluation Team has drawn up an updated project logical framework (see Annex C).

A similar impact study should then be done at the end of the project to be able to quantify the project's impacts and outcomes.

Project management

The Project Steering Committee has not met in 2006 and 2007. To the Evaluation Team's opinion the Committee should at least meet twice a year to provide overall guidance to the project. Now that RETDAP goes more from the awareness and basic capacity building towards implementation, its membership should be expanded to include private and public entities (if not in a decision making capacity, at least in an advisory role) that are actually involved in project implementation, such as Maldives Gas (wind energy), GFF (producing household biogas digesters), solar water heater importers, etc.

RE project development

The original project document refers to RE technologies in general in its components 4, 5 and 6, but actually this is masking the fact that RE technologies form quite a diverse group of technology in terms of maturity, financial viability, scale of application and type of application. It would be better to subdivide 'RE technologies' into certain *product-market clusters*. Each cluster faces different barriers and has different needs in terms of capacity building, technology support infrastructure (sales and after-sales) and financial support and requires different approaches by the government and other institutions involved.

We can distinguish between the following product-market clusters:

Individual RE applications

1) *Solar water heaters (SWH).* Main application is currently in the resorts. According to Energy Consulting Network (2004c), Alba International (a dealer of Solarhart's products) has around

half of the SWH market in the resorts[22]. Maybe around 27% of the hot water of the estimated 16,400 bed at resorts is heated with SWH systems (a total SWH surface area of around 6,560 m^2). Residential buildings are normally not equipped with domestic hot water, but a demand for hot water may rise in time and some support from the proposed Fund for RE Systems Applications (FRESA, component 6 in RETDAP) might be taken into consideration.

2) *Solar photovoltaics (PV).* With prices of around Rf 8-10/kWh PV systems are not feasible for rural electrification, given the fact that most households are electrified anyway. Applications mainly exist on boats, in telecommunications and maybe could be applied in 'green' resorts, e.g. for path lighting.

3) *Waste and biogas.* Most islands are small, with 300-2000 inhabitants. As fuel for cooking, households use a mix of kerosene, LPG together with other burnable biomass materials are used (that basically contain shrubs, coconut husks and parts of the coconut palm) for domestic uses (for lighting and cooking Due to scarcity of biomass and a ban on cutting trees, demand for LPG and kerosene is rising rapidly.

   A recent survey estimated that the annual waste generation on inhabited islands is about 0.8 kg per capita per day, consisting 75% of organic waste and 25% of inorganic waste. On the islands, waste is usually disposed of in (beach) landfills, burnt or simply dumped into the sea. Waste management measures have been proposed, such as fencing waste disposal sites on the islands and segregation of non-combustible waste; e.g. items such as cans or plastic may be recycled and green waste (kitchen and fish waste) may end up in backyard composting.

   Another use of organic waste is in a biogas digester to generate energy with the additional benefit that the sludge can be used as fertilizer to enrich the low-nutrient island soil. Currently, one manufacturer in Maldives (Mr. Luthfee; Guaranteed Fiberglass Fabrication; see picture) has tested one type of household-size bio-digesters (see picture) of the floating-drum type, made of fibreglass-reinforced polyester. Fiberglas material is well-known in Maldives and for example used in the manufacturing of boats (of which Guarantee Fiberglass is one of the manufacturers, based on Thilafushi island, near Male'). The estimated investment cost of this plant is about Rf 8000 and could provide enough cooking gas for a family of 6 people. A household uses typically one LPG bottle (10 kg) per month at a cost of US$ 15 per bottle and an initial investment cost for bottles and one stove of about USD 70-80.

   Despite its reported technical and financial feasibility, the sale of household bio-digesters is not moving due to lack of marketing and awareness and access to funds. RETDAP could support demonstrating its practical application in a number of island communities. If proven to

[22] The following rule of thumb is used. Per bed 30 litre of water and 0.4 m^2 of storage is needed. The amount of oil saved in terms of energy is 1,700-3,200 kWh/m^2. Assuming a bed occupation rate of 60%, the savings are 1,170-2,190 kWh/m^2. On an annual basis, the savings are 6.3-11.8 GWh or 630-1,200 m^3 of oil.. The potential for new SWH in the resorts may be around 4,800 m^2 (12,000 beds) . Cost of the SWH is around Rf 10,000/m^2. Subtracting the cost of fuel (around Rf 5,300/m3 of oil) and the avoided cost of the electrically heated tank gives a payback period of about 2-3 years.

be acceptable by the island villagers, the proposed RETDAP renewable energy fund (FRESA) could help villagers in acquiring household biogas digesters[23].

Community-level and industrial RE applications

4) *Solar-diesel, wind-diesel and wind-solar-diesel hybrid systems.* In comparison with stand-alone wind or solar PV configurations, wind and solar diesel hybrid systems can be feasible under the right conditions. One reason why stand-alone RE system for electricity generation are not feasible is their low capacity utilization factor, i.e., a large part of the energy produced is not utilised expect during peak demand hours.

