
Initial Environmental Examination for Thaa and Noonu Atoll (POISED Phase 5 sub-Project)

Prepared for

Preparing Outer Islands for Sustainable Energy Development (POISED) Project

Ministry of Environment

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1 Executive summary

This initial environmental examination (IEE) is conducted for the renewable energy (RE) hybrid solutions to be implemented in Thaa Atoll (sub-project) in Maldives under the Asian Development Bank's (ADB) Technical Assistance to Maldives for Preparing Outer Islands for Sustainable Energy Development Project (POISED or the Project). POISED aims to reduce diesel used in electricity generation through installation of RE hybrid solutions and energy efficiency improvements in the generation and distribution of electricity. This sub-project, Phase 5, is part of the POISED project funded through an additional financing from Asian Development Bank (ADB). The scope of this IEE is limited to the following planned activities of the sub-project.

- Installation of solar PV systems (ground mounted and roof top) on islands of Thaa atoll
- Refurbishment of distribution mini-grid systems at connection points on islands of Thaa atoll
- Installation of 4 solar powered Community Ice Plants in three islands of Thaa atoll and 1 island in Noonu Atoll.

The IEE does not include the establishment of powerhouses in the islands as the project will be using the existing powerhouse setups (which has undergone an EIA process) in the islands.

The Maldives has about 140 MW of installed diesel generation capacity on the inhabited islands and another 100 MW on the tourism islands. Given the geographic location of islands, each island is electrified with its own diesel powered mini grid system resulting in expensive and not very reliable supply. The cost of diesel power is unaffordable at 30-70 cents/kWh and requires government subsidies in excess of \$40 million annually. Electricity sector subsidies are also one of identified areas for government expenditure management. In 2012, Maldives spent over \$470 million for oil imports of which fuel imports for electricity generation contributes significantly. The high diesel dependence of Maldives also makes its carbon emissions per unit of electricity among the highest in the region.

The Maldives has significant renewable energy resources namely solar power and in some pockets wind power. The POISED project is an initiative by the Government to support energy efficiency and renewable energy investments in outer islands.

The sub-project includes addition of RE hybrid (diesel + solar PV) systems with grid support battery system in 12 inhabited islands in Thaa Atoll. In total the sub-project includes 2,490kWp of PV, a battery storage system of power 1,125kW and capacity 2,250kWh, EMS systems and grid upgrades, costing US\$ 5.46 million. The project also includes of installation of 4 solar-powered ice plants with a total capacity of 50T/day of ice production and with 985 kWp solar power. The ice plants are estimated to cost about US\$ 2 million.

- Component 1: Installation of solar PV systems (ground mounted and roof top)
- Component 2: Refurbishment of distribution mini-grid systems
- Component 3: Installation of 4 Solar Powered Ice Plants
- Component 4: Capacity building of PMU/FENAKA/STELCO staff on O&M of RE systems

1.1 Natural and Social Environment at Site

Natural Environment. The sub-project will be implemented in 12 islands of Thaa Atoll, which is a southern central atoll of the Maldives. The islands are in the same geographic region and share many similarities in terms of climatic conditions, physical environmental as well as social and cultural characteristics. The climate is tropical and monsoonal with the weather dominated by the dry season (December to April) associated with the northeast monsoon and the rainy season

(May to October) brought by the summer southwest monsoon. The temperature ranges between 25°C and 31°C throughout the year. Wind direction over the central atolls vary between west-southwest and west-northwest of which predominant winds blow in a westerly direction.

Maldives has limited terrestrial biodiversity due to the lack of land, salinity, alkaline soils, and salt laden winds but is rich in marine biodiversity. There are some abundant beach vegetation including shrubs and large trees. Some common plants are ironwood, Indian almond, marer, beach gardenia and coconut palm among others. The average vegetation cover in the islands is 28%. Only 2 of the islands maintain more than 50% of the natural vegetation. There are very few types of terrestrial fauna in the islands. However, there is a rich marine biodiversity in the Maldives including Thaa Atoll. There are no wetland areas in Thaa Atoll. Freshwater is available as a very thin lens in the ground, which is susceptible to saltwater intrusion. Rainwater is mainly used in the islands for potable purposes.

