DANIDA MIXED CREDITS

Maldives Fourth Power Development Project

Appraisal

February 20, 2007

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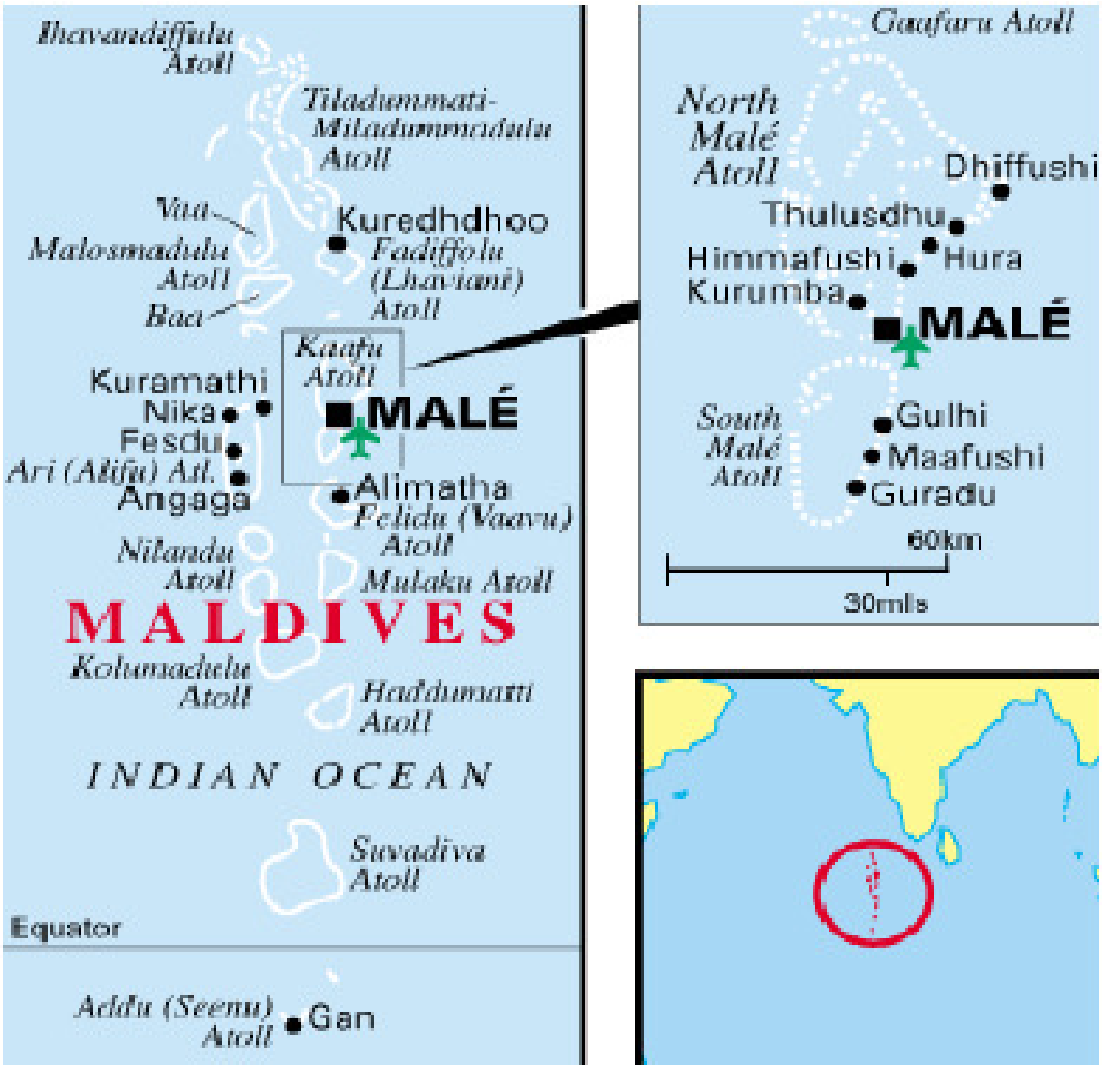
Map of Location



List of Abbreviations and Definitions

CIRR	Commercial Interest Reference Rates
DDO	Diesel Destillate Oil
DGU	Diesel Generator Unit
HFO	Heavy Fuel Oil
IFO	Intermediate Fuel Oil
IRR	Internal Rate of Return
M	million
MEEW	Ministry of Energy, Environment and Water
MPND	Ministry of Planning and National Development
MoFT	Ministry of Finance and Treasury
MVR	Maldives Rufiyaa
NPV	Net Present Value
STO	State Trade Organisation
UNFCCC	United Nations Framework Convention on Climate Change

Definitions:

Dependable capacity	90% of the rated capacity
Firm capacity	All DGUs less the largest unit operating at 90 % of rated capacity
Operational capacity	= dependable capacity

Exchange rates (November 2006):

USD 1 =	MVR (Maldivian Rufiah) 12.85	DKK 5.8
€ 1 =	MVR (Maldivian Rufiah) 15.6	DKK 7.5

INTRODUCTION

Danida's Mixed Credit Programme has financed two power projects in the Maldives: the "Malé Power Station (4.3 MW)" in 1998 and the "Third Power System Development Project (2 x 6 MW)" in 2001.

The Board of Directors of STELCO approved the financing of the Fourth Power Development Project to be implemented by STELCO in September 2004.[1] In May 2005, based upon request from potential Danish suppliers, Danida's Committee for Mixed Credits found that the Fourth Power Development Project might in principle be eligible for support. This was subject to a number of conditions, including confirmation of its priority from the Government of Maldives.

The tender organised by STELCO and advertised in March 2005 asked for 2x8 MW diesel generators with equipment to handle IFO180 plus the civil works for a 3x8 MW diesel power plant. It resulted in bids from two companies. Bids were opened 14 August 2005. On August 17, the Project Coordinating Committee decided to cancel the bid as the tender was not internationally advertised, and thus did not follow Government Tendering Procedures.

An international expression of interest for the project was advertised in September 2005; it resulted in two companies being short listed. In February, in response to wishes expressed by the Minister of Finance, the tender was changed to a 2x12 MW diesel power plant plus some additional works not included in the first tender. In addition it was decided that the tender was to be organised by the Ministry of Finance and Treasury (MoFT). Only one of the two companies attended the pre-bid meeting held in MoFT on 4th April 2006; the other declined to submit a bid. MoFT cancelled the pre-bid meeting as only one party attended; subsequently, the tender was cancelled.

In May and August 2006, Danida received confirmation from the Department of External Resources that the Government of the Maldives attached high priority to the project and requested a Danida Mixed Credit. In response, Danida decided to undertake the project appraisal and fielded for this purpose an appraisal team composed of Mr Wolfgang Mostert, Energy Economist (Team Leader); Mr Preben Jørgensen, Power and Energy Expert; and Mr. Christian Lind Jacobsen, Head of Section, Danida's Secretariat for Mixed Credits. The team stayed from November 2 to 12 in Malé; the list of persons met is attached as Annex I.

The team would like to express its gratitude for the time that interviewed persons made generously available to provide information and to STELCO in particular for the excellent organisation of the program of visits and other logistics.

This appraisal report expresses the views of the appraisal team, which may not be shared by the Government of the Maldives or by Danida.

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[1] Previously, two power projects in the Maldives have been financed by Danida's Mixed Credit Programme, viz. "Malé Power Station (4.3 MW)" and "Third Power System Development Project (2 x 6 MW)".

EXECUTIVE SUMMARY

The 24 MW Fourth Power Development Project comprises a new production facility to be placed at the STELCO power plant in Malé composed of a new power house, 3x8MW diesel generating units (DGU's), mechanical and electrical auxiliaries, supervisory control and data acquisition system (SCADA), extension to the existing tank farm, the rehabilitation of engine hall structures for the existing DGU 5 and environmental safeguard investments. The tender documents will include provision for adequate technical training.

The total financial cost is estimated at €44.4 million (m) composed of a turn-key contract of €33.5 m, €3.5 m for contingencies and €6.9 m for custom duties and local taxes. Due to financial limits on the size of the Danida Mixed Credit, the investment is divided into two separately financed packages, one financed by the Mixed Credit, the other by MoFT acting on behalf of the State the owner of STELCO. The division of the investment package is summarized in table 1.

Table 1: Summary Table of Contract Split between Mixed Credit and STELCO

	Danish financing Millions €	GoM financing Millions €
2 x 8 MW DGU, de-NOx, IFO-treatment, 1x800 m3 HFO tank, clearing of existing structure on project site, and civil works for 3x8 MW	23.5	
1 x 8 MW DGU, SCADA, 1x800 m3 HFO tank, noise attenuation of existing installations and tools for all DGU's and rehabilitation of structures for exist. DGU 5		10.0
Contingencies for unforeseen risks during construction	1.5	2.0
Customs duties on imported items		6.9
Engineer for supervision		0.8
Totals	24.7	19.7
TOTAL COST	**44.4**	

Danida's mixed credit of €24.7 million is composed of a 10-year loan of about €19 million to be given by a Danish Commercial Bank to MoFT at a zero rate of interest and of an up-front grant of around €5.7 million.[2]

The MoFT finances all costs of import duties and taxes in the Maldives, the Engineer for supervision as well as others costs of investment above the Mixed Credit of €24.7 million. The scope of the MoFT-financed part of the project (and thus, of the whole project), depends on the finance MoFT is able to secure. Funding of €6.9 m in custom duties is no issue – it is an "internal accounting exercise" for MoFT. The €0.8 m for the supervising engineer will be paid out of

[2] Danida's subsidy consists of payment of (i) all interest, the export credit premium and other financial costs on the loan, and of (ii) an up-front grant to reduce the balance of the loan to a level that complies with OECD's requirements for a minimum 50% concessionality level. The size of the up-front grant in percent of the mixed credit depends on various factors, including OECD's reference rate of interest (CIRR) at the time of signing of the loan agreement.

STELCO's operating surplus, the €12 m for the "hard investments" require an external source of finance as the national budget is too small to accommodate the funding without taking a loan. The required loan is inscribed on the 2007 state budget, but MoFT must get the loans in practice. If the loans secured during 2007 turn out to be insufficient to cover the total investment, STELCO will be forced to prioritize the sequencing of the investments, postponing part of the investment to 2008 or 2009.
MoFT onlends the Mixed Credit of €24.7 million to STELCO at a rate of interest of 8%. There are no other financial charges.

The commercial contract with the winning bidder will become effective upon approval of the loan agreement between Ministry of Finance and a Danish lending bank. It is expected that 14-18 months will pass from that date and until plant commissioning.

The tender documents for tender two can be reused; but need to be revised in some respects to describe more clearly the scope of works and to conform to the guidelines for Danish mixed credits.

The implementation of the full-scope project will safeguard Malé's power supply up to the year 2012 and enable STELCO (and its consumers) to benefit from the financial savings associated with the use of lower cost IFO.

The financial NPV of the investment for STELCO depends on the Government's tariff policy; the present average tariff of 2.85 MVR/kWh does not allow STELCO full cost-coverage. Tentatively, based on the Government's fulfilment of STELCO's requested tariff increase to 4 MVR/kWh, the NPV of the project cash-flow (which includes payments of interest and repayment of the MIXED Credit loan) is estimated at 2 percent. The project economic rate of return is higher than 10%.

The investment in IFO-treatment facility and the proposed 87% annual operation on IFO brings a huge financial benefit: the NPV of the €1.7 m investment is around €28.8 m.

In a sensitive environment like Malé any industrial operation poses an added environmental burden. But the foreseen investments in environmental safeguards (de-NOx and noise attenuation), as well as operational recommendations make problems associated with the environment manageable. The net CO_2-emissions of 0.9m tons cannot be avoided as economic generation alternatives do not exist.

A list of recommendations and conditions is found in chapter 7 of this report.

1 PROJECT BACKGROUND

1.1 Project Justification and Objectives

STELCO, the State Electric Company Ltd. was established in 1997 as successor to the then Maldives Electricity Board. As a limited liability company held 100% by the Government of the Maldives (by MoFT), STELCO is responsible for the generation, distribution, and sale of electricity throughout the Maldives. STELCO has approximately 750 employees and serves Malé and nearby Vilingili as well as some twenty-five outlying islands with electricity.

The Malé power supply system is the largest network operated by STELCO. Demand for generation of electricity in Malé, which accounts for 75% of STELCO's sales in 2006 grew rapidly in the past, with an annual average growth rate of 11.4 % since 1995 but STELCO kept up with the rising demand through the regular installation of new generating sets. In 2006, the Malé power plant's installed capacity of 29.6 MW is fully absorbed as the peak demand in Malé of 27 MW[3] reached the level of the *dependable/operating capacity* (=90% of installed rated capacity) of plant; thus, *firm power* (all DGUs less the largest unit operating at 90 %) is not available.

To avoid load shedding of consumers STELCO has adopted three interim measures.

(i) STELCO operates the DGUs at the plant beyond recommended operating hours for maintenance.

(ii) STELCO stopped using IF0180 as fuel on its two largest units (which can operate on IFO/HFO), switching back to the higher cost but less maintenance demanding diesel fuel operation.

(iii) STELCO has acquired four 1 MW high-speed mobile generating units and placed them at the site; and may acquire two more.

In addition, as a permanent measure, STELCO is running a "rational use of energy" campaign to induce consumers to save on their power consumption.

A maximum of three units of 8 MW or two units of 12 MW can still be accommodated at the site of the Malé Power Station. Alternative sites at Malé for power generation are not available; sites at nearby small islands take several years to develop and call for investments in underwater cables. The project's proposed expansion of the power station by 24 MW to 53.6 MW could be operational towards the end of year 2008 and provide Malé with a dependable/ operating capacity of 48.6 MW. Assuming that the annual growth in power demand at Malé from 2007 onwards drops to 10% per year, peak demand would reach the level of firm capacity (39.6 MW) already in 2010 and the level of operational capacity in 2012.

The proposed project will allow STELCO to satisfy the demand for power in Malé with a minimum of load shedding – until a new power plant can be set up on an island outside Malé. In addition to the avoided economic cost of load shedding, the economic benefits comprise lower operating costs (due to the use of lower priced HFO-fuel).

[3] Peak demand in 2004 was only 20.1 MW!

1.2 Economic Environment

1.2.1 Economy of the Republic of Maldives

The Republic of Maldives with population of 340,000 in 2005 has a territory of 300 sq. km spread over 1200 small coral islands and sandbanks grouped into 26 atolls, in the Indian Ocean. The islands extend more than 820 km from north to south and 130 km from east to west. 202 of the islands are inhabited; a further 98 islands are turned into tourist resorts.

GDP-per-capita was US$ 2,500 in 2003, the highest in South Asia. GDP growth during the last three decades averaged 8% per year with tourism and fishing being the main drivers. Prior to the tsunami, which devastated South and Southeast Asia in December 2004, the Maldives had achieved buoyant growth over the past two decades. However, for the first time, it is estimated that the country recorded a negative growth rate of –4.6% in 2005; the cost of reconstruction led in 2005 and 2006 to large public sector deficits. The negative economic growth rate did not reduce the growth rate in Malé's power demand: migration to Malé pushed the growth rate upward. Tourism, which propelled the growth of associated industries including construction and transportation, now accounts for about one-third of GDP and more than 40% of the government budget. The fishing industry accounts for two-thirds of exports and employs nearly 20% of the workforce. The fishing industry benefits from improved world tuna prices and higher catch since 2004 as well as industry liberalization and modernization. Literacy rates among the Maldives' young are almost 100%, the highest in South Asia.

Government finance	1990	2000	2005	2006
Million Rufiyaa				
Revenue & grants	589	2,373	4,543	6,549
Revenue	504	2,207	3,661	4,854
Tax revenue	294	1,014	1,599	2,115
Non-tax revenue	204	1,189	2,028	2,707
Capital revenue	6	4	34	32
Grants[1]	85	166	882	1695
Expenditure & net lending	747	2,694	5,740	8,645
Current expenditure	372	1,876	4,240	4,993
Capital expenditure[3]	376	818	1500	3651
Net lending	9	-46	-91	-65
Overall deficit(-),including grants	-159	-322	-1,197	-2,096
Financing	159	322	1,197	2,096
Foreign (net)	74	4	316	1759
Disbursements	114	129	569	2049
Repayments(-)	40	126	253	298
Domestic[2]	85	318	881	337
Overall deficit(-),excluding grants	-244	-487	-2,079	-3,791
Functional classification of central government expenditure				
Total expenditure	100	100	100	100
Public services	34	43	32	29
Social services	33	42	52	51
Economic services	31	12	14	18
Interest on public debt	2	4	2	2

1 Excludes grants for direct expenditure by donors.
2 Primarily reflects net borrowing from Maldives Monetary Authority
3 Includes net lending
Note: Figures for 2005 are provisional and figure for 2006 are budget Estimates

The Ministry of Planning and National Development prepares five year development plans. The vision of the 6th National Development Plan (2001-2005) is towards improved quality of life for all Maldivians and stresses the importance of adopting a sustainable energy policy for the country. The 7th National Development Plan exists in draft stage late 2006.

A special feature of the Maldives, derived from lack of space (population density is probably the highest in the world) and a vulnerable environment is the use of specialized islands. Of those in the immediate neighborhood of Malé:

- Hulhule harbors the International Airport
- Hulhumale is being developed into a 50,000 people island with some industrial activity
- Vilingili Island is a "suburb" of Malé
- Thilafushi is used for waste management
- Funadhoo serves as Malé's fuel depot,
- Gulhi Falhu is developed as a port island

1.2.2 National energy policy and sector institutions

The Maldives is very heavily dependent (98 % of energy supply) on imported petroleum products, particularly diesel. Total final energy consumption amounts to 148,000 toe, with transport consuming 46,000 toe or 31%.