   The performance of wind systems is critically dependent on the wind speed, because the energy harvested is proportional to the velocity cubed. A wind resource map was made by the US National Renewable Energy Laboratory (NREL, 2003) based on satellite data. The measurements done at Vilingili, Meedhoo and Eydhafushi generally show somewhat lower wind speeds than the NREL estimates, but analysis by Energy Consulting Network (2004c) shows that wind-diesel hybrid systems can be feasible in comparison with stand-alone diesel generator sets under the right conditions in islands in the windy belts (wind velocity above 5 metres per second) and on islands with more than 40 households; such a wind hybrid system would cost about Rf 1.5-2.7 million (providing power for 40 and 60 household respectively) with an internal rate of return of 12-15%. A RE hybrid system can bring the price of electricity down with US$ 5-10 cents/kWh (Van Alphen, 2004).

   Wind-diesel hybrid systems are in most cases more profitable than their solar-diesel counterparts. Reflecting the relative high cost per kWh of solar power, solar-diesel hybrid systems are not feasible yet, unless subsidised by up to 60% of capital cost (Energy Consulting Network, 2004c) or unless international prices of PV panels come down substantially. On the other hand, a solar-diesel hybrid is easier to operate and requires less training of personnel and adding this cost of makes the technology more compatible.

   A national level study should be made on the power tariff. Current tariffs are supposed to cover operation cost (fuel and the operator's salary) of the diesel generator. The proceeds go into the local 'community fund'. In case of losses, these are covered from the same fund. In the case of renewable energy, the initial cost of investment is much higher in comparison with diesel generators, while the operating cost is lower (since fuel consumption is much less in hybrid systems). A tariff structure should be designed in which part of the RE investment cost is paid back to the investor/owner of the RE equipment.

5) *Solar powered desalination* plants (capable of producing 500 litres a day) are planned to be installed in R. Fainu and B. Goidhoo in 2007. If successful, this technology would be a solution for expensive plants that now run on diesel (CDE, 2007)

6) *Biomass* (wood and plant residues) as such is readily available at the islands and being used for cooking and smoking fish. Theoretically, biomass can be used in gasification or to generate steam for on-site heat application or power generation. Gasification technology has still not quite matured, but steam turbine technology is well established. However, to supply a typical Maldivian island with 500 inhabitants, the electricity base load demand would be too small for rational utilisation of such a plant (Energy Consulting Network, 2004a) as the typical range of viable small applications is 0.4-1.3 MW_{elec} (assuming an efficiency of 15-25%), which is larger than the power demand on the average island. A biomass energy facility could be viable if (a) additional small industrial uses would be available (e.g., workshop for nearby

[23] As such biogas is a versatile fuel,; it can be used for lighting, cooking, power generation. As a rule of thumb1 m^3 of biogas is equivalent to lighting a 12-20 W CFL for 30 hours, to cooking 3 meals for a family of 5-6 and to replacing 0.7 kg of petrol or is able to generate 1.25 kWh of power. This would require a 9 m3 plant, costing about $ 300-400 and would require an input of 25 kg of biomass per day.

resort, desalination or ice production) and if (b) part of the excess heat can be used in a combined heat power (CHP or co-generation) scheme, e.g., generating 0.5 MW_{elec} of power and 3.7 MW_{th} of heat (steam). Such a biomass CHP plant would need around 25-30 tonnes of biomass a day, but such amount of biomass would be available only on a few islands.

Industrial applications

7) *Landfill gas.* Waste from Male', Hulhule' airport, Vilingili and some resorts is shipped to a landfill on Thilafushi island. The total amount of waste shipped to Thilafushi was about 170,000 tonnes in 2002. The landfill was established in 1992 and a total of 640,000 tonnes had been deposited by 2003. Some materials such as scrap steel, plastic, aluminium cans, lead batteries, concrete and other building materials are separated and recycled, while the rest is piled and burned in open air. The combustion is far from completed, leaving some 50% of the waste in the landfill. Landfill gas originates from bacteria in the process of bio-degradation of the organic part of the waste under anaerobic (without air) conditions. It is mixture of methane (45-60%) and carbon dioxide. Some landfill gas extraction tests have been done at Thilafushi. Assuming an annual waste disposal of 90,000 tonnes, the potential landfill gas resource has been estimated at 400 tonnes of oil equivalent (toe) per year in 2006 ending with 16,380 toe per year in 2015 (Energy Consulting Network, 2004b and 2004c). The accompanying economic analysis of waste-to-energy scheme shows that the operation can be economically feasible[24]. This assumes that the gas generated could be sold to or be used for electricity generation for the neighbouring industries. RETDAP should support, maybe not the investment, but at least the preparation and development of a full-scale project.

