ENVIRONMENTAL IMAPCT ASSESSMENT REPORT

FOR THE OPERATION OF

ELECTRICITY GENERATING FACILITY AND DIESELINATION PLANT AT ETHERE MADIVARU, NORTH ARI ATOLL

BANAYAN TREE MALDIVES, ETHERE MADIVARU, NORTH ARI ATOLL

Declaration of the Consultant

Declaration of the Consultant

I hereby certify that the statement made in this environmental impact study for the power generating and desalination plant at Ethere Madivaru island are true, complete and correct to the best of my knowledge and available information.

Hazim Rasheed

EIA Consultant (Registration Number: EIA 15/2009)

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List of Abbreviations

EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
MEA	Maldives Energy Authority
MHTE	Ministry of Housing, Transport and Environment
SWRO	Sea Water Reverse Osmosis
UNEP	United Nations Environment Programme
ToR	Terms of Reference
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
RO	Reverse Osmosis
dB	Decibels
kW	Kilowatt
KVA	Kilovolt ampere

NON-TECHNICAL SUMMARY

Ethere Madivaru is located in the North Ari Atoll and it is operated as a picnic island by the Banyan Tree Maldives. It consists of 4 rooms and other facilities required for the operation of the service.

This EIA is in accordance with the requirement of Environmental Protection Agency (EPA) and Maldives Energy Authority (MEA) guidelines that requires submitting an EIA in applying for registration to generate electricity and produce desalinated water.

The power generation and desalination in the island has been operating under the license for the operation of Picnic Island in Madivaru Island.

The island is equipped with all the necessary equipment, in particular a sewage treatment plant, a powerhouse, fuel tanks and desalination plants.

The peak demand of power is 90 kW, and the powerhouse is equipped with 2 x 200 kW generators. The fuel tanks are in a concrete bund, and supply is done via a pipe laid from the supply jetty.

The water necessary for the resort is produced through reverse osmosis plants and the peak demand is estimated at 400 m3/ day.

Eventually, during the operations, the main environmental concern is global with the increased emission of green house gases.

Since both of the facilities are in operational stage and are vital components of the island operations. Alternative to the project include the do-nothing scenario where the operation continues without registration which will ultimately lead to difficulties in upgrading of the facility.

1 INTRODUCTION

This report assesses the environmental impacts associated with the operation of powerhouse and desalination plant in AA. Ethere Madivaru Picnic Island. Also this report gives alternatives to reduce the impacts caused during operation of the facilities.

1.1 Project Background

The island was developed as a picnic island and necessary facilities were developed to provide the services to the person who comes to the island. Provision of reliable electricity and pure water was the first priority of the island developer. Since service required by the persons who visit to the island will not be fulfilled without these two basic services. Hence in the very beginning the power generation and desalination facilities were developed. The power generation facility includes generation, transmission and distribution equipments and desalination facility includes pumps and membrane systems.

Figure 1 Generating sets and desalination facilities uesd at the island

1.2 Purpose of the Report

This Environmental Impact Assessment (EIA) for the existing seawater reverse-osmosis (SWRO) facilities and powerhouse on AA. Ethere-Madivaru Island has been carried out at the request of the island management in order to fulfill the requirement of the Maldives Environmental Protection Agency (EPA) and Maldives Energy Authority (MEA). The primary objective of this report is to evaluate the potential environmental impacts due to operation of above mentioned facilities. The components include with facilities are the intake and discharge pipelines in the sea; transmission and distribution pipelines on land; the building and associated facilities to contain the SWRO units, the operational phase of the facilities, diesel generators, fuel storage and power distribution network.

1.3 Scope of the Environmental Assessment

According to the Environmental Protection and Preservation Act of Maldives (Act No. 4/93) Maldives and the new EIA regulation require conducting EIA in prior to the development of commercial facilities. And facilities which are developed prior to the establishment of EIA regulation should conduct EIA and should submit EIA report when they apply for the powerhouse and desalination operation registration. As such a scoping application was submitted to EPA to develop a ToR to conduct an EIA to see the impact of operating said two facilities at AA. Ethere Madivaru island. The ToR (a copy is attached at Appendix 3) was approved in consultation with representatives from Environmental Protection Agency (EPA), Ministry of Housing, Transport and Environment (MHTE), Maldives Energy Authority (MEA), Ministry of Tourism, representative from the proponent and EIA consultants. A copy of MEA guideline to register power generating facility is attached as Appendix 6.

2 PROJECT DESCRIPTION

2.1 (Sea Water Reverse Osmosis) SWRO

In order to provide safe water to the staff and guests of the island, the management has installed 30ton/d SWRO facility. This plant consists of double stage RO Aqua Reef brand plant manufactured by Static company private limited, Maldives. This plant is a fully automated processor controlled system. Intake water for the plant is sea water which is taken from the lagoon and discharge from the plant is also goes to the lagoon. Both the intake and discharge is through pipeline buried under the ground on the land and goes under the jetty to the lagoon. The SWRO plant and its components used at the island is shown in the figure 2

