UNDP - Maldives
Technical Assistance for
Development of Annual Energy Statistics
Maldives

Project INT/03/R11 – 05 MDV 1130

Maldives
Energy Balances and Indicators
2003-2005

September 2006

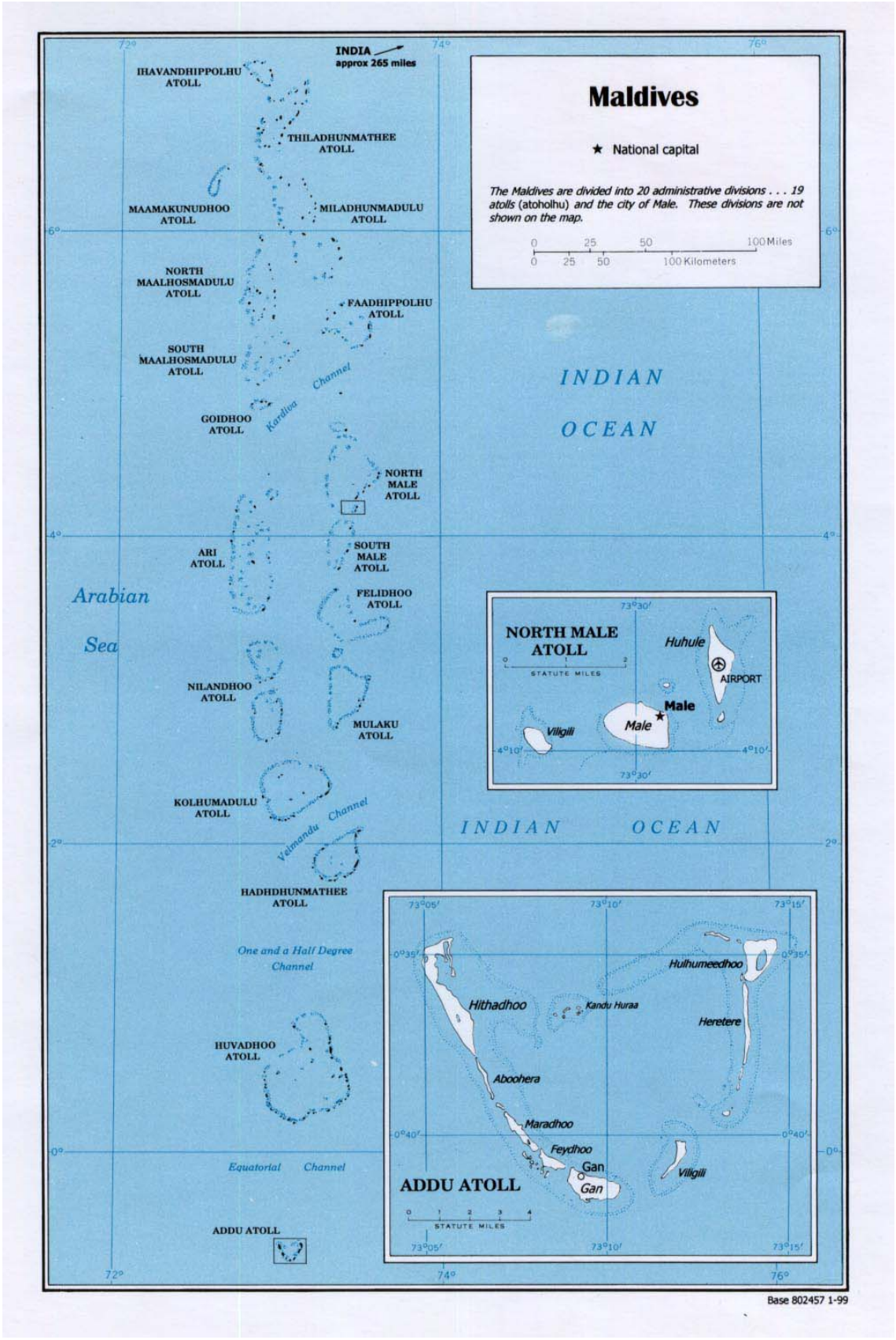
Prepared for

Ministry of Environment, Energy and Water (MEEW)

by

ENERGY CONSULTING NETWORK

Map of Location



List of Abbreviations

Abbreviation	Full Meaning
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
CO2	Carbon Dioxide (one of the so-called "green house gases")
COP	Conference of the Parties to the Framework Convention of Climate Change
DEA	Danish Energy Authority
DK	Denmark
EAC	Energy Advisory Committee
ECNet	Energy Consulting Network
Elec.	Electricity
EU	European Union
GDP	Gross Domestic Product
GHG	Green house gas (principally CO2)
HFO	Heavy Fuel Oil
IPP	Independent Power Producer
JI	Joint Implementation
MCST	Ministry of Communication, Science and Technology (the former recipient)
MEEW	Ministry of Energy, Water and Environment (the present recipient)
MOAD	Ministry of Atolls Development
MPND:	Ministry of Planning and National Development
MEDT	MEDT: Ministry of Economic Development and Trade
MTCA	Ministry of Tourism and Civil Aviation
MFMR	Ministry of Fisheries, Agriculture and Marine Resources
Mt	Million ton
Mtoe	Million ton oil equivalents
MW	Mega Watt (106 Watt)
NGO	Non-governmental organization
PAG	Project Advisory Group
PMG	Project Management Group
R&D	Research and Development
RES	Renewable Energy Sources
STELCO:	State Electricity Company
STO	State Trade Organisation
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax

Units

Given the variety and general in-consequence regarding the use of energy units when referring to energy resources and utilisation of resources found in the available literature, we have chosen to use the following units, which in relation to the physical units are based on the SI-system.

Measure	Unit	Conversion
Energy contents	Joule (J) , Watt-hours (Wh), toe	1 toe=11,63 MWh 1 PJ = 10^{15} J = 0.278 TWh = 0.239 million Gcal 1 TWh = 10^{9} kWh = 0.860 million Gcal = 3.6 PJ 1 PJ = 23,900 tonnes oil equivalent (toe) 12,75 Rf = 1 USD (as of 2005-08-15)
Capacity	Watt (W)	
Temperature	Celcius (°C)	
Currency	Rf (Maldivian Rufiah, Rf)	

Prefix

The following prefixes have been used to indicate powers of 10:

Number	Prefix	Abbreviation
10^{15}	Peta	P
10^{12}	Tera	T
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	Kilo	k

Energy carriers characteristics / Assumptions

In the energy balances all basic data are re-calculated into one common unit of measure, which is "ton oil equivalent", or toe. One toe is the same energy unit as a ton of standard crude oil, and is defined as 11,630 kWh. All energy forms in the balance is re-calculated into this format. This ensures:

- National comparability between energy carriers, fuels, and energy types
- International comparison and benchmarking

The basic characteristics and toe conversion factors are shown in the table below.

Energy carrier	Density (ton/m^3)	Heat value (GJ/ton)	Toe conversion factors (toe/ton)
Heavy Fuel Oil	0.93	42.2	1.038
Diesel oil / gas oil	0.84	42.7	1.035
Petrol/motor gasoline	0.75	43.8	1.070
Jet petrol (JP 1)	0.80	43.5	1.070
Aviation gasoline	0.71	43.8	1.070
Kerosene	0.80	43.5	1.045
LPG	0.54	46.0	1.130

Source: toe conversion factors, mainly from IEA

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1 INTRODUCTION

This report is prepared by Energy Consulting Network (ECNet) for the Maldivian Ministry of Environment, Energy and Water (MEEW). The work receives economic support from UNOPS, United Nations Office for Projects Service (Nordic Funds).

The report relates to the project "Technical Assistance for Development of Annual Energy Statistics in the Maldives", in short 'ESTAT-Maldives'. The project is carried out as part of the United Nations Development Programme (UNDP) for Maldives, in an effort to prepare for permanently establishing Annual Energy Statistics for the Maldives. The General objectives of the project are:

- To strengthen the MEEW capacity
- To monitor the development in the national energy consumption
- To meet international requirements to the quality and reliability of national energy balances
- To improve the statistical decision basis for national energy planning

The point of departure is the Energy Statistics for 2002 that was established in the course of the UNDP project INT/03/R11 - 02 MDV 1180. The 2002 statistics was made in 2004 and the development since then clearly indicates the value for the Maldivian authorities of having energy statistics. The energy imports equal considerable shares of the overall Maldivian imports and influence the economic development of the country to a very high extent. Growing imports of energy and increasing prices on fuels has worsened the situation – and the need for reliable energy statistic data is clear.

The project goal is to obtain a situation where the Maldivian Energy Administration is able to handle all activities related to establishing national energy balances for the country. The specific objectives are to strengthen the MEEW by:

- Improving collection and processing of data for establishing national energy balances
- Applying internationally recognised procedures for energy data handling.
- Building up capacity on establishing energy balances in compliance with international requirements
- Establishing annual energy balances for 2003, 2004 and 2005

The project contains significant elements of hands-on training but also dedicated 'training sessions'. The project was started in July 2005, and runs until October 2006.

This report presents the energy balances for 2003, 2004 and 2005 and energy indicators for the Maldives. Thus, this report constitutes the following milestone no. 4 project deliveries:

- R2: Maldivian Energy Balance 2003
- R3: Maldivian Energy Balance 2004
- R7: Maldivian Energy Balance 2005
- R8: Maldivian Energy Indicators and international comparison

Copenhagen, 2006-09-30

Nick Bjørn Andersen
Project manager

Copenhagen, 2006-09-30

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Quality assurance

2 Why Energy Balances in The Maldives

Growing energy demand, depleting resources, energy dependency, security and efficiency as well as environmental concerns calls for a close monitoring of the energy situation. Having a clear view of the situation implies detailed and reliable data on the different parts of the production and consumption chain. This involves proper reporting mechanisms, sound check procedures and adequate resources.

The importance of energy statistics is recognized by a number of international organizations and initiatives are ongoing to improve these statistics, not least as budget cuts and shortage of experienced staffs have been widely encountered in many countries leading to less reliable statistics. One of the priorities is to raise the level of expertise in basic energy statistics so that common definitions and good methodologies can be applied. Another priority is to raise the awareness of policy makers of the importance of having valid statistics – and on how lack of data may impact the decision-making process.

The **Maldivian national priorities** in the energy sector are:
- Provision of electricity to the atolls, especially to remote islands, in reliable, equitable and affordable way;
- Development of a pricing policy for electricity provision;
- Reducing the dependence on the imported fossil fuels in terms of fuel storage capacity and vulnerability to price fluctuations;
- Environmental degradation and the detrimental effects of global warming

Addressing these issues, the Maldivian 6th National Development Plan mentions these targets:
- Explore possible sustainable sources of energy for power generation and desalination;
- Strengthen policy-making and regulatory bodies in the energy sector and formulate an energy policy;
- Training of technical personnel at all levels for the energy sector, especially for the Atolls;
- Conduct awareness regarding fuel consumption and sustainable use of energy sources;

Establishing Annual Energy Statistics for the Maldives will support the implementation of the above Maldivian Sixth National Development Plan by making it possible to monitor the development. Established annual energy statistics will provide basis for:
- Monitoring the development in energy demand and consumption
- Identifying energy consumption by sectors and by geography
- Evaluating implementation of the Renewable Energy Action Plan (as presented in the course of the UNDP project INT/03/R11 - 02 MDV 1180)
- Assessing the environmental situation and challenges

2.1.1 Monitoring the development in national energy consumption

Maldives imports all fossil fuels for domestic use. Energy imports equal considerable shares of the overall Maldivian imports and influence the economic development of the country to a very high extent. Maldives mainly use fossil fuels for generating electricity and in the transportation sector, in the forms of diesel, gasoline, kerosene and LPG. The annual consumption of fuels is growing in parallel with the general development of the country and is influenced by the growing activities in tourism, being a major component of the GDP.

2.1.2 Meeting international requirements to energy statistics

For the Maldives, international relations - annual energy statistics and energy indicators are very important for a due interaction and communication with bodies like UN, ADB, IEA and others.

Basically the prevailing standards for annual energy statistics encompass the following:

- The statistics must include a sufficient level of details
- The statistics must be complete
- Basic energy information should be available and reliable.

International requirements are also related with the use of certain kinds of questionnaires, concepts, methods and indicators in order to obtain international comparability. In this context different cooperation activity takes place involving UNSD, EUROSTAT, IEA, OECD a.o.

2.1.3 Improving decision basis for energy planning

National energy balances for the Maldives will provide profound opportunities for the energy administration and the political level to be ahead of the development. Apart from being able to make energy planning and employing renewable energy sources it is in parallel possible to assess energy efficiencies in a wide range of areas.

This may form the basis for political decisions on required level of efficiency for end-user devices, energy conversion efficiencies and methods, transport logistics etc. and may thus further influence the legal framework – thereby also forming the institutional and political basis for reducing the dependence on imported fossil fuels and for international co-operation on reduction of CO_2-emissions.

A successful establishment of Annual Energy Balances will provide information needed for raising the awareness of fuel consumptions and thereby motivate different actors in the Atolls and in the tourist sector to take socio-economic and environmental sustainable decisions for the development.

3 ENERGY BALANCE METHODOLOGY

The Maldives does not only need the energy statistics for the international communication and interaction, but as basis for governing its development. Therefore the energy statistics shall be established to meet domestic requirements as well as international requirements.

This implies that the energy statistics shall contain options for breaking-down energy figures according to natural Maldivian sub-sectors and in parallel contain figures that can be aggregated into overviews meeting international requirements.

These requirements have formed the basis for the applied procedures and formats.

3.1.1 Maldivian energy statistics - format

The form used for the **supply side** is shown below.