RE project financing mechanism

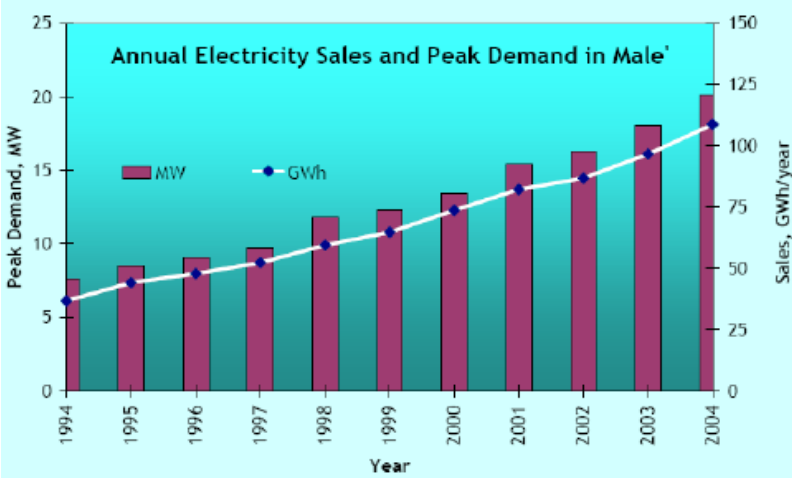
For each of the above-mentioned product-market clusters, it should be defined by what financing mechanism the Fund for RE Systems Applications (FRESA) could contribute. For example, rural electrification is highly subsidised in Maldives, whether diesel or RE technology is utilised. Usual practice is that the power generation equipment is provided with government funds to the community. It should be carefully looked at what role the proposed Fund for RE Systems Applications (FRESA, component 6) can play in community-level activities[25]. FRESA can play a more obvious role in financially supporting individual-level RE systems, such as biogas digesters and solar water systems

It is anticipated that the FRESA will be set up as a 'revolving fund'. An exit strategy needs to be designed, i.e., how the Fund would function and be replenished after RETDAP ends in 2008. Funding can come various sources, such as donors (e.g., GEF is contributing $ 250,000 to set up the Fund), funds public and private financial institutions, general tax revenues, environmental taxes, levy on energy sales, etc.).

[24] The landfill space at Thilafushi is created by excavating 60 m ×30 m ×5 m deep portions (called cells) and creating peripheral sand-bagged walls. After about one year the cell is filled and capped with sand. Equipping four new landfill gas cells with gas collection systems would require a series of investments of about US$ 6.2 million. 1 m^3 of landfill gas make 1.7 kWh of electricity which could be sold at Rf 3.5/kWh (US$ 0.27/kWh, the price at which the current power plant sells its power). Thus, the value of landfill gas is $ 0.425/m^3. The total amount of gas produced over 10 years is calculated at 25 million m., equivalent to US$ 10.6 million of income. Additional income could be generated if such a project would be registered with the CDM Executive Board and the CO_2 emission avoided could be sold as 'certified emission reduction'.

[25] Also, the size of a typical island electrification project is larger equivalent to the Fund's size. For example, the solar system on Mandhoo Island costed around Rf. 2 million, while the UNDP/GEF seed money for FRESA is about Rf 3 million. Without substantial money infusion, FRESA can only be used for individual-scale applications.

Figure 2 Annual electricity sales and peak demand, Male'



Source: CDE, 2007, taken from European Union SMILES project

Energy efficiency is currently not within the scope of RETDAP, but must be addressed by MEEW into one overall sustainable energy strategy. Due to economic and population growth, electricity demand has been rising rapidly, especially in the capital island Male', as indicated in Figure 2.

Apart from applying RE sources, two options to reduce the fossil fuel consumption are:
1) Energy efficiency and demand-side management
2) Introduce public transport in Male'.

Non-residential buildings (government and commercial offices) are the principal electricity consumers, representing over 52% of total energy consumption in 2003 (CDE, 2007) with the residential sector accounting for the remaining 48%. The high energy demand in offices leads to a high day peak; as much as 84% is contributed by the non-residential sector and a great share can be attributed to the air conditioning loads. Power demand may reach twice the current installed capacity in the next 5-7 years, but the possibility of expand STELCO's power station on the already congested island is very limited.

With GEF[26] and/or other funding, UNDP could support a medium-sized energy efficiency in buildings project, focussing first on the public buildings (offices, hospitals, schools, etc.), second on buildings under design or under construction as well as giving support to owners of existing buildings. Activities could include:

- Increase awareness (on public building and government officials, building constructors and owners) on available approach to implement energy efficiency in buildings;
- Showcase ' green' investments in public buildings;
- Policy framework and regulatory measures, such as building codes and standards and labels for appliances;
- Setting up an 'energy conservation fund' (that perhaps could be initiated by expanding the renewable fund FRESA into energy efficiency and conservation) and appropriate financing mechanisms.