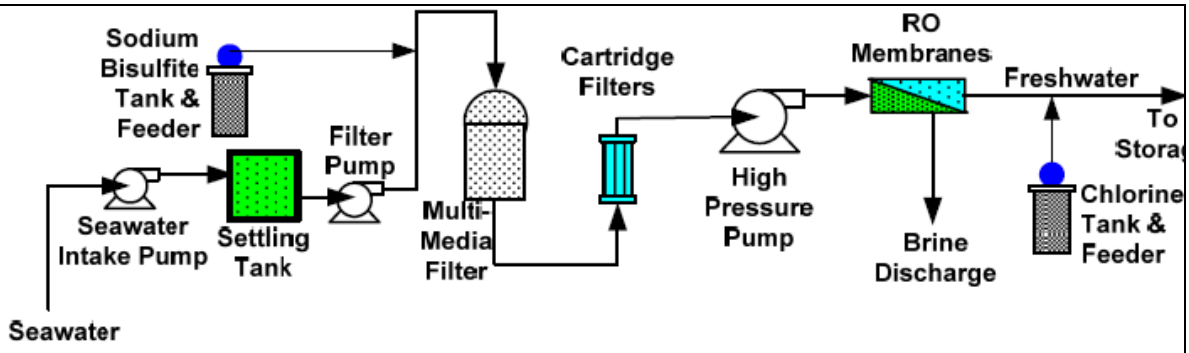

Figure 2 Major components of the sea water reverse osmosis unit

2.2 POWERHOUSE

Electricity required for the operation of the island is met by operating diesel generators. Two diesel generators of 200kW and one diesel generator of 80kW are operated at the island. Power generated by the diesel generators are distributed through low voltage underground cable. Bulk fuel storage of 15000 litres and two day tank of 500 litres of each with supply and return piping between the fuel tanks and the generating sets are installed. A metering, control and protection panel for the generating sets and distribution feeders are also installed at the island.

Underground distribution system with necessary cable, distribution substations, distribution feeder boxes and service cables are installed to cater the demand.

The noise level at different direction of powerhouse were measured and it was found that noise level is less than the required level of 85 dB (A) at 15 meters in any direction from the powerhouse.

Six meter of vegetation is found around the powerhouse which help to minimize sound level and act as a carbon sink.

In order to reduce the oil spillage an inlet pipe to the bulk storage tank is laid up to the shore from were fuel is supplied to it beside from this all the staff from powerhouse are given proper training to handle fuel. Table 1 shows specifications of the existing diesel generators.

Table 1 Specification of the existing diesel generating sets

Prime output (KVA)	200KVA
Guaranteed Fuel Consumption (l/Hr)	
Full Load	48.7 Liters/Hour
75% Full Load	36 Liters/Hour
50% Full Load	24.4 Liters/Hour
Type of Engine Governor	Electronic
Range of Governor Regulation	0.50%
Type of Engine to Alternator	Cummins 6CTAA8.3G3
Coupling	Stamford UC274K

2.3 Operational Activities

2.3.1 SWRO

Water scarcity is a serious impediment to economic growth, social development and human health. It furthermore may cause severe ecosystem damage if water abstraction rates exceed natural renewal rates. To cope with water scarcity, many communities around the world turn to non-typical source waters and treatment techniques, such as rainwater harvesting, water reuse or desalination of sea and brackish water. As desalination technology serves a broad spectrum of uses and applications, facilities differ in terms of production capacity, process design and energy supply. They range from small, standalone units with a water

production of less than 100 m3 per day to large industrial sized plants with an installed capacity of more than 1 million m3 per day. Where cheap fossil energy or waste heat is not available, RO is usually the preferred desalination technology due to its lower energy demand compared to thermal desalination processes.

Seawater is pumped into the facility, have some pretreatment in the settling tank and then, after further treatment passed through the reverse osmosis membranes. Both freshwater and brine is produced. The fresh water is pumped into the storage tanks and the brine returned to the sea.

Water pumped into the storage tanks is disinfected using a chlorine solution. The water is then be pumped into the distribution system where it can be collected from the water taps.

The pumps and electrical equipment used are properly serviced and cleaned at regular intervals

Special care is given to ensure that the reverse osmosis membranes are stored so that they are safeguarded from microbial and other deterioration.

Sources of Water

Water is one of the most valuable natural resources in small island states Like Maldives. The available sources of water on small islands are very limited and the management of Madivaru Resort recognizes the need for conservation of water. The only natural sources of water are groundwater and rainwater, which are both scarce resources in the Maldives. Tourist resorts have a high demand for water of superior physical, chemical, and microbiological quality. This can severely stress the water resources available and thus the main source of water supply will be met through the implementation of a desalination plant.

Ground water

The ground water will not be used for any purpose on the island. Contamination of ground water from sewage will not be a problem as sewage will not be allowed to soak into the soil and adequate sewage treatment and disposal facilities will be in place.

Desalinated Water

Desalinated water is piped to all the buildings in the resort. All the guest accommodations have desalinated water for all purposes.

Although using desalinated water reduces the demand for natural sources of water, a great deal of contemplation should be given to conserve desalinated water because the desalination process consumes energy.

In peak 400 m3 of desalinated water is consumed daily for the operation of the resort. The plants use the most modern and energy saving technology available to date and have energy recovery turbines installed, reducing the energy requirements.

Seawater is pumped to the plant via a pipe laid on the reef with the inlet positioned in the lagoon.

Figure 3 Desalination plant used at the island

2.3.2 Powerhouse

Twenty four hours electricity is provided at the island. Electricity is generated using diesel generators.

Condition and Safety of Electrical Equipment

The powerhouse is located away from the residential area. The site is reasonably sized and sufficient land is available. The building consists of a machine room, which houses the generators and a room with control panel, spare parts, tools and documents. Noise attenuation and ventilation is well provided.

Figure 4 Diesel generating sets used at the island

Figure 5 Panel board used at powerhouse

The exhaust outlets from the diesel engines are located at the rear of the building with the discharge about four meters above ground level.

There are 03 Cummins generator sets installed in the powerhouse, of 200kW, 200kW and 100kW, nameplate rated capacity. They are relatively new, two being manufactured in 2001 and one in 2002.

The control panel is designated to operate all three generator set at a time. Each generator set is connected to a day tank. Walls have been constructed around the day tanks to avoid oil spillage. Fuel oil is supplied from a bulk storage tank located outside the powerhouse. A RARCOR water separator filter is installed at the outlet. The fuel supply pipe and return pipe of all engines are reinforced rubber hose.

Figure 6 Day tanks located outside the powerhouse

Distribution

Distribution is by underground cables. The Glass Reinforced Polyethylene (GRP) distribution boxes (DBs), 8 per feeder, are installed. Distribution cables are with four core copper conductors; Polyvinyl Chloride (PVC) insulated and steel armored mechanical protection.