The manufacturing, commerce and services sector accounts for 83,000 toe or 56%, including consumption of resorts amounting to 22,000 toe or 14.8 % of total energy consumption. The dominant final use of energy is diesel, primarily for fishing and sea-based transport to and from inhabited islands and resorts. In 2002, the country imported 181,000 metric tones of diesel. Almost 56% of the diesel oil used for electricity production is used in the resorts, 29% is used for electricity production by STELCO, and the remaining 15% is used in the islands and for industrial purposes.[4]

The *Ministry of Energy, Environment and Water (MEEW)* created in 2006 is the key sector institution:

- Its *Energy Department* with a staff of ten is responsible for formulating energy policies and strategies, and the electrification of outer islands not served by STELCO. Its first major output is the National Maldives Energy Policy of 2006.
- The *Maldives Energy Authority* under the ministry has existed under various ministries since 1999 under the name of Maldives Electricity Bureau. Its staff of six (in 2006 only four) has the mandate to regulate the energy sector in the Maldives.
- The ministry's *Environmental Research Centre* is responsible for approving the environmental impact assessment of power projects.

Maldives was the first country to sign the Kyoto Protocol and ratify it in 1998 and is a party to the United Nations Framework Convention on Climate Change (UNFCCC).[5] The Maldivian national priorities in the energy sector are:

- Provision of electricity to the atolls in a reliable, equitable and affordable way;
- Development of a pricing policy for electricity provision;

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[4] Source: National Energy Policy Maldives 2006

[5] The year 2002 green house gas (GHG) emissions of approximately 665,000 ton CO2 per year from energy supply in the Maldives stem from use of imported fossil fuels. CO2 emission per capita of 2.4 ton are below the worldwide average of 3.9 ton and close to the level of China.

- 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

Based on the above, the 6th National Development Plan (2001-2005) mentions as targets for the energy sector: (i) explore possible sustainable sources of energy for power generation and desalination; (ii) 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.

The policy is being implemented.

- The two largest DGUs at Malé were provided with the capacity for IFO fuel consumption
- A heat recovery steam generator installed on one of the diesel generators in Malé converts seawater into potable water for the internal use of the State Electric Company (STELCO).

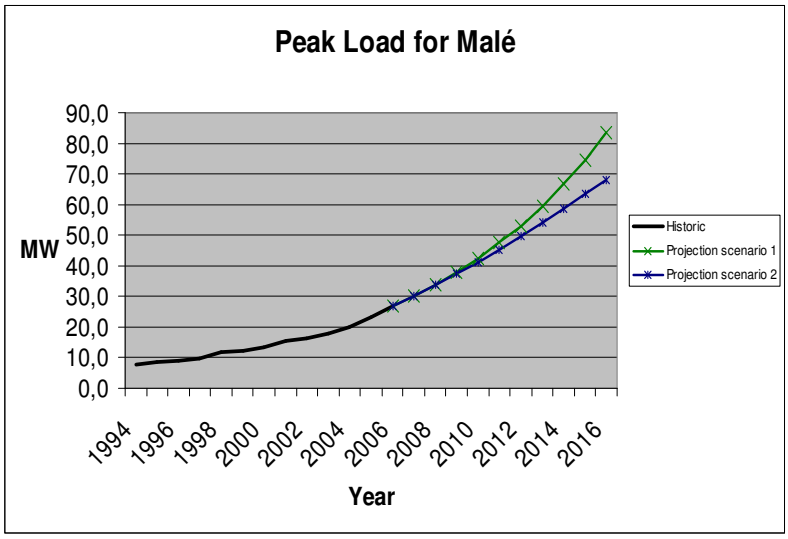
There has been liberalization as far as import of fossil fuels is concerned. But the State Trading Organization (STO) whose shares are held by Ministry of Finance accounts for the major share of fuel imports to the country.

1.2.3 Power demand and supply

The power demand and supply situation in Malé was analyzed competently in the Power Extension Study, Part I in 2004 and Part II in 2005. Part I covers the situation up to the year 2012. It concluded that additional capacity of up to 24 MW was required to cover the increase in demand up to 2010/11. Part II looked at the situation up to 2020 and 2030 for the "greater Malé area" (Male + neighbouring islands). It foresaw peak demand in Malé's system to increase to between 53 MW and 67 MW in 2020 depending on the forecast scenario, and peak demand in the "Greater Male' Area" to reach between 69 and 92 MW. For Malé an additional rated capacity of between 35 and 50 MW would need to be installed between 2012 and 2020, while the greater Malé area required an installed capacity of between 90 and 115 MW considering 90% operational load and satisfaction of the firm capacity condition.

Fuelled, inter alia, by the explosive growth of the population in Malé from 90,000 beginning of 2004 to 125,000 in 2006, power demand during the last two years grew faster than foreseen in Part I of the study to 125 GWh in 2006. Peak demand in 2006 reached 26.5 MW surpassing the level of *dependable capacity* (=90% of rated installed capacity). This forced STELCO to invest in four 1 MW mobile DGUs to cover peak demand and capacity shortfalls when generators were taken out for minor maintenance. It also forces STELCO to operate all existing capacity, postponing maintenance and overhauls beyond recommended operating hours, well-knowing that this mode of operation risks to be penalized by heavy costs when a DGU breaks down due to maintenance failure. In addition, STELCO has during the last six months stopped using IFO180 as fuel, since IFO-operation is more complex, accident prone and maintenance intensive than DDO operation.

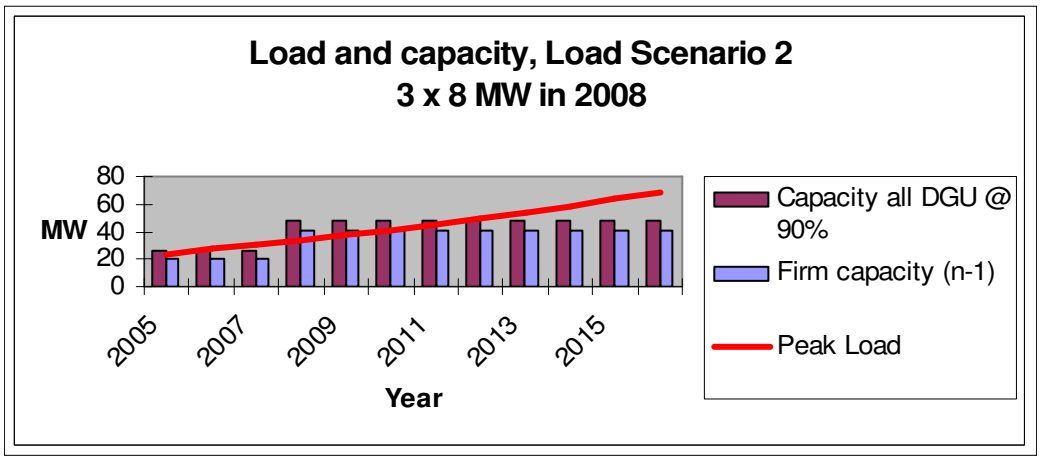
For this study, two load forecast scenarios were elaborated, a high and a conservative, see the chart.



The high scenario (Scenario 1) foresees a continuation of the historical growth rate of 11%. The conservative and more realistic scenario (Scenario 2) assumes an 11% growth rate in 2007, after which a decline of 0.5% per year is expected in the growth rate; bringing it down to 7.5% in 2014.

For the post-2012 situation plans are to interconnect a series of islands around Malé through under-water cables. Thus, for the future it makes better sense to analyze the power demand for the "larger Malé" area. Assuming that the economic growth rate of the Maldives during the last three decades prevails in the greater Malé area during the next 15 years, the "conservative scenario" leads to a drop in the GDP-elasticity of power demand in greater Malé from 1.3 to 0.9 during the next ten years.

The figure below visualises the implications of scenario 2 in terms of peak load requirement and installed capacity at the Malé power plant before and after the addition of 24 MW at the plant. By 2012, peak demand is expected to equal the operational capacity of the plant.

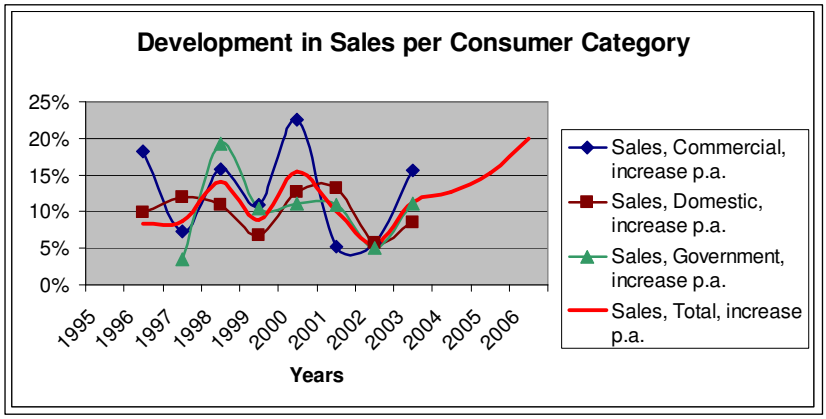


The distribution of kWh sales in Malé shows that business consumers account for about half of annual billed kWh (kWh-consumption), domestic consumers for one third and Government (including public lighting and private schools) for about one sixth.

Table 2: Distribution of power sales by consumer category

Malé system	kWh/year	In %
Domestic	57,816,114	34%
Business	83,092,016	49%
Government	28,014,956	17%
TOTAL	168,923,086	100%

Over this period the growth rate in annual power consumption showed important variations, fluctuation between 4 and 23 %, see the chart. As demonstrated in Power Extension Study Part I, the trend up to 2004 was a slight decline in the growth rate for commercial and domestic consumers while the rate increased for the administration. Sales to commercial customers show the highest variations in the annual growth rate, domestic customers the lowest. After 2004 total sales went up steeply once more.



1.2.4 Power sector regulation and power tariffs

The Presidential Office is the most important regulator of the power sector in the Maldives. The key issues in the power sector are regulated by Presidential decrees, the Parliament later adds its approval. STELCO is by Presidential Decree authorised to operate. In 1995 STELCO was formed by Directive of President himself; the company act by Parliament was adopted in 1997.[6] The President appoints STELCO's Board of six members, the Chairman[7] and the Managing Director. The President's Office is responsible for tariff approval after a proposal for tariff adjustment has been made by STELCO and been accepted by Ministry of Finance.

STELCO's *tariff structure* for Malé Region has eight consumer categories and within each category a four steps-tariff that increases with consumption, see Annex III. Business customers cross-subsidize all other customers. No fixed charges nor time of day tariffs are charged. STELCO charges tariffs according to location: in the smaller islands tariffs are higher than in Malé. Yet, due to much lower costs of production, STELCO normally has a financial surplus on its operations in Malé which is used to cross-subsidize tariffs on the smaller islands. Proposals for *changes in the STELCO's tariffs* are initiated by management. Once approved by STELCO's Board, the draft tariff structure is submitted to Ministry of Finance and Treasury (MoFT) for approval from where it proceeds to the Office of the President. The Maldives Energy Authority presently regulates the small actors only: only one producer is allowed on each island. In the Maldives no study seems to have been made to assess the social implications of energy pricing and tariff policy and their impacts on stimulating energy efficiency and conservation.

Electricity belongs to the *subsidized* consumer goods, a list which includes water, sugar, rice, health services (except in Malé). The Government has for a long time subsidized tariffs charged by island power houses; in 2005 the Government had provided subsidies also to STELCO. STELCO has its tariff reduced by 10% in 2002, and the increase in diesel fuel prices during 2003 to 2006

[6] STELCO was founded in 1949 as Gvt Electricity Department to provide electricity to Government buildings. Later the department's mandate was expanded to supply electricity also to households who can afford it.
[7] The present Chairman is Deputy Minister for Education

undermined its financial viability. Subsidy policy decisions originate from the Ministry of Finance and are discussed at three Cabinet Sub-Committees: Economic Committee, Administrative Committee and Social Committee.

Investment decisions by STELCO are subject to scrutiny by two committees: the Project Appraisal Committee (MoFT , Ministry of Foreign Affairs, Ministry of Gender, MEEW, MPND) chaired by the Ministry of Planning and National Development (MPND) decides on the project's priority at national level and its viability; the Aid Coordination and Management Committee discusses the financing of project.

Changes in *STELCO loans* are subject to decision of MoFT. If the loan is guaranteed by Government, MPND must give its opinion and approve it. One of the criteria is that the project is included in the economic development plan.

The *construction license* to investment projects is issued by Malé Municipality for construction in Malé, construction on other islands is authorized by Ministry of Housing and Urban Development.

Plans for establishing an interconnected grid between the islands are initiated by Ministry of Energy, Environment and Water (MEEW).

The Government's Tender Evaluation Board is responsible for overseeing that tenders organized by public institutions and state-owned companies proceed according to procedure.

1.2.5 Financial status of STELCO

STELCO pays no income taxes on its profits, but has to hand over 75% of any profits to the Government as owner.

The financial status of STELCO is weak due to Government tariff policy. According to STELCO's financial projections, the total cost of fuel in 2006 is expected to equal 91% of revenue[8], while STELCO's operating surplus before depreciation will be around zero. A litre of diesel at the Malé power plant in October 2006 cost STELCO 8.48 MVR; with a fuel consumption of 0.25 litre per generated kWh and 0.28 per billed kWh, the cost of fuel per consumed kWh is MVR 2.37. The tariffs charged to domestic consumers range from 1.60 to 2.2 MVR/kWh; the average tariff for power consumption in Malé was 2.85 MVR/kWh.

STELCO's financial analysis show that in order to reach financial sustainability either:

- the price of diesel must drop to 4.8 MVR/litre at the present level of tariff,
- or the tariff must be increased to around 4 MVR/kWh if the price of diesel remains at the average level of year 2006.

MoFT gave STELCO 100 million MVR in subsidy to cover its financial losses in 2004. Half of the money was used to pay up foreign loans to Ministry of Finance, one quarter to purchase the four 1 MW gensets installed at the Malé power plant.

[8] Annual cost for fuel is expected to be 400-480 million MVR plus lubricants of 25-30 million MVR.

In 2006, STELCO submitted six proposals for tariff adjustments to MoFT. STELCO proposed to eliminate the consumption-related tariff steps and to charge each consumer category the same flat rate. The proposed average tariffs ranged from 3.75 to 4.23 MVR/kWh for Malé; the latter representing an increase of 48%. The proposals were rejected by MoFT and/or President's Office who do not deem it politically acceptable to raise tariffs by 25% or more in one go. The political decision is to do it gradually, together with capital injections from MoFT into STELCO. In addition, MoFT believes that STELCO can make savings in its costs of operation.

Due to the financial situation, STELCO is unable to get loans from the commercial banks in the Maldives or abroad.

The precarious situation leads to delays in the preparation of STELCO's annual reports. STELCO completed the company report for 2004[9] in March 2006; the year 2005-report exists at the end of 2006 in the draft stage.

1.2.6 Financial status of consumers

According to the year 2004 "Vulnerability and Poverty" report electricity is a high priority for consumers. The Maldives have the highest per capita income of South Asia; yet the cost of housing on severely crowded Malé – in some apartments inhabitants take turns sleeping in rooms - is very high. The cost of electricity, therefore, represents a not insignificant expenditure for households, particularly once STELCO's tariffs are raised to full cost-coverage levels.

1.3 Conclusions concerning the Economic Environment

The strong economic growth in the Maldives, which fuels the demand for power, shows no signs of abatement in the near to medium term future. The need for the requested expansion in power capacity was identified in a professional manner in STELCOs power expansions plan, and complementary actions to reduce the growth in power demand by energy saving campaigns are being implemented. The "Mixed Credit project" (16 MW), as seen in table 3, will succeed in providing sufficient "firm capacity" to cover the demand for load only during the short end of 2008-period, when the plant is commissioned, and load-covering "dependable capacity" only until 2010.

Table 3: Load Coverage - firm and dependable capacity

	2007	2008	2009	2010	2011	2012	2013
Scenario 2 "conservative forecast"	11%	10.5%	10.0%	9.5%	9.0%	8.5%	8.0%
demand for load	30.0	33.4	37.2	41.5	46.2	51.5	57.4
firm capacity, 24M¤	20.8	41	41	41	41	41	41
firm capacity, 16 MW	30.2	33.9	33.9	33.9	33.9	33.9	33.9
dependable capacity, 24MW	26.7	48.3	48.3	48.3	48.3	48.3	48.3

[9] According to the audited statement in 2004, depreciation in 2004 was 51.4 million; accumulated 390 million.
Staff costs amounted to 41 million (684 staff in 2006). Debt was 15 million MVR.

dependable capacity, 16 MW	26.7	41.1	41.1	41.1	41.1	41.1	41.1

The Fourth power project (24 MW) provides “firm capacity” equal to the demand for load until 2010 and load-covering dependable capacity until 2011/12.

A more rational, modern power sector structure is slowly emerging. A power regulatory authority is being build up and the need to allow IPP-investments to enter the market in the post-2012 period will force the authorities to implement a more rational tariff and regulatory regime. The alternative to tariff increases – periodic equity injections into STELCO by the Government will come unaffordable due to the rapid increase in power consumption.

2 ANALYSIS OF TECHNICAL SOLUTIONS

2.1 Standards of Power Supply

The objective of defining power quality requirements is to ensure that the quality of supply for STELCO's consumers is within the limits set by STELCO, alternatively relevant IEC standards. These standards prescribe maximum variations in frequency and voltage at the consumers' premises. Supplying the consumers with quality supply then imposes limitations on variations in frequency and voltage from the power station but also on voltage drops in the associated sub-transmission and distribution system up to the consumers' premises.

The team **recommends that the Tender Material** defines the output of the generating plant comprising prime mover (diesel engine), alternator and dependant and independent auxiliaries according to ISO 3046 (for the engine) and ISO 8528 for the plant.

2.2 Options for Generation

2.2.1 Solar and wind energy

For power stations in the size required for Malé the choice of technologies is limited. Renewable energy sources are not a realistic option. Solar energy, which is abundantly present in the island, will have prohibitive high investment costs in the MW-size required, and the space for the panels is not available. Wind turbines that could supply energy for Malé exist and the technology is well proven. The average wind speed for Malé, being close to equator, is too low for wind turbines to be a feasible supplementary option for power supply. The only feasible solution for Malé is thermal power production.

2.2.2 Thermal power generation

For thermal production steam turbines, gas turbines and diesel engines are possible prime movers.

The power requirement is too low for steam turbines and given the need for boilers to produce the steam space is also not available for this option.