At present transportation is not well organized with any systematic and planned public transport (both in Male' and outer atolls). As a result usage of privately owned cars and motorbikes, demand

[26] Under the new GEF 4 funding cycle (starting 2007), the following strategic programmes have been identified under climate change: (1) Promoting energy efficiency in residential and commercial buildings, (2) Promoting energy efficiency in industry, (3) Promoting market approaches for (on-grid) renewable energy, (4) Promoting sustainable energy production from biomass and (5) Promoting sustainable systems for urban transport. More information is available at the GEF website www.thegef.org

for fuel, cost of transport air pollution and traffic congestions has increased drastically in Male' over the years. It is expected that it will grow by 200% over 15 years. Another reason for the resent congestion is the haphazard traffic management and lack of parking management. Many roads in Male' have been made one-way. There is evidence from the traffic counts that this needs to be revised since directional splits in the two way roads are disproportionate indicating that road utilisation has become poor. There is no parking fee and no effective control of parking at the present. Even though there is considerable pedestrian activity, facilities for pedestrians in Male's narrow streets is grossly under provided. Introduction of good quality public transport and pedestrian facilities will reduce this growth rate. There is also the need to consider some roads where pedestrian flows are dominant to be redesigned as pedestrian walkways with limited vehicular access.

With GEF and/or other funding, UNDP could support a medium-sized public transportation project in Male', focussing on the following activities:

- Public education, advocacy and awareness;
- Introduction of a high-quality minibus system in Male' (requiring a fleet of about 15 minibus with 16-20 seating capacity)
- Reduction of energy demand
- Re-engineering of roads and of parking facilities
- Good traffic management

Such activities could be part of a wider package of measures proposed in the study EDC (2007b), including promotion of fuel-efficient vehicles, alternative fuels, vehicle management and fiscal policies.

ANNEX A. TERMS OF REFERENCE OF THE EVALUATION

Independent Evaluation of Climate Change / Renewable Energy Project, Maldives

Project Title:	Renewable Energy Technology and Application Project (RETDAP)
Functional Title:	International Consultant for Independent Evaluation
Duration:	May to June 2007
Travel costs:	The costs of in-country mission(s) of the consultant are to be included in the lump sum.

1. Purpose of the Evaluation

In accordance with UNDP/GEF M&E policies and procedures, all regular and medium-sized projects supported by the GEF should undergo a Mid Term Evaluation.

The Mid Term Evaluation is intended to assess the relevance, performance and success of the project up to date. It looks at signs of strength, weakness and impact and sustainability of results, including the contribution to capacity development and the achievement of global and national environmental goals.

The Mid Term Evaluation also identifies/documents lessons learned and makes recommendations to improve implementation of the project.

The Mid Term Evaluation will feed into management and decision making processes of UNDP, Government and national stakeholders. Furthermore, it will give important inputs to the Country Office Environmental Outcome Evaluation to be carried out simultaneously.

2. Project Description

The Renewable Energy Technology Development and Application Project is a Global Environment Facility (GEF) co-financed project, implemented by the United Nations Development Programme (UNDP) and executed by the Ministry of Environment, Energy and Water (MEEW) in the Maldives.

The development goal of this project is the reduction of the growth rate of GHG emissions from fossil fuel demanding activities, particularly diesel power generation through the removal of major barriers to the development and application of renewable energy-based systems that can replace part of the fossil fuel use in the Maldives. The project has assessed the potential for implementing renewable energy (RE) applications for electricity and non electricity production according to the native sources of energy available in the country and has produced a comprehensive set of energy statistical data currently being updated.

Furthermore, RETDAP is promoting the widespread implementation and ultimately commercialization of RE technologies, as well as the establishment of an environmental incentive for the adoption and commercialization of RE in the country. It involves the design, development and implementation of appropriate policies, strategies and interventions addressing the fiscal, financial, regulatory, market, technical and information barriers to RE development and utilization.

It also involves the development of interventions for strengthening of the relevant institutional structures and national capacity for the coordination and sustainable management of RE initiatives in the country.
This project also involves capacity building activities for enhancing the country's capability in establishing workable and viable schemes for supporting RE applications with emphasis on the design, development, financing, implementation and management of RE projects, taking into consideration relevant lessons from past RE projects in other Small Island Developing States (SIDS).

The project was designed as a four year project and was signed in May 2004. The project schedule was affected due to the 2004 Asian Tsunami when government and UN work was focused on Tsunami relief work for the greater part of 2005. The Mid Term evaluation originally planned for in 2006 is therefore being carried out in 2007.

4. Evaluation objectives and scope

The objective of the Mid Term Evaluation is to assess the achievement of project objective up to date, identify strengths and weaknesses and suggest actions to improve project implementation, the contribution to the general goal/strategy, and the project partnership strategy.