	Diesel	HFO	Petrol	JET A1	LPG	Kerosene	Biomass	Electricity	Heat	Total
Resources	1	2	3	4	5	6	7	8	9	
Domestic resources										
Biomass										-
Solar										-
Imports										
Oil products										-
Exports										
Oil products										-
Stock										
Changes in stock										-
Gross Domestic Consumption										-

For the **conversion of energy,** natural conventional Maldivian sub-sectors have formed the basis.

The sub-sectors comprise the following:

- STELCO: the major public power company that is providing power to Male and a number of islands in the Atolls
- Power producers on islands other than those power by STELCO. Close-to-all inhabited islands have now power supply. Some of these plants are comparably small.
- Some auto-producers: the airports, industries, desalination plants and the fishing industry
- The 87 Tourist Resorts

Conversion
Electricity (including distribution losses)
STELCO
STELCO, Male and Vilingili
STELCO, Atolls
Domestic Airports
Community / Private (Atolls)
Desalination industry
Industry, cold stores and canning
Resorts (conversion and distribution)

The break-down of **final energy consumption** comprises three main end-user categories, being:

- Households – residential use
- Manufacturing, commerce and service
- Domestic transport

The further breakdown in sub-categories is shown in the overview below.

As the residential consumption patterns in the capital, Male, and on the neighbouring islands are quite different from the consumptions in the outer islands (abbreviated: the Atolls), the consumptions have been estimated for these two areas separately.

This counts as well for the 'Manufacturing, commerce and service' that also accordingly have been divided in 'Male' and the 'Atolls'.

Industrial activities are rare in the Maldives – only counting a few canning industries and a few desalination plants. A number of minor manufacturing is found, but not showing any significant consumption of electricity or energy in general.

Thus, it has been chosen to combine 'manufacturing', 'commerce' and 'service' in one category. In the area of service – the tourist industry comprising 87 resort islands represents a major share of the final energy consumption, as it will be seen in the energy balances.

The transport sector shows a considerable consumption of energy – mainly diesel.

Moreover the fishing boats use a significant part of the overall diesel consumption.

These patterns have formed the basis for the above way of making the breakdown, which moreover match the dominant economic sectors of the Maldives.

Final Energy Consumption

Households - residential
- **Male - capital area**
- **Atolls**

Manufacturing, commerce and service
- **Male and Vilingili**
  - Public buildings including schools
  - Industry, manufacturing and commercial
  - Fishing (boats)
  - Desalination industry
  - Waste (Thilafushi)
  - Government buildings
- **Atolls**
  - Public buildings including schools
  - Manufacturing
  - Cold stores and canning
  - Desalination industry
  - Fishing (boats)
- **Resorts etc. (ex transport)**
  - Resorts etc.

Domestic Transport
- Hulhule Airport (operation)
- Domestic air transport
- Sea transport, Atolls
- Sea transport, Tourists&pleasure
- Vehicles, Male
- Vehicles, Atollls

Final Energy Consumption Total

3.1.2 International format

The above breakdowns do at the same time provide data for standard energy balances suitable for international comparison.

For the Maldives many of the breakdown categories of the international energy balance formats will be empty since the related activities do not occur in the Maldives.

There are many power plants and only very little CHP[1]. Only one CHP plant has been identified in a canning industry.

[1] Cogeneration of Heat And Power

SUPPLY AND CONSUMPTION
Production
Imports
Exports
International Marine Bunkers
Stock changes
TOTAL PRIMARY ENERGY SUPPLY
Transfers
Statistical Differences
Electricity Plants
CHP Plants
Heat Plants
Gas Waste
Petroleum Refineries
Coal Transformation
Liqufaction plants
Other Transformation
Own use
Distribution losses
TOTAL FINAL CONSUMPTION

TOTAL FINAL CONSUMPTION
INDUSTRY SECTOR
Iron and Steel
Chemicals and Petrochemicals
of which feedstock
Non-ferrous metals
Non-metallic minerals
Transport Equipment
Machinery
Mining and Quarrying
Food, Beverages and Tobacco
Paper, Pulp and Printing
Wood and Wood Products
Construction
Textile and leather
Non-specified

TRANSPORT SECTOR
International Civil Aviation
Domestic Aviation
Road
Rail
Domestic Navigation (Sea Tansport)
Pipeline Transport
Non-specified transport
OTHER SECTORS
Commerce - Public Services
Residential
Agriculture/Forestry
Fishing
Non-specified

Regarding industries, only industries in the category 'food, beverage and tobacco' have been identified (see overleaf). These are canning industries having freezing capabilities and cold stores.

Nevertheless, this categorisation will be used to aggregate the energy statistical data and thus allowing for a wider comparison.

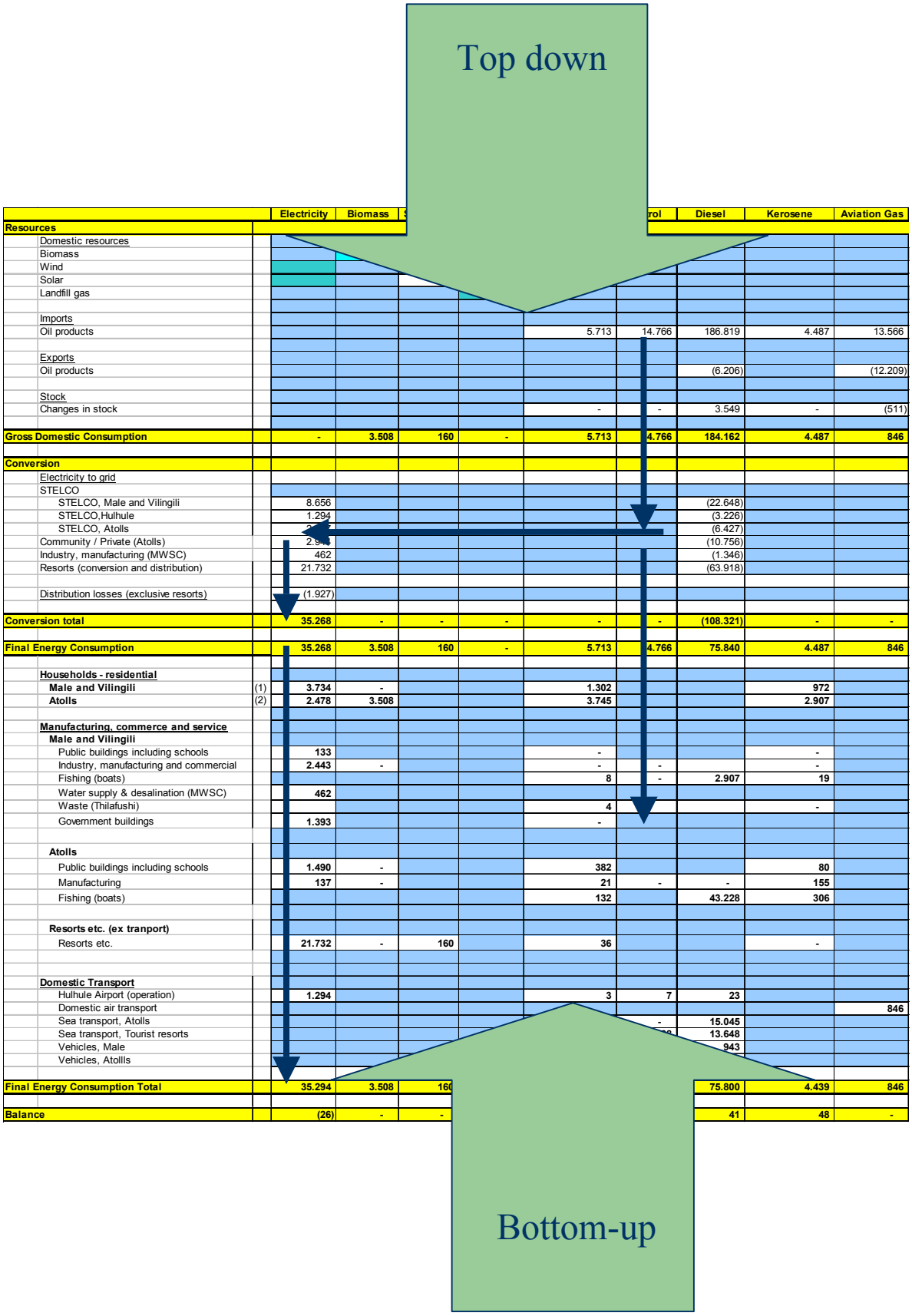
3.2 Principle of the energy balance

The basic principle is that the balance is divided into three parts:

1. Primary energy - imported and indigenous energy in its raw forms
2. Conversion of primary energy into electricity (and thermal energy)
3. Final energy demand at the point of end use.

It is, in principle, possible to follow the energy flow through the balance, from import/inland resource over conversion to distribution among types of end-users (illustrated by arrows on the figure).

Below the basic form used for the energy balance is seen.



		Electricity	Biomass				rol	Diesel	Kerosene	Aviation Gas
Resources										
Domestic resources										
Biomass										
Wind										
Solar										
Landfill gas										
Imports										
Oil products						5.713	14.766	186.819	4.487	13.566
Exports										
Oil products								(6.206)		(12.209)
Stock										
Changes in stock						-	-	3.549	-	(511)
Gross Domestic Consumption		-	3.508	160	-	5.713	4.766	184.162	4.487	846
Conversion										
Electricity to grid										
STELCO										
STELCO, Male and Vilingili		8.656						(22.648)		
STELCO,Hulhule		1.294						(3.226)		
STELCO, Atolls		[illegible]						(6.427)		
Community / Private (Atolls)		2.[illegible]						(10.756)		
Industry, manufacturing (MWSC)		462						(1.346)		
Resorts (conversion and distribution)		21.732						(63.918)		
Distribution losses (exclusive resorts)		(1.927)								
Conversion total		35.268	-	-	-	-	-	(108.321)	-	-
Final Energy Consumption		35.268	3.508	160	-	5.713	4.766	75.840	4.487	846
Households - residential										
Male and Vilingili	(1)	3.734	-			1.302			972	
Atolls	(2)	2.478	3.508			3.745			2.907	
Manufacturing, commerce and service										
Male and Vilingili										
Public buildings including schools		133				-			-	
Industry, manufacturing and commercial		2.443	-			-	-		-	
Fishing (boats)						8	-	2.907	19	
Water supply & desalination (MWSC)		462								
Waste (Thilafushi)						4			-	
Government buildings		1.393				-				
Atolls										
Public buildings including schools		1.490	-			382			80	
Manufacturing		137	-			21	-	-	155	
Fishing (boats)						132		43.228	306	
Resorts etc. (ex tranport)										
Resorts etc.		21.732	-	160		36			-	
Domestic Transport										
Hulhule Airport (operation)		1.294				3	7	23		
Domestic air transport										846
Sea transport, Atolls							-	15.045		
Sea transport, Tourist resorts								13.648		
Vehicles, Male								943		
Vehicles, Atollls										
Final Energy Consumption Total		35.294	3.508	160				75.800	4.439	846
Balance		(26)	-	-				41	48	-

3.3 Governing approach

Data for the supply of energy to the Maldives exist and are available from the 'Customs Department. The changes in stocks of fuels cause some problems, as procedures for this has not yet been put in place.

For the conversion of energy and for the final energy consumption, the following data have been identified:

- Consumption data for customer groupings and related consumption of diesel for STELCO-operated Atolls
- Consumption of electricity and related fuel consumptions for three months in the autumn 2005. The data covers around 150 islands, but around 35 datasets were invalid

From these figures the conversion of fuel into power and specific electricity consumption data can be estimated. On this basis a power sector analysis has been conducted – as shown later.

Many other data need also to be estimated. Basically the main approach is to derive 'specific consumption figures' and to multiply by a corresponding 'factor' reflecting the activity level.

As the uncertainties are considerable, the calculation and time development of figures for the Final Consumption composition of energy balance is an interlinked exercise. In general and in the course of the action, only a limited number of Surveys has yet been conducted.

As a consequence the only possible approach to identify data has been to model the end-use elements and having as the target a zero balance at the bottom, equalling the statistical difference. To make sure that there is consistency in the figures, most analyses and data are checked top-down (if official data exist) and crosschecked by bottom-up analyses. As far as possible, redundant data are applied for checking.

For the 2003, 2004 and 2005 balance the above approach is the only way forward, but this is going to be improved along with better and scheduled data collection and surveys – intended to be introduced in the coming years. These surveys will considerably reduce many of the uncertainties in the energy balance.

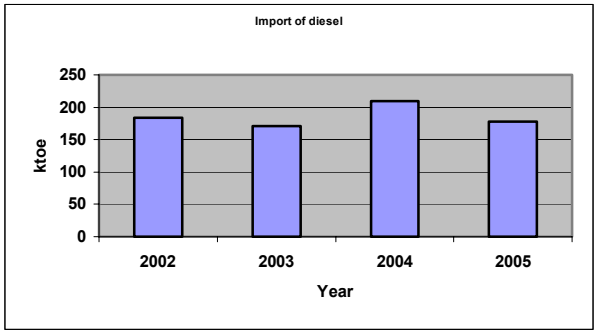
The surveys and questionnaires are described in the report: '***Energy Data Collection Procedures'*** and these have to some extent been tested on a pilot basis[2]. The report '***Recommendation on Further Development of Energy Statistics'*** presents in more detail the necessary actions to be taken.

[2] The Pilot testing is described in the report: '***Energy Data Handling Toolbox'***

4 FUEL SUPPLY

4.1 Diesel

Diesel is the main imported energy carrier. Maldives Customs Service registers the import, and reliable data can be obtained from their office.



The domestic diesel consumption tends to fluctuate over time reflecting the Maldivian economy and in this respect also the December 2004 tsunami.