Gas turbines operated on fuel oil could be a possibility. They have lower costs of investments but due to lower energy efficiencies they are uneconomic for base load operation, whereas they would be suitable for peak capacity. However, gas turbines are somewhat fragile and require specialist knowledge both for operation and maintenance. This knowledge is not available at STELCO and probably not in the island. Even if STELCO technician would certainly be able quickly to learn operating a gas turbine, maintenance and repair would have to be carried out by specialists from

abroad. The only remaining, feasible alternative for Malé Power Station is then using diesel engines as prime movers.

Diesel engines represent the right choice for the present project. Diesel engines can be operated on a variety of fuels from distilled diesel oil (DDO) over intermediate fuel oils (IFO) to heavy fuel oils (HFO). IFO is cheaper than DDO; however, use of IFO increases the cost of operation other than for fuel and has more negative impacts on the environment: IFO180 used by STELCO has a SO_2-content of 3.5% versus 0.5% for DDO. STELCO has modified the fuel supply system for two of the existing diesel engines so that they can operate on IFO, in order to lower the production costs.

Use of IFO increases the cost of operation other than for fuel - it increases the burden on the operation and maintenance staff and wear and tear in the engines - and has more negative impacts on the environment: A major difference between these fuel oils is the viscosity, i.e. the viscosity for IFO's and HFO's are higher than for DDO (less fluid), up to e.g. 700 cSt. For using these oils in the engine, fuel must be conditioned, i.e. heated up in order to lower the density to a level suitable for fuel pumps and injectors. The supply of heat often comes from a boiler installed in the exhaust gas stream. It is important to stress that modification to the engine itself is normally not required to operate on IFO or HFO.

In order to provide the plant with flexibility regarding future supplies of fuel oil, the Team **recommends that the tender documents specify**:

- that the diesel engines shall be able to operate on HFO up to 700 cSt;
- that the fuel treatment equipment shall be able to condition at least IFO 180,
- that the treatment plant shall be able to condition fuel of up to 360 cSt.

Diesel engines can either be used as they are on in combined cycle. In combined cycle the exhaust gasses are used to drive a gas turbine that drives a small alternator. This alternator delivers its power to the networks and thus improves efficiency of the entire plant. However, when the plant is using part of the exhaust gas energy for conditioning the fuel and for heating tanks, it may be necessary to install a boiler to re-heat the exhaust gas prior to using it in the gas turbine, thus lowering the efficiency. A combined cycle installation is more complicated to operate and is normally not considered economically feasible for the relatively small size of plant in question. This is more so as the Malé Power Station is expected be operating as peak load station in the nearer future when base supply is taken over by a power plant to be located outside Malé.

The Team concludes that STELCO's decision to order ordinary turbocharged diesel engines without combined cycle for the power plant is the right choice of technology. Diesel engines are well known by STELCO and should not present a technical problem whether of same make as the existing engines or of a different make.

2.3 Power Supply Network Technology and System Losses

The present project concerns the power production facility only. STELCO's consultant, OLP, has carried out a network analysis with emphasis on load flow and short-circuit currents in order to establish whether the increased power production can be evacuated from the power station and whether the increase of production capacity has other impact that needs to be addressed.

The study concludes that the system needs reinforcement over time as load grows, in terms of cables with larger cross sections and larger transformers in some areas to evacuate the energy. This is considered normal reinforcement work and is not part of the present project.

The study also concluded that the cross section of some cables needed to be increased because of the increased short-circuit capacity of the system, unless the fault-clearing time in case of short circuits could be reduced below 0,7 secs. These cables are the same as those that will have to be replaced to cater for the growing load. Should the replacement of the cables not be undertaken on the time of commissioning of the new plant, it should be possible to reduce fault-clearing time in the system such that the cables will not be damaged.

System losses, defined as the difference between units generated and units billed, are around 11%. Absolute figures for losses in the individual years and the variations from year to year fluctuate considerably. But the OLP study showed a decline in system losses from 14% of generation to some 10% from the mid-1990s to 2004. Conventionally defined as losses in transmission and distribution, the figure would be relatively high for a small system as the one found in Malé[10]. However, the figure includes also the consumption of the power station auxiliaries and STELCO's own use of electricity. The figure, therefore, is proof of efficient distribution.

As a consequence, the appraisal does not include any works outside the power station.

2.4 Operation and Maintenance

STELCO has a 57 persons staff at the existing power station. Adding 3 new generating units will have some implication that need to be addressed by STELCO management.

Whereas the extension is not expected to have an impact of the number of staff in the control room, it may be necessary to increase the number of staff supervising normal operation on the floor. Maintenance will go from smaller verifications to overhauls that become current after approx. one year of operation. The need for repairs is more difficult to estimate. It is obvious that three new units represent the risk of more pieces that can break-down, and operation on IFO will also entail more work for maintenance/repair than operation on DDO.

The power station management shall assess the needs for extra staff to handle the plant extension. An alternative hereto would be outsourcing. The Team has not had the opportunity to investigate whether companies that could undertake, e.g. overhauls for STELCO are available in the island. Given that the STELCO engines are larger than any other engine in the island, only companies used to undertake the same kind of work on ships are an option. However, the ships based in Malé are smaller, and the team concludes that STELCO will have to rely on its own resources for maintenance and repair.

[10] For reference purposes: transmission losses in Denmark are 2% and distribution losses 5%.

2.5 Potential Suppliers

The power station extension includes a large variety of mechanical and electrical/instrumentation equipment, that all have to be included in a Plant and Design-Build-type contract.

The invitation to bid concerns Danish companies only. From displays of interest in the present project and from recent projects tendered elsewhere it can be expected that several, qualified contractors will be interested and that the level of competition should be similar to that of international tendering

To the Team‘s knowledge, only few engine manufacturers worldwide have engines of the required size, MAN B&W and Wärtsilä being the largest producers. These companies have a full range of 4-stroke engines up to approx. 18 MW. If these companies either decide to tender or form alliances with others to do so, it may be difficult for others to present competitive bids. In reality it is likely that only two companies or associations present bids with MAN and Wärtsilä engines respectively. This situation is not particularly related to floating the tender in Denmark. During the first abortive international call for expressions of interest for the Fourth Power Development project several companies from different countries displayed interest, but only two companies tendered, one with a MAN B&W genset, the other with a genset from Wärtsilä. A tender round with two bidders would then represent as good an international competition as is possible, even when only Danish bidders are eligible. Past experience, perhaps with exception of the first tender round for the Fourth Power Development Project in 2005, has not given rise to doubts about the level of competition.

Regarding equipment to be supplied other than the generating sets it would be advantageous to have makes similar to the existing provided that STELCO finds the performance satisfactory, and also to limit stocks of spare parts if possible. However, it is not advisable to insist on specific makes, as this might have a negative impact on the price level.

The Mission has only identified one supplier who is difficult to exclude: the supplier of the SCADA system - unless the existing SCADA system be completely abandoned. For the Third Power Development Project a new SCADA system for all 7 generating units was installed. Given that the inclusion of the new production plant in the SCADA system will necessitate replacement of essential parts of the existing system, the **Team recommends that the tender documents** grant free choice of SCADA supplier to the tenderers.

2.6 Technical sustainability

The project is based on well-proven technologies similar to those already implemented in the Maldives. Given the already-existing experience and the envisaged training related to the specific equipment being installed; STELCO will, beyond any doubt, be able to operate and maintain the plant in a sustainable way.

2.7 Conclusions and recommendations

The Team finds that the proposed solution for increasing the production capacity to meet the demand for power in the short and medium term by installing three diesel generating units of a total capacity of approximately 24 MW represents the best choice.

The Team particularly **recommends equipment be included that allows operation on IFO** as a means to lower the cost of production per kWh.

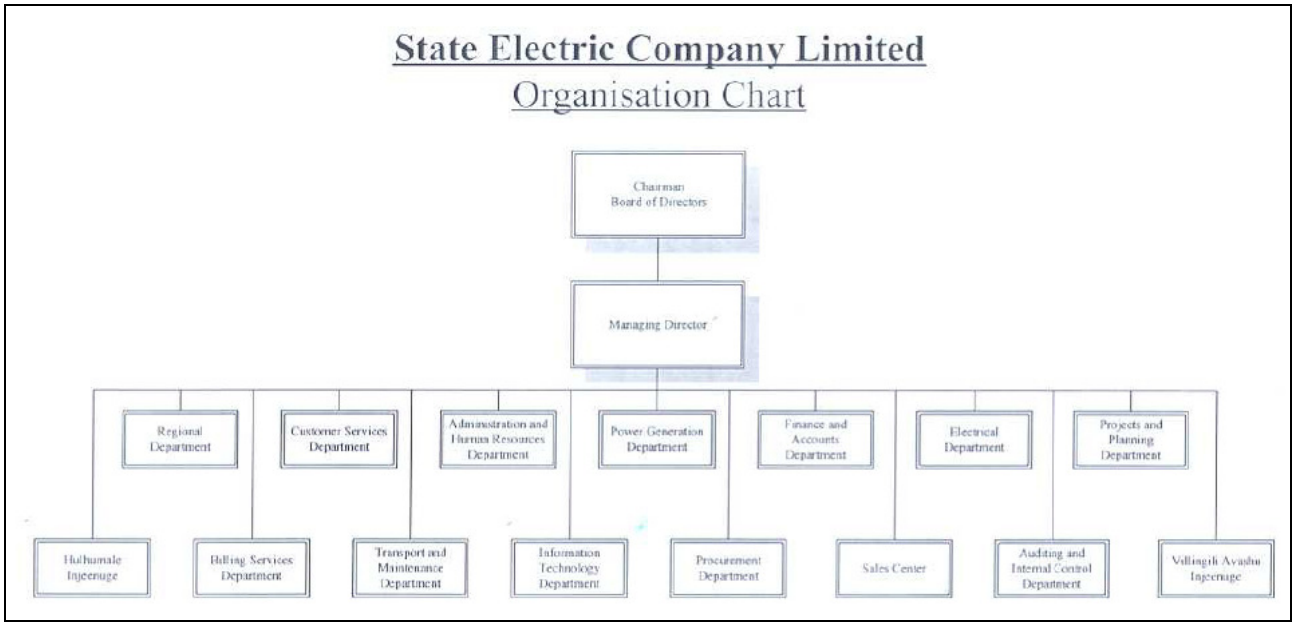
In case of approval of financing by the Mixed Credits Committee the Team **recommends** that STELCO finalises the existing tender documents, taking into account the recommendations of the present report and engages an experienced engineer to monitor the implementation of the project.

3 ORGANISATIONAL ANALYSIS

3.1 Project Implementation Organisation: STELCO

The project implementation organisation is the 100 % state-owned power company STELCO whose history goes back to 1949 when it was known as the Electricity Department. The Electricity department was transformed into the Maldives Electricity Board in 1982, and changed to the present STELCO in 1995/97 (Year of Presidential Decree and Act of Parliament, respectively).

STELCO owns and operates some twenty power stations and distributions systems, of which the Male' system is by far the largest.



The Board and the Managing Director (who is also board member) are appointed by the President.

STELCO is well-managed in areas directly under control of management: (i) the Malé power station is well maintained and very clean, which is normally a good indication of a well-functioning organisation; (ii) the technical and non-technical losses in Malé are lower than 11% and (iii) the commercial department achieves billing rate and consumer payment rates in line with international best practice - 98% of consumers are billed on time, 95% of billed are collected within the first ten days per month, most of non-collected are from Gvt offices.[11] Readings from meters are manually taken each month. In October 2005, only 3.000 customers out of 34,000 had not settled their bills. If people do not pay within ten days they are charged 2%. If they still do not pay after 3 days, STELCO sends a cautionary charge , then cuts off supply.

[11] Some Gvt schools have not paid for three years in a row. Debt Collection Department has a separate department for that purpose. STELCO has set up a special unit for that purpose to persuade Gvt department to withhold owed amount and pay STELCO directly.

The generating units are well-serviced. But in the present situation where production capacity is insufficient it has been noted that important maintenance activities, particularly for DGU 6 and 7 have been postponed to avoid load shedding. Although that is understandable from a short-term company/client perspective, it is a risky policy as it can be major technical break-down. If that occurred, the loss of a larger production unit would severely impact the company's capacity to supply its clients.

3.1.1 Recommended Project Organisation

For the implementation of the project, the Team **recommends – as already foreseen by STELCO - a traditional project organisation** for the project where:

- STELCO appoints a *Project Formulation Team* for the preparation of the Tender and a *Project Implementation Unit* for the implementation of the project until commissioning;, confirmation of this is to be a condition for Danida approval;
- STELCO as Employer engages an experienced engineering company as Engineer to undertake the preparation of tender documents, the entire tender procedure as well as the supervision of works, the words Employer, Engineer and Contractor used in the sense of FIDIC, Plant and Design-Build and with roles and responsibilities as stipulated herein;
- the Engineer supervises the works both under Danish and under Maldivian financing;
- the intervention by the Engineer is estimated by the Team at 35 man months throughout the construction period and until the issuance of a clean performance certificate at the expiry of the defects notification period;
- the Contractor being a Danish company gets his payments directly from the Danish bnk upon instruction from the Employer through the Engineer (given that the financing is to be made available as per an agreement to be entered into between the government of the Maldives and a Danish commercial bank and that a local bank will not be required).

Concerning the **form of the tender the team recommends:**

- it be a *Danida condition* that STELCO and its engineer modify the tender documents prepared for the re-tendering called off in April 2006 in order for it to conform the Danish Mixed Credits guidelines. (Annex VI to the present report present a not exhaustive list of areas to be modified), and that Danida finances the fielding of an engineer to assist STELCO in the required formal adjustment of the Tender Document
- As a limited number of bidders is expected to float an open tender in Denmark – provided that the national rules for public tenders allow it - and to post-qualify the bidders, instead of using time on pre-qualification.

3.2 Human Resources and Personnel Policy

Career fields in STELCO comprise Mechanical Engineering, Electrical Engineering, Accounting (ACCA), Business Administration, Civil Engineering, IT, HR Management.

STELCO has a staff of 697, of which 57 work in the Power Generation Department in Malé.

The staff of STELCO have not yet created a labour union to safeguard its interest and dialog with management. Despite this, salary levels in the company are above those of the public sector. STELCO is considered an attractive employer and the company has generally no problems in attracting qualified applicants for vacant positions.

Female technicians and engineers are non-existent in the Maldives. The 80 women employed in STELCO work in administrative positions. STELCO does not discriminate when recruiting. The Assistant Director, Human Resources, is female.

The Maldives has no university. After high-school, Maldivians seeking further education go to universities abroad for study. STELCO has a good HRD (human resource development) –policy. Staff are supported in getting supplementary and post-graduate courses at universities and technical schools abroad.

The staff is highly motivated.

A minor weakness in personnel policy noted by the Team is the absence of an incentive policy to motivate staff to take on more complex tasks and technologies. IFO-operation is more labour-intensive than DDO-operation and more difficult. Yet, when STELCO in 2005 switched to use of IFO as fuel in some generators, STELCO did not assign more staff to generation, nor pay staff for the overtime work that resulted from the switch to IFO. For obvious reasons, the staff developed a sceptical attitude towards the benefits to STELCO from IFO-operation.[12] The Team, therefore, **recommends** STELCO management to introduce incentive payments for operating the diesels in the more work intensive and more complex mode of IFO-fuel use, in particular to pay for overtime work that results from the operation.

3.2.1 Recommended Technical Training

As part of the project implementation STELCO's staff shall be trained to ensure that the power station extension be operated optimally and required programmed maintenance works and repairs be executed correctly.

[12] The negative attitude was revealed in statements like: "IFO-operation is not good; increases the risk of equipment failure and the price difference to DDO is not as large as foreseen in the feasibility study / power expansion plan which recommended switch to IFO.

Technical raining will be required for major equipment that is new to STELCO. New to the staff will the de-NO_x systems and training for this is included by STELCO in the set of documents from the last and failed Tender.
As the training is best undertaken by the Contractor; *trainers* shall come from the individual suppliers whenever possible.

In order for the training to be cost-effective training sessions are preferably conducted in Malé. Some training is, however, best conducted at the manufacturers premises in order to have access to plant similar to that to be installed at the power station and for which transport of dummies will not be practical, such as diesel engines.

Training in repair concerns the *diesel engine* as well as *separators* and *turbo charger*. Whereas diesel engine, alternator and MV switchboard repair for practical reason may be best undertaken at the factory, the other training courses are suggested to take place at site as this allows a larger number of participants virtually at low costs. Training in repair shall take place using special equipment for this purpose. The equipment to be installed at the power station shall not be used for this purpose. For training at site the trainer shall carry with him models, dummies, etc. to allow for simulation of faults, behaviour of equipment in special operation and fault situations.

The training programme shall include a number of modules address different staff categories from station management to skilled workers. Trainers from the manufacturers shall conduct the training session for specific equipment. The training program has the following scope:

Training for Power Station Management.

The power station management training shall focus on operation strategies in various load ad fault situations with special emphasis on ensuring the most economical operation mode in all situations, considering both the existing and new production units as well as the fuel options. As part of the training regulator settings for the entire plant shall be developed to ensure optimum co-functioning of exiting and new plant.

Training of Operating Staff

The module shall include operation of the new plant in normal and fault situations as per operation strategies directed by management from control room and local level as well as surveillance of parameters available on remote and local instrumentation. The training shall include sessions in the use of documentation prepared specifically for the operating staff.

Training of Mechanical Staff

This module is to be divided into a theoretical part addressing the mechanical engineers and foremen and a practical part for foremen and skilled workers.

The training concerns the basic functioning of the different equipment, programmed maintenance, repair works, use of the documentation and selection of spare parts.

The maintenance training shall cover all mechanical equipment and systems, while the repair training shall concern the diesel engines, turbochargers, de-NOx equipment, separators and fuel feeder-booster systems.

Training of Electrical Staff

The training concerns the basic functioning of the different electrical equipment, programmed maintenance, repair works, use of the documentation and selection of spare parts.

The maintenance training shall cover all electrical equipment and systems, while the repair training shall concentrate on alternators, voltage regulators, chargers, protection relays inclusive of programming of parameters and MV-switchgear.

Training of I&C Staff

The training concerns the basic functioning of the different instrumentation and control equipment, programmed maintenance, repair works, use of the documentation and selection of spare parts.