The Evaluation will focus on the following aspects:

A) Project design and its relevance in relation to:
   1. Development priorities at the national level;
   2. Stakeholders – assess if the specific needs are being met;
   3. Country ownership/drivenness – participation and commitments of government, local authorities, beneficiaries and private sector;
   4. UNDP mission to promote Sustainable Human Development (SHD) by assisting the country to build its capacities in the focal area of environmental protection and management;

B) Performance focusing at the progress that has been made by the project relative to the achievement of its objective and outcomes:
   1. Effectiveness - extent to which the project is achieving its objectives and the desired outcomes, and the overall contribution of the project to national strategic objectives;
   2. Efficiency - assess efficiency against overall impact of the project for better projection of achievements and benefits resulting from project resources, including an assessment of the different implementation modalities and the cost effectiveness of the utilisation of GEF resources and actual co-financing for the achievement of project results;
   3. Timeliness of results.

C) Management arrangements focused on project implementation:
   1. General implementation and management - evaluate the adequacy of the project implementation structure, including partnership strategy and stakeholder involvement from the aspect of compliance to UNDP/GEF requirements and also from the perspective of "good practice model" that could be used for replication;
   2. Financial accountability – extent to which the sound financial management is being an integral part of achieving project results, with particular reference to adequate reporting, identification of problems and adjustment of activities, budgets and inputs;
   3. Monitoring and evaluation on project level – assess the adoption of the monitoring and evaluation system during the project implementation, and its internalization by competent authorities and service providers; focusing to relevance of the performance indicators, that are SMART, i.e.:
      - Specific: The system captures the essence of the desired result by clearly and directly relating to achieving an objective and only that objective.

- Measurable: The monitoring system and indicators are unambiguously specified so that all parties agree on what it covers and there are practical ways to measure it.
- Achievable and Attributable: The system identifies what changes are anticipated as a result of the intervention and whether the result(s) are realistic. Attribution requires that changes in the targeted developmental issue can be linked to the intervention.
- Relevant and Realistic: The system establishes levels of performance that are likely to be achieved in a practical manner, and that reflect the expectations of stakeholders.
- Time-bound, Timely, Traceable and Targeted: The scheme allows progress to be tracked in a cost-effective manner at desired frequency for a set period, with clear identification of particular stakeholders group to be impacted by the project.

In addition to a descriptive assessment, all criteria should be rated using the following divisions: Highly Satisfactory, Satisfactory, Marginally Satisfactory, and Unsatisfactory with an explanation of the rating.

5. Evaluation methodology

The evaluation will take place mainly in the capital city Male', within the Ministry of Environment, Energy and Water (MEEW) and UNDP, with occasional travel to the field. The evaluator is expected to follow a participatory and consultative approach ensuring close engagement with the government counterparts, the members of the project team, and direct beneficiaries.

The evaluator is expected to consult all relevant sources of information, such as the project document, project reports – incl. Annual Reports, project budget revision, progress reports, project files, national strategic and legal documents, and any other material that s/he may consider useful for evidence based assessment.

The evaluator is expected to use interviews as a means of collecting data on the relevance, performance and success of the project. S/He is also expected to visit the project sites and some new sites, where the technology has been replicated.

Although the mission should feel free to discuss with the authorities concerned all matters relevant to its assignment, it is not authorized to make any commitment or statement on behalf of UNDP or GEF or the project management.

This Mid Term Evaluation should link in closely with the planned UNDP outcome evaluation. The RETDAP project is one of the main contributors to the UNDP outcome: Environmental management, including climate change and sustainable energy integrated into national development frameworks and sectoral strategies and programmes, which will be carried simultaneously with the RETDAP midterm evaluation.

The Consultant should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

6. Deliverables

The output of the mission will be the Mid Term Evaluation Report.

Initial draft of the Mid Term Evaluation Report will be submitted to MEEW and UNDP for review. After incorporation of comments, adjusted draft will be submitted for final review. The comments will be incorporated and the report finalised. One mission to the Maldives will be conducted.

7. Indicative activities

- Development of methodological instruments for the evaluation

- Setup the mission dates and detailed mission programme preparation in cooperation with UNDP and MEEW.
- Review of all available materials
    - Acquaintance with the project document and other relevant materials with information about the project;
    - Familiarization with Maldives energy efficiency policy framework;
- Briefing with UNDP and MEEW, briefing with the project management and project staff
- Interviews with key beneficiaries and stakeholders.
- Visits to project sites (Mandhoo, selected islands where awareness was conducted, etc.)
- Analysis of collected data
- Structuring and development of a draft report
- Completing of the draft report
- Presentation of draft report for comments and suggestions
- Briefing with UNDP, project management and project staff;
- Review of additional information;
- Elaboration of final report)
    - Incorporation of comments and additional findings into the draft report
    - Presentation of adjusted draft report for comments and suggestions
    - Finalization of the report
- Submission of final report

ANNEX B. ITINERARY OF THE EVALUATION TEAM; LIST OF DOCUMENTS

B.1 Mission schedule and list of people met

In the two weeks from 13 to 28 August, the same Evaluation Team not only evaluated the RETDAP project, but also evaluated the Outcome of the Environment-Climate Change cluster of activities of UNDP. The following table shows the meetings held by the Team for both the RETDAP and the Outcome Evaluation.