In addition to the import the balance consist of net storage of diesel oil, and bunkering. The registered imports and exports are shown below. The export represents here the bunkering of diesel.

Diesel / Marine gas oil	2003	2004	2005	
Import	165.233	202.530	178.109	Metric Tonne
Re-Export	17.784	15.500	16.743	Metric Tonne

4.2 Heavy Fuel Oil

Heavy Fuel Oil (HFO) has been imported since 2005. The fuel is used for the STELCO power production plant in capital Male, only.

Maldives Customs Service registers the import, and reliable data can be obtained from their office. Though – in 2005 – some of the imported HFO was registered as diesel since the category HFO was not yet in place in the Customs Service's accounting systems. Therefore – in the further analysis - numbers from STELCO on imported HFO for 2005 has been used and the corresponding amount of imported diesel has been corrected accordingly. The below numbers show the registered import.

In addition to the import the balance consist of net storage of HFO.

Heavy fuel oil	2003	2004	2005	
Import			11.410	Metric Tonne

4.3 Petrol

Petrol is the second largest imported energy carrier. The Maldives Customs Service registers the import, and reliable data can be obtained from their office.

The imports are shown below.

Petrol / gasoline	2003	2004	2005	
Import	12,213	18,461	19,209	Metric Tonne
Export				Metric Tonne

4.4 LPG

The Maldives Customs Service registers the import, and reliable data can be obtained from their office. LPG is bottled in the Maldives.

The imports are shown below.

LPG	2003	2004	2005	
Import	3,558	6,488	7,150	Metric Tonne
Export				Metric Tonne

4.5 Kerosene

The Maldives Customs Service registers the import of "kerosene" and "lamp oil", and reliable data can be obtained from their office. Lamp oil is included in the kerosene figure as the two products are quite similar.

The imports are shown below.

Kerosine Oil & Lamp Fuel	2003	2004	2005	
Import	4.981	8.518	1.174	Metric Tonne
Import	4.860	8.383	1.059	Kerosene only

4.6 Jet A1

The Maldives Customs Service registers the import of Jet A1 as "aviation gas". The imports are shown below.

Aviation Gas	2003	2004	2005	
Import	112,415	132,448	98,715	Metric Tonne
Export	99,498	116,617	85,678	Metric Tonne

A significant share of the Aviation Gas is re-exported; used for fuelling international aircrafts that are taking-off from Hulhule Airport.

4.7 Biomass

In September 2003 a comprehensive questionnaire was sent out by the MEEW to all inhabited islands in the Maldives, asking about use of energy, and available biomass resources. Additionally, the Consultant made a series of site visits to 7 small communities on seven different islands in October 2003.

For more details on the biomass potential and utilisation, the reader is suggested to refer to "Technical Report - Biomass Survey", Assessment of Least-cost, Sustainable Energy Resources, Maldives (Project INT/03/R11 – 02 MDV 1180).

4.8 Solar heat

At present, solar heating is primarily used in resorts for heating of water. Based on a Survey in 2003 and a pilot testing of a new Resort Survey[3] - involving selected resorts - a qualified estimation has been made as shown below. The use of solar heating expresses the net utilised energy on the user side, i.e. in the showers.

Resorts - Solar heating of Domestic Hot Water		**2002**	**2003**	**2004**	**2005**
Number of resorts		87	87	87	87
Bed capacity		**16.400**	**16.444**	**16.858**	**17.348**
of which with solar hot water	%	50	50	50	50
of which with solar hot water		8200	8222	8429	8674
Bed Capacity Utilization Rate (%)		**68,9**	**77,2**	**83,9**	**52,1**
Average number of beds in use, supplied with solar		**5650**	**6347**	**7072**	**4521**
Total number of bednights		**4.066.000**	**4.704.601**	**5.109.977**	**3.300.125**
Number of bednights supplied with solar hot water		2.062.177	2.316.795	2.581.255	1.650.063
Growth rate, bednights				*108,6%*	*65%*
Number of solar m2 per bed		0,5	0,5	0,5	0,5
Number of m2 solar collector in use		**2.825**	**3.174**	**3.536**	**2.260**
Average daily heat produced by solar, per bed	kWh	0,9	0,9	0,9	0,9
Average yearly production by solar, per bed	kWh	329	329	329	329
Solar heat utilised /year	MWh	**1856**	**2085**	**2323**	**1485**
Solar heat utilised /year	**toe**	**159,6**	**179,3**	**199,8**	**127,7**
Volume of water heated (22 C)	liter/day/bed	**35,1**	**35,1**	**35,1**	**35,1**
Estimated demand for hot water per bed night	liter	**60,0**	**60,0**	**60,0**	**60,0**
Volume of water heated per year	m3	**72.310**	**81.238**	**90.512**	**57.859**
Total Yearly demand for hot water	m3	**243.960**	**282.276**	**306.599**	**198.008**
Covered by solar heating		**29,6%**	**28,8%**	**29,5%**	**29,2%**

4.9 Other energy sources

On the resource side the only power applications at the moment can be wind or solar PV-based production of electricity. At the moment one solar-diesel system have been implemented. The telecommunication company Dhiraagu has some PV panels in use to supply their masts with power for stand-alone operation at remote locations, but not significant to the energy balance. A pilot demonstration of a small biogas digester is ongoing on Thilafushi Island.

[3] Tested on two Resort Islands, May-June 2006

5 CONVERSION ANALYSIS

The by far most significant energy conversion process is converting diesel to electricity. Close to a 100% of the population is provided with electricity produced by diesel generators. The electricity production is decentralised, and based on production units of various size. In the assessments, the supply of electricity has been divided into the following segments:

1. STELCO operation of power systems in Male and Vilingili
2. STELCO operation in 21 other islands in the Atolls
3. Power system in Hulhule International Airport
4. Islands covered by other public or private operators in the Atolls (Non-STELCO Atolls)
5. Power production (auto-production) in the desalination plants
6. Electricity production in industries (auto-producers)
7. Electricity production in tourist resorts

Due to the smaller size of the systems and lack of data on distribution losses (except for the STELCO areas); the power systems are handled in a simplified version. The input is defined as supply of diesel or HFO[4] and the output is supplied electricity to the end-users. Thus, the distribution losses are not handled separately, though known for the STELCO operated areas.

5.1 STELCO operations 2003

The operations of STELCO (diesel to electricity) are well documented. 25 Islands are covered by STELCO in 2003. Two of these, LH.Hinnavaru and DH.Kudahuvadhoo was added in 2003 and are not included below, in order to make it possible to compare the remaining 23 islands for all the years 2002-2004.

YEAR 2003	Efficiency in production	Efficiency in distribu-tion	Distribu-tion losses	Overall efficiency	Popula-tion	House-holds	Specific elec. consump.
	%	%	%	%	(-)	(-)	kWh/cap.
HA.Dhidhdhoo	30.9%	90.9%	9.1%	28.1%	2860	467	231
HA.Hoarafushi	27.8%	74.1%	25.9%	20.6%	2297	416	175
HA.Thuraakunu	25.0%	43.9%	56.1%	11.0%	426	66	131
HDh.Hanimaadhoo	29.7%	82.5%	17.5%	24.5%	1043	269	417
HDh.Kulhudhuffushi	33.5%	88.5%	11.5%	29.7%	6805	1331	378
SH.Milandhoo	28.7%	74.2%	25.8%	21.3%	839	184	242
N.Velidhoo	32.7%	84.2%	15.8%	27.5%	1929	370	251
R.Hulhudhuffaaru	30.4%	73.8%	26.2%	22.4%	971	215	180
B.Eydhafushi	30.4%	81.0%	19.0%	24.6%	2483	362	297
LH.Naifaru	32.3%	79.4%	20.6%	25.6%	3833	666	258
K.Himmafushi	31.9%	74.4%	25.6%	23.8%	908	135	556
K.Guraidhoo	29.4%	82.5%	17.5%	24.3%	1267	233	354
K.Kaashidhoo	30.4%	83.2%	16.8%	25.3%	1625	288	225
K.Maafushi	36.0%	85.9%	14.1%	30.9%	1921	169	704
K.Thulusdhoo	28.3%	93.4%	6.6%	26.4%	865	153	565
GA.Villinigili	35.5%	87.2%	12.8%	30.9%	2338	377	298
GDh.Gadhdhoo	31.3%	87.7%	12.3%	27.4%	1759	355	240
GDh.Thinadhoo	34.4%	82.1%	17.9%	28.3%	5059	859	347
CPS.S.Hithadhoo	37.4%	80.8%	19.2%	30.2%	9783	1584	892
S.HulhodhooMeedhoo	33.6%	77.1%	22.9%	25.9%	3226	743	231
GN.Fuahmulah	34.2%	85.0%	15.0%	29.1%	7784	1421	265
Male'	39.4%	89.3%	10.7%	35.2%	73508	9800	1314
Villingili	34.1%	90.5%	9.5%	30.8%	4520	601	677
SUM/Average (Total)	**38.0%**	**87.9%**	**12.1%**	**33.4%**	**138,050**	**21,057**	**898**
Male	39.4%	89.3%	10.7%	35.2%	73,508	9,800	**1,314**
Vilingili	34.1%	90.5%	9.5%	30.8%	4,520	601	**677**
Stelco Atolls	34.2%	82.5%	17.5%	28.2%	60,021	10,656	**405**

[4] HFO: Heavy Fuel Oil

Data on the size of the population are available from the Ministry of Atolls Development. Though, it is commonly known that these figures do not represent the actual size of the population and will in some cases overestimate the population by up to 35% - the reason being that many Maldivians are registered in their home island, although they are living and working in Male.

Instead the size of the population has been estimated based on the Housing Census 2000 data that are considered much more accurate. The consumption data for K. Maafushi include electricity consumption for desalination.

5.2 STELCO operations 2004

The operations of STELCO (diesel to electricity) are well documented. 27 Islands are covered by STELCO in 2004. Four of these, LH.Hinnavaru, DH.Kudahuvadhoo, N.Holhudhoo and Hulhumale' were added in 2003 or 2004 and are not included below, in order to make it possible to compare the remaining 23 islands for all the years 2002-2004.

YEAR							
2004	Efficiency in production	Efficiency in distribu-tion	Distribu-tion losses	Overall efficiency	Popula-tion	House-holds	Specific elec. consump.
	%	%	%	%	(-)	(-)	kWh/cap.
HA.Dhidhdhoo	33.7%	88.2%	11.8%	29.7%	2876	496	269
HA.Hoarafushi	28.4%	82.1%	17.9%	23.3%	2310	491	236
HA.Thuraakunu	26.1%	46.3%	53.7%	12.1%	428	70	150
HDh.Hanimaadhoo	30.6%	85.1%	14.9%	26.0%	1049	339	519
HDh.Kulhudhuffushi	34.0%	89.9%	10.1%	30.6%	6843	1644	422
SH.Milandhoo	27.9%	82.2%	17.8%	22.9%	843	229	321
N.Velidhoo	31.5%	83.8%	16.2%	26.4%	1940	436	285
R.Hulhudhuffaaru	30.8%	73.9%	26.1%	22.8%	976	246	193
B.Eydhafushi	35.7%	87.5%	12.5%	31.2%	2497	378	336
LH.Naifaru	32.9%	82.6%	17.4%	27.2%	3855	734	289
K.Himmafushi	34.7%	68.1%	31.9%	23.6%	913	149	763
K.Guraidhoo	29.2%	85.6%	14.4%	25.0%	1274	256	390
K.Kaashidhoo	30.1%	83.6%	16.4%	25.1%	1635	314	253
K.Maafushi	36.9%	88.0%	12.0%	32.5%	1932	190	839
K.Thulusdhoo	33.7%	78.5%	21.5%	26.4%	870	170	645
GA.Villinigili	34.2%	88.9%	11.1%	30.4%	2351	389	345
GDh.Gadhdhoo	31.0%	86.4%	13.6%	26.8%	1769	366	251
GDh.Thinadhoo	34.1%	80.6%	19.4%	27.5%	5088	975	378
CPS.S.Hithadhoo	37.2%	79.0%	21.0%	29.4%	9838	1759	894
S.HulhodhooMeedhoo	33.9%	78.8%	21.2%	26.8%	3244	879	252
GN.Fuahmulah	34.4%	84.8%	15.2%	29.2%	7828	1590	295
Male'	39.6%	89.6%	10.4%	35.4%	74431	9800	1461
Villingili	36.0%	86.3%	13.7%	31.0%	4577	601	742
SUM/Average (Total)	**38.3%**	**88.0%**	**12.0%**	**33.7%**	**139,369**	**22,501**	**996**
Male	39.6%	89.6%	10.4%	35.4%	74,431	9,800	**1,461**
Vilingili	36.0%	86.3%	13.7%	31.0%	4,577	601	**742**
Stelco Atolls	34.6%	82.2%	17.8%	28.4%	60,361	12,100	**442**

5.3 STELCO operations 2005

The operations of STELCO (diesel to electricity) are well documented. 27 Islands are covered by STELCO in 2005. Four of these, LH.Hinnavaru, DH.Kudahuvadhoo, N.Holhudhoo and Hulhumale' were added in 2003 or 2004 and are not included below, in order to make it possible to compare the remaining 23 islands for all the years 2002-2005.