The training concerns the automated controls (PLC), instrumentation, fire alarms, video surveillance. For programmable equipment the training shall include training in programming and modification of same.

The team **recommends** that:

- it be a condition for Danida approval of Mixed Credit Finance that STELCO prior to the finalisation of the Tender documents prepares a capacity building plan for inclusion in the tender documents that specifies who is to be trained, in what and how, with indicative man days for the training and a plan for the monitoring of the outcome of the training;
- the following training modules be included in the tender documents: (i) training of operators, (ii) training in programmed light maintenance, (iii) training in overhaul works and repair,;
- verification of the training in terms of person days and capacity building be done at plant commissioning

3.3 Conclusion: Assessment of STELCO's Capacity

STELCO is a well-managed company with good records in plant operation and demonstrated strength in the preparation and implementation of previous power projects.

The power station staff is well qualified to operate and maintain the plant as well as to operate the connected substation in the City. As the envisaged extension of the production capacity will be based on same technologies, the staff will have no difficulties in operating the new plant.

Given that STELCO in general is able to attract skilled labour, there should not be problems in associating new staff required for the increased workload due to the extra generators and due to operating on the more work-demanding IFO-fuel.

3.4 Project Programme and Timetable for Implementation

The following timetable include remaining project preparation activities as well as the timeframe for the implementation of the project:

Table 4: Time Table

Activity	Completion Date
Final debriefing note from Appraisal Mission	10/11 – 2006
Draft Appraisal Report	09/12 – 2006
Comments to draft report	20/12 – 2006
Final Appraisal Report	31/12 – 2006
Presentation of project to the Committee for Mixed Credits for approval	January session 2007
Approval of project and of Maldivian-financing by GoM	15/02 – 2007
Lifting of any outstanding matters regarding authorities approval of EIA	01/02 – 2007
Submission of draft Tender Documents for construction to Secretariat for mixed credits	01/03 – 2007
Submission of draft Tender Documents for Engineer to Secretariat for mixed credits.	01/03 – 2007
Comments to draft tender documents for construction by Secretariat for Mixed Credits	15/3 – 2006
Final Tender Documents for construction	01/04 – 2007
Final tender documents for recruiting the Engineer	01/04 – 2007
Floating of Tender for construction	15/04 – 2007
Floating of Tender for Engineer	15/04 – 2007
Tenderers visit to site	30/04 – 2007
Initial contact to and negotiations with potential lending Danish bank	30/04 – 2007
Submission of bids for construction (common bid for Danish and Maldivian-financed parts)	31/05 – 2007
Submission of bids for construction (common bid for Danish and Maldivian-financed parts)	31/05 – 2007
Presentation of tender evaluation report for construction for non-objection (Danish-financed part)	15/06 – 2007
Presentation of tender evaluation report for Engineer for non-objection	15/06 – 2007
Contract negotiations (both for Danish and Maldivian-financed parts)	30/06 – 2007
Contract negotiations with Engineer	01/07 – 2007
Negotiation of loan with Danish commercial bank	15/07 – 2007
Engineer's contract effective	15/07 – 2007
Presentation of End-user's Declaration	01/08 – 2007
Presentation of Exporters Declaration	01/08 – 2007
Presentation of Borrowers Guarantee	01/08 – 2007
Approval of loan by Secretariat for mixed Credits	01/08 – 2007

Signing of Commercial Contract (Danish-financed part)	15/08 – 2007
Signing of contract (Maldivian-financed part)	15/08 – 2007
Power of Attorney for Engineer to release payments	15/08 – 2007
Advance payments for construction contracts	15/09 – 2007
Construction contracts effective	15/09 – 2007
Taking-Over certificates	15/12 – 2008
End of Defects liability Periods	15/06 – 2010

4 ENVIRONMENTAL IMPACT ASSESSMENT

4.1 EIA Report and Procedures

Environmental awareness is high in the Maldives and the media is eager to take up environmental issues and report about complaints from the public. The public, understood as people in the neighbourhood, had made complaints about soot, smells and noise that are taken into account in the past. STELCO took contact with the Kalaafaanu School, where high noise levels were recorded; this led to noise attenuation measures being applied in the Third Power Development Project that reduce the noise to the present levels.

The Maldives passed an Environmental Protection Act Law in 1994, which requires an EIA to be done for all major physical projects. But as far as the technical analysis and procedures for EIAs are concerned, the involved parties are at an early stage of a steep learning curve. Emission or noise standards have not yet been fixed in follow-up regulations, instead the Ministry of Environment, Energy and Water (MEEW) normally refers to US-EPA's standards in its evaluations and decisions. These have status of guidelines only. According to the instructions of the Ministry of Environment and Construction, the US EPA standards for air quality shall be respected in the Maldives. Where US EPA standards are not giving values, other internationally recognized standards are accepted e.g. the World Bank or IMO (International Maritime Organisation) standards.

The environmental project risks have been assessed in the year 2004 in the Power Extension Study Part I by Özen Leithoff Power AG (OLP) and in the environmental impact assessment, EIA, of September 2005 prepared for STELCO by CDE, Commerce, Development and Environment Pvt. Ltd. The reports address the majority of verification point listed in the Danish Mixed credit Guidelines for Environmental Impact Assessment.

The major recommendations in both reports concerned (i) investment in NO_x reduction system, (ii) not using IFO180 in diesel operation during the 15% of the year when winds blow the exhaust from the power plant over Malé, (iii) improving noise attenuation also at the existing powerhouse to keep total noise level within 58 db, (iv) increasing chimney height to maximum allowed limit, (v) emission and noise monitoring equipment is to be installed at the plant site.

The EIA elaborated by CDE was presented to MEEW who, on the 18th September of 2006 issued a Decision Note (see Annex IV). The Decision Note gives a conditional approval of the envisaged project. The Note dictates that certain mitigating measures are implemented as part of the project and that a monitoring program (noise and emissions) shall be put in place and regular reports submitted to MEEW. The principal required mitigating measures are the following:

- Soot filters shall be used
- De-NO_x systems shall be used when the wind blows the emissions towards Malé
- Noise attenuators shall be used to reduce noise levels emitted by the generators
- Existing attenuation walls shall be improved
- Hearing protection gear shall be provided for staff working in the powerhouse
- Sulphur content in the fuel shall be reduced and maintained within limits
- Stack height shall increased to the maximum allowable

The MEEW informed the appraisal team that its priority concerns relate to (i) emissions of NO_x, SO_2 and SPM and (ii) fuel handling and storage.

4.2 Environmental Impact of the Existing Power Station

Present emission levels of PM 10 and SO_2 are well below the requirement for satisfaction of USEPA-limits.

4.2.1 Soot and SO_2 Emissions

The USEPA ambient air quality standard for SO_2 is 365 ug/m^3 as 24-hour average; and 80 ug/m^3 over a year.

Complaints received from the public concern soot, smell (possibly of sulphur) close to the power station when operating on IFO. STELCO has not operated DGU 6 and 7 on IFO since May 2006 so it was not possible for the Team to assess for itself the impact of this mode of operation. It was also unclear to assess exactly the origin of the complaints regarding soot. Normally the power station will not emit soot, and particularly not when operating on DDO. It is possible that complaints about soot stems from observations during starting-up of the engines, where a heavy smoke plume is inevitable during a very short period of time. Normally a diesel engine is stopped and started on DDO in order to flush the combustion lines, pumps and injectors for IFO/HFO that could stick when temperature goes down after stopping the engine. For short stops when the engine does not really cool down, and particularly for the light IFO used (180 cSt) this may not be required. The Team was informed that STELCO in many cases did start and stop on IFO, and the soot complaints may be related to this practice.

4.2.2 Noise Emissions

The noise from the existing plant has apparently not given raise to complaints. An explanatory factor is that few are affected by the noise. The Southern long side of the plant faces the sea, see photo. To the east the powerhouse noise emissions are largely screened-off by the administration building. To the west noise is reduced by the tank farm and a stone and brick making site before it reaches some taller residential buildings at a distance. The North-Western part faces the six-story administration building of STELCO. It is only towards the Northern long part of the plant site, where the Kalaafaanu School and the Ameenee Magu are located at approx. 60 m from the wall of the

existing powerhouse that a potential problem exists.

The noise standards proposed by the World Bank (World Bank "Pollution and Prevention Handbook" (used in the EIA and by MEEW) are a maximum level of 65 dB during daytime and 55 dB during night time. For the Third Power project, the financing agent ADB adopted the USEPA noise standards. Before the implementation of the Third Power Project the noise level inside the school had been measured at 70 dBA. The existing power plant was specified and approved with 60 dB at Kalaafanu School excluding road traffic and other noises.

The EIA for the Fourth Power Project undertook measurements of the noise levels at the school entrance, which showed a level of 62 dBA during the day (a level not causing speech interference) and of 59 dBA at night.[13] MEEW has so far accepted this as no complaints about noise levels have been filed.

Noise-wise it is an advantage that the power station uses seawater cooling as important parts of noise from many power stations stem from air coolants placed in open air. But there is still room for improving of noise emissions to the North side. The gable has a large entrance where the sealing with the frame and possibly between frame and building structure could be improved, or the entire entrance could be replaced by a special soundproof gate. The windows located in the gable may also be worthwhile replacing or removing as well as the gate to the courtyard between the powerhouse and the old administration building. It could further be considered to double the noise attenuation panels screening-off noise from the exhaust gas silencer platform and screening between the powerhouse and the desalination plant building.

The above description of the noise situation does not refer to the present situation where 4 of 1 MW high-speed units have been placed outside the power station perimeter in the Fenmeeru Hingun as a preliminary measure. The noise level from these increases the noise beyond the 58 dBA limit. Since these units will be replaced by the 24 MW, the de facto impact of the new powerhouse is to decrease the noise level coming form the plant.

4.2.3 Seawater Cooling

Seawater is used for cooling. The power station has double water intake from the sea as well as outfall of used cooling water. The latter will have a higher temperature than the sea. According to

[13] Close to gensets the measured noise levels were at Southside 65 dB during day and at night, and at the North side 69 dB at night and 71 dB during day.

CDE this will be diluted quickly as the outfall is located on the brink of the atoll where water depths are considerable and currents between the atolls important.

4.3 Environmental Impacts during Construction

The nuisances during construction are those traditionally known. Given the noise level from the existing power station, there will only be few occasions where extra noise will be perceived.

Apart from noise from the construction site there will be impacts from transport of materials. It is unclear how the contractor will arrange its transports. One possibility is to bring it on barges to the coast immediately outside the construction site, another is to unload at the harbour. In the latter case there will be substantial number of heavy transports through the city. The transportation of the engine would be a special case even that it will probably be necessary to partly dismantle it to reduce weight.

A particular problem is related to the fact that the construction site is extremely narrow, see photo.

It will be impossible for the contractor to store materials and to have its site office inside the power station perimeter. The team **recommends** that STELCO contact relevant authorities in order to obtain permission to use areas outside the perimeter during the (limited) construction period. The area immediately outside the site is of recreational nature, but it is imperative to give the contractor the best possible working conditions to reduce construction time and to limit costs. Imposing on the contractor a storage area and site office at any location that is not adjacent to the construction site should be avoided. Given the nature of financing be it for the Danish-financed part or for the part to be financed by GoM, the Maldivian stakeholders should intervene in order to avoid extra costs.

Environmental nuisances are considered minimum to moderate in the EIA and should be tolerated.

4.4 Environmental Impacts during Operation

Environmental impacts during operation are well described in the EIA. The present report concentrates on the following impacts from operating the new plant that have been particularly discussed during the mission:

- Noise
- SO_2
- NO_x
- Soot
- Sea water cooling
- Treatment of oily water and waste oils
- Fire hazards

4.4.1 Noise Emissions

The noise level for the new 24 MW generators is in the EIA estimated at 119 dBA inside the power house. Given that it will be a Plant and Design-build contract, the contractor shall design the plant such as some functional criteria be respected. Noise emissions from the new plant should be reduced as much as possible through (i) use of materials for the powerhouse that attenuate noise and (ii) the positioning of the plant.

An increase in noise by 3 dB implies a doubling of the noise level; and as noise pollution by a new noise source to an existing source of noise is additive, adding a new plant with a noise level of 55 dBA next to an existing plant with a noise level of 55 dBA would increase the total noise level to 58 dBA. The target for the Fourth Project adopted by MEEW is to keep the total noise level from the Malé power in front of the school down to 58 dBA. The achievement of that requires both that further investments are undertaken to limit noise emissions from the present plant – see examples listed in section 4.2.2 – and to reduce noise emissions from the new plant to a maximum of 55 dBA and preferably below, if it is more cost-effective to undertake further investments to reduce noise emissions from the new powerhouse (measured at the entrance the school) below 55 DBA than to invest in other noise reduction measures.

The team **recommends for the preparation of the specifications in the Tender Documents** the following:

- That STELCO accepts the financing by Danida of an assessment of the present and future noise level next to the power plant. The assessment shall include a description of the neighbouring areas next to the power plant. The assessment will include a mapping of the future noise level (measurements and/or modelling according to an international accepted model). Finally, the assessment shall include a cost estimate of reducing the noise level from the estimated resulting level of 58dB(A) in selected reference points next to the power station. Any relevant recommendations are to be approved by Danida and reflected in the specifications of the Tender documents.
- The new power house is to be orientated such that the stacks are to the South, the advantage being that the powerhouse itself screens towards North the noise direction of which is the major concern.
- For plant located high such as boilers and combustion air intake it may be required to screen towards West in order to limit emissions in direction of the residential building in that direction.

SO_2 and NOx emissions

The OLP-report recommended to handle the SO_2-emission problem by operating the diesels exclusively on diesel whenever the wind direction blew exhaust gases from the plant towards the city (happens around 13% of the time during a year). According to the EIA the SO_2 level remains below the USEPA limits after the plant extension even if the plant uses IFO180 with a maximum 3.5 % sulphur content during 87% of the year.

The Decision Note from MEEW requires the sulphur content to be reduced, however without fixing limits and without defining what the reduction concerns: whether it relates to the sulphur content in the IFO that is used of sulphur content per kWh of generated output.

Lowering the sulphur content can be done (i) in a desulphurisation plant, (ii) by purchasing an IFO with lower content of sulphur e.g. max. 2%; (iii) by using DDO where the sulphur content is max. 0.5 %; or (iv) operating a mix of units on DDO and IFO. A desulphurisation plant is not an option: it produces large amounts of waste products such as gypsum that will have to be taken care of in an environmental-friendly way, it needs space and is costly.

In November 2006 the price difference per ton was only US$4, see table for Singapore Platts (the leading reference for international oil product prices) November 16, 2006.

Table 5: Price Difference IFO and DDO Platts November 2006

Fuel	SO_2-content	Price		Difference	
FO 180cSt	2.00%	294	USD/MT	-$220	-43%
FO 180cSt	3.50%	290	USD/MT	-$224	-44%
DDO		70	USD/bbl		
		514	USD/MT		

Table 5 shows (i) the limited price difference per MT between IFO180 with 2% and 3.5% SO_2-content and (ii) the large price difference on the international market between IFO180 and DDO.

The difference in the price per ton charged by STO to STELCO was much lower, please see table 6.

Table 6: Price Difference IFO and DDO charged by STO to STELCO

	Diesel MRF/litre	IFO180 MRF/litre	Difference MRF/litre	in %
4 April/9 May 2005	6.27	4.88	1.39	22%
8 Oct/9 Oct 2005	7.37	5.88	1.49	20%
8 May/11 May 2006	7.97	6.55	1.42	18%

As a cost-effective and environmentally justifiable way to comply with MEEW's air quality objectives, the **Team recommends to MEEW** to impose the following operating conditions on STELCO:

- a max. 2% SO_2-content on the use of IFO-fuels,
- DDO-only operation when fumes blow towards Malé,

The OLP-report concluded in its environmental evaluation section that NOx-emissions from the Malé plant were the most serious of all environmental problems. The OLP report recommended SCR (Selective Catalytic Reaction) as the appropriate de-Nox technology, a finding which is supported by the TEM: the other De-NO_x technologies, Direct Injection or Humid Engine being either experimental or potentially limiting the choice of engines for the project.

The Decision Note from MEEW stipulate that De-NO_x systems be used when the fumes blow towards Malé.

Operation of the De-NO_x system require injection of urea in quantities depending on the required NO_x-reduction. The De-NO_x operation generates significant extra costs for urea and the disposal of the waste products as the used urea has to be dealt with in an environmental friendly way, e.g. through incineration.

The Team has been in contact with a Catalyst expert to verify the SCR's system compatibility with high sulphur IFO. The advice received was that sulphur in itself does not create problems for the catalyst. However, *use of IFO/HFO create SO_3* which again can create harmful aerosols. In order to minimize SO_3/aerosols a *low-oxidation catalyst with low vanadium contents* should be preferred.

Another aspect is *HFO/IFO and imperfect combustion*, where combustion residues could clog the catalyst.

The Team **recommends**

- that STELCO accepts the financing by Danida of an assessment of the future air pollution aspects from the existing and new power production plant based on operational information, relevant physical and topographical properties and calculation PM, SO2 and NOX in Male city area and surroundings. Application of an international air pollution model is recommended. The assessment should include a discussion of the operational aspects of switching between high sulphur fuel and DDO taking into account the dominant wind directions as input to the further discussions between STELCO and MEEW. The assessment should include the operational aspects of possible reduction of NOX from the flue gases including training, reagent supply, waste generation and the outcome of the abovementioned calculation of NOX in Male city etc.

4.4.2 Soot emission

For the existing plant, it is not clear whether the complaints about soot stems from the visual impact of the heavy smoke at start-up or whether this is related to the practice of stopping/starting the engines on IFO instead of DDO. The **team recommends** that this be clarified and discussed with MEEW before prescribing the use of soot filters for the new engines. Any kind of filter potentially create counter pressure in the exhaust system and extra maintenance work, and should be avoided if possible.

4.4.3 Seawater Cooling

Seawater cooling for the diesel engines is the preferred alternative to cooling tower that consume large amounts of fresh water and to radiator cooling that generate noise from the fans, and seawater is abundantly present. The choice of system does not impact the diesel engine as the jacket- and charge air-cooling water (HT water) is separate from the external cooling water through the use of heat exchangers. There may be an impact in the sense that seawater and cooling tower cooling could lead to slightly higher output of the engine that radiator cooling due to better cooling of the combustion air.