Mon 13/08	• Arrival of Mr. J.H.A. van den Akker (international consultant) in Male' • Meeting of international consultant and national consultant (Ms. Marie Saleem) at UNDP with Ms. Melaia Vatucawaqa (Deputy Resident Representative), Mr. Juan Gollan (Energy and Environment Officer), Ms. Hudha Ahmed (Assistant Resident Representative and Ms. Aminath Shooza
Tue 14/08	• Meeting with Energy Department staff of Ministry of Environment, Energy and Water (MEEW), Mr. Abdul Razzak Idris (Deputy Minister of Energy and RETDAP Project Director), Mr. Ajwad Musthafa (Deputy Director), Mr. Haikal Ibrahim (acting RETDAP Project Manager) and Mr. Jadulla (RETDAP Assistant Project Manager) • Meeting with the Integrated Climate Change Strategy (ICCS) team of MEEW (responsible for NAPA, NCSA and TNA studies), Mr. Athif Saleem • Meeting at MEEW's Environment Research Centre (ERC), responsible for the National Framework for Solid Waste Managementr, Mr. Gordon Ewers
Wed 15/08	• Meeting at MEEW with Mr. Abdullahi Majeed (Deputy Minister of Environment) and Mr. Amjad Abdalla (Assistant Director General)
Thu 16/08 - Sat 18/08	• Report writing
Sun 19/08 – Mon 20/08	• Travel to Mandhoo Island in Ari Atoll, site of solar-diesel hybrid system and a waste collection centre
Tue 21/08	• Report writing
Wed 22/08	• Meeting at Maldive Gas (Mr. Zuhain Zahir, Managing Director)
Thu 23/08	• Meeting at MEEW (Mr. Yooshau Saeed, Project Manager NCSA)
Fri 24/08 – Sun 26/08	• Report writing
Mon 27/08	• Presentation on preliminary findings and recommendations on the RETDAP and Outcome evaluations
Tue 28/08	• Departure of Mr. Van den Akker from Male'

B.2 List of documents

Renewable Energy Technology Development and Application Project (RETDAP)

1. *Progress Reports* (2004-2005) and *Project Monitoring forms* (first and second quarter of 2007)
2. *Minutes of meeting* of the Inception Workshop (November 2004)
3. *Minutes of meeting* of Project Steering Committee (July, August and November 2004)
4. *UNDP Project Document of RETDAP*
5. *Project Document* of "Assistance to Maldives in Developing the Energy Sector through Energy Resource Assessment leading to Sustainable Energy Formulation", UNDP Thematic Trust Fund on Energy for Sustainable Development (Energy TTF)
6. Terms of Reference of the "Assessment of Least-Cost, Sustainable Energy Resources – Maldives", funded by UNDP Nordic Fund and implemented through UNOPS
7. *Annual reports* (2003 and 2004) of the Energy TTF/UNOPS activities
8. *Biomass Survey, Technical Report* (Energy Consulting Network, 2004a)
9. *Final Report: Landfill Gas* (Energy Consulting Network, 2004b)
10. Final Report, Assessment of Least-Cost, Sustainable Energy Resources, Maldives (Energy Consulting Network, 2004c)
11. Energy Supply and Demand, Technical Report (Energy Consulting Network, 2003)
12. *National Energy Policy – Maldives*, Final draft (Aldover, 2006)
13. *Maldives, Energy Balances and Indicators 2003-2005* (Energy Consulting Network, 2006)
14. *Fund for Renewable Energy System Applications (FRESA), Financing Scheme, Financing Application Guidelines and Operational Plan*, Angelica Salomon-Dealino (2006)
15. *Final Mission Report*, Angelica Salomon-Dealino (2007)

Most documents are available at www.meew.gov.mv/retdap

Other documents:

16. *Wind Energy Resource Atlas of Sri Lanka and the Maldives,* by D. Elliott, M. Schwarz, G. Scott, S. Haymes, D. Heimillier and R. George, National Renewable Energy Laboratory (NREL, 2003). Available at www.rsvp.nrel.gov/wind_resources.html
17. *The Implementation Potential of Renewable Energy Technologies in the Maldives,* K. van Alphen (2004), Utrecht University, Maledives
18. *Maldives Climate Change In-Depth Technology Needs Assessment – Energy Sector*, by Commerce Development and Environment (CDE, 2007a)
19. *In-Depth Needs Assessment on Transport Sector* (CDE, 2007b)