YEAR							
2005	Efficiency in production	Efficiency in distribu-tion	Distribu-tion losses	Overall efficiency	Popula-tion	House-holds	Specific elec. consump.
	%	%	%	%	(-)	(-)	kWh/cap.
HA.Dhidhdhoo	33.1%	93.4%	6.6%	30.9%	2725	525	329
HA.Hoarafushi	32.9%	87.2%	12.8%	28.7%	2188	566	319
HA.Thuraakunu	30.3%	47.4%	52.6%	14.4%	406	75	187
HDh.Hanimaadhoo	34.7%	84.6%	15.4%	29.4%	994	410	676
HDh.Kulhudhuffushi	32.9%	92.9%	7.1%	30.6%	6484	1957	531
SH.Milandhoo	29.5%	84.7%	15.3%	25.0%	799	275	475
N.Velidhoo	32.0%	86.0%	14.0%	27.6%	1839	502	370
R.Hulhudhuffaaru	34.3%	81.1%	18.9%	27.8%	925	277	399
B.Eydhafushi	36.0%	89.0%	11.0%	32.0%	2366	395	414
LH.Naifaru	32.7%	86.3%	13.7%	28.2%	3653	803	371
K.Himmafushi	34.8%	68.4%	31.6%	23.8%	865	164	871
K.Guraidhoo	30.2%	87.4%	12.6%	26.4%	1207	280	472
K.Kaashidhoo	30.4%	87.8%	12.2%	26.7%	1549	341	327
K.Maafushi	36.7%	90.4%	9.6%	33.1%	1831	212	1215
K.Thulusdhoo	29.8%	86.1%	13.9%	25.6%	825	188	783
GA.Villinigili	32.2%	89.9%	10.1%	28.9%	2228	402	435
GDh.Gadhdhoo	30.5%	87.9%	12.1%	26.8%	1676	378	295
GDh.Thinadhoo	34.4%	82.2%	17.8%	28.3%	4821	1092	463
CPS.S.Hithadhoo	37.7%	81.5%	18.5%	30.7%	9322	1935	966
S.HulhodhooMeedhoo	34.4%	82.7%	17.3%	28.4%	3074	1015	312
GN.Fuahmulah	35.7%	86.9%	13.1%	31.0%	7417	1760	376
Male'	40.1%	89.5%	10.5%	35.9%	98355	10500	1274
Villingili	36.3%	89.5%	10.5%	32.5%	6048	700	653
SUM/Average (Total)	**38.8%**	**88.6%**	**11.4%**	**34.4%**	**161,598**	**24,745**	**990**
Male	40.1%	89.5%	10.5%	35.9%	98,355	10,500	**1,274**
Vilingili	36.3%	89.5%	10.5%	32.5%	6,048	700	**653**
Stelco Atolls	34.8%	85.0%	15.0%	29.6%	57,195	13,545	**537**

5.4 Non-STELCO islands

Some of the conversion factors, especially those related to STELCO (diesel to electricity in STELCO operated areas), are well documented. However, the energy conversion at islands outside the STELCO operation area, and at resort islands are more difficult to assess.

Aiming at establishing an overview of needs for investment in the power sector and in order to follow up on the 2004 tsunami, the MEEW conducted a survey on electricity production and diesel consumption covering non-STELCO operated islands for the three months July-September 2005. Approximately 150 islands responded to the survey requests. Data from 116 of these islands was found to be valid for estimation of electricity consumption for the non-STELCO islands.

The applied approach encompass:

- Assessment of specific consumption of electricity
- Assessment of overall conversion efficiencies
- Estimations for islands not covered by STELCO based on average specific figures

The overall conversion efficiency includes the yearly average generation efficiency and the distribution efficiency. This overall efficiency is used since the figures known are:

- Metered electricity consumption
- Consumption of diesel for electricity production

As seen below, the specific consumption of electricity and the conversions efficiencies varies a lot. Some comments related to 'Other operators, Atolls' are:

- The assessment made for 2002 did not distinguish between Male and Vilingili and the estimate for other operators in the Atolls had a more rough nature
- For 'other operators' data for specific electricity consumption in 2003 and 2004 are not available. Instead a backwards extrapolation for 2003 and 2004 is made
- Based on the 2005 figures (three-months data) the conversion efficiency seem to be improved compared to 2002. Therefore, the 2005 values are assumed also for 2003 and 2004
- The conversion efficiency for the STELCO operated islands have been improved during the years 2002-2004

Power conversion 2002-2005	**Specific electricity consumption** 2002	2003	2004	2005
	kWh/capita	kWh/capita	kWh/capita	kWh/capita
Male, Vilingili	1.058	1.095	1.151	1.238
Atolls, STELCO operation	360	422	465	537
Atolls, other operators	111	119	127	136
Overall	**460**	**502**	**548**	**612**

Power conversion 2002-2005	**Conversion efficiency, overall** 2002	2003	2004	2005
	(-)	(-)	(-)	(-)
Stelco, Male	0,345	0,352	0,354	0,359
Stelco, Vilingili	0,288	0,308	0,310	0,325
Stelco, Hulemale				
Stelco, Atolls	0,280	0,282	0,284	0,296
Other operators, Atolls	0,206	0,205	0,205	0,205

From the specific consumptions and the overall conversion efficiencies the consumption of electricity has been estimated for 2003 and 2004 covering the electricity supply to all inhabited islands. The figures do not cover tourist resorts and the industrial area.

The following assumptions were applied:

- Based on figures from STELCO it has been found that the production of electricity is almost constant over the year (from month to month)
- Average consumptions per capita are used in the respective areas

From the specific consumptions per capita and the population data the consumption of diesel for electricity production has been found as shown below. For 2005 the diesel include a smaller amount of HFO.

Diesel MWH	**Estimated consumption of diesel** 2002	2003	2004	2005
	MWh	**MWh**	**MWh**	**MWh**
Total	**406.202**	**445.437**	**491.383**	**550.125**
Stelco, Male	252.451	274.725	306.857	348.962
Stelco Vilingili	10.004	9.920	10.937	12.162
Stelco Hulemale				
Stelco, Atolls	74.103	86.120	93.819	103.784
Other operators, Atolls	69.643	74.673	79.771	85.216

Similar the consumption of electricity provided **at end-users** has been computed as seen below.

Power MWH	Estimated electricity consumption 2002 MWh	2003 MWh	2004 MWh	2005 MWh
Total	**124.998**	**139.247**	**155.189**	**177.468**
Stelco, Male	87.033	96.596	108.774	125.344
Stelco Vilingili	2.880	3.058	3.394	3.949
Stelco Hulemale	-	-	-	-
Stelco, Atolls (in 2005)	20.751	24.281	26.664	30.702
Other operators, Atolls	14.333	15.312	16.357	17.474

Both regarding the consumption of diesel and the consumed electricity the term 'Other operators, Atolls' include STELCO operated islands that were included in the STELCO's operation during 2003 and 2004.

5.5 Power production in tourist resorts

All tourist resort islands have their own private electricity production. Detailed data covering all of these islands has not been available. A data questionnaire has been issued to produce a reliable basis for analysis of the resort consumption. Through 2002-2005, 87 resorts were registered.

Based on an analysis of the replies, it can be established that the average use of diesel for electricity production is 3,807 kg/bed. Using "bed" as the unit of scaling instead of "bednight" is due to the fact that the main part of the electricity demand is constant, as the A/C system and water pumps are in operation in all rooms/guest facilities, whether there is guests or not.

Electricity production and diesel consumption at tourist resorts

		2002	2003	2004	2005
Number of beds	[-]	16.400	16.444	16.858	17.348
Diesel consumption per bed	[kg/year]	3.807	3.807	3.807	3.807
Diesel consumption	**[toe/year]**	**63.918**	**64.291**	**65.907**	**66.887**
Average conversion efficiency	[-]	0,34	0,34	0,34	0,34
Electricity production	**[toe/year]**	**21.732**	**21.859**	**22.408**	**22.742**

The average conversion efficiency of 34% is based on information from selected resorts, and site visit experience with the level of maintenance and operation of the diesel gensets.

5.6 Power production in industries

A thorough mapping of power production in industries and manufacturing has not yet been carried out. From knowledge at the MEEW very little electricity is produced in the industry sector. The known producers are:

- Maldives Sewage and Water Company (MSWC) making desalinated water
- Fish canning and freezing companies (3 installations)

Desalination

Since 2002 Maldives Sewage and Water Company has widened its operation and is today also providing desalinated water for Hulemale and Maafushi.

Desalination - 2002

		Male	*Vilingli*	*Total*
Production per day	**m3**	4000	120	4120
Specific Energy Consumption	**kWh/m3**	3.5	6.0	
Daily Consumption	**kWh**	14000	720	14720
Yearly electricity consumption	**MWh**	5110	262.8	5372.8
Efficiency in electricity production		0.35	0.25	-
Diesel consumption	**MWh**	14600	1051	15651
Yearly diesel consumption	***toe***	**1255**	**90**	**1346**
Yearly electricity consumption	***toe***	**-**	**-**	**462**

More than 5000 m3 desalinated water is now produced every day. The diesel consumption has grown from 1346 toe in 2002 to 1747 toe in 2003 – and has further grown to 2126 toe in 2004. The estimate for 2005 is a total diesel consumption of 3138 toe.

Desalination - 2003

		Male	Vilingli	Total
Production per day	m3	4050	120	4170
Specific Energy Consumption	kWh/m3	4.55	6.3	
Daily Consumption	kWh	18420	756	19176
Yearly electricity consumption	MWh	6723	276	6999.24
Efficiency in electricity production		0.35	0.25	-
Diesel consumption	MWh	19209.429	1104	20313
Yearly diesel consumption	*toe*	**1652**	**95**	**1747**
Yearly electricity consumption	*toe*	-	-	**602**
Operation start		<2002	<2002	

Desalination - 2004

		Male	Vilingli	Hmale	Sub-Total	Maafushi	Total
Production per day	m3	4641	149	64	4854	112	4966
Specific Energy Consumption	kWh/m3	4.67	6.3	9.8		6.5	
Daily Consumption	kWh	21673	933	627	23233	682	23915
Yearly electricity consumption	MWh	7911	340	229	8480	249	8729
Efficiency in electricity production	{-}	0.35	0.25	0.42		0.32	
Diesel consumption	MWh	22602	1362	545	24509	767	25276
Yearly diesel consumption	*toe*	**1943**	**117**	**47**	**2061**	**66**	**2126**
Yearly electricity consumption	*toe*	-	-	-	**729**	-	**751**
Operation start		<2002	<2002	<2003		<2003	

Desalination - 2005 (estimated)

		Male	Vilingli	Hmale	Total	Maafushi	Total
Production per day	m3	5772	235	144.5	6152	171	6323
Specific Energy Consumption	kWh/m3	4.51	5.2	8.7		6.4	
Daily Consumption	kWh	26032	1224	1257	28513	1094	29608
Yearly electricity consumption	MWh	9502	447	459	10407	399	10807
Efficiency in electricity production	{-}	0.28	0.34	0.42		0.32	
Diesel consumption	MWh	33934	1314	1093	36341	1248	37589
Yearly diesel consumption	*toe*	**2918**	**113**	**94**	**3031**	**107**	**3138**
Yearly electricity consumption	*toe*	-	-	-	**895**		**929**
Operation start		<2002	<2002	<2003		<2003	

Fishing and canning industries

Some freezing/cooling storage facilities for fish have its own power production units. There is in total three installations, including one that additionally produces canned fish. The below figures covers 2002, but since new data for 2003- 2005 has not been collected, the consumptions are assumed for these years, also.

		Fish canning	Freezing plant	Freezing plant	Total
Diesel consumption (ton/day)	ton/day	7.5	4.5	4.5	16.5
Days of production per year	365				
Diesel consumption (ton/year)	ton/year	2,738	1,643	1,643	6,023
Annual diesel consumption	toe/year	2,833	1,700	1,700	6,233
Efficiency in electricity production		28%	28%	28%	
Electricity production	**toe/year**	**793**	**476**	**476**	**1,745**
Efficiency in steam production		50%			
Steam use	**toe/year**	**1,417**			**1,417**

6 FINAL ENERGY CONSUMPTION – DEMAND SIDE

In the following the energy demand is analysed and described.

6.1 Households, Manufacturing and Public sector

Electricity
The following specific electricity consumptions have been identified.

Power conversion 2002-2005	Specific electricity consumption 2002	2003	2004	2005
	kWh/capita	kWh/capita	kWh/capita	kWh/capita
Male, Vilingili	1.058	1.095	1.151	1.238
Atolls, STELCO operation	360	422	465	537
Atolls, other operators	111	119	127	136
Overall	**460**	**502**	**548**	**612**

The break down on households for Male and Vilingili can be established from combining the information regarding electricity production, distribution losses (from STELCO), and population with information from the 2000 Housing Census on electrical appliances and utilisation in the household sector.

The break down on public and manufacturing for Male and Vilingili can be established from combining the information regarding electricity production, distribution losses (from STELCO), and population with information from the STELCO 2003, 2004 and 2005 operations statistics.

Looking at electricity alone there are significant differences in the consumption pattern between Male and the islands. The difference between the STELCO supplied areas and the private/community-supplied areas is ascribed to the more developed and stable supply in STELCO's areas. A stable supply provides for larger consumption.

The identified growth rates are seen below.

Growth rates - electricity consumption (*)		
(*) Compared to the year before	**2004**	**2005**
Specific Electricity growth rate, Male	5,1%	7,6%
Specific Electricity growth rate, Atolls	9,0%	12,3%
Population growth rate, Male area	7,1%	7,1%
Population growth rate, Atolls	-0,3%	-0,3%

Cooking
From the 'Population and housing Census, 2000' a lot of useful information has been found. Nevertheless, it has been encountered that some changes in the consumption fuels have taken place since 2000. Wood is used much less for cooking than in 2000 and the use of wood in Male has totally vanished.

The analysis is based on MPND, Population and Housing Census 2000, table H-17: "Households classified by type of living quarters and fuel used for cooking" containing data for the year 2000. The development during the years 2003-2005 have been estimated from the 2000 data using the identified development in domestic consumption of LPG and kerosene.