According to OLP's study the existing seawater system with double water intake and outfall is redundant for the presently installed capacity and should be sufficient also for additional 24 MW. Nevertheless the tender documents prescribe that additional water intake be provided from drilled wells.

Use of cooling water *returns water at higher temperature* and leads to *chlorination of the water*. The EIA concludes that the higher temperature of the outfall is without importance as the outfall is located near the edge of the atoll where water depth increases sharply. Outside the power station, given the location on the outside of the atoll, water depths are the order of 2 – 300 m.

The Team **recommends that the tender documents as already foreseen by STELCO and by MEEW:**

- prescribe a Δt of 11 C^o for cooling water;
- fix limit values for the content of chloride in the outfall water

4.4.4 Treatment of Oily Water and Waste Oil

The existing power station has a system where potentially polluted water from rains, washing, etc. is collected and sent to gravity oil/water separators and where a special oil/water separator cleans oily water from the engine hall and from the separators to a level of max. 10 ppm (which is the max. value from the IMO regulations for water to be discharged into harbours, etc.) before discharging into the drains. The oil collected is stored in 200 l drums and sent to Thilafushi (island some kilometres from Malé) for incineration. The same applies to waste oil from the engines. STELCO does not operate an incineration plant of its own.

For the new plant the **team recommends in the tender documents** to specify a system whereby:

- Water that potentially could be polluted (from tank farm retention perimeters, paved outdoor areas, transformer cells, etc.) is led to gravity oil/water separators. Attention is drawn to the fact that high-efficiency gravity separators exist with a much better performance than traditional concrete gravity separators and should be prescribed in the tender documents.
- Water that is polluted (from turbo charger washing, separators, engine part washing areas, workshop, engine hall, etc.) shall be treated in a plant that ensures max. content of Hydrocarbons of 10 ppm. before discharged into nature.
- Waste oil from the engines shall be collected in drums for transport to incineration plant or in a tank for later transfer to drums for incineration.

4.4.5 Fire Hazards

The existing power station has traditional fire fighting equipment in the form of foam/CO_2 extinguishers for fire in different media and water. Firewater from the station's fresh water tank, alternatively from the city's water supply system. Electrical pumps backed up by a diesel firewater pump ensure Pumping/pressurising.

Inserting a 24 MW production plant in the rather small station site brings about a rather congested site with short distances between plants and between plant and fuel storage. According to drawings

in the tender documents the distance between the 2 x 12 MW powerhouse and the retention wall of the tank farm is only 3 m. A powerhouse for 3 x 8 MW DGU will probably have a different lay-out, but distance to tank farm is not expected to change much.

The Team **recommends**:

- that STELCO with its consultant examines the "new power station-fuel storage tank distance" aspect in detail as regards respecting international standards and insurance company requirement e.g. for wire walls;
- the Tender material specifies that the design and lay-out for the plant complies with international safety standards and can be insured against fire hazards at a reasonable premium;
- that it is a Danida condition that the new plant can and will be insured.

4.4.6 CO_2-emissions

The emissions of CO_2 from the IFO-fired diesel power plant amount to about 0.75 ton per MWh of generation. The expected lifetime generation of 1400 GWh generates CO_2-emissions of 1m tons, the net expansion in lifetime generation at the Malé power plant due to the investment in the 16 MW of 1200 GWh gives raise to emissions of 0.9 million tons CO_2.

Economic power supply alternatives to diesel power generation do not exist. Demand side measures to reduce the consumption of power are being implemented.

4.5 Monitoring of Environmental Impacts

4.5.1 Environmental Management Plan

Regarding the *external environment STELCO is accountable to MEEW*, which will monitor that the Environmental Management Plan specified in the IEA report and in MEEW's Decision Note shall be implemented.

In addition to being an instrument for reporting to the authorities, the *recurrent monitoring activities* should increase awareness regarding both working and external environmental issues at all levels of STELCO's organisation.

4.5.2 Calculation and Monitoring of Gaseous Immission Levels

The pattern of spreading of gaseous emissions depends among other things on stack height. OLP's study is based on 30 m stacks while the EIA contains calculations of SO_2 and PM_{10} based on 45 m stack height, which is the maximum height because of the near-by airport and aviation authorities' requirements for the Inner Horizontal Surface that include the whole of the Malé Island. The EIA does not contain assessment of NO_x, but the OLP study concludes that NO_x may be inside USEPA's limit values.

In Malé monitoring of air quality does not take place on a regular basis and MEEW does not have equipment for measuring air quality. MEEW has requested that the present project provides equipment for current control of essential parameters of air quality.

The tender documents for the year 2006 failed tender specified a measuring station to be installed on the roof of STELCO's administration building for measuring wind speed and directions, air temperature, humidity, barometric pressure, SO_2, NO_2, PM_{10} and acidity (pH) of rainwater. The station is to provide instantaneous reading as well as storing of data. A display monitor and operator alert system will be available in the power station's central control room. The latter will be of use to the operator if immission limits are exceeded or if the final operation mode includes different forms of operating the DGU's in different weather situations, particularly the wind directions.

In theory, output from the weather and air quality monitoring station could provide useful data for the monitoring program. In practice, the information value is limited because the station is located too close to the chimney to provide good data: most emissions will fly over the station; the measured immissions, therefore, will be low. The implications of the measured data for air quality in Malé, therefore, need to be interpreted by STELCO/MEEW based on agreed dispersion models.

Since the installed price for the weather and air quality monitoring station can be up to €550,000 and annual operating costs be up to €130,000, **the Team concludes** that the proposed station does not provide enough value for money.

An *alternative method for the monitoring of air quality*, which is cheaper, yet provides better data, uses the following steps to generate the targeted information:

- Based on information about the quality of used fuel and fuel consumption per kWh (or per day or per hour) it is possible to *calculate the theoretical emissions per m^3 and per kWh of SO_2, NO_x, SPM,* etc.
- The environmental monitoring plan imposed by MEEW stipulates that STELCO at periodic intervals performs *SO_2, NO_x, SPM measurements at the upper part of the chimneys* to verify how actual emissions correspond with the calculated emissions. The data is used to "calibrate" the calculations.
- Based on *agreed dispersion models* and information on average weekly or monthly wind directions, the impact of the emissions from the plant on air quality in Malé (immissions) is calculated.
- High quality *information on daily/hourly wind directions* can be secured from the wind measurement station at the nearby airport.

The **Team recommends** to:

- Danida not to accept the inclusion of the proposed station in the tender material for the investment package to be financed by the Mixed Credit;
- STELCO and MEEW before finalisation of the Tender documents for the additional investments to reflect once more on the cost-benefit effectiveness of investing in the proposed measuring station compared to the alternative control mechanism composed of an agreed dispersion model and measurement of SO_2-emissions directly at the upper part of the chimneys.

4.6 Overall Conclusion concerning Project Environmental Impacts and Mitigating Measures

The project environmental impacts are acceptable and do not pose significant health or nuisance risks for the population. The investments in mitigating measures that will be included in the Tender Material and the operating conditions imposed on STELCO by MEEW's decision note (and later precisions that can be expected) include all measures that can be economically justified.

There is scope for some optimisation in the presently envisaged measures and the team has made some recommendations to achieve these.

5 FINANCIAL AND ECONOMIC PROJECT ANALYSIS

5.1 Investment Budget and Costs of Operation

5.1.1 Investment budget

The investment budget estimated at April 2007-price level is as follows:

Table 7: Investment Budget and Source of Finance

Description	Plant/importsCIF M€	Construction M€	Total M€
Danish-financed part			
Diesel Generating sets, 16 MW	3.8	1.1	4.9
Mechanical auxiliaries	4.1	0.3	4.4
Electrical auxiliaries	2.8	0.6	3.4
Instrumentation and controls	0.9	0.5	1.4
De-NOx plant	0.5	0.1	0.6
HFO plant	1.5	0.2	1.7
1x800 m3 HFO storage tank	0.4	0.1	0.5
Civil works	5.1	1.5	6.6
Sub-total	19.1	4.4	23.5
Contingency, 5%			1.2
Danida-total			**24.7**
Maldivian-financed part			
Diesel Generating set, 8 MW	2.3	0.6	2.9
Mechanical auxiliaries	2.2	0.1	2.3
Electrical auxiliaries	1.0	0.1	1.1
Instrumentation and controls	0.4	0.2	0.6
1x800 m3 HFO storage tank	0.4	0.1	0.5
SCADA	0.7	0.1	0.8
Tools	0.6	0.0	0.6
Noise attenuation existing plant	0.1	0.1	0.2
Rehabilitation of structures DGU5	0.7	0.3	1.0
Sub-totals	8.4	1.6	10
Contingency, 20%			2.0
Maldivian financing including contingency			**12.0**
Total project, excluding contingencies	**27.5**	**6**	**33.5**
Total project, including contingencies			**36.7**
Ancillary costs to be supported by GoM :			

- Import duties, 25 % of total CIF amount	6.9
- Engineer for supervision *)	0.8
TOTAL	**44.4**

*) Estimated on the basis of 35 man-months (2.5 x construction period of 14 months) at an all-inclusive rate of 20.000 €/month, and 0.1 M € of contingency.

The total project costs exclusive of contingencies, import duties and engineer result in a cost per MW of 1.4 M€ which is high compared with the costs of investments normally seen for diesel power plants worldwide. It is caused by various site-related factors such as: (i) protection against corrosive sea-environment that motivate choice of "high-cost" solutions, (ii) the high costs of transported equipment and materials to Maldives, and (iii) the high cost of civil works in Malé. STELCO has no investments funds of its own and cannot get a commercial bank loan due to its precarious financial position. STELCO's co-financing equity contribution out of self-generated revenue is limited to the cost of the supervising engineer, which is estimated at €0.8 m.

The MoFT pays for the import duty and local taxes, estimated at €6.9 m, via a simple accounting exercise for the state budget.

Since the co-financing ability of Mixed Credits for the project is limited to a maximum of €24.7m, the cost of investment (excluding supervising engineer and import duties and local taxes) of €33.5 m had to be split into a Mixed Credit component and a "third-party" component of €12 m. The distribution shown in table 7 was defined by the need to have a Mixed-Credit project that "could stand on its own feet", capable of being implemented and be operational even if funding for the complementary component is postponed for some of its elements.

5.1.2 Costs of operation

The assumptions concerning the costs of O&M are listed in table 8.

Table 8: O&M Cost Assumptions

Costs			
Annual operating hours by fuel consumption	17%	83%	
Fuel consumption	80% load	60% load	
- diesel fuel DDO	205	215	g/kWh
- IFO180	210	220	g/kWh
Cost of fuel per ton ("base price" and "high price")	MVR/litre	MVR/kg	High price
- DDO	6.5	8.78	9.5
- IFO	5.5	6.12	6.62
Lube oil consumption	0.6	g/kWh	
Price of lube oil			
- IFO-operation	3,200	€ per ton	
- DDO-operation	2,700	€ per ton	
- average	3,200	€ per ton	
Lifetime of diesel generator	100,000	operating hours	
Rehabilitation after 65000 hours of operation	25%	of initial cost of	

		investment
Annual maintenance & spare parts	3.0%	of original cost of investment
Cost of de-Nox operation	0.50	€-cents/kWh
De-nox operation in % of yearly operating hours	0.15%	
Other costs	0.15	MVR/kWh
Distribution losses	11%	
Cost of retailing (marginal costs)	0.20	MVR/kWh

The prices for LFO180 and DDO are two big unknowns in the costs of operation. First of all because of the uncertainty about the world market price of crude oil: the higher the price, the higher is the absolute difference in the price levels of LFO180 and DDO.[14] But also because there is uncertainty about STO's costs of storage and handling. Table 9 shows the cost structure from STO's purchase price fob to STO's delivered price at the power plant from May 2005 to May 2006.

Table 9: STO's Cost Structure for DDO and IFO180

	Diesel $/ton	Transport $/ton	MVR/litre	Handling MVR/litre	IFO180 $/ton	$/ton	MVR/litre	Handling MVR/litre
4 April/9 May 2005	423	45	5.05	1.22	256	50	3.30	1.58
8 /9 Oct 2005	560	45	6.52	0.85	311	50	4.18	1.70
8 /11 May 2006	620	45	7.17	0.80	350	50	4.31	2.24

Two price scenarios were made for the fob prices for DDO and IFO180:

- the "base price assumption" reflects the Platt[15] prices Singapore of October 2005, which roughly amounts to the average price of fuel during the 2004-2006 period;
- the "high price assumption" equals the Platt prices Singapore of May 2006.

STO's historical costs of handling in the table above are gross estimates made by the authors of this report using the following approach: (i) it is assumed that the cost of sea transport per ton for all three deliveries to STELCO was US$ 45 per ton; (ii) the cost of handling was calculated as the residual, by deducting the calculated cif-cost per litre from the price per litre charged by STO to STELCO.

One notices in table 9, that whereas the price for handling DDO declined, the price for handling IFO180 increased from delivery to delivery. Presumably the first evolution shows the impact of beginning competition in the supply of DDO to the Maldives: two other oil importers compete with STO for market share. In HFO/IFO, STO has a de facto monopoly being the only supplier who had invested in HFO-storage facilities. STO claims to have invested US$5 million in converting some of its storage tanks to IFO-use. One may assume that STO reacted to STELCO's low volume of IFO purchases by spreading its annual amortization of the investment over a smaller annual IFO-volume.

[14] The Financial Analysis in Power Extension Part I report had the following assumptions: "assuming that in constant prices, HFO costs 60 US$ less per ton in the low fuel price scenario, 80 US$ less in the medium and 120 US$ less in the high scenario".

[15] Platt is the most important international provider of daily price information on fuel prices.

The cost estimates for STO's landed cost cif for DDO and IFO from 2009 onwards are found by adding to the fob-prices in table 9, the cost of freight of US$45 for DDO and of US$50 for IFO, as well as a $5 per ton price premium for 2% SO_2 content in IFO180.

In the spreadsheet calculations for this report it is assumed that STO's future costs of handling DDO are 0.85 MVR per litre DDO and that the absolute and relative increase in IFO volume from 2008 reduces the difference in STO's cost of handling between DDO and IFO to 50%; this leads to a cost of handling IFO of 1.28 MVR per litre.

With these assumptions the price scenario for the base price assumptions leads to a price per kg fuel of 8.8 MVR for DDO and 6.1 MVR for IFO180, whereas the high prices are 9.5 and 6.6 MVR respectively.

It is assumed that the generation units are fuelled 87% of the time by HFO and 13% by DDO.

Other prices are subject to uncertainties: for example the assumed marginal increase in the cost of retailing per 1 kWh expansion of power sales. But these do not affect the results in any significant way.

5.2 Financial Analysis

5.2.1 Terms of Project Finance

The mixed credit of €24.7 million to co-finance the project is composed of a 10-year loan of around €19 million given by a Danish Commercial Bank to MoFT at a zero rate of interest and an up-front grant of around €5.7 million.[16] MoFT on-lends the Mixed Credit finance of €24.7 m to STELCO at a rate of interest of 8%. There are no other financial charges. The exchange rate risk is taken by MoFT as confirmed by MoFT.

The €12.8 million "third-party" investment is assumed to be financed by a self-financed contribution of €0.8 m (the cost of supervising engineer) and a loan of €12m which STELCO gets from a development bank channelled through MoFT as direct loan-taker. The Government's year 2007 fiscal budget prepared end-December 2006 includes a provision for loan financing for the implementation of the project. Whereas it may be difficult for the Government to secure full financial closure at such notice, one can be certain – due to the need for the additional 8 MW to avoid major load shedding - that the investment in the 8 MW will take place; the question is just when? The conservative assumption in this report is that the Government will succeed during 2007

[16] The Mixed Credit's subsidy consists of Danida paying for (i) interest on the loan, (ii) export credit premium, (iii) other financial costs, as well as (iv) an up-front grant (to reduce the balance of the loan): The size of the latter is determined residually, as the grant amount needed to bring the total subsidy up the 50% concessionality level fixed by OECD rules. The exact composition of Danida's subsidy (including the size of the up-front grant and thus the exact loan amount) depends on various factors, including the actual rate of interest (CIRR) at the time of signing of the loan agreement.

to get funds for the urgent investments in noise attenuation, tools, the Scada system and the rehabilitation of the building structure supporting DGU5 (total investment of €3.1m), whereas the investment in the 8 MW, the associated mechanical electrical auxiliaries and controls plus the 800 m3 storage tank will be delayed two years leading to a commissioning of the 8 MW DGU end-2010.

5.2.2 Financial Benefits to STELCO from the Mixed Credit Investment

The financial benefits to STELCO from the Mixed Credit financed investment change over the timeframe of the project:

- During the 2009-12 period, STELCO's financial benefits come from cost reductions in generation (IFO-use) and from the revenue of larger retail sales.
- The growth in power demand will by 2012 have reached the level of dependable capacity for the full 24 MW project. In line with the power expansion plan, it is assumed that IPPs start providing power from other islands to the greater Malé region (a number of small islands that are interconnected by transmission cables) from the year 2013 onwards. From 2013 onwards, STELCO could, in theory, stop its own generation and purchase power from the IPPs for its distribution arm; the benefits to STELCO as a vertically integrated power company from then on consist of savings in power purchases from IPPs.

Financial Benefits to STELCO from the Project

From 2009-12	From 2013-2028
• Reduced cost of generation (switch to IFO, lower costs of maintenance) • Revenue from increased retail sales of power	• Saved payments for power supply from IPPs

The financial benefits to STELCO are subject to a number of uncertainties, the most important of which are:

- STELCO's average tariff in Malé, which is assumed to be increased from the present 2.85 MVR/kWh (18 €cents) to 4.00 MVR/kWh (26 €cents).
- The price of diesel and of LFO180 throughout the period (not a problem if the regulatory authorities accept tariff adjustments in line with fuel price fluctuations)
- How power production at the Malé power station will be affected by supply from IPPs (the calculations are based on an 80% net capacity utilization for the 24 MW power plant from 2009-12, 50% in 2013-2014, 55% in 2015, 60% in 2016 and 65% in 2017, after which it falls to 40% from 2018 onwards
- The level of the IPP-tariff. Tariff-payments in IPP contracts will be split into a "payment for capacity" (a payment per day/month of de facto available capacity at the IPP-plant) and a payment for "energy" (a payment per delivered kWh, which will depend inter alia, on the price of the fuel). The financial calculations assume that the total payment is saved when STELCO generates power at its Malé plant.