Fuel and Lubricating Oil Handling

Fuel is supplied to the bulk storage tank through underground lied galvanized steel (GI) pipes. Fuel oil supplier connects the valve at the jetty to the fuel supplier's tank and deliver he required amount of fuel.

3 PROJECT ALTERNATIVES

General

This chapter describes project alternatives considered, including a no action alternative. The possible alternatives are:

- The source of feed water for the SWRO units
- Technical feasibility
- Use of renewable energy technologies in generating electricity and water
- Environmental acceptability

3.1 Alternatives Available

3.1.1 No Action Alternative

The no action alternative for the installation of the SWRO and power plant were not considered since the system is already in use and operating.

3.1.2 Alternative Water Sources Option

Upon investigation of the borehole option, various potential problems with both assuring proper construction to avoid contaminating the freshwater lens and then being certain that a feed water, in terms of salinity, suspended solids and quantity would be available once the wells were completed.

3.1.3 Alternative for electricity generation

Solar Photovoltaic can be used as alternative for electricity generation. Ethere Madivaru Island being a smaller island, island does not have enough space to install solar panels enough to meet the electricity demand of the island. Hence only half of the electricity demand of the island could be met by installing solar panels at available space. These PV panels can be installed at the roof top of the buildings. Other renewable energy such as wind will not be a suitable option to install due to the small size of the island and due to the noise pollution.

3.1.4 Technical Feasibility - The use of a borehole at the plant site would theoretically be a good idea. However, with the exception of one large plant in Malé, none of the other SWRO units in the Maldives appear to be using this concept. The feed water for the large plant in Malé has a high level of hydrogen sulfide requiring an extra treatment step.

3.1.5 Environmental Acceptability –The borehole would need to be constructed through the lens and then seawater would be pumped through the well. Although the borehole would

have specified a sealed annular space between the pipe carrying the seawater and the hole constructed for the well, there would have always been the risk that this would fail resulting in salt water entering the freshwater lens and contaminating the water which is a source of supply for the island.

4 METHODOLOGY

General

There are no standards set either by EPA or MEA to conducts or to follow in conducting EIA to know negative impact due to the operation of power generating facilities and desalination plants. Hence EIA was conducted considering internationally accepted standards mainly Resource and Guidance Manual for Environmental Impact Assessments prepared by UNEP and standards specifies by the engine manufactures.

4.1 Power System

Exhaust temperature was measured using infrared thermometer and based on the exhaust temperature the type of emission from generator set was identified and compared with the manufactures specification and found it is inline with the manufactures specification.

Power system control equipments were inspected through visual inspection. Whole control room is air-conditioned and all the equipments are on running condition.

Figure 7 Panel board used at the powerhouse

Sound measurement was conducted using handheld sound meter and sound level inside the powerhouse at a 2m distance from the generating set was found 97.8dB. Also sound level was measured from outside the powerhouse at a distance of 3m and it was found 60dB.

Generating sets are mounted on special mounting and which facilitates the vibration and take care of the shock generated due to the vibration.

Figure 8 Generating sets installed at powerhouse

Technical staff of the island is well trained and they take outmost care in handling and disposing the fuel.

4.2 Desalination Plant

The outlet of the desalination plant is placed well away (about 30m) from the salt water inlet for the desalination plant. The point of discharge has minimal effect to the surrounding reef since there are no live corals around the outlet area.

Figure 9 Outlet of the desalination plant

Water samples from inlet, outlet of the desalination plant was taken and chemical analysis was conducted at Maldives food and drug Authority and results conformity to the standards. In addition to this ground water sample and sample of desalinated water used in the island was taken chemical test were conducted. The result of the test was attached at Appendix 3 and 4.

Figure 10 Intake of the desalination plant

Survey was conducted to see the impact due to discharge water from the desalination plan to the corals and other marine species.