ANNEX C. REVISED LOGICAL FRAMEWORK

Table 10 Summary of indicators describing the project's performance and impacts

Description	Output indicators	Baseline value	Mid-term target value (August 2007)	End of project target value (end of 2008)
1. *Reduction in annual growth of greenhouse gas emissions (development goal)* Annual electricity production from RE sources that were installed under influence of the project Market transformation	• Power generation and annual energy production with RE • Annual GHG reduction • Cumulative GHG reduction • % of RE in Maldivian energy mix	• Only few applications (solar water heaters in hotels and PV for telecommunications)	• Some 80 kW of solar/wind/diesel hybrid systems is installed or under installation, but only one (8 kW, Fainu) was operational by August 2007 • GHG reduction depends on actual RE energy production	• Target installed capacity of RE in hybrid systems is 260 kW • Installed capacity and RE energy production in other RE systems (biogas, other) • GHG reduction will depends on actual operation of RE hybrid and other RE systems • % of RE in energy mix • Number and kind of RE market the project has transformed (hybrids, biogas, waste, SWH, etc.)
2. *Outcome 3: RE Policy and Regulatory Framework* Development of sectoral policies, laws and regulations that support the project goal	• Government policy and accompanying implementing rules and regulations on the utilization of feasible RE resources for electricity and non-electricity projects is established	• No RE policy	• Draft National Energy Policy	• Policy approved and implemented • Strategy and regulation to promote RE for community electrification (hybrids), individual (biogas, SWH) and waste-to-energy applications
Output 3.1 Output 3.5	• Adequately staffed Energy Department • An initial detailed evaluation report on the energy supply and end-use consumption in Maldives, including energy demand and energy trends • Assessment of least-cost energy	• Few energy staff at MCST	• Problems with staffing at Energy Department in newly formed MEEW • Energy supply and demand survey (2003) • Assessment of least-cost RE sources (2004)	• Energy Department adequately staffed • Energy supply and demand survey (2003) • Integral least-cost assessment of conventional and RE

Description	Output indicators	Baseline value	Mid-term target value (August 2007)	End of project target value (end of 2008)
Output 3.6 Output 3.2 Output 3.3	sources • The Energy Department updates and reports on the energy balance of the country annually • National Energy Policy of Maldives is prepared and completed • Policy study on OIA electrification and electricity pricing; • Policy study on incentives for individual and/or private sector RE applications\ • Strategy and regulations in place on RE based community-level and RE individual level applications • National workshops on RE promotion and relevant policies		• Energy balances 2003-2005 • Draft National energy policy • Pending • Pending • Pending • Pending	technologies (proposed) • Regularly updated energy balances • Energy policy approved and implemented • Studies completed, RE strategy formulated and national workshops held • RE targets integrated into 7th National Development Plan
3. *Outcome 2:* RE Resource Assessment	• A comprehensive assessment and database of RE resources in the country completed	• No RE resource assessment	• Comprehensive RE resource database	• Comprehensive RE resource database expanded with biomass and ocean energy potential assessments
Outputs 2.1-2.4 Output 2.5	• RE resource assessment methodology and assessment • Development of RE simulation methodology and simulations • Training on RE resource assessment, monitoring and evaluation of data • About 30% of trained staff is involved in providing training on RE resource assessment	• No RE resource assessment or methodologies	• Suitable methodology agreed and assessments done on biomass, landfill gas and solar and wind energy (in hybrid systems) • Staff has been trained on RE assessment (solar/wind measurements) and simulations (with HOMER); personnel sent to AIT for training on solar and biomass; one seminar	• More detailed biomass assessment in atoll/island groups and studies on OTEC and marine waves • Staff has been adequately trained on solar and wind measurements as well as of biomass and waste assessment • About 30% of trained staff is involved in providing training

Description	Output indicators	Baseline value	Mid-term target value (August 2007)	End of project target value (end of 2008)
4. Outcome 1: RE Information Services and Awareness creation Improvement of awareness amongst users	• A sustainable and continuously evolving program of providing RET information services and awareness enhancement, covering the energy applications of RE resources is established & implemented	• No information is available on RE in Maldives	• Awareness creation, but not RE Centre is developed yet	• Fully functioning RE information centre cum one-stop-shop, continuing the education and awareness enhancement initiated under RETDAP
Output 1.1, 1.3 and 1.5 Output 1.4	• RE Centre established at MEEW • Publication and circulation of a quarterly newsletter • Abstracts/Information Notes on relevant articles on RE Technology are annually prepared; • Library at Centre with subscription to relevant scientific journals and information materials and books on RE • Functioning and regularly updated website • RE "one-stop-shop" service is established at the RE Centre in MEEW to cater to the provision of RE market services • Monitoring and profiling of RE projects in Maldives • Dissemination of printed materials and multi-media	• No RE Center • No information campaigns	• No RE Centre established and some information exchange • Energy webpages have been set up as part of MEEW website • Awareness activities in six atolls; leaflets distributed • Field trips by officials • Report on RE and EE Media and Communication Plan	• Fully functioning RE Centre established and functioning that provides one-stop-shop services (to about 40 clients annually), collects and disseminates information in printed and electronic form, circulates a RE newsletter, organises technical and other trainings on RE and gathers data on ongoing RE activities in Maldives • Product exhibition • Awareness creation activities and technology demonstration in OIA • Media and communication action plan
5.*Outcome 4: RE Training and Capacity Building* Improvements of understanding of technology amongst energy	• Continuing RE technology education and training • Established RE technology support services	• No RE technology education programme • No RE technology support services	• No RE technology education programme, except some seminars and study tours • No RE technology support services	• Assessment of RE technology support system and recommendations • Comprehensive training course established (in coop. with Maldivian educational