5.2.3 Results of the financial analysis for the Mixed Credit financed investment

The financial analysis, see table 10, was done from two angles: financial NPVs and IRRs were calculated both for the *cash-flow* (repayment on principal as cost, but no depreciation) and for *straight line depreciation of the investment over 20 years* (replacing repayment of loans as a cost item). In both cases, STELCO is assumed to pay no company taxes.[17]

Table 10: Results of Financial Analysis

	NPV	IRR
"Repayment of loans" cash-flows		
Base fuel price case, 17% DDO	-58m MVR (€3.7m)	2%
Base fuel price, 100% DDO operation	-516m MVR (€33.1m)	negative
High fuel price case, 17% DDO	-101m MVR (€6.5m)	0
"Depreciation" cash –flows		
Base fuel price case, 17% DDO	-22m MVR (€1.4m)	2%
Base fuel price, 100% DDO operation	-480m MVR (€30.7m)	negative
High fuel price case, 17% DDO	-64m MVR (€4.1m)	negative

The financial analysis confirms:

- The justification of STELCO's request for an average tariff of 4.00 MVR/kWh. For the base case fuel price assumption (Platts Singapore) of US$316 per ton for IFO180 and US$560 per ton DDO, the project investment yields STELCO a financial IRR of only 2% when the tariff is 4.00 MVR/kWh.
- That the switch to IFO during 87% of the time is essential. Depending on whether the calculations are done on a repayment basis or a depreciation basis, use of DDO only reduces the NPV at the unchanged power tariff of 4.00 MVR/kWh from minus MVR 22-58m (€1.4-3.7m) to minus MVR 480-516m (€30.7-33.1m)
- The dependence of financial viability on the international price of DDO and IFO as long as the regulatory authorities do not apply an automatic fuel adjustment formula in the annual tariff approval procedure. The high fuel price assumption of US$355 per ton for IFO180 and US$620 per ton DDO, decreases the NPV from minus MVR 58m to minus MVR 516m.

The most striking result of the financial analysis is the high rate of return on the investment in IFO-treatment facilities: the investment of €1.7 m in IFO treatment equipment increases the NPV by about €29.5m, that is, the financial NPV net of the investment is €28.8m![18]

The "OECD" cash-flow table (see Annex V) shows the cumulative cash-flow turning positive in year 2024.

[17] The financial situation each year is so tight as to make the case of profits close to irrelevant and as STELCO is 100% Government owned, the Government has other means to extract financial surplus out of STELCO.

[18] In the table, the cost of investment in HFO/IFO fuel handling is not deducted from the cost of investment.

5.3 Economic Analysis

Since the fuel prices paid by STELCO do not include taxes and import duties, the financial and economic prices of the fuels – before taking into account the economic costs of environmental externalities - are identical.

Economic costs that are not included in the financial analysis comprise the environmental cost of SO_2, NO_x and CO_2-emissions. Since during 87% of the time, the wind blows SO_2 and NO_x emissions away from Malé, the environmental cost of these emissions during that time of operation is minimal. For the 13% of the time that these emissions have an impact on Malé, these have a negative health impact. The EIA-study for the power plant, however, did not include any quantification of these damage costs.

The emissions of CO_2 from the IFO-fired diesel power plant amount to about 0.75 ton per MWh of generation. The expected lifetime generation of 1400 GWh generates CO_2-emissions of 1m tons, the net expansion in lifetime generation at the Malé power plant due to the investment in the 16 MW of 1200 GWh gives raise to emissions of 0.9 million tons CO_2. The Maldives is one of the countries in the world that will be most affected by global warming. But since the Maldives is not an Annex I country, there is no direct quota-derived cost associated with these emissions. Using the year 2006 average level of CER-prices of around €5.5 as reference price, the negative NPV associated with the CO2-emissions from the net expansion in generation amounts to €4.8 million (CO2-costs are discounted at zero percent), or 75m MVR.

The two most important economic benefits which are not explicit part of the financial analysis are (i) the economic value of the *consumer surplus from power consumption* derived from the well-known fact that the *consumers' average willingness-to-pay* for electricity is higher than the average tariff, and (ii) the *economic value of avoided loss shedding* for household consumers and the service industry[19]

Until the year 2013, when the first IPP can be expected to be operational, all net increase in annual power generation due to the 16 MW, see the table 11, represents avoided load shedding. The fall in avoided load shedding in 2011 is due to the entry into operation of the new 8 MW DGU, which also expands annual generating capacity.

[19] The optimum level of security of supply concerns establishing the *economically optimum level of reserve capacity*. A power system must have sufficient reserve capacity to cover the demand for peak power when units are hit by unscheduled production stops. An *optimised power expansion plan* invests up to the level of reserve capacity that provides the system with the optimal "*loss of load probability" (or LOLE, "loss of load expectation"*). The installed generating capacity in a power system is expanded to the point, where the *annuitised incremental cost of adding an additional "xx" MW* equals the *economic value of the expected marginal reduction in annual load shedding* (probability that load shedding will occur during "yy" hours of the year multiplied by the economic cost per MWh of non-satisfied power demand). Such advanced modelling is seldomly undertaken. In practice in smaller systems such as in Malé the "n-1" rule of thumb" is applied: the reserve capacity in the system must equal the capacity of the largest installed unit.

Table 11: Net additional power generation due to extra 16 MW

	2009	2010	2011	2012
Net additional power generation due to extra 16 MW	48 GWh	66 GWh	32 GWh	51 GWh

Load shedding imposes the following costs on *industrial consumers*: (i) Loss of production output directly in existing firms and indirectly as investors hesitate to invest in new production when the energy supply situation is uncertain. (ii) Increased cost of production due to losses on perishable inputs, particularly in the processing of agro-industrial products. (iii) Increased cost of production at industrial plants due to non-optimal (or worse) production scheduling. (iv) Increased cost of production due to investments in stand-by diesel power units and their higher costs of operation per kWh than power purchased from STELCO. The costs imposed by load shedding on *households* comprise the costs of inconvenience (loss of consumer welfare) and costs for alternative sources of lighting and electricity. The cost per MWh of non-satisfied power demand is the weighted average of the "economist cost of consumer inconvenience per lost MWh" and of the "economic cost of non-satisfied productive demand for power per MWh".

Data to make an estimate of the economic cost of load shedding in the Maldives does not exist. In low income developing countries estimates are typically around US$ 0.5 per kWh = 38 €cents = 6 MVR, which is 50% higher than the MVR 4 per kWh tariff assumed in the financial calculations. In higher income developing countries – such as the Maldives – the figure is higher. Yet, using the conservative avoided cost estimate of 6 MVR/kWh instead of the sales revenue estimate for the power expansion figures in table 11 increases the project NPV by MVR 339m (=€22m).

Data on *consumer willingness to pay* in the Maldives is not existing. But it is certainly higher than the assumed financial price of 4 MVR/kWh.

Including the negative NPV impact of the cost of CO_2-emissions as well as the positive NPV impact of the value of avoided load shedding increases the economic NPV by MVR 264 (=€17m) compared to the financial NPV. The economic IRR is higher than 10%.

5.4 Conclusions and Recommendations resulting from the Financial and Economic Analysis

The financial rates of return of the project depend on the Government's tariff policy. The present average tariff of 2.85 does not cover the average cost of generation of the new 24 MW powerhouse. As long as the tariff is lower than STELCO's cost of production per incremental kWh, an expansion in production (capacity) such as will occur from the project increases STELCO's financial deficit, making Government equity inputs necessary in future years.

Under the modest assumption of a tariff increase to 4 MVR/kWh, the *financial IRR of the project's cash flows for STELCO is about 2%;* the financial NPV discounted at 6%, is, therefore negative. But one should note that since the IRR and NPV calculations are applied to the net financial cash-flows of NPV, the financial situation of STELCO is improved by the project!

The *economic IRR is higher than 10% and the economic NPV is positive*.

The i*nvestment in IFO-treatment facility* and the proposed 87% annual operation on IFO brings huge financial benefit: the NPV of the €1.7 m investment is around €28.8 m.

The Team **strongly recommends to the Government of the Maldives:**

- to implement a stepwise annual increase in STELCO's average tariff to at least 4 MVR/kWh within the next two years;
- to ask MoFT to order STO to provide information to the national competition authority and to STELCO about the cost of STO's storage and handling of IFO as a function of the annual volume which STELCO purchases

6 COMPLIANCE WITH DANIDA CRITERIA

6.1 Analysis of work environment and compliance with national labor laws

6.1.1 Working Environment

A thermal power station contains a variety of zones having different working environment in terms of noise, fire hazards, oils, chemicals, electric hazards and risk of falling objects. The risks need to be dealt with separately for each zone.

For the existing power station offices are located in a building adjacent building and do not present particular risks. The central control room is placed in the powerhouse building but is well screened off from noise and does not present particular hazards. The remote control for the new production units will be located in the central control room.

The engine hall and tank farm areas present the highest risks and theses risks can only partly be mitigated. In terms of noise, the use of personal audible protection devices is mandatory given that engines and other machineries cannot be screened-off as access is needed for checks during operation. The noise level close to the engines can be more than 100 dB(A). Handling oils and chemicals presents risks and the staff must wear suitable clothes, gloves, eye protection, respiratory protection, etc. depending on the specific situation. Because of the risk of falling objects in these areas, protection helmets and reinforced shoes must be used at all times. All this measures are already established STELCO practice.

The plant is kept very clean and protective head gear is used by workers when being in the engine room.

STELCO has no labour union. But salary levels are above the average for public sector employees.

The team recommends to STELCO to adjust the number of operational staff in generation to the more labor intensive operation of IFO180 and to introduce incentive payments for their overtime work.

6.2 Assessment of Assumptions and Risk Analysis

6.2.1 Lessons learned from the two failed tenders

The tender in 2005 for 2x8 MW diesel generator units (DGUs) with an optional third resulted in bids of €25.5 million (net of import duties and local taxes), which was €10.9 m (74%) above the

US$18.3 m (€14.6 m) cost estimate made by STELCO's consultant in the November 2004 Power Extension Study. It most certainly triggered the decision by the Government to call off the tender for reasons of procedure. The price of €1.5 million per installed MW is extremely high by international standards. As the price of diesel engines ex manufacturer has gone up since 2005 on the international market, and the scope of the project in the second tender was expanded to include the rehabilitation of engine hall structures for the existing DGU 5 (no cost estimates done by engineers), the bid-cost per MW would have been even higher in the second tender. In addition, the expansion of the capacity by 8 MW to 2 x 12 MW would have added a further €7 million or so to the cost of the project.

The high cost per MW witnessed in the first tender is caused by the following factors:

- High costs of civil works in Malé
- High costs of imports and logistics to get equipment and material onshore
- Very difficult project site.[20]
- Choice of high cost specifications and solutions for the power plant in the tender document
- NOx reduction system
- A less than optimal distribution of project risks: too many risks and uncertainties are shifted onto the contractor.[21]
- Competition between two suppliers only

In view of the serious power capacity constrains in Malé, it is essential that the third tender leads to a successful conclusion. Therefore, a conservative - but nevertheless realistic – estimate of costs has been made in this report. In addition the tender document will be reviewed carefully to review the potential for more optimal and cost-effective risk sharing. Shifting risks onto a contractor is justified economically whenever the contractor has the comparative advantage in estimating and managing the risk; shifting other risks onto a contractor gives too little value for money.

6.2.2 Splitting of the project into two separately financed packages

The scarcity of Mixed Credit funding enforces the split of the project into two components. Ideally, the two components would be tendered as one project with is financed from two different sources. Unfortunately, this approach risks to be seen as not complying with OECD rules against "contract splitting". Therefore, two separate tenders must be held. There is, therefore, a possibility that two different bidders win the two tenders. If that situation were to happen, it would give raise to two problems: one of coordination of work at the site, the other of installing two 8 MW generators of one make and one 8 MW generator of another manufacturer. For specialised equipment such as the IFO-treatment equipment, the splitting of the contract poses no problem.

Since no lender has been found yet for the package not funded by the Mixed Credit, there is a risk that part of the complementary investment is postponed; other parts may be left out completely.

[20] Getting on the work done on STELCO's plant area with minimum interruption of existing plant operation is a great challenge, space for the constructors deposit area is not identified yet

[21] The two shortlisted contractors had drawn attention to the latter aspect in their comments to the tender material for the second tender.

The consequences of postponement depend on the object:

- Not ordering and installing the *1x8MW DGU* at the same time as the other two DGUs would increase the cost of its later installation, force STELCO to keep the four 1 MW "container DGUs" at the Malé plant as reserve units, reduce the security of supply at the plant and depending on how long the installation is delayed, lead to some load shedding during peak hours.
- Not installing the *SCADA* and other instruments would likely lead to some increase in the cost of operation due to less than optimal plant operation
- Not undertaking the strengthening the *foundations of the existing powerhouse* risks may cause a failure of the basement structure for one of the DGUs with associated medium term disruption of generation from that generator, higher costs of increased construction and repair work.
- Not implementing the *noise attenuation measures* at the existing plant would affect the local population and lead to a reaction from MEEW in terms of an administrative order.
- Not installing the *second 800 m^3 IFO-tank* reduces the "operating autonomy" provided by the storage tanks at the plant. 16 MW DGUs operating at a load factor of 0.7 consume 62 m3 of IFO per day, meaning that they empty the 800 m^3 tank within 12 days, whereas 24 MW by consuming 93 m^3 per day empty the tank within 8 days. Thus, not installing the tank means that STELCO needs to get new supply by barge from STO' storage tanks every 12th (8th) day instead of every 24th (16th) day.

The listed risks are deemed to be acceptable.

6.3 Justification for Danida Support

The provision of good quality power supply to Malé supports the creation of employment and economic growth and satisfies what is deemed to be a "basic consumption need" by the population of the Maldives: having high quality power supply on the tourist resorts and low quality power supply on the "capital island" is not politically and socially acceptable.

There is an urgent need for new power capacity and no alternative source of finance is available within the short-term horizon. The Project matches the Maldives' development priorities and relevant expertise for project implementation is available in Denmark. General project after sales service is available in the Maldives, specialists are found in the region.

STELCO is a capable organisation with proven skills in managing investment projects and the later operation of new plant.

The Project is under present tariff terms not commercially viable. STELCO is financially sustainable only once tariffs have been adjusted to full-cost-coverage levels. The Government is in principle ready for that, but prefers a gradual annual increase in tariffs towards full-cost coverage level.

6.4 Project Monitoring Indicators

The most important indicator for **output** is the installed and operational power capacity in MW at the plant before and after the installation of the equipment. It is to increase from 29 MW to 53 MW.

The most important indicators for the **outcome** are:

- number of staff being trained and person-days of training
- installed MW of generating capacity
- annual supply of energy to the distribution net (MWh) from 2009;
- available hours (availability factor).
- percentage of annual operation on IFO and annual cost savings compared to 100% DDO-fuel use
- the statistics for load shedding at the plant during 2007/08 (before operation of the plant) and from 2009 to 2013

The loan agreement for the Mixed Credit will impose on STELCO the obligation to report once per year during the five consecutive years from commissioning on the results achieved with regard to the outcome indicators.

In addition, information on these issues can be found in the annual report by STELCO.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Justification and Scope of Project

STELCO is a well-managed company with a good record in plant operation and demonstrated strength in the preparation and implementation of power projects. But due to the Government's tariff policy, STELCO is financially weak and therefore unable to secure commercial loans, making the implementation of its investments dependent on access to concessional loans. A more rational, modern power sector structure is slowly emerging: a power regulatory authority is being build up and the need to allow IPP-investments to enter the market in the post-2012 period will force the authorities to implement a more satisfactory tariff and regulatory regime. But in the short to medium term only gradual, stepwise increases in the power tariff are expected."

The strong economic growth in the Maldives, which fuels the demand for power, shows no signs of abatement. The project satisfies an objective need for more power capacity on the country's main island, which was identified in a professional manner in STELCO's power expansions plan. The Government's project appraisal process in the Maldives is comprehensive and confirmed the national priority of the project. Complementary actions to reduce the growth in power demand by energy saving campaigns are already being implemented.

The implementation of the full-scope project safeguards Malé's power supply for at least up to the year 2013 and enables STELCO (and its consumers) to benefit from the financial savings through the use of lower cost IFO. Future expansion in power capacity will have to come from power plants located on small artificial islands located outside Malé.

The economic IRR of the project is substantially higher than 10%, while the financial IRR is around 2%. The financial NPV of the €1.7 m IFO-handling investment is €28.8m.

In a sensitive environment like Malé any industrial operation poses an added environmental burden. But the foreseen investments in environmental safeguards (de-NOx and noise attenuation), as well as operational recommendations make problems associated with the environment manageable.

The financial cost of the total investment is estimated at €44.4 m composed of a turn-key contract of €33.5 m, €3.2 m for contingencies, €6.9 m for custom duties and local taxes and €0.8m for the supervising engineer. Due to financial limits on the size of the Danida Mixed Credit, the investment is divided into two separately financed packages, one financed by the Mixed Credit, the other by MoFT as owner of STELCO. Danida's mixed credit of €24.7 million is composed of a 10-year loan of around €19 million given by a Danish Commercial Bank to MoFT at a zero rate of interest and of an up-front grant of approximately €5.7 million.

The commercial contract with the winning bidder will become effective upon approval of the loan agreement between Ministry of Finance and a Danish lending bank. It is expected that 14-18 months will pass from that date and until plant commissioning.