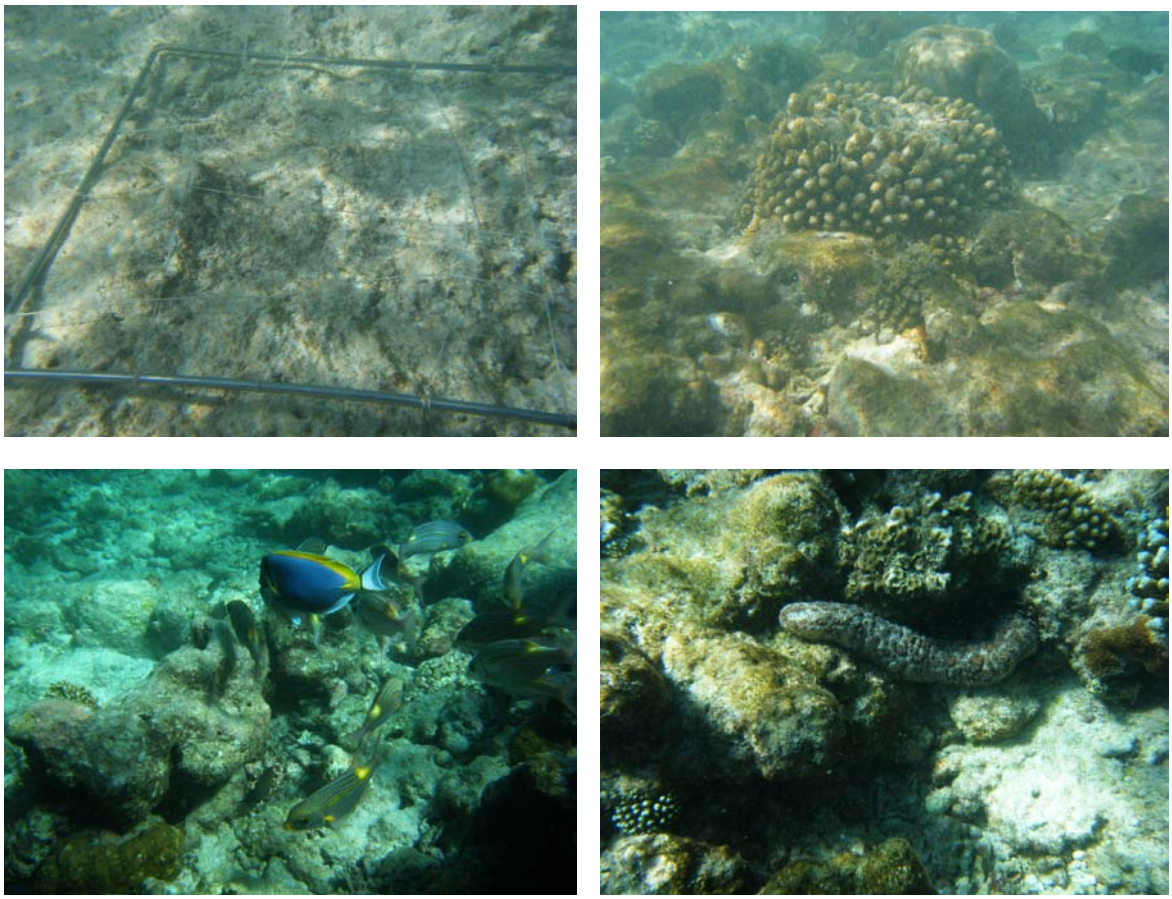

Figure 11 Coral and other living organisms at the surveyed area

5 ENVIRONMENTS

5.1 Ground Water

Groundwater was collected by digging a hole and sample was collected. The quality of the water is normal but groundwater is not used for any purpose at the resort this is because the island management does not want to deplete the groundwater due to the hotel operation (Tables 2).

Table 2 Result of the ground water quality test carried out on the samples collected from Ethere Madivaru island

Parameter	Test Result
Physical Appearance	Pale yellow with suspended solid
Oxygen Demand, Biological	26mg/L
Oxygen Demand, Chemical	0mg/L
PH	7.8
Electrical Conductivity	1421µs/cm
Tubidity	0 NTU
Phosphate	0.38 mg/L

5.2 Seawater

Seawater samples were collected at two points. The results of the seawater quality tests on the water samples collected from these sites are shown in table 3 and 4. Table 3 shows the water quality at the desalination plant inlet and table 4 shows the water quality at the desalination plant outlet.

Table 3 Result of water quality tests carried out on the seawater samples collected from desalination plant inlet

Parameter	Test Result
Physical Appearance	Clear
Oxygen Demand, Biological	22mg/L
Oxygen Demand, Chemical	444mg/L
PH	7.0
Electrical Conductivity	43400µs/cm
Turbidity	3 NTU
Phosphate	0.18 mg/L

Table 4 Results of the water quality tests carried out on the seawater samples collected from desalination plant outlet

Parameter	Test Result
Physical Appearance	Clear
Oxygen Demand, Biological	200mg/L
Oxygen Demand, Chemical	452mg/L
PH	7.0
Electrical Conductivity	43100µs/cm
Turbidity	0 NTU
Phosphate	0.18 mg/L

The chemical analyses do not show any inconsistencies between the two sites. Biological oxygen demand and turbidity is higher at the inlet, but still in the normal parameter range for seawater. The water was clear at all sites.

5.3 Marine life

The marine life around the RO plant's intake and outlet was assessed using quadrat method. Benthic substrate cover was surveyed. A detail of quadrat survey methodologies is found at English et al 1997. The survey sites are fixed and are easily detectable. Because of this no GPS positioned were taken. Both intake and outlet are beneath the existing jetty.

In-take area

The intake was anchored at the seaward end of the jetty. The depth is about 3m. The results show that the live coral cover around the sea water intake area was about 10.5%. Dominant form of corals is branching corals. The dominant fish taxa observed included Acanthuridae. The figure below depicts the benthic cover at the intake area.

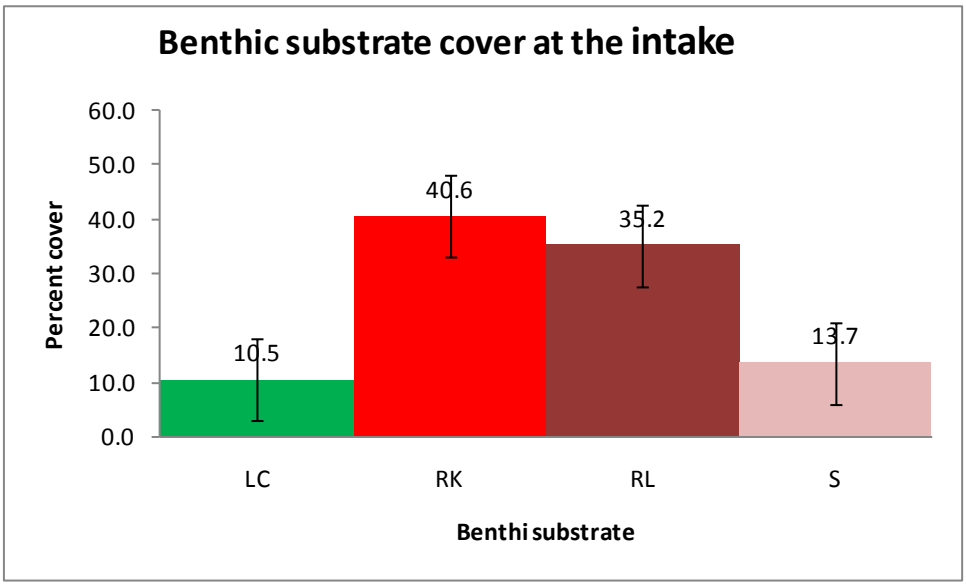

Figure 12: Percentage cover of benthic substrate present at the intake area. The benthic covers are given in percentages of the bottom area surveyed. LC =live coral, RK = rock, RL = rubble, and S = sand

Outlet area

The outlet was anchored near the landward end of the jetty. The depth is about 0.5m. The results show that the live coral cover around this area was about 0.5%. Dominant form of corals is encrusting corals. The dominant fish taxa observed included Pomacentridae. The figure below depicts the benthic cover at the intake area.