There are no nationally protected areas within Thaa Atoll. However, there are 12 sites identified as ecologically sensitive areas by the EPA including sites on 2 of the sub-project islands. In addition, there is an ecologically sensitive area on Noonu Landhoo where the ice-making plant will be built. However, the project work on these sites will not affect the ecologically sensitive areas. There are a number of species of fauna protected in the whole of Maldives including Thaa atoll. These include 103 species of birds, all species of turtles and rays and skates protected under the EPPA 4/93. In addition, dolphins, Napoleon wrasses, giant clams, black coral, whale sharks, conch shells, whales, sharks, berried female lobsters and lobsters less than 25cm in total length are protected under the Fisheries Act 5/87. Large trees are protected under the Regulation on Conservation of Old Trees.

Social Environment. The project islands consist of small communities with populations ranging from 404 to 2,589. Excluding the large populations in Vilufushi, Guraidhoo and Thimarafushi (with populations over 2,000), the rest of the islands have an average population of about 967. There are also number of foreign workers residing in all islands with the agricultural island of Kan'doodhoo having a high ratio of local to foreign workers (4:1). All islands have access to primary level health services. The Atoll Hospital in Veymandoo provide secondary medical care. In terms of education, pre-primary to secondary level education is available in all 12 islands. Education up to high secondary levels is provided in Vilufushi, Guraidhoo and Thimarafushi.

The major livelihood activities for the 12 islands are government employment, building construction, agriculture, fishing, wood crafting, hand crafting and thatch and rope weaving. Youth are mainly engaged in tourism, construction, and fishing. Thatch weaving is common in all islands with the elderly and women being involved in this.

1.2 Impacts assessment and mitigation

Direct, indirect impacts as well as positive and negative impacts of the project were assessed for the planning, construction, and operational phases of the sub-project. Overall, the benefits outweigh the minor to moderate negative impacts from the sub-project. Communities benefit from improved power generation facilities which are more environmentally friendly with lowered emission and noise levels. The communities expect this to contribute to improved health of the community. Economic benefits from reduced diesel consumption are anticipated by communities in the long-run. Local economy of the communities will also benefit from influx of assessment teams, workers, and others during various stages of the project. The various assessments during the planning stage has seen an increase in awareness of renewable energy, energy efficiency and conservation by communities.

Careful site selection at the planning stage avoids many negative impacts. This includes impacts on terrestrial biodiversity, relocation, or loss of residential, agricultural, and recreational land. Most negative impacts are minor to moderate and most of the impacts during the construction phase are of short duration and has high recoverability of going back to the original status. The island communities do not see influx of workers as a big issue as there already are a lot of expatriates working in the communities and they are used to the dynamics. The communities voice that the slight inconveniences are not a big issue compared to the long-term benefits.

Table 1. Summary of Negative Impacts and Mitigation for Thaa islands

Stage	Impact	Significance	Mitigation
Planning	Disturbances to avifauna (mainly crows which are considered a pest) from use of drone to survey rooftops	Minor	Careful use during operations
	Impacts on privacy of nearby residents from use of drone to survey rooftops	Moderate	Time for survey is based on consultation with Island Councils and nearby residents are informed earlier of the survey.
Construction	Impacts on vegetation	Minor	Careful site selection to avoid removing of trees.
	Noise disturbances to residents	Moderate	Select machinery that will minimise noise Times of work are chosen after discussion with Island Councils to minimise disturbances to residents.
	Difficulty in road access during trench digging for cable upgrades	Moderate	Work will be carried out as fast as possible Whole roads will not be blocked
	Difficulty to access public buildings during construction	Minor	Schedule of work will be discussed with Island Council and will accommodate their suggestion on best times for work.
	Disturbances due to traffic to and from sites	Minor	This will not be a lot.
	Waste generated	Minor	Disposed as instructed by Island Council. Waste that cannot be safely disposed at the islands will be removed to a facility such as Thilafushi by contractors. Work will be carefully overseen by powerhouse managers and Island Councils
	Community health and safety	Minor	Some risks of safety may occur if community members access site but this will be unlikely as the area will be closed off during construction.