7.2 Specific Recommendations and Conditions

7.2.1 Recommendations to Danida

The team **recommends:**

- To present the €24.7 m project to Danida's Committee for Mixed Credits for its approval in January 2007;
- that STELCO appoints a *Project Formulation Team* for the preparation of the Tender and a *Project Implementation Unit* for the implementation of the project until commissioning;
- that STELCO and its engineer modify the tender documents prepared for the re-tendering called off in April 2006 in order for it to conform the Danish Mixed Credits guidelines. (Annex VI to the present report present a not exhaustive list of areas to be modified), and *that Danida finances the fielding of an engineer* to assist STELCO in the required formal adjustment of the Tender Document
- That STELCO accepts the financing by Danida of an assessment of the present and future noise level next to the power plant. The assessment shall include a description of the neighbouring areas next to the power plant. The assessment will include a mapping of the future noise level (measurements and/or modelling according to an international accepted model). Finally, the assessment shall include a cost estimate of reducing the noise level from the estimated resulting level of 58dB(A) in selected reference points next to the power station. Any relevant recommendations are to be approved by Danida and reflected in the specifications of the Tender documents.
- It be a *condition for Danida* loan approval that STELCO prior to the finalisation of the Tender documents prepares a *capacity building plan* for inclusion in the tender documents that specifies who is to be trained, in what and how, with indicative mandays for the training and a plan for the monitoring of the outcome of the training; verification of the training in terms of person days and capacity building is to be done at plant commissioning.
- that STELCO accepts the financing by Danida of an assessment of the future air pollution aspects from the existing and new power production plant based on operational information, relevant physical and topographical properties and calculation PM, SO2 and NOX in Male city area and surroundings. Application of an international air pollution model is recommended. The assessment should include a discussion of the operational aspects of switching between high sulphur fuel and DDO taking into account the dominant wind directions as input to the further discussions between STELCO and MEEW. The assessment should include the operational aspects of possible reduction of NOX from the flue gases including training, reagent supply, waste generation and the outcome of the abovementioned calculation of NOX in Male city etc.
- That the proposed immission measurement station not be included in the tender material for the investment package to be financed by the Mixed Credit, as the station is unlikely to provide sufficient "value for money".

7.2.2 Recommendations to STELCO

Project Organisation

For the implementation of the project, the Team recommends – as already foreseen by STELCO - a traditional project organisation for the project where:

- STELCO appoints a *Project Formulation Team* for the preparation of the Tender and a *Project Implementation Unit* for the implementation of the project until commissioning;
- STELCO as Employer engages an experienced engineering company as Engineer to undertake the preparation of tender documents, the entire tender procedure as well as the supervision of works, the words Employer, Engineer and Contractor used in the sense of FIDIC, Plant and Design-Build and with roles and responsibilities as stipulated herein;
- the Engineer supervises the works both under Danish and under Maldivian financing;
- the intervention by the Engineer is estimated by the Team at 35 man months throughout the construction period and until the issuance of a clean performance certificate at the expiry of the defects notification period;
- the Contractor being a Danish company gets his payments directly from the Danish bnk upon instruction from the Employer through the Engineer (given that the financing is to be made available as per an agreement to be entered into between the government of the Maldives and a Danish commercial bank and that a local bank will not be required).

Concerning the **form of the tender** the team recommends**:**

- As a limited number of bidders is expected to float an open tender in Denmark – provided that the national rules for public tenders allow it - and to post-qualify the bidders, instead of using time on pre-qualification.

Human Resource Development

The team *recommends* that:

- the following training modules be included in the tender documents: (i) training of operators, (ii) training in programmed light maintenance, (iii) training in overhaul works and repair, (iv) training in the use of the monitoring station for gaseous imissions if STELCO decides to undertake the investment;

Technical solutions

Generating Technology

The Team *recommends that the tender documents***:**

- in order to provide the plant with flexibility regarding future supplies of fuel oil specify: (i) that the diesel engines shall be able to operate on HFO up to 700 cSt, (ii) that the fuel treatment equipment shall be able to condition at least IFO 180, (iii) that the treatment plant shall be able to condition fuel of up to 360 cSt;
- define the plant comprising prime mover (diesel engine), alternator and dependant and independent auxiliaries according to ISO 3046 (for the engine) and ISO 8528 for the generating plant.

Scada system

The *Team recommends that the tender documents* grant free choice of SCADA supplier to the tenderers, given that the inclusion of the new production plant in the SCADA system will necessitate replacement of essential parts of the existing system.

Environmental safeguards

Noise reduction

The team *recommends for the preparation of the specifications in the Tender Documents*:

- The new power house be orientated such that the stacks are to the South, the advantage being that the powerhouse itself screens towards North the noise direction of which is the major concern.
- For plant located high such as boilers and combustion air intake it may be required to screen towards West in order to limit emissions in direction of the residential building in that direction.

De-NOx

The Team *recommends to STELCO* that:

- prior to finalising the tender documents STELCO examines whether in order to minimize SO_3/aerosols a *low-oxidation catalyst with low vanadium contents* is to be preferred;
- STELCO studies whether the exhaust gasses should by-pass the catalyst during the operation periods where De-NO_x would not be required, i.e. 85% of the year.
- the EIA be completed with calculations of NO_x for 45 m stack height.

SO_2

As a cost-effective and environmentally justifiable way to comply with MEEW's air quality objectives, the *Team recommends to MEEW* to impose the following operating conditions on STELCO:

- a max. 2% SO_2-content on the use of IFO-fuels,
- DDO-only operation when fumes blow towards Malé,

Cooling water

The Team recommends that the tender documents as already foreseen by STELCO and by MEEW**:**

- prescribe a Δt of 11 ^{o}C for cooling water;
- fix limit values for the content of chloride in the outfall water

Soot emissions

The team recommends:

- that STELCO, before prescribing the use of soot filters for the new engines, clarifies and discusses with MEEW before whether the public's complaints about soot stem from the visual impact of the heavy smoke at start-up or whether this is related to the practice of stopping/starting the engines on IFO instead of DDO.

Treatment of Oily Water and Waste Oil

For the new plant the *team recommends in the tender documents* to specify a system whereby:

- Water that potentially could be polluted (from tank farm retention perimeters, paved outdoor areas, transformer cells, etc.) is led to gravity oil/water separators. Attention is drawn to the fact that high-efficiency gravity separators exist with a much better performance than traditional concrete gravity separators and should be prescribed in the tender documents.
- Water that is polluted (from turbo charger washing, separators, engine part washing areas, workshop, engine hall, etc.) shall be treated in a plant that ensures max. content of Hydrocarbons of 10 ppm. before discharged into nature.
- Waste oil from the engines shall be collected in drums for transport to incineration plant or in a tank for later transfer to drums for incineration.

Fire hazards

The location of the new powerhouse close to the tank farm gives raise to some concern. The Team recommends:

- that STELCO with its consultant verifies the separation and constructional details be verified in respect of fire prevention regulations and insurance matters.;
- that STELCO verifies that the new plant can be insured against fire before the Tender Document is finalized.

Monitoring and measurement station placed on top of STELCO building

The team recommends to STELCO and MEEW before finalisation of the Tender documents to reflect once more on the cost-benefit effectiveness of investing in the proposed measuring station compared to the alternative control mechanism of a agreed dispersion models and measurement of NOx, SPM and SO_2-emissions directly at the top of the chimneys.

7.2.3 General recommendations to MoFT

The Team **strongly recommends to MoFT**

- to implement a stepwise annual increase in STELCO's average tariff to at least 4 MVR/kWh within the next two years;
- to order STO to provide information to MoFT, the national competition authority and STELCO about the cost of STO's storage and handling of IFO-180 as a function of the annual volume which STELCO purchases

ANNEXES

Annex I: List of Persons met

Ministry of Finance and Treasury
Mr. Riluwan Shareef, Deputy Minister

Ministry of Foreign Affairs, Department of External Resources
Dr. Hussain Niyaaz, Executive Director
Mr. Ali Naseer Mohamed, Assistant Director General
Ms. Aishath Azeema, Deputy Director
Mr. Mohamed Inaz, Desk Officer

Ministry of Planning and National Development
Mr. Ahmed Mohamed, Executive Director
Mr. Mohamed Imad, Director, Spatial Planning

Ministry of Environment, Energy and Water
Environmental Research Centre
Mr. Ahmed Saleem, Deputy Director
Maldives Energy Authority
Mr. Abdulla Wahid, Deputy Director General
Energy Department
Mr. Ajwad Musthafa; Assistant Director

STELCO
Mr. Abdul Shakoor, Managing Director
Mr. Mohamed Rasheed, Deputy Managing Director
Mr. Mohamed Latheef, Director
Mr. Aboobakuru Mohamed, Deputy Director
Ms. Aishath Reesha Zubair, Assistant Director
Mr. Ahmeed Shafeeu, Senior Engineer
Mr. Ibrahim Athif, Senior Engineer
Mr. Abdulla Mushrif, Electronics Engineer
Mr. Ahmed Iqbal, Engineer

State Trading Organisation, STO
Mr. Adam Saleem, Assistant Managing Director
Mr. Ismail Ali Jaleel

Consultants
Mr. Levent Özen, Chairman, OLP-Özen Leithoff Power AG

Annex II: Country Development Indicators

Maldives Data Profile			
Click on the indicator to view a definition	**2000**	**2004**	**2005**
People			
Population, total	290.2 thousand	321.2 thousand	329.2 thousand
Population growth (annual %)	2.7	2.5	2.5
Life expectancy at birth, total (years)	65.4	67.2	..
Fertility rate, total (births per woman)	4.7	4.1	..
Mortality rate, infant (per 1,000 live births)	45.0	35.4	..
Mortality rate, under-5 (per 1,000)	60.0	45.6	..
Births attended by skilled health staff (% of total)	..	..	..
Malnutrition prevalence, weight for age (% of children under 5)	..	..	..
Immunization, measles (% of children ages 12-23 months)	99.0	97.0	..
Primary completion rate, total (% of relevant age group)	..	99.7	..
School enrollment, primary (% gross)	127.3	103.5	..
School enrollment, secondary (% gross)	55.6	72.8	..
School enrollment, tertiary (% gross)	..	0.2	..
Ratio of girls to boys in primary and secondary education (%)	101.3	101.8	..
Literacy rate, adult total (% of people ages 15 and above)	..	96.3	..
Environment			
Surface area (sq. km)	300.0	300.0	300.0
Forest area (sq. km)	10.0	..	10.0
Agricultural land (% of land area)	33.3	..	..
CO2 emissions (metric tons per capita)	1.7	..	..
Improved water source (% of population with access)	..	83.0	..
Improved sanitation facilities, urban (% of urban population with access)	..	100.0	..
Economy			
GNI, Atlas method (current US$)	584.1 million	771.1 million	787.4 million
GNI per capita, Atlas method (current US$)	2,010.0	2,400.0	2,390.0
GDP (current US$)	624.3 million	799.6 million	817.0 million
GDP growth (annual %)	4.4	8.8	-3.6
Inflation, GDP deflator (annual %)	1.5	6.4	6.0
Exports of goods and services (% of GDP)	89.5	89.3	..
Imports of goods and services (% of GDP)	71.6	78.4	..
Gross capital formation (% of GDP)	26.3	34.0	..
Revenue, excluding grants (% of GDP)	34.5	33.7	40.8
Cash surplus/deficit (% of GDP)	-5.0	-3.5	-5.1
States and markets			

Time required to start a business (days)	..	12.0	12.0
Fixed line and mobile phone subscribers (per 1,000 people)	110.5	450.7	..
Internet users (per 1,000 people)	20.7	59.2	..
High-technology exports (% of manufactured exports)	..	1.1	..
Global links			
Merchandise trade (% of GDP)	79.7	102.9	110.5
Foreign direct investment, net inflows (BoP, current US$)	13.0 million	14.7 million	..
Long-term debt (DOD, current US$)	184.7 million	304.4 million	..
Present value of debt (% of GNI)	..	41.6	..
Total debt service (% of exports of goods, services and income)	4.2	4.6	..
Official development assistance and official aid (current US$)	19.3 million	27.9 million	..
Workers' remittances and compensation of employees, received (US$)	2.0 million	3.0 million	..
Source: *World Development Indicators database*, April 2006			

Millennium Development Goals

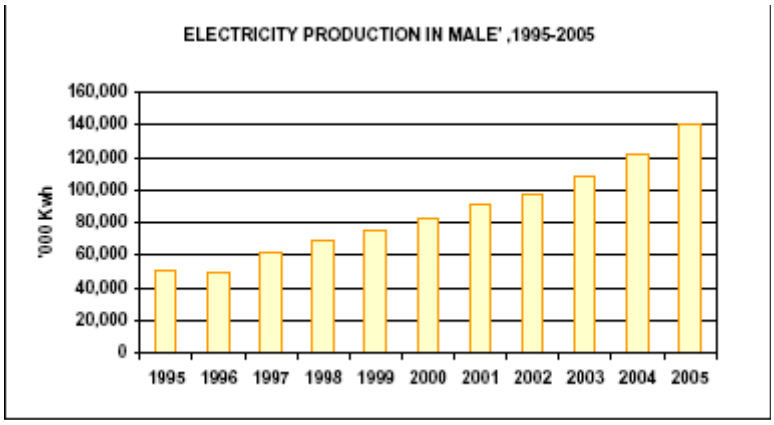
	1990	1995	1998	2001	2004
Goal 1: Eradicate extreme poverty and hunger					
Income share held by lowest 20%	..	..	..	..	..
Malnutrition prevalence, weight for age (% of children under 5)	..	43	45	30	..
Poverty gap at $1 a day (PPP) (%)	..	..	..	..	..
Poverty headcount ratio at $1 a day (PPP) (% of population)	..	..	..	..	..
Poverty headcount ratio at national poverty line (% of population)	..	..	..	..	..
Prevalence of undernourishment (% of population)	..	..	15	..	11
Goal 2: Achieve universal primary education					
Literacy rate, youth total (% of people ages 15-24)	98	..	..	..	98
Persistence to grade 5, total (% of cohort)	..	..	..	..	..
Primary completion rate, total (% of relevant age group)	..	..	159.1	..	99.7
School enrollment, primary (% net)	..	..	98	93	..
Goal 3: Promote gender equality and empower women					
Proportion of seats held by women in national parliament (%)	6.0	..	6.0	6.0	6.0
Ratio of girls to boys in primary and secondary education (%)	..	..	101.0	101.1	101.8
Ratio of young literate females to males (% ages 15-24)	100.0	..	..	..	100.3
Share of women employed in the nonagricultural sector (% of total nonagricultural employment)	31	32	34	35	36
Goal 4: Reduce child mortality					
Immunization, measles (% of children ages 12-23 months)	96.0	96.0	98.0	99.0	97.0
Mortality rate, infant (per 1,000 live births)	79	63	..	45	35
Mortality rate, under-5 (per 1,000)	111	86	..	60	46
Goal 5: Improve maternal health					
Births attended by skilled health staff (% of total)	..	90.0	..	70.3	..
Maternal mortality ratio (modeled estimate, per 100,000 live births)	..	..	..	110.0	..
Goal 6: Combat HIV/AIDS, malaria, and other diseases					
Children orphaned by HIV/AIDS	..	..	..	..	..
Contraceptive prevalence (% of women ages 15-49)	..	..	32	..	39
Incidence of tuberculosis (per 100,000 people)	147.7	..	..	..	48.8
Prevalence of HIV, female (% ages 15-24)	..	..	..	..	..
Prevalence of HIV, total (% of population ages 15-49)	..	..	..	..	..
Tuberculosis cases detected under DOTS (%)	..	101.2	90.7	71.1	93.5
Goal 7: Ensure environmental sustainability					
CO2 emissions (metric tons per capita)	0.7	1.1	1.2	3.1	..
Forest area (% of land area)	3	..	..	3	3
GDP per unit of energy use (constant 2000 PPP $ per kg of oil equivalent)	..	..	..	..	..
Improved sanitation facilities (% of population with access)	..	..	..	..	59
Improved water source (% of population with access)	96	..	..	..	83
Nationally protected areas (% of total land area)	..	..	..	..	..
Goal 8: Develop a global partnership for development					
Aid per capita (current US$)	98.2	230.1	91.0	83.7	87.0
Debt service (PPG and IMF only, % of exports of G&S, excl. workers' remittances)	4	3	4	4	5
Fixed line and mobile phone subscribers (per 1,000 people)	28.9	55.1	78.6	154.9	450.7
Internet users (per 1,000 people)	0.0	0.0	5.5	33.6	59.2
Personal computers (per 1,000 people)	..	11.9	21.8	50.3	112.1
Total debt service (% of exports of goods, services and income)	5	3	4	5	5
Unemployment, youth female (% of female labor force ages 15-24)	..	3.0	..	5.1	..
Unemployment, youth male (% of male labor force ages 15-24)	..	1.4	..	4.0	..
Unemployment, youth total (% of total labor force ages 15-24)	..	1.9	..	4.4	..
Other					
Fertility rate, total (births per woman)	6.3	5.6	5.2	4.3	4.1
GNI per capita, Atlas method (current US$)	..	..	1850.0	1990.0	2400.0
GNI, Atlas method (current US$) (billions)	..	..	0.5	0.6	0.8
Gross capital formation (% of GDP)	..	31.3	30.1	28.1	34.0
Life expectancy at birth, total (years)	60.5	62.8	63.9	66.3	67.2
Literacy rate, adult total (% of people ages 15 and above)	94.8	..	..	..	96.3
Population, total (millions)	0.2	0.3	0.3	0.3	0.3
Trade (% of GDP)	88.5	169.9	168.2	156.8	167.7

Source: World Development Indicators database, September 2006

ELECTRICITY

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Electricity Utilization in Male' (in ' 000 Kwh	20,253	44,182	46,970	52,069	59,332	64,674	73,684	82,146	86,751	96,584	108,774	125,344
Electricity production by locality (in ' 000 Kwh)												
Total	29,515	63,271	64,124	80,672	92,704	103,775	116,513	130,321	140,849	156,683	176,977	204,133
Male'	23,965	50,514	49,021	61,253	68,630	75,677	82,688	90,645	97,480	108,190	121,395	140,065
International Airport	2,998	6,327	7,823	9,267	10,241	10,799	12,550	14,167	15,048	15,237	16,858	18,580
Other selected islands	2,552	6,430	7,280	10,152	13,833	17,299	21,275	25,509	28,321	33,256	38,724	45,488

Source: Statistical Yearbook of Maldives 2006



Annex III: Existing and proposed Tariff Structure for Malé Region

POWER HOUSE		Malé Region*			
		Existing Rates	Proposed Rate	Increment	Increased %
Domestic	Units≤ 100	1.60	3.65	2.05	128%
	Units 101-200	1.70	3.75	2.05	121%
	Units 201-300	2.15	3.85	1.70	79%
	Units ≥ 301	2.20	4.00	1.80	82%
Business	Units≤ 100	3.15	4.15	1.00	32%
	Units 101-200	3.25	4.20	0.95	29%
	Units 201-300	3.65	4.30	0.65	18%
	Units ≥ 301	3.75	4.55	0.80	21%
Business Special	Units≤ 100	3.15	4.50	1.35	43%
	Units 101-200	3.25	4.55	1.30	40%
	Unit 201-300	3.65	4.65	1.00	27%
	Units ≥ 301	3.75	4.75	1.00	27%
Government	Units≤ 100	2.15	4.50	2.35	109%
	Units 101-200	2.25	4.55	2.30	102%
	Units 201-300	2.65	4.65	2.00	75%
	Units ≥ 301	3.75	4.75	1.00	27%
Government Schools	Units≤ 100	2.15	4.50	2.35	109%
	Units 101-200	2.25	4.55	2.30	102%
	Units 201-300	2.65	4.65	2.00	75%
	Units ≥ 301	3.75	4.75	1.00	27%
Private Schools	Units≤ 100	2.15	3.50	1.35	63%
	Units 101-200	2.25	3.65	1.40	62%
	Units 201-300	2.65	3.75	1.10	42%
	Units ≥ 301	2.65	3.85	1.20	45%
Phonebooth	Units≤ 100	3.15	3.50	0.35	11%
	Units 101-200	3.25	3.65	0.40	12%
	Units 201-300	3.65	3.75	0.10	3%
	Units ≥ 301	3.75	3.85	0.10	3%
Street Lights	Units≤ 100	3.15	4.00	0.85	27%
	Units 101-200	3.25	4.25	1.00	31%
	Units 201-300	3.65	4.35	0.70	19%
	Units ≥ 301	3.75	4.45	0.70	19%

* Male region includes Male', Hulhumale', Villingili & Thilafushi.