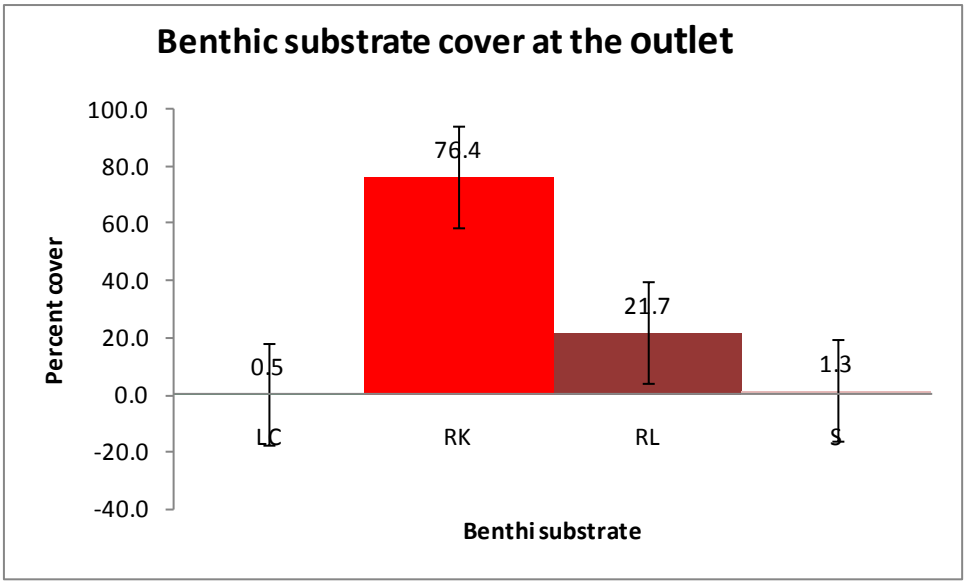

Figure 13: Percentage cover of benthic substrate present at the outlet. The benthic covers are given in percentages of the bottom area surveyed. LC =live coral, RK = rock, RL = rubble, and S = sand

6 IMPACT ANALYSES AND MITIGATION

6.1 Impact Analysis and Mitigation

This section will describe the potential impacts of operation of the Power System, SWRO units and associated systems on the islands and the proposed measures to mitigate any adverse impacts.

Number of impacts to the island those are associated with this project. The most significant are listed below.

6.1.1 Visual

The building used to contain the SWRO equipment and power system equipments are single storey concrete block buildings, resembling the construction of other structures on the island.

The only other really visible structure will be the black HDPE storage tanks which are the same as the ones that are already on the island and part of the concrete settling tanks.

The distribution system is buried and has no visual impact except for the water taps. Thus the construction and structures should not have an adverse visual impact.

6.1.2 Noise

There are several sources of noise. The most prominent will be the diesel generators and high pressure pump for the SWRO unit.
The high pressure centrifugal pump makes a whine-type noise. The decibel level is 50dB at the property line (boundary wall).
The decibel level of the generating sets at 3 meter from the boundary wall is 60dB

6.1.3 Marine Environment

The marine environment has some minor disturbance due to the installation of an intake pipe (~ 50- mm diameter) made of HDPE. It is be laid on the bottom of the lagoon and weighted with concrete collars about every 6 to 8 meters as required to keep it in place. Full care was taken to minimize damage to any live corals or vegetation during the installation. The flow in the pipeline is approximately 70 liters/minute (l/min) or 19 gallons per minute (gpm)

The brine disposal line was constructed in a similar manner as the intake. The flow in the pipeline is approximately 48 l/min (or 13 gpm).

6.1.4 Freshwater Lens

One source of water for the island is groundwater. This water is derived from rainfall and accumulates as a freshwater lens under the island. It is important that this source of water is preserved. The only exposure to contamination of the freshwater lens will come from the intake and brine discharge lines that will go from the shoreline to the site of the SWRO. The location of the intake and discharge lines that transfer saline water between the sea and the SWRO facility has been made so as to minimize this distance.

The use of HDPE pipe means that there will be very few joints along the run. The pipes were buried about 500-mm below ground surface (bgs) to reduce the potential for damage by foot or vehicular traffic.

7 CONCLUSIONS

7.1 Conclusions

Based on the assessment presented in this report, we have the following conclusions:

• The Power system, SWRO facilities and associated appetencies on the islands has no significant negative impact

• Positive impacts clearly outweigh the negative impacts, which are minor and can be mitigated

• The project activities are compliant with laws and policies

Appendix 1 Sound Pressure Levels

Power Generation — **Sound Data**

1120DFLC 50 Hz

Sound Pressure Levels dB(A)

Configuration	Distance (meter)	Position (Note 1)								8 Position Average
		1	2	3	4	5	6	7	8	
Standard - Unhoused (Note 3)	7	91	89	89	91	87	91	92	90	90
	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	80	86	83	85	82	85	86	87	85

Note:

1. Position 1 faces the engine front at 23 or 33 or 52 feet (7 or 10 or 15 m) from the center of the generator set. The positions proceed around the generator set in a counter-clockwise direction in 45° increments.
2. Data based on full rated load with standard radiator-fan package. Sound pressure level for heat exchanger/remote radiator if applicable will be lower.
3. Sound data for generator set with infinite exhaust do not include exhaust noise.
4. Sound pressure levels per ANSI S1.13-1971 as applicable.
5. Reference sound pressure is 20 µPa.
6. Sound pressure levels are subject to instrumentation, measurement, installation and generator set variability.