The use and type of fuels for cooking is undergoing changes. The main structural change is a reduction in use of fuel wood and biomass and an increase in use of LPG and electricity (see

also: Shaheed 2001 RETDAP). Import figures on LPG and kerosene for the years 2005 indicate a decrease in consumption of kerosene; a further increase in the use of LPG and moreover imply a decrease in the use of biomass.

The distribution of fuels has in first instance been changed to estimate the situation in 2002 as described in the report 'Energy Supply and Demand' for the precedent project[5]. As a guide to the magnitude of change, the result of the Biomass Survey (precedent project) - including the survey questionnaire as well as the imports figures of LPG - has been used. Further the above changes in the use of LPG, kerosene and biomass for cooking has been used to establish a model for the development during 2003-2005.

Assumptions:
The assumptions include:

- Utilised energy for cooking (supplied to the pan/pot/oven) is 3.58[6] kWh/day/household
- Efficiency in utilisation of the specific fuel

Fuel	*Efficiency*[7]
Firewood	35%
Kerosene oil	53%
LPG	53%
Electricity	78%
Other (not defined – probably biomass)	35%

Changes in fuel for cooking

Households: Changes in use of fuels for cooking		**number of households**	**number of households**
	2003	**2004**	**2005**
	[-]	**[-]**	**[-]**
Male' - overall	**0**	**0**	**0**
Fire wood	-233	0	0
Oil	117	-1.500	-2.500
Gas	204	1.000	2.000
Electricity	0	500	500
Other	-88	0	0
Total (ex other)	0	0	0
Atolls, overall	**0**	**0**	**0**
Fire wood	-13.100	0	0
Oil	2.000	-5.000	-7.000
Gas	9.700	5.000	7.000
Electricity	1.400	0	0
Other	0	0	0
Total (ex other)	0	0	0

Break-down of energy end-use

Specific energy consumption in cooking		**kWh/day**	**kWh/day**
Utilised energy for cooking (energy to pot) per household	3.58	3.58	3.58
	%	**%**	**%**
Growth Rate, Households, Male	n.a.	4.0%	4.0%
Growth Rate, Households, Atolls	n.a.	2.0%	2.0%

[5] Energy Supply and Demand - Assessment of Least-cost, Sustainable Energy Resources – Maldives. Project INT/03/R11 – 02 MDV 1180

[6] This is equivalent of 2 average cooking places (each 650 W) used for approx. 2.75 hours/day.

[7] ESMAP, Guinea, Household Energy Strategy, Report no 163/94, World Bank 1994 (plus consultants estimations)

Based on the Housing Census 2000 and the above assumptions regarding the use of LPG, kerosene and biomass, a breakdown of energy end-use on user categories has been derived as shown in the following tables covering 2003 - 2005.

Total Energy demand - 2003 (toe)

Male&Vilingili	toe			Population: 91009	
toe	Electricity	Biomass	LPG	Kerosene	Total
Households	4153	0	1092	914	6159
Lightning	1001	0	0	1	
Appliances & AC	3140	0	0	0	
Cooking and smoking	12	0	1092	913	
Public	148	0	0	0	148
Manufacturing&commerce	2718	0	0	0	2718
		0	0	0	
Government buildings	1549	0	0	0	1549
Total	**8568**	**0**	**1092**	**914**	**10574**

Atolls	toe			Population: 186455	
toe	Electricity	Biomass	LPG	Kerosene	Total
Households	2066	1863	2353	3803	10084
Lightning	919	0	0	235	1154
Appliances & AC	902	0	0	0	902
Cooking and smoking	209	1863	2353	3567	7992
Others	36	0	0	0	36
Public	1222	0	382	75	1680
Lightning	743	0	0	0	743
Appliances & AC	479	0	0	57	536
Cooking and smoking	0	0	382	18	400
Others	0	0	0	0	0
Manufacturing&commerce	112	0	21	143	276
Lightning	56	0	0	86	143
Appliances & AC	56	0	0	57	113
Cooking and smoking	0	0	21	18	39
Others	0	0	0	0	0
Total	**3400**	**1863**	**2755**	**4021**	**12039**

Total Energy demand - 2004(toe)

Male&Vilingili	toe			Population: 97476	
toe	Electricity	Biomass	LPG	Kerosene	Total
Households	4661	0	1356	620	6637
Lightning	1126	0	0	1	
Appliances & AC	3535	0	0	0	
Cooking and smoking	0	0	1356	620	
Public	166	0	0	0	166
Manufacturing&commerce	3059	0	0	0	3059
		0	0	0	
Government buildings	1744	0	0	0	1744
Total	**9630**	**0**	**1356**	**620**	**11606**

Atolls	toe		Population:	185904	
toe	Electricity	Biomass	LPG	Kerosene	Total
Households	2227	1863	3415	2740	10245
Lightning	998	0	0	235	1234
Appliances & AC	980	0	0	0	980
Cooking and smoking	209	1863	3415	2504	7992
Others	39	0	0	0	39
Public	1328	0	381	75	1784
Lightning	807	0	0	0	807
Appliances & AC	521	0	0	57	578
Cooking and smoking	0	0	381	18	399
Others	0	0	0	0	0
Manufacturing&commerce	122	0	20	143	285
Lightning	61	0	0	86	147
Appliances & AC	61	0	0	57	118
Cooking and smoking	0	0	20	18	39
Others	0	0	0	0	0
Total	**3677**	**1863**	**3816**	**2958**	**12314**

Total Energy demand - 2005(toe)

Male&Vilingili	toe		Population:	104403	
toe	Electricity	Biomass	LPG	Kerosene	Total
Households	5373	0	1851	94	7318
Lightning	1298	0	0	1	
Appliances & AC	4074	0	0	0	
Cooking and smoking	0	0	1851	94	
Public	192	0	0	0	192
Manufacturing&commerce	3526	0	0	0	3526
		0	0	0	
Government buildings	2010	0	0	0	2010
Total	**11100**	**0**	**1851**	**94**	**13045**

Atolls	toe		Population:	185355	
toe	Electricity	Biomass	LPG	Kerosene	Total
Households	2468	1863	4903	1252	10486
Lightning	1118	0	0	235	1353
Appliances & AC	1097	0	0	0	1097
Cooking and smoking	209	1863	4903	1016	7992
Others	44	0	0	0	44
Public	1487	0	380	75	1942
Lightning	904	0	0	0	904
Appliances & AC	583	0	0	57	640
Cooking and smoking	0	0	380	18	398
Others	0	0	0	0	0
Manufacturing&commerce	136	0	20	143	299
Lightning	68	0	0	86	154
Appliances & AC	68	0	0	57	125
Cooking and smoking	0	0	20	18	39
Others	0	0	0	0	0
Total	**4092**	**1863**	**5303**	**1470**	**12728**

6.2 Vessels

A model has been established in order to estimate the fuel consumptions for vessels in the Maldives.

Categorisation of vessels

Vessel Categories 22-May-06	Fleet size registered	Active %	Active units	Average Size feet	Engine HP	Fuel	Speed full speed knots	Consump. lit/hour full speed	Consump. lit/hour idling	Consump. liter/km	Operation at full speed hours/year	Operation idling hours/year	Fuel consump. at full speed lit/year	idling lit/year
TOTAL	6508		2746											
1 Mechanised fishing vessels	**3266**		**1050**						**10%**					
1.1 Fishing vessels: < 60 feet	3052	29%	885	50	50	diesel	9	12	1,2	0,7	540	240	5.735.318	254.903
1.2 Fishing vessels: 60-80 feet	120	75%	90	70	140	diesel	10	32	3,2	1,7	540	240	1.547.710	68.787
1.3 Fishing vessels: > 80 feet	40	85%	34	95	500	diesel	11	100	10,0	4,9	540	240	1.837.133	81.650
1.4 Small collecting vessels	44	75%	33	80	350	diesel	11	80	8,0	3,9	540	240	1.425.600	63.360
1.5 Collecting Mother vessels	10	75%	8	250	1000	diesel	13	229	22,9	9,5	540	240	925.714	41.143
2 Passenger (Tourist) vessels	**1541**		**951,7**											
2.1 Tourist Dhonis	380	60%	226	36	130	diesel	9	30	3,0	1,8	450	0	3.034.003	-
2.2 Tourist speed launches	1030	60%	618	36	400	petrol	30	65	6,5	1,2	210	0	8.435.700	-
2.3 Tourist Ferries and catamerans	18	85%	15	75	2200	diesel	28	503	50,3	9,7	400	0	3.077.486	-
2.4 Safari boats	113	80%	90	42	400	diesel	15	80	8,0	2,9	450	450	3.256.409	325.641
3 Transport (Cargo) vessels	**348**		**70**											
3.1 Dhoni	132	50%	66	36	170	diesel	9	39		2,3	500	0	1.276.110	-
3.2 Batheli	127	50%	64	36	120	diesel	5	27		2,9	375	0	649.997	-
3.3 Barge	81	50%	41	60	250	diesel	9	57		3,4	375	0	863.677	-
3.4 Others	8	50%	4	36	150	diesel	11	32		1,6	375	0	48.256	-
4 Transport (Pass.&cargo) vessels	**1166**		**583**											
4.1 Dhonis	1137	50%	569	50	170	diesel	9	39		2,3	625	63	13.739.934	-
4.2 Ferries and boats	29	50%	15	75	600	diesel	13	120		5,0	450	38	783.483	-
5 Water sport vessels	**30**		**24**											
5.1 Speed launches	30	80%	24	36	400	petrol	30	65	6,5	1,2	225	38	351.000	5.850
6 Pleasure Crafts	**115**		**68**											
6.1 Speed launches	30	80%	24	30	200	petrol	20	33	3,3	0,9	225	38	175.500	2.925
6.2 Yachts	85	80%	68	??	100	diesel	9	23	2,3	1,4	225	38	348.030	5.801
7 Others	**42**													
Other vessels	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A			150	15		

The model uses a number of specific parameters:

- Number of active vessels
- Typical specific consumption of fuel per hour
- Speed and operation hours per year

To a large extent, the categorisation of the vessels is in line with most categorisations applied by different Maldivian ministries, although the aim here has been to separate the vessels serving tourists. The shown figures are all rough estimates; i.e. also on the number of vessels being active (fleet size). When using the model the following estimates on fuel consumptions for 2003 have been found.

The development during 2004 and 2005 is described in section 6.5.

Fuel consumption in vessels - liters of fuel

			... Of which				
	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	
LITERS	TOTAL	TOTAL	Male		Atolls		Distance
	lit/year	lit/year	lit/year	lit/year	lit/year	lit/year	km/year
TOTAL	**39.390.146**	**8.970.975**	**6.602.250**	**1.838.801**	**32.787.896**	**7.132.174**	**27.973.011**
Of which fishing	11.981.319	-	1.783.820	-	10.197.500	-	9.706.234
Of which passenger and goods	17.361.458	-	3.472.292	-	13.889.167	-	7.137.548
Of which transport of tourists	9.693.538	8.435.700	1.222.298	1.687.140	8.471.241	6.748.560	10.373.761
Of which pleasure crafts and oth	353.831	535.275	123.841	151.661	229.990	383.614	755.468

6.3 Resorts

As the consumption of energy is significant in the tourist resorts, a specific investigation is prepared for this area. During 2003-2005, 87 resorts were registered, but some were not in operation the following half year after the December 2004 tsunami.

There is no official information available on the energy consumption in the resorts, but a survey covering a selection of 10 resorts was conducted during October- December 2003 in order to assess the consumption of energy and to derive consumption patterns. Further data for additional 2 resorts were added in 2006[8].

Based on an analysis of the replies, the following assumptions can be established:

[8] Pilot testing of Resort Survey

- Use of diesel for electricity production: 3,807 kg/bed/year
- Use of electricity per year per bed: 15,460 kWh/bed/year
- Use of LPG for cooking: 0.0078 kg/bed night

The above values are assumed unchanged during 2003-2005.

Using "bed" as the unit of scaling instead of "bednight" is based on the fact that by far the main part of the electricity demand is constant, as the A/C system etc. are in operation in all rooms/guest facilities regardless if there are guests or not. The use of LPG for cooking is, on the contrary, related to the amount of meals and therefore to the actual tourist bed nights.

Growth - Tourist Resorts (*)			
(*) Compared to the year before	**2003**	**2004**	**2005**
Bed capacity	16.444	16.858	17.348
of which with solar hot water	50%	50%	50%
Bed Capacity Utilization Rate (%)	77%	84%	52%
Average number of beds in use, supplied with solar	6.347	7.072	4.521
Number of solar m2 per bed	0,5	0,5	0,5
Solar heat utilised (MWh/year)	2085	2323	1485
Solar heat utilised (toe/year)	179	200	128
Growth in hot water consumption, base 2002 (toe/year)	68	69	-247

6.4 Vehicles

The analysis of the energy consumption for land transport in vehicles is based on the Statistical yearbook, Table 11.3: "Registered and Newly Registered Vehicles According to Type, 2000 – 2002", and on the consultant's former evaluations in 2003-2004. In the table below **covering the assessment for 2002** the assumptions made regarding the distribution between petrol and diesel fuel is made (based on input from Ministry of Transport), and the average distance and fuel economy.