	Occupational health and safety	Moderate	Careful monitoring and training of workers on safety issues.
Operation	Reduction in noise and pollution from powerhouses	Minor	Monitoring of these parameters according to Environmental Monitoring Plan
	Disturbances to avifauna from glare of PV panels	Minor	This will be low as there are few birds in the islands. Most of the birds in the residential areas are crows which are considered a pest.
	Occupational health and safety from battery units	Moderate	Buy high quality battery units with built in automatic fire alarms Location away from normal work areas Proper training of staff on the risks Set up water and wash areas near battery storage areas in case of any accidents to staff and spill of chemicals.

The alternatives analysis considers with and without project scenarios. It was found that without the sub-project, the Maldives would continue to pay heavy price for diesel import which will affect the overall economic development of the country and the islands. In addition, there is benefit in terms of sustainable electricity supply to the consumers and decrease in smoke particles and hence improved health conditions. Alternative sites (both on rooftops and ground mounting), areas, were considered and land with low environmental value is chosen for PV installation.

An Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) have been developed to ensure continued monitoring of environmental impacts and mitigation actions during construction and operational phase. The monitoring focuses on air quality, noise levels and occupational health and safety in both phases. Training of staff and workers on safety is of utmost important. In addition, the physical works carried out by contractors will be carefully monitored. Details of the plan are in

Project activity /stage	Potential impact	Proposed mitigation measure	Mitigation Cost	Institutional responsibility	Implementation schedule
A. Pre-construction					
Location	Encroachment into precious ecological and protected areas	Careful site selection to avoid encroachment of ecological sensitive areas including protected areas and areas of historical and cultural importance. On Veymandoo, Kan'doodhoo and Landhoo no permanent or temporary project facilities will be sited within 50m of the ecologically sensitive areas identified by EPA. No works will commence until MEECT has submitted screening	Project Cost	EA, IA through PMC	Detailed design

		<p>form for Thaa atoll to EPA and they have confirmed if any further study is required.</p> <p>If more than 10 trees on an island will be cut, EIA will be submitted to the EPA and decision notice obtained before any works start on site.</p> <p>No trees protected under the Regulations of Conservation of Old Trees will be cut.</p> <p>For each tree cut two replacement trees of locally native species will be planted elsewhere on the island.</p> <p>For ice making plants pipes will only be installed where the lagoon is totally devoid of coral or seagrass; this will be confirmed by a marine ecologist who will supervise the pipeline installation and undertake a photographic record of before and after</p>			
	Topography and visual impacts	Careful selection of site away from inhabited areas.	Project Cost	EA, IA through PMC	Detailed design
Access	Impacts due to construction of new access roads and wharfs	<p>Proposed sites are accessible by existing wharf and road network. Therefore, no need to construct new access roads or wharfs.</p> <p>In case requirement arises for new roads/wharfs, this EMP will be updated to address associated impacts.</p>	Project Cost	EA, IA through PMC	Detailed design
Project design	Negligence of environmental mitigation measures	Ensure that EMP is included in the bidding documents	Project cost	EA, IA through PMC	Tendering process
	Updating EMP	Mitigation measures defined in this EMP will be incorporated into the detailed design to minimize adverse impacts. If any modifications in the design need to be made, the EMP will be reviewed to see if any updates need to be made and in the event the EMP needs to be updated, this will be updated with ADB clearance and shared with Contractor for implementing.	Project cost	EA, IA through PMC	Detailed design
		Prepare environmental contract clauses for contractors, namely the special conditions (e.g. reference EMP and monitoring table)	Project cost	EA, IA through PMC	Tendering process