Sound Power Levels dB(A)

Configuration	Octave Band Center Frequency (Hz)								Sound Power Level
	63	125	250	500	1000	2000	4000	8000	
Standard - Unhoused (Note 3)	96	101	110	113	116	116	112	108	121

Note:

1. Data based on full rated load with standard radiator-fan package. Sound power for heat exchanger/remote radiator if applicable will be lower.
2. Sound power per ANSI S12.34-1988 and ISO 3744 as applicable.
3. Sound data for generator set with infinite exhaust do not include exhaust noise.
4. Reference sound power is 1pW=1 x 10^{-12} W.
5. Sound power levels are subject to instrumentation, measurement, installation and generator set variability.

Appendix 2 Exhaust Emission Data Sheet

Exhaust Emission Data Sheet
880DFHD
50 Hz Diesel Generator Set

Engine Information:

Model:	Cummins Inc. QST30-G4	Bore:	5.51 in. (140 mm)
Type:	4 Cycle, 50°V, 12 Cylinder Diesel	Stroke:	6.50 in. (165 mm)
Aspiration:	Turbocharged and Low Temperature Aftercooled	Displacement:	1860 cu. in. (30.5 liters)
Compression Ratio:	14:1		
Emission Control Device:	Step Timing Control (STC) and Separte Circuit Low Temperature Aftercooling		

	Standby	Prime
PERFORMANCE DATA		
BHP @ 1500 RPM (50 Hz)	1300	1180
Fuel Consumption (gal/Hr)	59.1	53.2
Exhaust Gas Flow (CFM)	6310	5820
Exhaust Gas Temperature (°F)	1070	1050
EXHAUST EMISSION DATA		
HC (Total Unburned Hydrocarbons)	0.30	0.35
NOx (Oxides of Nitrogen as NO2)	6.70	6.60
CO (carbon Monoxide)	1.50	1.20
PM (Particular Matter)	0.10	0.11
SO2 (Sulfur Dioxide)	0.13	0.13

All values are Grams per HP-Hour

TEST CONDITIONS

Data was recorded during steady-state rated engine speed (± 25 RPM) with full load (-2%). Pressures, temperatures, and emission rates were stabilized.

Fuel Specification:	ASTM D975 No. 2-D diesel fuel with 0.03-0.05% sulfur content (by weight), and 40-48 cetane number
Fuel Temperature	99 ± 9 °F (at fuel pump inlet)
Intake Air Temperature:	77 ± 9 °F
Barometric Pressure:	29.6 ± 1 in. Hg
Humidity:	NOx measurement corrected to 75 grains H2O/lb dry air
Reference Standard:	ISO 8178

The NOx, HC, CO and PM emission data tabulated here were taken from a single engine under the test conditions shown above. Data for the other components are estimated. These data are subjected to instrumentation and engine-to-engine variability. Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures and instrumentation. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may results in elevated emission levels.

Appendix 3 Result of the water samples collected from Ethere Madivaru

National Health Laboratory
Maldives Food and Drug Authority, Male' Republic of Maldives

WATER CHEMISTRY ANALYTICAL RESULTS

REPORT NUMBER: NHL/TR-WC/RC0060

*NAME OF CLIENT: AA.ETHERE MADIVARU RESORT
*PURPOSE OF TESTING: Quality monitoring

TIME TESTED: -
*COLLECTED BY: -

*LOCATION OF SAMPLE	AA.ETHERE MADIVARU RESORT			TEST METHOD	REFERENCE RANGE W.H.O Guideline for Drinking Water
	DESALINATION PLANT INLET	DESALINATED DRINKING WATER	DESALINATION PLANT OUTLET		
Requisition Form No:	NHL/WC-2010/RQ0052				
*Date sampled	10/01/2010	10/01/2010	10/01/2010		
*Time Sampled	-	-	-		
*Type of water	Desalinated	Desalinated	Desalinated		
Date tested	12th -18th /01/2010				
Sample ID	120110WC146	120110WC148	120110WC149		
PARAMETER TESTED					
Physical Appearance	Clear	Clear	Clear	-	Clear & colorless
Oxygen Demand, Biological	22 mg/L	4mg/L	200 mg/L	Adapted from HACH BOD Trak instruction manual	-
Oxygen Demand, Chemical	444 mg/L	16 mg/L	452 mg/L	Method 8000, (Adapted from DR2010™/4000™/6000™ Spectrophotometer procedure manual)	-
pH	7.0	7.4	7.0	Method 4500-B p-94 page 65 electrometric method Adapted from standard methods 19th edition for the examination of water and waste water by APHA	-
Electrical Conductivity	43400 µs/cm	40 µs/cm	43100 µs/cm	Adapted from orming checkmate 3 meter instruction manual	-
Turbidity	3 NTU	1 NTU	0 NTU	(Adapted from DR4000™/Spectrophotometer procedure manual) Adapted From Hach 2100 N Turbidimeter Instruction Manual	-
Phosphate	0.18 mg/L	0.18 mg/L	0.18 mg/L	Method 8048, (Adapted from DR2010™/4000™/6000™ Spectrophotometer procedure manual)	-

COMMENT:

Authorized by

Analyzed By
Amira Ahmed

Technical Manager
Fathmath Safoora

National Health Laboratory
Male' Republic of Maldives

Date: 20th January 2010

NOTE: * Information supplied by the client

This result is valid only for this sample. This report is not for duplicate or advertisement without prior approval from NHL

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Appendix 4 Result of the ground water sample collected from Ethere Madivaru Island

National Health Laboratory
Maldives Food and Drug Authority, Male' Republic of Maldives

WATER CHEMISTRY ANALYTICAL RESULTS

REPORT NUMBER: NHL/TR-WC/RC0061

•NAME OF CLIENT: AA.ETHERE MADIVARU RESORT
•PURPOSE OF TESTING: Quality Monitoring