	2002	Fuel			Avg. Dist	Mileage	Fuel economy petrol	Fuel economy diesel
Type of vehicles	**Registered**	**Petrol**	**Diesel**	**Total**	**km/day**	**km/year**	**km/liter**	**km/liter**
All Types	**19,914**							
Motor Car	1,948	100%	0%	100%	15.00	5,475	12.0	14.0
Motor Cycle/Auto Cycle	14,248	100%	0%	100%	10.00	3,650	22.0	
Lorries/Trucks/Tractors	707	98%	2%	100%	40.00	14,600	6.0	8.0
Van/Bus	613	28%	72%	100%	40.00	14,600	7.0	8.0
Jeep/Landrover/Pickup	1,243	25%	75%	100%	40.00	14,600	7.0	10.0
Taxis(running in Male')	567	100%	0%	100%	70.00	25,550	12.0	14.0
Other Vehicles	588	90%	10%	100%	5.00	1,825	6.0	8.0
Source: Ministry of Transport and Civil Aviation								

This leads to the calculation of the total fuel consumption, based on the amount of registered vehicles, and assuming a distribution between Male and Islands as indicated in the below table.

	2002	Male	Atolls	Total petrol	Total diesel	Male diesel	Atolls Diesel	Male petrol	Atolls petrol
Type of vehicles	**Registered**			**Liter**	**Liter**				
Motor Car	1,948	100%	0%	884,721	3,475	3,475	-	884,721	-
Motor Cycle/Auto Cycle	14,248	95%	5%	2,363,873	-	-	-	2,245,679	118,194
Lorries/Trucks/Tractors	707	99%	1%	1,690,185	22,636	22,410	226	1,673,283	16,902
Van/Bus	613	85%	15%	353,977	808,995	687,646	121,349	300,880	121,349
Jeep/Landrover/Pickup	1,243	85%	15%	648,136	1,361,085	1,156,922	204,163	550,915	97,220
Taxis(running in Male')	567	100%	0%	1,207,238	-	-	-	1,207,238	-
Other Vehicles	588	99%	1%	160,965	13,414	13,280	134	159,355	1,610
Total	**19,914**			**7,309,094**	**2,209,605**	**1,883,733**	**325,873**	**7,022,072**	**355,275**
					toe	**1,638**	**283**	**5,635**	**285**

In section 6.5 the development during 2003-2005 is described.

6.5 Supplemental data on development in consumption data

For some of the data, where the forecasting has not been described earlier in this report, rough estimates on the development have been made for 2003, 2004 and 2005. This counts for the data in the below table.

GDP Growth rates (*)

(*) Compared to the year before	Basis	2003	2004	2005
Fisheries	GDP		-0.3%	0.0%
Tourism	Tourist bednights		9.0%	-18.0%
Construction	GDP		10.5%	10.0%
Transport (domestic sea cargo, air cargo)	Traffic activicy level (*)		22.0%	-8.0%

(*) weighted average of domestic air and sea transport figures

As basis for the above data is used fixed prices (US$ 2000 prices), except for the Tourism sector where the number of tourists has been applied. The impact of the GDP development on energy consumption has led to the following assumptions:

- The energy consumption in fisheries is assumed unchanged 2003-2005
- The main impact of the growth rates in the Tourisms sector is the effect on transport. Thus this effect is assumed to be included in the development of the transport sector. The change in number of tourists has no or little influence on the energy consumption in Resorts, as analysed in an earlier section
- A growing construction sector will lead to more transport and higher consumption of electricity. The effect on transport is assumed to be included in the above numbers, whereas the effect on electricity consumption to a high extent already is included in the electricity consumption figures received through the applied Power and Heat Survey

Thus the conclusion is that the main effect on the energy consumption of changing GDP figures is the impact on fuels used for transport; i.e. diesel and petrol.

Growth rates - transport (*)

(*) Compared to the year before	2003	2004	2005	Fuel
Fishing (boats)				
Male and Vilingili	n/a	5%	-5%	diesel
Atolls	n/a	5%	-5%	diesel
Sea transport				
Sea transport, Atolls	n/a	30%	-5%	diesel
	n/a	30%	-5%	petrol
Sea transport, Tourists&pleasure	n/a	30%	-5%	diesel
	n/a	30%	-5%	petrol
Vehicles				
Vehicles, Male	n/a	45%	30%	diesel
	n/a	50%	30%	petrol
Vehicles, Atollls	n/a	45%	30%	diesel
	n/a	50%	30%	petrol

7 ENERGY BALANCE 2003 - 2005

7.1 Quality of data

In the establishing of the energy balances 2003-2005, a variety of models have been used, as described earlier in this report.

Import data on all fuels have been obtained from the official source: Maldives Custom Service. This suggests certain solidity and reliability regarding the import figures.

Establishing data on **energy stock changes** has caused severe problems. The reasons might be lack of internal fuel accounting systems in some of the companies importing and handling fuels. Importers may in addition be reluctant to provide the requested data in the form of the Fuel Product Survey.

For the **conversion of diesel to power** very solid data have been received from STELCO and based on an MEEW Survey conducted in the autumn 2005 also good estimates has been derived for islands not covered by STELCO.

Energy Balance 2003
The applied models and estimations produce an energy balance for 2003 showing only small statistical differences. Although estimations on the distribution into sectors of the final energy consumption are difficult, the energy balance numbers for the 2003 balance are considered valid for showing the energy flows in the country.

It is seen that renewable energy only constitutes a minor share of the energy supply:
- Biomass: 2377 toe
- Solar heating of domestic hot water: 160 toe

In total the renewable energy part covers 1.2 % of the total energy consumption

Energy Balance 2004
When comparing the 2004 balance with the 2003 balance it is seen that:
- The import and consumption of diesel has grown significantly. 40% of the final consumption of diesel cannot be explained by indices for economic development and by the models used. The deviations are critical.
- Consumption of petrol has grown considerably, which was expected as there is a growing number of cars and motor bikes
- The domestic use of Jet A1 has grown significantly, which was expected since the domestic aviation activity is growing.
- The use of LPG has grown significantly, which is in line with information obtained from the importers
- The use of Kerosene has grown significantly. This indicates that the kerosene may have been used to other purposes than mainly for cooking and lighting, as assumed.– alternatively, kerosene may have been lost during the 2004 tsunami or a significant amount of kerosene has been stored to be used in 2005
- As expected the consumption of electricity has grown moderately

The Energy balance 2004 shows significant statistical difference as to:
- Consumption of diesel 40% of final consumption
- Consumption of petrol 8% of final consumption
- Consumption of LPG 26% of final consumption
- Consumption of Kerosene 54% of final consumption

Much effort has been out into investigating the reasons for these differences – until now without success. As given from the economic development figures in section 6.5 and from other sections it is clear that the GDP growth rates are high in 2004 and 2005 and the transport indicators shows a 22% increase in transport activity in 2004 and subsequently a decrease by 8% in 2005.

Even such considerable changes cannot explain the final consumption of diesel in 2005. Here the statistical difference amounts to half the final energy consumption. More investigation is needed as described further below.

Energy Balance 2005
The applied models and estimations produce an energy balance for 2005 showing only small statistical differences, but lacking figures on stocks and stock changes may influence the validity of the energy balance. As a consequence some of the figures for the domestic consumption of energy carriers may show to be invalid as well. The balance will not show valid figures until the lacking data on stock changes are included.

When comparing the 2005 balance with the 2004 balance it is seen that:

- The import and consumption of diesel has been reduced significantly
- The domestic use of Jet A1 has increased
- The use of LPG is steady growing, being in line with information obtained from the importers
- The use of Kerosene has decrease significantly.
- As expected the consumption of electricity has grown moderately

Further investigations
As a result the energy balances has been established showing a significant growth in the domestic diesel consumption in the 2004 energy supply. Although economic growth figures can explain a part of the growth, some further investigations are recommended before the MEEW release the 2004 and 2005 energy balances. Also the aggregated consumption in 2004 of LPG and kerosene far exceeds the demand for these fuels; assumed to cover cooking needs etc.

Possible reasons for the statistical differences in 2004 are:

- Inconsistencies in the importers and energy distributors assessment of stocks. Maybe dates of registration of imports around 1 January causes distortions
- Energy consumptions not known or not covered by the models used. If so, other use of the fuels should be investigated.

The domestic consumption figures for diesel, petrol, kerosene and LPG in the balances cannot be considered valid until further investigations has been on the flows of these energy carriers.

Thus further investigations in these areas are of utmost importance. It is recommended:

- That MEEW scrutinize the data in the energy balances to detect the character of the energy consumptions in 2004 and 2005
- That MEEW take meetings with each of the importers/distributors to discuss and map the flow of energy carriers

7.2 Energy Balance 2003

The table below provides an overview of the energy balance of the Maldives for the year 2003.

Maldives Energy Balance 2003 (Unit: toe)

	Diesel	Petrol	JET A1	LPG	Kero-sene	Bio-mass	Elec-tricity	Heat	Total
Resources	1	3	4	5	6	7	8	9	
Domestic resources									
Biomass						2.763			**2.763**
Wind									-
Solar								160	**160**
Landfill gas									-
Imports									
Oil products	171.017	13.068	120.284	4.021	5.205				**313.595**
Exports									
Oil products	(18.406)		(106.462)						**(124.869)**
Stock									
Changes in stock	(1.830)	301	(3.962)	296	352				**(4.843)**
Gross Domestic Consumption	**150.780**	**13.369**	**9.860**	**4.317**	**5.557**	**2.763**	**-**	**160**	**186.805**
Conversion									
Electricity (including distribution losses)									
STELCO									-
STELCO, Male and Vilingili	(24.475)						8.569		**(15.906)**
STELCO, Atolls	(7.405)						2.088		**(5.317)**
Domestic Airports	(3.661)						1.281		**(2.380)**
Community / Private (Atolls)	(6.421)						1.317		**(5.104)**
Desalination industry	(1.747)						602		**(1.145)**
Industry, cold stores and canning	(6.233)						1.745	1.417	**(3.071)**
Resorts (conversion and distribution)	(64.291)						21.859		**(42.432)**
									-
									-
Conversion total	**(114.232)**	**-**	**-**	**-**	**-**	**-**	**37.460**	**1.417**	**(75.355)**

Final Energy Consumption	**36.548**	**13.369**	**9.860**	**4.317**	**5.557**	**2.763**	**37.460**	**1.576**	**111.450**
Households - residential									-
Male - capital area				**1.092**	**914**	**-**	**4.153**		**6.159**
Atolls				**2.353**	**3.803**	**2.763**	**2.066**		**10.984**
									-
Manufacturing, commerce and service									-
Male and Vilingili									-
Public buildings including schools				**-**	**-**		**148**		**148**
Industry, manufacturing and commercial	**-**	**-**		**-**	**-**	**-**	**2.718**		**2.718**
Fishing (boats)	**1.551**	**-**		**60**	**83**				**1.694**
Desalination industry							**602**		**602**
Waste (Thilafushi)				**4**	**-**				**4**
Government buildings				**-**			**1.549**		**1.549**
									-
Atolls									-
Public buildings including schools				**382**	**75**	**-**	**1.222**		**1.680**
Manufacturing	**-**	**-**		**21**	**143**	**-**	**112**		**276**
Cold stores and canning	**-**	**-**		**-**	**-**	**-**	**1.745**	**1.417**	**3.162**
Desalination industry	**-**						**-**		
Fishing (boats)	**8.866**			**301**	**359**				**9.525**
									-
Resorts etc. (ex transport)									-
Resorts etc.				**36**	**-**	**-**	**21.859**	**160**	**22.054**
									-
Domestic Transport									-
Hulhule Airport (operation)	**319**	**25**					**1.281**		**1.625**
Domestic air transport			**9.860**						**9.860**
Sea transport, Atolls	**15.094**	**-**							**15.094**
Sea transport, Tourists&pleasure	**8.735**	**7.199**							**15.934**
Vehicles, Male	**1.638**	**5.635**							**7.273**
Vehicles, Atollls	**283**	**314**							**597**
									-
Final Energy Consumption Total	**36.486**	**13.173**	**9.860**	**4.248**	**5.376**	**2.763**	**37.456**	**1.576**	**110.937**
Balance	**62**	**196**	**-**	**69**	**181**	**-**	**5**	**-**	**512**

7.3 Energy Balance 2004

The table below provides an overview of the energy balance of the Maldives for the year 2004.