Climate Change	Risk of climate change	Provided solar PV plants with resilience to climate change through compact and preassembled systems resistant to marine/coastal environments. Foundations and racking system will be designed to withstand powerful cyclones and hurricanes, which will limit the probability of generation unavailability as well as reducing any potential hazard of panels being lifted up and blown onto adjacent properties.	Project cost	EA, IA through PMC	Detailed design
Equipment design and selection	Release of toxic chemicals and gases in receptors (air, water, land) Noise from equipment/machineries	<ul style="list-style-type: none"> The new and replacement diesel generators will be designed to comply with World Bank/IFC's EHS guidelines for small combustion facilities and EHS guidelines for ambient noise both for day time and night time. Ensure equipment and machinery used for construction will not release any toxic chemicals, such as CFCs. All battery units will be installed with nearby fresh water taps in case staff do come into contact with the lithium solution. Batteries bought for the project will be of high quality and come in prefabricated casing with built-in automatic fire alarm system, fire extinguishers and sand buckets will also be provided 	Project Cost	EA, IA through PMC	Tendering process
Statutory clearances/permits	Delay in the project process	Ensure that all necessary permits and clearances i.e. environmental permit from EPA, Island Environment Authority) are obtained prior to commencement of civil work.	Project Cost	EA, IA through PMC	Prior to commencement of civil work
Involuntary resettlement or land acquisition	Social inequities	Compensation paid for temporary/permanent loss of productive land as per entitlement framework and its process, if necessary.	Project Cost	EA, IA through PMC	Prior to commencement of civil work
Site clearing	Cutting/trimming of trees and removal of vegetative cover	Compensatory afforestation as per government policies.	To be included in EPC Contractor cost.	EPC Contractor & PMC	Preparation of site prior to civil work
B. Construction					

Construction of access road	<ul style="list-style-type: none"> - Increase in airborne dust particles - increased land requirements for temporary accessibility 	All proposed sites are accessible with existing road. These roads will be used for construction and access to the cable route/sites will be maintained in good condition wherever possible to avoid dust emission.	To be included in Contractor cost.	EPC Contractor, EA/IA through PMC	During civil work construction
Installation of Solar Panels, and Storage of construction material and movement of vehicles	Topography and visual impacts	Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction
Construction activities	Generation of dust by construction activities	<ul style="list-style-type: none"> - Vehicles carrying soil, sand, or other fine materials to and from the sites must be covered. - Water will be spread on construction sites and access roads each day. - Soil excavated from foundation footings disposed of at designated places. - Protect /preserve topsoil and reinstate after construction completed. 	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction
Construction debris and wastewater	<p>Adverse impacts on surrounding environment due to construction waste.</p> <p>Pollution of water bodies due to disposal of waste material into water bodies.</p>	<ul style="list-style-type: none"> - Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time. - Provision of facilities for handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements. - Purchase of perishable construction materials such as paints incrementally to ensure reduced spoilage of unused materials. - Use of building materials that have minimal packaging to avoid the generation of excessive packaging waste. - Use of construction materials containing recycled content when possible and in accordance with accepted standards. 	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction

		<ul style="list-style-type: none"> - Dispose construction related waste in consultation with the Island Council, records of all waste generated and where and how it was disposed will be kept - On the completion of works, no waste will be left on the island for the Island Council to recycle or dispose of - Construction waste that cannot be reused will be regularly transported offsite for disposal at the waste management center like Thilafushi, and not allowed to accumulate on site over long periods. - Careful monitoring of workers will be conducted by the management to ensure waste is not disposed into marine waters. - Fuel and other hazardous materials securely stored at least 100m from high tide line on impermeable bunded surface e.g., drip trays. - Safe handling and disposal of phased out equipment including DG sets. - Provision of adequate drainage system including controlled collection and preliminary treatment of wastewater. 			
Movement and operation of construction equipment	Noise generated from operation and movement of trucks and cranes	<ul style="list-style-type: none"> - Construction techniques and machinery selection seeking to minimize ground disturbance. - Conduct work after consultation with the Island Councils to choose a time that will cause minimal disturbances to community - Solar panel installations at schools will be scheduled to avoid class disturbance. - Construction activities only undertaken during the day between 6:00 am and 10:00 pm and local communities informed of the construction schedule. - Noise level at nearest residential property or other sensitive receptor not to exceed EHS guideline levels (or <3dB(A) increase if already exceeded and baseline noise monitoring was conducted to inform 	To be included in EPC Contractor cost.	EPC Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction

		this) - Workers not to be exposed to machines noise level not more than 85 dB(A) at average 8 hrs or be provided with hearing protection.			
	Visual impacts from storage and haulage of construction material	Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.	To be included in EPC Contractor cost.	EPC Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction
Transportation of equipment and construction material.	Dust and particulate emission from movement of construction vehicles transporting equipment and construction material.	- Truck wheels cleaning - Road covering (if possible), cleaning and spraying water (if necessary) and watering	To be included in EPC Contractor cost.	EPC Contractor	During land clearing and civil work construction
Cutting of trees and clearing / trimming of trees and vegetative cover	Loss of trees and vegetative covers	- Removal of only those trees, which are necessary. - Marking of trees to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance. - Transplanting of trees if this is possible. - Prohibiting illegal cutting of trees by construction workers for domestic uses. - Planting of trees in coordination with the Island Authorities of target island	To be included in EPC Contractor cost.	EPC Contractor	During land clearing and civil work construction
Public access	Hindrance to public access due to project construction activities	- Consultation with residents to reach agreements - Development of temporary access roads and traffic diversion plan, if required - Adequate safety measures like traffic controller, erect and maintain barricades, signs, markings, flags, lights etc.	To be included in EPC Contractor cost.	Contractor, PMC, Island Council	During land clearing and civil work construction
Occupational Health and Safety	Impacts on workers health due to working with trucks and piling cranes, Building construction, high voltage work	- Provide Safety Manual - Provide Safety Plan - Supervision and Inspection - Protection PPEs/gears - Contractor to arrange for health and safety training sessions and clear warning signs where required. - Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements.	To be included in EPC Contractor cost.	Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction

		<p>To minimize health impacts, following additional measures would be implemented.</p> <ul style="list-style-type: none"> - Construction activities only undertaken during the day and local communities informed of the construction schedule. - Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities. - Protect /preserve topsoil and reinstate after construction completed. - Contract provisions specifying minimum requirements for workers camps. - Contractor to prepare and implement a health and safety plan including safety manual. - Contractor to arrange for health and safety training sessions. - World Bank's EHS guidelines will be followed to ensure health and safety of workers. 			
Construction activities	Unexpected environmental impacts	If unexpected environmental impacts occur during project construction phase, the PMC will update the EMP, and the environmental protection measures will be designed and resources will be utilized to cope with these impacts.	Project cost	EA, PMC	During construction
C. Operation and Maintenance					
Reflection and glare from Solar arrays	Visual impacts and glare	Design of solar arrays to absorb incident solar radiation. Proper orientation of arrays.	To be included in EPC Contractor O&M cost.	EPC Contractor	During tendering, operation and maintenance
Cleaning of Solar Panels	Wastewater Generated from cleaning of solar panels	Provision and cleaning of adequate drainage system. Groundwater will not be used for cleaning PV panels, harvested rainwater or dry-cleaning method will be used. Otherwise, the water to be used for washing of the solar panels will be taken from outside sources. No detergent will be used in washing of solar panels. If bird droppings are soiling panels	To be included in EPC Contractor O&M cost.	EPC Contractor	During operation and maintenance