TIME TESTED: -
•COLLECTED BY: -

•LOCATION OF SAMPLE	AA.ETHERE MADIVARU RESORT	TEST METHOD
	GROUND WATER	
Requisition Form No:	NHL/WC-2010/RQ0052	
•Date sampled	10/01/2010	
•Time Sampled	-	
•Type of water	GROUND	
Date tested	18th -18th /01/2010	
Sample ID	120110WC147	
PARAMETER TESTED		
Physical Appearance	Pale yellow with suspended solid	-
Oxygen Demand, Biological	26 mg/L	Adapted from HACH 8000 Test in struction manual
Oxygen Demand, Chemical	0 mg/L	Method 8000, (Adapted from DR2010™/4000™/5000™ Spectrophotometer procedure manual)
pH	7.8	Method 4500-B c/4, page 95 electrometric method Adapted from standard methods 19th edition for the examination of water and waste water by APHA
Electrical Conductivity	1421 µs/cm	Adapted from conring check mate II meter instruction manual
Turbidity	0 NTU	(Adapted from DR/4000™ Spectrophotometer procedure manual) Adapted From Hach 2100 N Turbidimeter Instruction Manual
Phosphate	0.38 mg/L	Method 8048, (Adapted from DR2010™/4000™/5000™ Spectrophotometer procedure manual)

COMMENT:

Authorized by

Analyzed By
Aminath Nazra

Technical Manager
Fathmath Safoora

National Health Laboratory
Male', Republic of Maldives

Date: 20th January 2010

NOTE: • Information supplied by the client

This result is valid only for this sample. This report is not for duplicate or advertisement without prior approval from NHL

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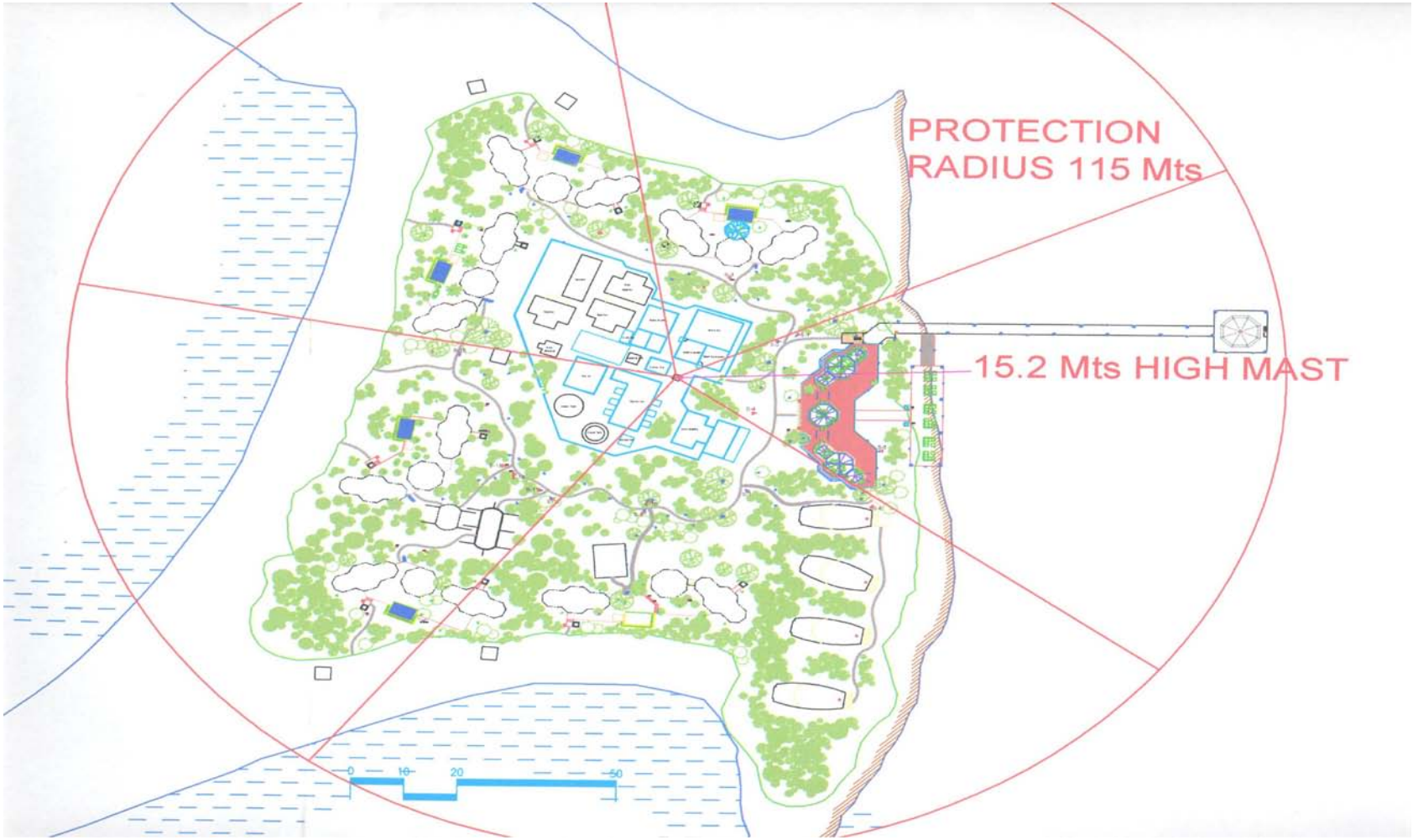
Appendix 5 Map of the Island



Appendix 6 Site Layout Island

Appendix 7 TOR issued by Environmental Protection Agency (EPA) for EIA

Environmental Protection Agency
Male', Republic of Maldives

Terms of Reference for the Environmental Impact Assessment for existing Power Generation and Desalination Facility at Etheremadivaru resort, AA. Atoll

The following TOR is based on the scoping meeting held on the 28th October 2009, for undertaking the Environmental Impact Statement report for the registration of electric poer system and desalination plant at Etheremadivaru, aa. atoll

This document is a legally binding document prepared after consultation with all relevant stakeholders and the EIA report must strictly follow the activities under this ToR.