Annex IV: MEEW Decision on EIA

بسم الله الرحمن الرحيم

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Ministry of Environment, Energy and Water

Decision Note

18 October 2006

Environmental Impact Assessment for the Proposed Fourth Power Development Project, Male', Maldives

After giving due consideration to the *Environmental Impact Assessment for the Proposed Fourth Power Development Project, Male', Maldives*, proposed by State Electric Company Ltd. (STELCO), for the purpose of increasing the electricity generation capacity for Male' and based on the evaluation of the above-specified report, we hereby give a CONDITIONAL APPROVAL to carry out the proposed activities with the understanding that;

- The Developer shall submit to the Ministry of Environment, Energy and Water, the required information which is contained in the ATTACHMENT 1 to this Decision Note within a period of 30 days from the date of this Decision Note.
- the developer shall only pursue the proposed activities as outlined in the Environment Impact Assessment (EIA) for fourth power development project, Male', these include
- it is the developer's responsibility to implement the environmental mitigation measures outlined in the ATTACHMENT 2 to this Decision Note. The Ministry reserves the right to impose any additional environmental management measures if found to be necessary;
- the developer shall submit environmental monitoring report outlined in the ATTACHMENT 3 to this Decision Note; and
- the developer is aware that under the National Environment Protection Act (Law no. 4/93) the Ministry reserves the right to terminate any activities without any compensation if found to have caused significant, irreversible impacts on the environment.

2nd Floor, Huravee Building
Ameer Ahmed Magu
Male', Republic of Maldives

Tel: 3324861
Fax: 3322286
E-mail: env@environment.gov.mv

ATTACHMENT 1 – MITIGATION MEASURES

The following information shall be submitted within 10 days from the date on this Decision Note.

- To what extent the input of fuel will be increased based on the increased demand for electricity requirement in the future;
- What added fuel requirements have been forecasted as a direct result of the proposed project? As well as how much waste oil is expected to be generated given the fuel requirements of the project?
- need firm commitment on measures to reduce SO_2 emissions as it has been predicted that it will be slightly higher than present levels as well as other mitigation measures such as air pollution abatement measures, noise abatement measures, and health and safety aspects as a result of the proposed project development;
- public perception expressed in a public consultation viewpoint with regards to the proposed project development, given the existing levels of emission, discharge, etc from STELCO; and
- development of a Contingency Plan in cases of emergency, pollution, fire, accidents, etc.

ATTACHMENT 1 – MITIGATION MEASURES

The following specific measures during construction and operation phase shall be strictly followed.

Air Pollution Abatement Measures

- Soot filters shall be used to lower impacts of particulate matter;
- De-No_x systems shall be installed to reduce NO_x emission when the wind blow the emission plume towards Male'; and
- when the wind blow the emission plume over Male' the system shall be switched to DO (Diesel Oil).

Noise Abatement Measures

- Noise attenuators and silencers shall be used to reduce noise levels emitted by the generators;
- existing attenuation walls shall be improved by using double panels filled with noise absorbing materials;
- noise level shall be monitored before and after installing the new generators;
- hearing protection gear shall be provided to staff working in the powerhouse; and
- increase awareness on the environmental and health effects of air pollution from the use of fuel.

Health and Safety

- Sulphur content of the fuel shall be reduced and maintained within limits at all times;
- coinciding the generator, use alternatively with others to reduce their use during the period when the wind blows the plume gases over Male';
- better engineering controls and filters shall be installed to reduce harmful gaseous before exhaust gases are dispersed through the chimney;
- the chimney height shall be increased to the maximum allowable limit in Male';
- regular monitoring of the immediate lagoon, ground and the groundwater around project site shall be conducted to check for any possible leaks of oil;
- improve fore drills and occupational safety of the staff; and
- existing oil spill contingency plan shall be strengthened;

Disposal of Waste Lube Oil

- Leaking oil from engines shall be collected and led into leak oil tanks; and
- this leak oil shall be collected together from lube oil separators and transported to Thilafushi.

ATTACHMENT 3 – ENVIRONMENTAL MONITORING

The environmental monitoring program outlined in (*page 8-4 – 88-8*) of the Environmental Impact Assessment Report shall be undertaken and implemented and summary environmental monitoring reports shall be submitted to the Environment Research Center once every two months.

Annex V: Tables from Financial and Economic Analysis

Assumptions

1. Annual Gross and Net Production

Installed capacity	24	MW
adjustment of installed capacity for derating effect:	7%	
Net capacity	22	MW

	2,009	2010	2011	2012	2013
New DGU capacity utilization	0.80	0.80	0.80	0.80	0.50
Annual full operating hours	7,012	7,012	7,012	7,012	4,383
Production, GWh	104	104	104	104	65
Annual increase in power demand	10%	9.5%	9.0%	8.5%	8.0%
Annual power demand at retail level	169	185	201	218	236
Required power generation	189	207	226	245	265
Potential output from present installed 29 MW capacity	142	142	142	142	
Net additional power generation due to extra 16 MW	48	66	32	51	
Power generation from new 8 MW			52	52	
Power generation from installed 29 MW capacity	85	103	70	89	

2. Costs

	DDO	IFO	
Annual operating hours by fuel consumption	17%	83%	
Fuel consumption	80% load	60% load	
- diesel fuel DDO	205	215	g/kWh
- IFO180	210	220	g/kWh
Cost of fuel per ton	DDO	IFO	
base price (fob) Singapore Platts	560	316	US$/ton
high price (fob) Singapore Platts	620	355	US$/ton
- transport to Malé	45	50	US$/ton
- STO costs of handling	0.9	1.3	MVR/litre
- base price	7.4	5.5	MVR/litre
- base price	8.8	6.1	MVR/kg
- high price	9.5	6.6	MVR/kg
Lube oil consumption	0.6	g/kWh	

Price of lube oil	€ per ton	MVR/kg		
- IFO-operation	3,200	50		
- DDO-operation	2,700	42		
- average	3,200	50		
Lifetime of diesel generator	100,000	operating hours		
Rehabilitation after 65000 hours of operation	25%	of initial cost of investment		
Annual maintenance & spare parts	3.0%	of original cost of investment		
Cost of de-Nox operation	0.010	€-/kWh		
De-nox operation in % of yearly operating hours	0.15%			
Other costs (manpower, etc)	0.15	MVR/kWh		
Distribution losses	11%			
Cost of retailing (marginal cost per expanded MWh-sales)	0.40	MVR/kWh		
	2007	2008		
Supervising consultant	0.4	0.4	€million	
	6	6	MVR	13

3. Benefits

Average retail tariff			
- present	2.85	MVR/kWh	
- future from day 1 of plant operation	4.00	MVR/kWh	
Net reduction in maintenance due to reduced DGU-use	0.5	€cents/kWh	
Reduction in fuel consumption due to reduced DGU-use	10	gr/kWh	
Avoided future purchase of power from IPPs	2.32	MVR/kWh	
Economic value of avoided loss shedding	8	MVR/kWh	

3. General economic and financial parameters

Exchange rates	MVR		
Euro	15.6		
US$	12.85		
Rate of inflation	2%		
Financial discount rate, real	6%		
Economic discount rate, real	6%		
Private investor	12%		
Conditions of Mixed credit loan and of additional-loan			
- maturity	10	years	
- on-lending rate of interest	8%		
- size of loan (Mixed Credit)	24.7	€million	385
- size of loan additional-loan	12.8	€million	200

Financial Impact on STELCO, “Repayment of Loans”, Base Case Fuel Price

YEAR	2009	2010	2011	2012	2013	2014	2015	2016	2017
Annual power generation, GWh	104	104	104	104	65	65	72	78	85
Expansion in annual generation of GWh	48	66	32	51	0	0	0	0	0
Expansion in annual power sales, GWh	42	58	29	46	58	58	64	70	75
Replaced generation at DGUs 1-6	57	39	72	53					
I. COSTS									
Cost of supervising consultant (accum.)	7								
Cost of operation: (m MVR)									
Diesel fuel	32	32	32	32	20	21	23	25	27
IFO180	111	111	111	111	69	73	80	87	94
Lubricants	3	3	3	3	2	2	2	2	3
Annual maintenance & spare parts	12	12	12	12	12	12	12	12	12
Overhaul									
Cost of de-Nox-operation	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Other costs (manpower, ect)	16	16	16	16	16	16	16	16	16
Payment of interest (m MVR)									
Interest on-lended Mixed Credit loan	31	27	23	20	17	14	11	8	5
Interest on-lended additional loan	0	0	0	0	0	0	0	0	0
Capital payments (m MVR):									
Repayment, on-lend Mixed Credit loan	39	37	36.3	35.5	34.8	34.1	33.5	32.8	32.1
Repayment, on-lend additional loan	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Costs of distribution excl. line losses	17	23	11	18	23				
Sub-total COSTS:	260	260	244	247	193	171	176	182	189
II. BENEFITS									
Power revenue from increased sales	170	234	115	183					
Fuel savings on replaced DGU1-6 ge.	5.0	3.4	6.3	4.6					
Fuel savings on switch to IFO	36	36	36	36	22	22	25	27	29
Reduced O&M from reduced DGU1-6	0.4	0.3	0.6	0.4					
Savings on purchased IPP power					142	142	156	171	185
Sub-total BENEFITS	211	273	157	224	165	165	181	197	214

NET FINANCIAL BENEFIT	-61	13	-87	-23	-29	-6	5	15	25
NPV of Financial Benefit, (m MVR)	-58	-3.7	(euro)						
IRR	2%								

Cumulative Cash-Flows OCED Set-up

Year	Capital Costs	O&M Costs	Foreign Loans	Domestic Loans	Interest Foreign Loans	Interest Domestic Finance	Repay Foreign Loans	Repay Domestic Loans	Interest o Cumulativ Deficit or Surplus
2007	6		193						0.
2008	6		193						0.
2009		173			31		39		
2010		173			27		39		
2011		173			23		39		
2012		173			20		39		
2013		118			17		39		
2014		123			14		39		
2015		132			11		39		
2016		142			8		39		
2017		151			5		39		
2018		248			3		39		
2019		104							
2020		104							
2021		104							
2022		104							
2023		104							
2024		104							
2025		104							
2026		104							
2027		104							
2028		104							

Financial Impact on STELCO, “Depreciation”, Base Case Fuel Price

YEAR	2009	2010	2011	2012	2013	2014	20
Annual power generation, GWh	104	104	104	104	65	65	
Expansion in annual generation of GWh	48	66	32	51	0	0	
Expansion in annual power sales, GWh	42	58	29	46	58	58	
Replaced generation at DGUs 1-6	57	39	72	53			
I. COSTS							
Supervising consultant	13						
Cost of operation: (m MVR)							
Diesel fuel	32	32	32	32	20	21	
IFO180	111	111	111	111	69	73	
Lubricants	3	3	3	3	2	2	
Annual maintenance & spare parts	12	12	12	12	12	12	
Overhaul							
Cost of de-Nox-operation	0.02	0.02	0.02	0.02	0.02	0.02	0.
Other costs (manpower, ect)	16	16	16	16	16	16	
Payment of interest (m MVR)							
Interest on-lended Mixed Credit loan	31	27	23	20	17	14	
Interest on-lended additional loan	0	0	0	0	0	0	
Depreciation	19	19	19	19	19	19	
Costs of distribution excluding line losses	17	23	11	18	23		
Sub-total COSTS:	240	243	227	231	178	156	1
II. BENEFITS							
Power revenue from increased sales	170	234	115	183			
Fuel savings on replaced DGU-generation	5.0	3.4	6.3	4.6			
Fuel savings on switch to IFO	36	36	36	36	22	22	
Reduced O&M from reduced DGU1-6	0.4	0.3	0.6	0.4			
Savings on purchased IPP power					142	142	1
Sub-total BENEFITS	211	273	157	224	165	165	1
NET FINANCIAL BENEFIT	-42	31	-70	-7	-13	9	
NPV of Financial Benefit	-22	-1.4	(euro)				
IRR	2%						

Annex VI: Comments to Preliminary Tender Documents

During the team's stay in Malé it was presented with the tender document elaborated for the re-bidding in early 2006 based on 2 x 12 MW generating capacity. The document was of more than 950 pages and was subject to debate with STELCO and its consultant, OLP, during the visit.

The document was looked through, as it might be one explanation of the high tender prices experienced in the August 2005 tender round.

Preliminary commenting was supplied to STELCO in respect of compliance with the envisaged contract form, FIDIC Plant and design – Build as well as with the General Rules and guidelines for Procurement under Danish Mixed Credits. A copy of essential standard documents was mailed to STELCO and OLP during the visit and reference was made to the Secretariat for Mixed Credits' Internet site where additional information regarding mixed credits and procedures can be consulted.

Detailed commenting on the tender documents beyond what was already done is found to be outside the scope of the appraisal mission, however given that STELCO might instruct its consultant to review the documents, some guidance is presented below. It is emphasized that the below comments and examples are intended for guidance and cannot be taken as a comprehensive commenting on the entire document, nor as an instruction to alter the document.

Instructions to Tenderers
The above-mentioned general rules and guidelines comprise a model for Instructions to Tenderers, that should be consulted.

One of the more important differences is the absence of explicit criteria fro evaluating the bids. It is suggested to take inspiration from the guidelines and to present to the Tenderers the precise evaluation of technical and financial bids. This should include in detail how different generating set sizes and different fuel and lube oil consumption will be evaluated.

Preamble, General and Particular Conditions of Contract
Generally it is recommended to remove from Particular Condition all text that is already covered by the General Clauses of Contract (FIDIC). This would lead to a document significantly "lighter" and user-friendlier than the present 37 pages.

Regarding the Preamble it could be considered whether Retention on invoicing should be applied since a performance bond is defined. The requirement for a third party insurance of 50 MUSD may also be revised.

The Particular Conditions of Contract comprise some clauses that would potentially impose on the bidders to include a risk premium in its bid:
This goes for the clause stipulating increased power given to the Engineer's decisions, that Unforeseen Physical Conditions will only be paid to the Contractor at 50 %, for the payment by the Contractor of Engineer's fee of 1.000 €/day for repeated submission of documentation and for repeated/late factory tests, for the restrictions to the normal Variation Procedures, for the contradicting indications of whether import duties are part of the contract price, limitation of

extensions to time for completion if amendments to scope is less than 20 % of contract value, Increase of delay damages by coverage of Engineer's fees and that the Engineer will be acting as DAB. Also the implication in administrative terms of guarantee for materials or work exceeding the contractual warranty period bring uncertainties.

The Particular Conditions of Contract further comprise clauses that potentially increase costs and that could be reconsidered:
Travel to factory test on business class inclusive of two representatives from the Engineer in addition to STELCO staff, posting of three persons from the Contractor for a total of 15 manmonths during the warranty period, the requirement for an all-risk insurance of 110 % during the construction supplemented by a particular insurance for design of civil works, the stipulation that the before-mentioned all-risk 110 % insurance shall cover during the warranty period for all act, defaults, negligence and/or omission by Contractor/sub-contractors, Employer and third parties,

The administrative clauses shall include particular provision contained in the guidelines such as Right of Stoppage and Verification Requirements.

Technical Chapters
Generally it is recommended to review the technical chapters in order to ascertain that they are compatible with the latitude normally given to contractors in a Plant and Design-Build contract type. Contractors for this kind of work generally have internal construction standards and deviations from those could result in increased costs. Clauses that prohibit bidder's standard solutions may lead to unnecessary high costs.

It should also be ascertained that the tender documents promote the broadest possible competition, while assuring the critical performance or other requirements for the goods and/or works under procurement. As far as possible, the Buyer shall specify internationally accepted standards with which the equipment or materials or workmanship shall comply.

Clauses where standards are to be approved by the Employer/Engineer after tendering might create uncertainty as the Tenderer would not whether the materials in the bidding phase will be acceptable or not, and could make it difficult to evaluate the bids. Clauses stipulating that when standards have different quality or precision levels the highest shall always be supplied may lead to unnecessary costs.

Clauses where resolving a technical problem is not specified but the risk is entirely left to the contractor induce risk premiums. This at least valid for noise attenuation of existing power station, seawater system inclusive of drilled wells, capacity of existing firewater system