Maldives Energy Balance 2004 (Unit: toe)

	Diesel	Petrol	JET A1	LPG	Kero-sene	Bio-mass	Elec-tricity	Heat	Total
Resources	1	3	4	5	6	7	8	9	
Domestic resources									
Biomass						2.763			**2.763**
Wind									-
Solar								160	**160**
Landfill gas									-
Imports									
Oil products	209.619	19.754	141.719	7.332	8.901				**387.324**
Exports									
Oil products	(16.042)		(124.780)						**(140.823)**
Stock									
Changes in stock	2.551	85	(2.285)	231	(76)				**505**
Gross Domestic Consumption	**196.127**	**19.839**	**14.653**	**7.563**	**8.825**	**2.763**	**-**	**160**	**249.929**
Conversion									
Electricity (including distribution losses)									
STELCO									-
STELCO, Male and Vilingili	(27.325)						9.645		**(17.681)**
STELCO, Atolls	(8.067)						2.293		**(5.774)**
Domestic Airports	(4.060)						1.421		**(2.639)**
Community / Private (Atolls)	(6.859)						1.406		**(5.453)**
Desalination industry	(2.126)						751		**(1.376)**
Industry, cold stores and canning	(6.233)						1.745	1.417	**(3.071)**
Resorts (conversion and distribution)	(65.907)						22.408		**(43.498)**
									-
									-
Conversion total	**(120.577)**	**-**	**-**	**-**	**-**	**-**	**39.669**	**1.417**	**(79.492)**

7.4

Final Energy Consumption	**75.550**	**19.839**	**14.653**	**7.563**	**8.825**	**2.763**	**39.669**	**1.576**	**170.437**
Households - residential									-
Male - capital area				**1.356**	**620**	**-**	**4.661**		**6.637**
Atolls				**3.415**	**2.740**	**2.763**	**2.227**		**11.145**
									-
Manufacturing, commerce and service									-
Male and Vilingili									-
Public buildings including schools				**-**	**-**		**166**		**166**
Industry, manufacturing and commercial	**-**	**-**		**-**	**-**	**-**	**3.059**		**3.059**
Fishing (boats)	**1.628**	**-**		**60**	**83**				**1.771**
Desalination industry							**751**		**751**
Waste (Thilafushi)				**4**	**-**				**4**
Government buildings				**-**			**1.744**		**1.744**
									-
Atolls									-
Public buildings including schools				**381**	**75**	**-**	**1.328**		**1.784**
Manufacturing	**-**	**-**		**20**	**143**	**-**	**122**		**285**
Cold stores and canning	**-**	**-**		**-**	**-**	**-**	**1.745**	**1.417**	**3.162**
Desalination industry	**-**						**-**		
Fishing (boats)	**9.309**			**301**	**359**				**9.968**
									-
Resorts etc. (ex transport)									-
Resorts etc.				**36**	**-**	**-**	**22.408**	**160**	**22.604**
									-
Domestic Transport									-
Hulhule Airport (operation)	**340**	**56**					**1.421**		**1.816**
Domestic air transport			**14.653**						**14.653**
Sea transport, Atolls	**19.622**	**-**							**19.622**
Sea transport, Tourists&pleasure	**11.356**	**9.359**							**20.715**
Vehicles, Male	**2.375**	**8.453**							**10.828**
Vehicles, Atollls	**411**	**470**							**881**
									-
Final Energy Consumption Total	**45.041**	**18.338**	**14.653**	**5.573**	**4.019**	**2.763**	**39.632**	**1.576**	**131.595**
Balance	**30.509**	**1.501**	**-**	**1.990**	**4.805**	**-**	**37**	**-**	**38.842**

Energy Balance 2005

The table below provides an overview of the energy balance of the Maldives for the year 2005.

Maldives Energy Balance 2005 (Unit: toe)

	Diesel	HFO	Petrol	JET A1	LPG	Kero-sene	Bio-mass	Elec-tricity	Heat	Total
Resources	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Domestic resources										
Biomass							2.763			**2.763**
Wind										**-**
Solar									160	**160**
Landfill gas										**-**
Imports										
Oil products	184.343	11.839	20.553	105.625	8.079	1.227				**331.666**
Exports										
Oil products	(17.329)	-		(91.675)						**(109.004)**
Stock										
Changes in stock	(3.577)	(3.052)	(1.862)	3.280	(468)	(100)				**(5.780)**
Gross Domestic Consumption	**163.438**	**8.786**	**18.692**	**17.229**	**7.611**	**1.127**	**2.763**	**-**	**160**	**219.805**
Conversion										
Electricity (including distribution losses)										
STELCO										**-**
STELCO, Male and Vilingili	(22.265)	(8.786)						11.117		**(19.934)**
STELCO, Atolls	(8.924)							2.640		**(6.284)**
Domestic Airports	(4.240)							1.615		**(2.625)**
Community / Private (Atolls)	(7.327)							1.502		**(5.825)**
Desalination industry	(3.138)							929		**(2.209)**
Industry, cold stores and canning	(6.233)							1.745	1.417	**(3.071)**
Resorts (conversion and distribution)	(66.887)							22.742		**(44.146)**
										-
										-
Conversion total	**(119.015)**	**(8.786)**	**-**	**-**	**-**	**-**	**-**	**42.291**	**1.417**	**(84.093)**

Final Energy Consumption	**44.423**	**-**	**18.692**	**17.229**	**7.611**	**1.127**	**2.763**	**42.291**	**1.576**	**135.712**
Households - residential										**-**
Male - capital area					**1.851**	**94**	**-**	**5.373**		**7.318**
Atolls					**4.903**	**1.252**	**2.763**	**2.468**		**11.386**
										-
Manufacturing, commerce and service										**-**
Male and Vilingili										**-**
Public buildings including schools					**-**	**-**		**192**		**192**
Industry, manufacturing and commercial	**-**	**-**	**-**		**-**	**-**	**-**	**3.526**		**3.526**
Fishing (boats)	**1.547**	**-**	**-**		**60**	**83**				**1.690**
Desalination industry								**929**		**929**
Waste (Thilafushi)					**4**	**-**				**4**
Government buildings					**-**			**2.010**		**2.010**
										-
Atolls										**-**
Public buildings including schools					**380**	**75**	**-**	**1.487**		**1.942**
Manufacturing	**-**	**-**	**-**		**20**	**143**	**-**	**136**		**299**
Cold stores and canning	**-**		**-**		**-**	**-**	**-**	**1.745**	**1.417**	**3.162**
Desalination industry	**-**							**-**		
Fishing (boats)	**8.844**	**-**			**301**	**359**				**9.503**
										-
Resorts etc. (ex transport)										**-**
Resorts etc.					**36**	**-**	**-**	**22.742**	**160**	**22.937**
										-
Domestic Transport										**-**
Hulhule Airport (operation)	**660**	**-**	**69**					**1.615**		**2.344**
Domestic air transport				**17.229**						**17.229**
Sea transport, Atolls	**18.641**	**-**	**-**							**18.641**
Sea transport, Tourists&pleasure	**10.788**	**-**	**8.891**							**19.679**
Vehicles, Male	**3.087**	**-**	**9.298**							**12.385**
Vehicles, Atollls	**534**	**-**	**517**							**1.052**
										-
Final Energy Consumption Total	**44.101**	**-**	**18.775**	**17.229**	**7.555**	**2.005**	**2.763**	**42.224**	**1.576**	**136.228**
Balance	**322**	**-**	**(83)**	**-**	**56**	**(878)**	**-**	**67**	**-**	**(516)**

8 ENERGY INDICATORS

8.1 Maldives Indicators

Key indicators for the consumption of energy in the Maldives are shown in the table below. Utilising the Total primary Energy Supply (TPES), electricity consumption data and GDP data, different key indicators has been derived.

Moreover '**Compound Indicators'** has been calculated allowing for analysing the developments in consumptions and allowing for the later comparison with other countries.

Selected Indicators for the Maldives			2003	2004	2005
Key indicators	**Population**	Million	**0,277**	**0,283**	**0,290**
	GDP	Billion 2000 US$	**0,729**	**0,798**	**0,757**
	Fisheries	"	0,048	0,049	0,052
	Tourism	"	0,238	0,258	0,173
	Transport and communication	"	0,104	0,121	0,140
	Total Primary Energy Supply	Mtoe	**0,187**	**0,250**	**0,220**
	Fisheries	"	0,011	0,011	0,011
	Tourism (2)	"	0,083	0,091	0,092
	Electricity Consumption (1)	TWh	**0,14**	**0,16**	**0,18**
Compound indicators	**TPES/Population**	Toe/Capita	**0,67**	**0,88**	**0,76**
	TPES/GDP	Toe/thousand(2000)US$	**0,26**	**0,31**	**0,29**
	EI consumption/population	kWh/capita	**502**	**548**	**612**
	Fisheries				
	Percentage of GDP	%	**6,6%**	**6,1%**	**6,8%**
	Catches	1000 Metric Tonnes	**155,42**	**158,58**	**182,90**
	TPES/GDP	Toe/thousand(2000)US$	**0,22**	**0,23**	**0,20**
	TPES/Catch	Toe/1000 MT	**6,79**	**6,99**	**5,76**
	Tourism				
	Percentage of GDP	%	**32,7%**	**32,3%**	**22,8%**
	TPES/GDP	Toe/thousand(2000)US$	**0,35**	**0,35**	**0,53**
	TPES/Bednight	Toe/Bednight	**17,74**	**17,90**	**27,96**
	Bednights	1000	**4.704,60**	**5.109,98**	**3.300,00**

(1) excluding tourist resorts
(2) Assuming tourism is 33% of domestic aviation

The table show:

- The GDP shows significant growth in GDP in 2004 and a reduction in 2005, due to the 2004 tsunami impacting the tourism sector.
- The TPES/GDP shows the same tendency
- The electricity consumption is growing by approximately 10% per year, as an average for the Maldives. In praxis the growth rates differ a lot from island to island.
- The Fishing Sector's TPES/GDP for 2005 shows a tendency to reduce the consumption of energy in toe/1000 tons catch, basically due to better catches in 2005.
- In the Tourism Sector, the impact of the tsunami has reduced the number of bed nights considerably in 2005 and increased the TPES/GDP and the TPES/Bed night, reflecting that the consumption in the Tourist Resorts mainly correspond to the size and facilities in the resorts and is only to a minor extent influenced by the resort occupancy rates

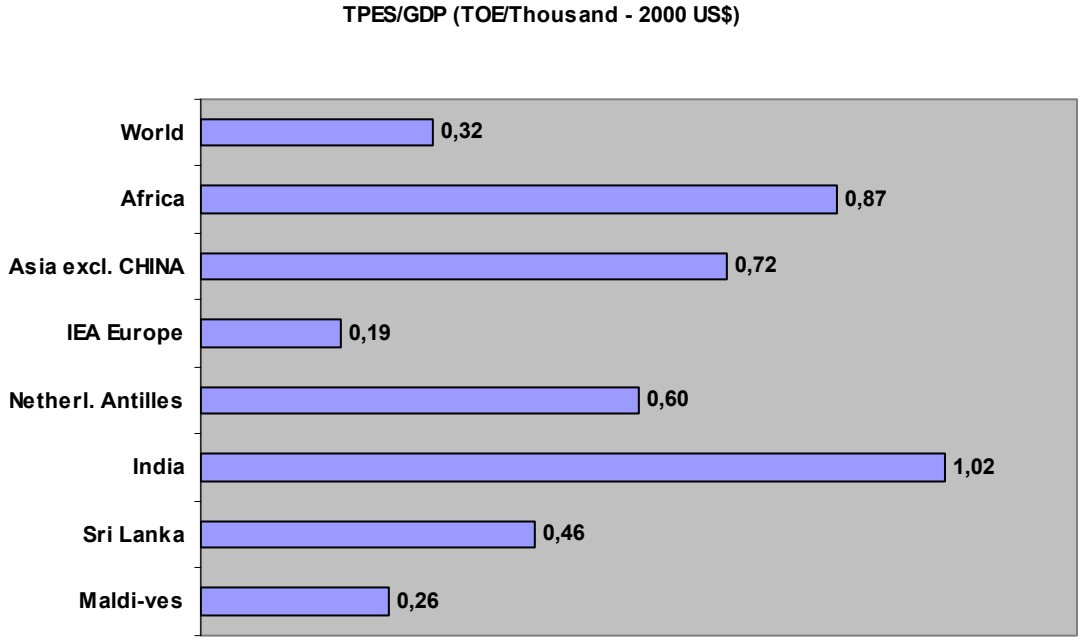
8.2 Comparison of indicators

In order to compare the Maldives with other countries with respect to energy consumptions, a general set of energy indicators may be used. The main idea is to use specific consumption numbers in the form of the below shown **compound indicators**.

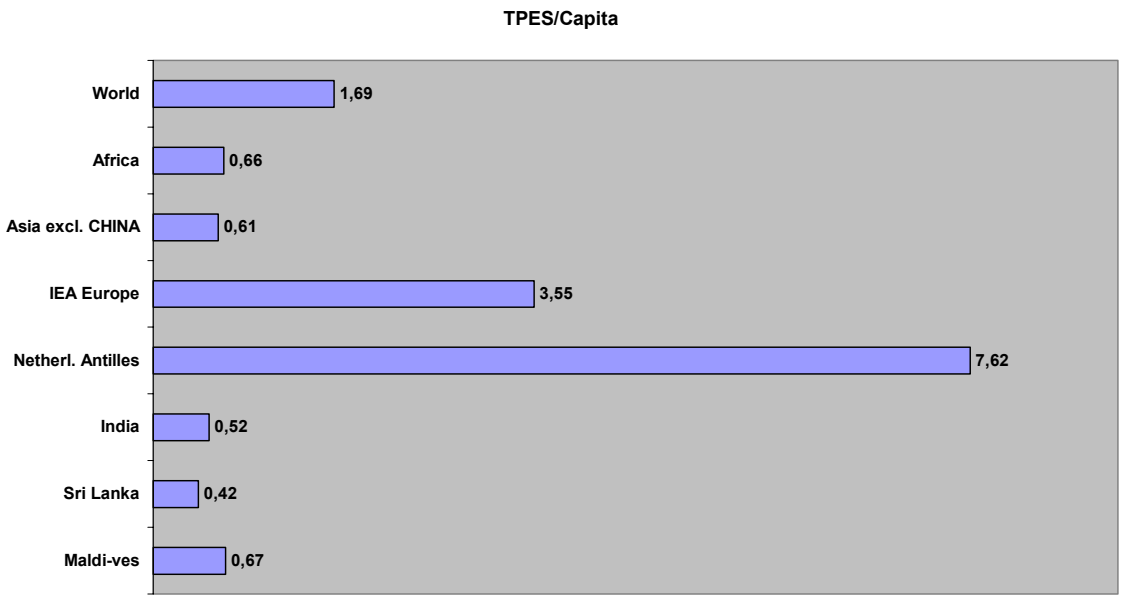
Energy Indicators 2003		Maldi-ves	Sri Lanka	India	Netherl. Antilles	IEA Europe	Asia excl. CHINA	Africa	World
Key Indicators									
Population	Million	**0,277**	19,23	1.064	0,22	486	2.018	851	6.268
GDP	Billion 2000 US$	**0,729**	17,70	544	2,72	8.942	1.697	641	33.391
GDP (PPP)	"	**2,34**	68,64	2.908	2,91	10.865	6.371	1.886	49.315
Total Primary Energy Supply	Mtoe	**0,187**	8,11	538	1,65	1.725	1.224	559	10.579
Electricity Consumption	TWh	**0,139**	6,26	463	0,94	3.009	1.181	440	15.223
Compound Indicators									
GDP/capita	US$ (2000)/capita	**2.626**	920	511	12.364	18.415	841	753	5.327
GDP (PPP)/capita	US$ (2000)/capita	**8.432**	3.569	2.732	13.227	22.376	3.157	2.216	7.868
TPES/Population	Toe/Capita	**0,67**	0,42	0,52	7,62	3,55	0,61	0,66	1,69
TPES/GDP	Toe/th. - 2000 US$	**0,26**	0,46	1,02	0,60	0,19	0,72	0,87	0,32
TPES/GDP (PPP)	"	**0,08**	0,12	0,19	0,57	0,16	0,19	0,30	0,21
Elec. consumption/population	kWh/capita	**502**	326	435	4.347	6.196	585	518	2.429