		increase the frequency of washing.			
Natural Disasters	Damage from cyclones and strong winds.	Design of foundations and racking system to withstand powerful cyclones and strong winds, which will reduce any potential hazard of panels being lifted up and blown onto adjacent properties.	To be included in EPC Contractor O&M cost.	EPC Contractor	During construction and operation and maintenance
Health and Safety	Health hazards in the event of accidents (cyclones, weather related events) and emergency	Emergency Response Plan Health and Safety Plan World Bank's EHS Guidelines will be followed.	O&M Cost	EPC Contractor	Emergency during operation and maintenance
Disposal and management of batteries	Impacts from used batteries and panels	Properly dispose the batteries as hazardous waste requiring transboundary disposal under the Basel Convention since facilities do not exist on the Maldives Replaced batteries will be stored in leak proof battery collection system provided by FENAKA until they are sent to authorised handlers / manufacturers for recycling and further management Only dry batteries will be transported to avoid possible leakages.	O&M Cost	EPC Contractor	During operation and maintenance
Disposal and management of used PV panels		PV panels that contain heavy metals will not be used since they could constitute hazardous waste.			
Storage and transport of diesel fuel		FENAKA will prepare and implement a plan for fuel and oil storage and handling. This will include (i) improvements to the existing bunded structure at the fuel storage tanks so that it will be protected from rain and will store spilt or leaked fuel for pump-out and proper disposal; (ii) redesign and construction of the existing oil-separator; and (iii) construction of a bunded concrete area for the storage of empty lubricant oil drums. Contractors' emergency response plan including occupational health and safety plan approved by PSC will be adopted to handle emergency situation during the operation period. Workers will be trained to deal with the emergency situations			

Operation of project facilities	Unexpected environmental impacts	If unexpected environmental impacts occur during project operation phase, the IA will update the EMP, and the environmental protection measures will be designed in compliance with World Bank's EHS Guidelines and resources will be utilized to cope with these impacts.	O&M Cost	IA	During operation
D. Decommissioning					
Dismantling of PV panels	Impacts from disposal of PV panels and batteries.	Contract agreements with PV panel suppliers for dismantling and disposal of panels and batteries.	Maintenance cost	EA	Post operation

Table 17. The EMP also includes a grievance redress mechanism.

1.3 Consultation, participation, and information disclosure

Stakeholder and community consultations have been carried out in each island in Thaa Atoll. This includes island councils, women's' development committees, teachers and school students and individual households. In addition to island level stakeholders, others such as the Ministry of Environment, Environment Protection Agency, utilities companies and Waste Management Agency were consulted. Information dissemination and awareness sessions were also conducted during field visits.

Overall, the community is positive and welcomed the installation of the PV hybrid installation. Many members stated their wish to start the project as soon as possible. The communities view the project as environmentally friendly and envisaged a reduction in noise and air pollution due to reduced use of diesel. Though they view there will be some disturbances to the community during the construction phase, they find it minor compared to the long-term benefits of the project. The communities are particularly receptive of the grid upgrading and replacement as they believe this will improve the quality of the service and reduce the costs of electricity.

2 Introduction

This initial environmental examination (IEE) is conducted for the renewable energy (RE) hybrid solutions to be implemented in Thaa Atoll and Noonu Atoll (sub-project) in Maldives under the Asian Development Bank's (ADB) Technical Assistance to Maldives for Preparing Outer Islands for Sustainable Energy Development Project (POISED or the Project). POISED aims to reduce diesel used in electricity generation through installation of RE hybrid solutions and energy efficiency improvements in the generation and distribution of electricity. This sub-project, Phase 5, is funded through ADB additional financing.

The Ministry of Finance (MOF) of Maldives is the executing agency for the sub-project. The Ministry of Environment (ME) and FENAKA are key implementing agencies for this sub-project.

2.1 Purpose of IEE

The purpose of this IEE is to assess potential environmental, health, safety and social impacts of the proposed interventions and propose suitable mitigation measures where required. The specific objectives of this IEE are to:

- provide an environmental and social baseline description of the sub-project;
- identify and describe the potential environmental and social impacts of the sub-project;
- design mitigation measures to minimize adverse impacts;
- describe the public consultation process and Grievance Redress Mechanism; and
- provide an Environmental Management and Monitoring Plan for the sub-project (including defining institutional responsibilities, capacity building and training, and the required budget).

This IEE has been carried out in compliance with the Project Administration Manual (PAM) and Environmental Assessment and Review Framework (EARF) prepared under POISED. This IEE also complies with the environmental impact assessment requirements of the Government of Maldives, as well as Safeguard Policy Statement (SPS 2009) of ADB.