1. *Introduction - Identify the development project to be assessed and explain the executing arrangements for the environmental assessment. Describe the rationale for the development and its objectives. Provide the background information on the project and costs of the project. Justification should be given into consideration purpose and objectives of the project.*

2. *Study Area - Specify the boundaries o f the study area for the assessment as well as any adjacent or remote areas that should be considered with respect to the project*

3. *Project proponent – Provide details of project proponents including any joint venture partners*

4. *Scope of Work - The following tasks will be performed:*

Task 1. Description of the Proposed Project –The description of the project should consider the following.

a) *Provide a brief description of the proponent, how the project will be undertaken, full description of the relevant parts of the project including infrastructure and fuel types and storage, using clearly labeled maps, scaled site plan. Highlight the safety measures that will be employed during operational phase of the project.*
b) *Details on project related wastes and emissions (noise), and how they will be managed, project inputs and outputs, project schedule; and life span.*

Task 2. Description of the Environment - Where baseline data is to be collected, careful consideration must be given to the design of the methodology and sampling programme. Data collection must focus on key issues needing to be examined for the EIA. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that the data collected is suitable for use as a baseline to monitoring impacts.

Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area (and disposal sites), including the changes to the existing environment in light of monitoring conducted after the commencement of the initial project.

a) *Physical environment: baseline data on relevant environmental components such as air quality, noise level, safety factors related to proposed project.*

b) *Natural environment: Evaluate the natural environment, especially the terrestrial environment. Describe of the general status of the groundwater in terms of the size and quality of the water lens.*

Groundwater quality should be assessed with respect to the location of the powerhouse and fuel storage.

Characterize the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. All available data from previous studies of the island, if available should be presented. Geographical coordinates of all sampling locations should be provided. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

Task 3. Legislative and Regulatory Considerations - Describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project.

Task 4. Determine the Potential Impacts of the Proposed Project – Identify impacts related to the project. Distinguish between significant impacts that are positive and negative, direct and indirect, and short and long term both during construction phase and operational phase. Identify impacts that are cumulative, unavoidable or irreversible. Particular attention shall be given to impacts associated with:

- *Fuel, oil handling and management*
- *Noise and emission reduction*
- *Visual amenity of the resort*
- *Impacts of emissions on the occupants of the resort*

Task 5. Analysis of Alternatives to the Proposed Project. – Describe the alternatives examined for the proposed project that would achieve the same objective including the "no action alternative. This should include; alternative technologies, material, locations to the proposed components of the project with economic, environmental and social factors taken into consideration. Distinguish the most environmentally friendly alternatives. Report should highlight how the location was determined and justify that the proposed location.

Task 6. Mitigation and Management of Negative Impacts – identify possible measures to prevent or reduce significant negative impacts to acceptable levels Mitigation measures should be identified for the project which should be both for construction and operational phase. Cost of the mitigation measures, equipment and resources required to implement those measures. A commitment regarding the mitigation measures should be submitted by the responsible person.

Task 7. Development of a Monitoring Plan – a reasonable time frame should be outlined for monitoring focused on the construction and operational phase. Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan. Detail of the monitoring programme including the physical and biological parameters for monitoring, frequency, duration and cost commitment from responsible person, detailed reporting timetable and ways and means of undertaking the monitoring programme shall be provided.

Task 8. Stakeholder Consultation – Major stakeholder consultation including Maldives Energy Authority, Ministry of Housing, Transport and Environment, Ministry of Tourism Arts and Culture, and other relevant stakeholders including the specific island [illegible] should be carried to include their perception of the

project. EIA report should include a list of people/groups consulted and the methodology of consultation. The discussions held at the scoping meeting will be also used as a part of consultation.

Task 9. Methodology Explain clearly the methodologies used for data collections, making predictions and data gaps and also the information on the uncertainties and assumptions involved in interpreting the data.

Presentation - The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2007.

Timeframe for submitting the EIA report - The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.

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22 November 2009

Appendix 8 Maldives Energy Authority Guidelines for power system approval

MALDIVES ENERGY AUTHORITY
GOVERNMENT OF MALDIVES

Guideline for Power Systems Approval:

Following information needs to be provided for the approval.

1. **Generation system:**
   a) Site Layout or Facility Layout – showing immediate surrounding.
   b) Powerhouse Floor Plan – showing major equipment and dimensions.
   c) Powerhouse Sectional view – showing major equipment and dimensions.
   d) Technical Specification of Generating sets and associated plant.

2. **Generator Control Panel and Distribution Panel:**
   a) Single line diagram of the Panels.
   b) Panel Load Calculation.

3. **Fuel System:**
   a) Fuel system layout (fuel storage & fuel handling system) – single line diagram.
   b) Type of Fuel and its specification
   c) Day tank and bulk tank capacities.

4. **Distribution Network:**
   a) Layout of Distribution Network; Substations, Distribution boxes and service cables on a scaled diagram.
   b) Single line diagram of distribution panels above 60A.
   c) Single line diagram of distribution boxes.
   d) Load forecast for the network.
   e) Voltage drop calculation and Network loss on each feeder.

5. **Electric Cable:**
   a) Technical specification of the cables used for transmission, distribution and electrical installations.
   b) International certification for the cables. (If not approved by MEA).

6. **Fire Fighting System and lightning Protection:**
   a) Certification or reference of approval fire fighting system from relevant government agency.
   b) Lightning Protection designs to be approved by MEA.

7. **Environmental Impact Assessment of the generation facility:**
   a) Certification or reference of approval from relevant Government agency.

8. **Tariff:**
   a) Estimated Capital Costs (in detail).
   b) Income & Expenditure projections for over 10years.
   c) Electricity Demand forecast for over 10 years.
   d) Proposed tariff for over 10 years.

9. **Rules and regulations of Powerhouse for consumers:**
   a) Draft rules and regulations of services to consumers.

NOTE:

- ***ALL documents submitted under items 1, 2, 3 & 4 should be verified by MEA Licensed Power Engineer (Name, Signature and License Number should appear on verified documents).***
- ***Items which are not relevant should be labeled as Not Applicable or NA.***
- ***MEA regulations could be collected from MEA.***