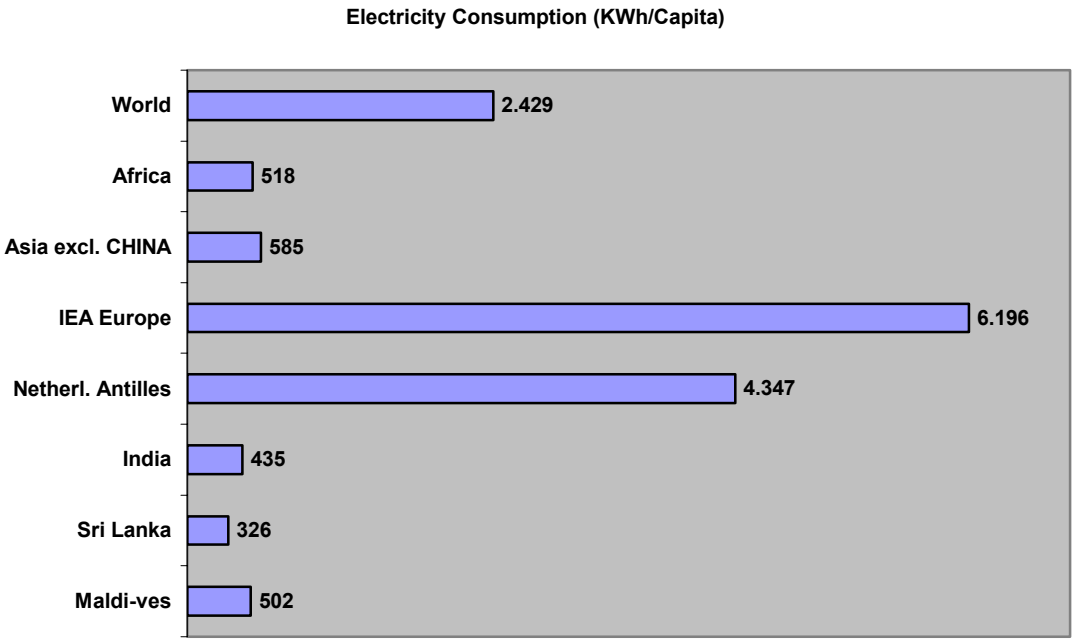
The comparison shows that:

- The specific energy supply – Total Primary Energy Supply (TPES) per capita is higher than in India, Sri Lanka and Asia
- The economic energy efficiency, measured as TPES/GDP is significantly better than in India, Sri Lanka and Asia, but is worse than in the European Union.
- The economic energy efficiency, measured as TPES/GDP (PPP[9]) is lower compared to the other countries including Sri Lanka and to the European Union, indicating better economic ability to import energy than in the compared countries.
- The electricity consumption per capita[10] is 60% higher than in Sri Lanka, indicating a stringer economy than in Sri Lanka, which is also seen from the GDP/capita figures.



[9] PPP: Purchase Power Parities (used instead of direct GDP)
[10] Not including Resorts


TPES/Capita
World
1,69
Africa
0,66
Asia excl. CHINA
0,61
IEA Europe
3,55
Netherl. Antilles
7,62
India
0,52
Sri Lanka
0,42
Maldi-ves
0,67


Electricity Consumption (KWh/Capita)
World
2.429
Africa
518
Asia excl. CHINA
585
IEA Europe
6.196
Netherl. Antilles
4.347
India
435
Sri Lanka
326
Maldi-ves
502

9 EMISSIONS

An evaluation of the emissions related to the Maldivian energy consumption. In this respect a simple approach has been applied; i.e. using the FCCC specific emission coefficients, as coefficients specific to the Maldives are not available. These coefficients is shown in the below table.

Energy Carrier	CO2
	ton/toe
Diesel	3.13
HFO	3.30
Petrol	3.09
Jet A1	3.05
LPG	2.75
Kerosene	3.05
Electricity	9.41
Heat	3.10

The resulting breakdown of emission for the different fuels and sectors have been computed based on the energy figures in the energy balances for 2003-2005.

CO2-emissions 2003 [ton/toe]

	Diesel	Petrol	JET A1	LPG	Kero-sene	Bio-mass	Elec-tricity	Heat	Total
Specific emission factors (ton/toe)	3,13	3,09	3,05	2,75	3,05	-	9,43	3,13	
Final Energy Consumption	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Households - residential									-
Male - capital area				**3.005**	**2.785**	**-**	**39.184**		**44.975**
Atolls				**6.474**	**11.591**	**-**	**19.491**		**37.556**
									-
Manufacturing, commerce and service									-
Male and Vilingili									-
Public buildings including schools				**-**	**-**		**1.395**		**1.395**
Industry, manufacturing and commercial	**-**	**-**		**-**	**-**	**-**	**25.640**		**25.640**
Fishing (boats)	**4.859**	**-**		**166**	**252**				**5.276**
Desalination industry							**5.678**		**5.678**
Waste (Thilafushi)	**-**	**-**		**11**	**-**		**-**		**11**
Government buildings				**-**			**14.616**		**14.616**
									-
Atolls									-
Public buildings including schools				**1.051**	**230**	**-**	**11.533**		**12.814**
Manufacturing	**-**	**-**		**56**	**437**	**-**	**1.058**	**-**	**1.552**
Cold stores and canning	**-**	**-**		**-**	**-**	**-**	**16.467**	**4.441**	**20.907**
Desalination industry	**-**						**-**		
Fishing (boats)	**27.775**			**827**	**1.093**				**29.695**
									-
Resorts etc. (ex transport)									-
Resorts etc.				**98**	**-**	**-**	**206.235**		**206.333**
									-
Domestic Transport									-
Hulhule Airport (operation)	**999**	**78**					**12.090**		**13.166**
Domestic air transport			**30.054**						**30.054**
Sea transport, Atolls	**47.288**	**-**							**47.288**
Sea transport, Tourists&pleasure	**27.366**	**22.249**							**49.615**
Vehicles, Male	**5.131**	**17.416**							**22.547**
Vehicles, Atollls	**888**	**969**							**1.857**
Statistical difference	**194**	**605**	**-**	**190**	**550**	**-**	**47**	**-**	**1.586**
Final Energy Consumption Total	**114.499**	**41.317**	**30.054**	**11.880**	**16.939**	**-**	**353.434**	**4.441**	**572.563**

CO2-emissions 2004 [ton]

	Diesel	Petrol	JET A1	LPG	Kero-sene	Bio-mass	Elec-tricity	Heat	Total
Specific emission factors (ton/toe)	3,13	3,09	3,05	2,75	3,05	-	9,41	3,13	
Final Energy Consumption	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Households - residential									-
Male - capital area				3.731	1.890	-	43.866		49.488
Atolls				9.399	8.352	-	20.955		38.705
									-
Manufacturing, commerce and service									-
Male and Vilingili									-
Public buildings including schools				-	-		1.566		1.566
Industry, manufacturing and commercial	-	-		-	-	-	28.787		28.787
Fishing (boats)	5.102	-		166	252				5.519
Desalination industry							7.064		7.064
Waste (Thilafushi)	-	-		11	-		-		11
Government buildings				-			16.409		16.409
									-
Atolls									-
Public buildings including schools				1.048	229	-	12.500		13.777
Manufacturing	-	-		56	436	-	1.147	-	1.639
Cold stores and canning	-	-		-	-	-	16.425	4.429	20.854
Desalination industry	-						-		
Fishing (boats)	29.164			827	1.093				31.084
									-
Resorts etc. (ex transport)									-
Resorts etc.				98	-	-	210.884	499	211.481
									-
Domestic Transport									-
Hulhule Airport (operation)	1.064	172					13.372		14.608
Domestic air transport			44.665						44.665
Sea transport, Atolls	61.474	-							61.474
Sea transport, Tourists&pleasure	35.576	28.924							64.500
Vehicles, Male	7.440	26.124							33.563
Vehicles, Atollls	1.287	1.454							2.741
Statistical difference	95.581	4.638	-	5.475	14.648	-	348	-	120.690
Final Energy Consumption Total	236.687	61.312	44.665	20.812	26.899	-	373.323	4.928	768.627

CO2-emissions 2005 [ton]

	Diesel	Petrol	JET A1	LPG	Kero-sene	Bio-mass	Elec-tricity	Heat	Total
Specific emission factors (ton/toe)	3,13	3,09	3,05	2,75	3,05	-	9,40	3,13	
Final Energy Consumption	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Households - residential									-
Male - capital area				5.092	288	-	50.493		55.873
Atolls				13.493	3.816	-	23.197		40.506
									-
Manufacturing, commerce and service									-
Male and Vilingili									-
Public buildings including schools				-	-		1.803		1.803
Industry, manufacturing and commercial	-	-		-	-	-	33.136		33.136
Fishing (boats)	4.846	-		166	252				5.264
Desalination industry							8.733		8.733
Waste (Thilafushi)	-	-		11	-		-		11
Government buildings				-			18.888		18.888
									-
Atolls									-
Public buildings including schools				1.044	229	-	13.979		15.252
Manufacturing	-	-		56	435	-	1.282	-	1.773
Cold stores and canning	-	-		-	-	-	16.402	4.441	20.843
Desalination industry	-						-		
Fishing (boats)	27.706			827	1.093				29.626
									-
Resorts etc. (ex transport)									-
Resorts etc.				98	-	-	213.724	500	214.323
									-
Domestic Transport									-
Hulhule Airport (operation)	2.069	212					15.181		17.462
Domestic air transport			52.517						52.517
Sea transport, Atolls	58.400	-							58.400
Sea transport, Tourists&pleasure	33.797	27.478							61.275
Vehicles, Male	9.671	28.736							38.407
Vehicles, Atollls	1.673	1.599							3.272
Statistical difference	1.008	(258)	-	155	(2.676)	-	630	-	(1.142)
Final Energy Consumption Total	139.171	57.767	52.517	20.944	3.436	-	397.448	4.941	676.223

10 CONCLUSION

This report provides data for the energy balances 2003-2005 for the Maldives. The validity of the balances for 2004-2005 are considered critical due to the following reasons:

- Data are lacking for the stocks of fuels for 2005. This counts for diesel, petrol, kerosene and LPG.
- The growth in diesel consumption from 2003 to 2004 requires further investigations
- The energy consumptions in the Maldives are sensitive to the economic development of the country and as shown in the previous sections significant changes in the economic development of the fisheries, tourist and public sectors are seen for 2003-2005
- Data for the impact of the economic development of the above economic sectors on energy consumptions cannot directly be identified and has subsequently been estimated

Sources of information

There are good and solid sources of information available in the Maldives. This includes:

- The Maldives Customs Service (MCS) has accurate and comprehensive data on imports of fossil fuels (oil, LPG, kerosene, petrol, aviation gas and aviation jet kerosene, etc.).
- The State Trade Organisation (STO) has information on bunkering and stock levels of oil, LPG and other oil products. These data have not yet been received.
- The State Electricity Company (STELCO) has over the years developed quite elaborate and informative statistics covering the islands that they supply with power.
- The Ministry of Transportation and Civil Aviation (MTCA) has been most helpful with the available information regarding the transport sector.
- Still, the official statistics from the "Census 2000 Census" provide basic information for establishing the energy balances. The coming Census 2006 is expected to improve the basis even further.
- Earlier conducted Surveys by the consultants on energy use in the Atolls and in tourist resorts has been used as a supplement
- The demand side study performed by the consultants in 2003-2004 has provided useful data for the demand side estimates.

Conclusion

Despite the critical issues referred to above, the established balances for 2003-2005 give valuable information. Some major issues are:

- The energy consumption in the Maldives is growing, although the economic downturn after the December 2004 tsunami has caused a decrease in consumption for 2005.
- More than **55%** of the diesel used for electricity production is used in the resorts
- STELCO counts for **33%** of the diesel used for electricity production
- The end-use shows **2.5%** renewable energy in 2003; decreasing to **2.0 %** in 2005.
- The economic energy efficiency, measured as TPES/GDP is significantly better than in India, Sri Lanka and Asia, but is worse than in the European Union.

Energy balances are fundamental for reliable modelling of potential energy market development, and for assessing effects of market intervention. Moreover the energy balance is necessary to assess the energy flows in the country. Thus, the main recommendations are[11]:

- It is recommended to investigate further the growth in energy consumption in 2004 and to provide a more accurate investigation on the changes in fuel stocks. Further investigations will eventually provide better data, and thus form the basis for an update of the presented energy balances for 2003-2005.
- It is recommended to use the developed survey questionnaires already for establishing the 2006 and 2007 balance.

[11] Please refer to the report: 'Recommendations on further development of Energy Statistics'