Description	Output indicators	Baseline value	Mid-term target value (August 2007)	End of project target value (end of 2008)
and equipment providers and decision-makers				institutes) on RE feasibility and management as well technical training (design, installation, maintenance and operation)
Output 4.2, 4.3, 4.4 and 4.6 Output 1.2, 4.5	• Assessment of RE technology support system (RE consultancy services, RE importation and local manufacturing and RE installation, R&D) • RE technology education programme	• - • -	• - • Study tours (to Malaysia and Thailand), seminars and workshops • Guarantee Fibreglass Fabrics (GFF) staff was trained to manufacture, operate and maintain biogas digesters • R. Fainu residents were trained to operate and maintain the solar-wind hybrid system	• Assessments have been carried out of viability of local RE consultancy and engineering services and local manufacturing of components • Plan formulated to enhance capacity of RE technology support system (solar & wind hybrids, biogas, waste, SWH, biomass) • Trained staff form MEEW, other government entities and private sector (on-the-job, seminars, study tour) • Annual training course of RE • At least 50% of trained staff is involved in RE management, operation or installation • Proposals for RE projects in OIA (how many?)
6.*Outcome 5: RE Financing Schemes* Increase in finance and financing mechanisms	• Financing assistance program for RE-based energy projects are established and availed of by project developers and island communities	• -	• Study on the operation of FRESA	• The RE Centre at MEEW processes about 40 applications

Description	Output indicators	Baseline value	Mid-term target value (August 2007)	End of project target value (end of 2008)
Output 5.1 Outputs 5.2, 5.3, 5.4, 6.9	• Training courses conducted • Provision of FRESA financing to approved applicants	• - • -	• Training on RE project finance for financial institutes and entrepreneur • Study on the operation of FRESA	• Training courses conducted for private and government financial institutions; commercial banks; and private entrepreneurs • Clear and well-defined mechanics and target groups of the FRESA financing scheme and legal status established • FRESA established • Exit strategy for FRESA for post-RETDAP period defined
7.*Outcome 6: RE Project Development*	• Demonstration of the techno-economic viability, design, development, financing and sustainable operation & maintenance of RE-based energy projects; • Effective demonstration of the techno-economic viability, design, development, financing and sustainable operation & maintenance of livelihood and productive use initiatives supported by RE-based energy projects.	• -	• First installation of solar-wind-hybrid systems • Pilot testing of biogas systems	• Installation of at least 260 kW RE in hybrid systems • Installation of household biogas systems • Plans for other RE systems (biomass, SWH, waste-to-energy)
Output 6.1, 6.2, 6.3, 6.4, 6.5	• Feasibility analyses of pilot RE-based energy systems in OIAs • Final list of demonstration sites (hybrid systems, biogas, waste-to-energy) • Energy demand and supply surveys at selected sites • Engineering design of RE systems at selected sites • Provision of FRESA financing (if	• -	• Surveys and baseline analysis on Mandhoo, Thinadhoo, Olhuvelifushi, Rasgatheem, Fainu and Hulhudhufaaru	• Surveys and baseline analysis on these and selected other islands

Description	Output indicators	Baseline value	Mid-term target value (August 2007)	End of project target value (end of 2008)
Output 6.6	applicable and necessary) • Equipment procurement, construction, installation and commissioning • Operation characteristics and beneficiary satisfaction		• Installation solar-(wind)-diesel systems on Mandhoo, Ghoidhoo and Fainu. Mandhoo not operational • Construction of hybrid systems on Uligam and Raimandhoo	• Installation of hybrid systems in various islands with a total capacity of 260 kW • At least 5 biogas digesters • installed and operational
Output 3.4, 4.1 Output 4.7	• Study of potential livelihood support and productivity projects and other value-added applications of RE resources • Proposals for RE-based power and heat system projects			• A total of X potential livelihood support and productivity projects are proposed and evaluated • Plans for installation of hybrid systems in 100 islands • Plans for development of other RE sources (e.g., biomass, waste-to-energy)
8.*Monitoring and evaluation*	• Monitoring and evaluation reports of project outputs, outcomes/impacts	• -	• Mid-term evaluation reports	• Monitoring and evaluation reports of project outputs, outcomes/impacts
Output 3.7, 3.8, 6.9 Project evaluation	• Baseline/mid-term impact study • End-of-project impact study • Design of financially sustainable RE promotion programme at MEEW • Mid-term evaluation report • Final evaluation report	• -	• Mid-term evaluation • Baseline/mid-term impact study needs to be urgently done	• End-of-project impact study (including M&E at pilot schemes and evaluation of policy guidelines and implementation • Follow-up RE promotion programme is in place • Final evaluation • National workshop presenting results of RETDAP and pilot schemes