2.2 Scope of IEE

The scope of this IEE is based on ADB SPS 2009 and EIA requirements of the GoM. For solar PV RE projects, the GoM does not require to have a full environmental impact assessment (EIA) but an IEE has to be submitted for approval. The scope of this IEE is limited to the following planned activities of the sub-project.

- Installation of solar PV systems (ground mounted and roof top) on islands of Thaa atoll
- Refurbishment of distribution mini-grid systems at connection points on islands of Thaa atoll
- Installation of Solar Powered Community Ice Plants in 4 inhabited islands (3 islands of Thaa atoll and 1 island in Noonu atoll)

The IEE does not include the establishment of powerhouses in the islands as the project will be using the existing powerhouse setups in the islands. All powerhouses have been established and operationalized following due environment assessments as required by the GoM EIA Regulations. As such transport and storage of diesel is also outside the scope of this IEE.

2.3 Background

The Maldives, located 750 km south west of Sri Lanka, is an archipelago consisting of 26 atolls and a total land area of about 300 km². About half the country's population lives on the outer islands which has 100% access to electricity. The Maldives has about 140 MW of installed diesel

generation capacity on the inhabited islands and another 100 MW on the tourism islands. Given the geographic location of islands, each island is electrified with its own diesel powered mini grid system resulting in expensive and not very reliable supply. The cost of diesel power is unaffordable at 30-70 cents/kWh and requires government subsidies in excess of \$40 million annually. Electricity sector subsidies are also one of identified areas for government expenditure management. In 2012, Maldives spent over \$470 million for oil imports of which fuel imports for electricity generation contributes significantly. The 100% diesel dependence of Maldives also makes its carbon emissions per unit of electricity among the highest in the region. State owned STELCO and FENAKA are the main electricity utilities responsible for supplying electricity to the communities in inhabited islands except a few where Island Councils are still responsible for the supplies.

The Maldives has significant renewable energy resources namely solar power and in some pockets wind power. Energy sector studies reveal that the cost of energy generation based on renewable energy and fossil fuel hybrids would be significantly lower compared to existing options. The Government has initiated two programs: one for the Greater Male region to increase renewable energy generation and the other on the Outer Islands to support energy efficiency and renewable energy investments.

The POISED project on the outer islands would transform the existing mini grids through physical investments in renewable energy, energy management and control systems, storage and improvements in distribution networks and significantly reduce the requirement for diesel to generate electricity. The project is aligned to ADB's Strategy 2020 of supporting sustainable energy growth, Energy Policy 2009 and is a part of the Maldives COBP for 2013-2015. It is expected that more efficient RE hybrid systems will be placed in 160 outer islands and the greater Male' region by end of the POISED project. In addition, capacity building for staff at the ME, FENAKA and STELCO. The capacity building areas would include procurement, project management, technical, financial management, gender and safeguard support and training.

2.4 IEE Methodology and Outline

This IEE is based on primary data collected from site visits and field surveys and secondary information collected from various sources. During site visits the specialists had consultations with various stakeholders including island councils and local executive powers for their opinions on the sub-project. The results of the consultations with councils and communities as well as an evaluation of the institutional framework have been incorporated into this assessment. The preparation of this IEE generally included the following processes.

- Review of available literature, including but not limited to, EIAs, monitoring and baseline reports, and technical reports/studies related to proposed sub-project;
- Conduct field visits to collect primary or secondary data relevant to the sub-project area to establish the baseline environmental condition;
- Carry out consultation with key stakeholders and administrative authorities to identify their perception on the sub-project, introduce project components and anticipated impacts;
- Assess the potential impacts on environmental attributes due to the location, design, installation and operation of the sub-project through field investigations and data analysis;
- Explore opportunities for environmental enhancement and identify mitigation measures;
- Prepare an environment management plan (EMP) outlining the measures for mitigating the impacts identified including the institutional arrangements;
- Identify critical environmental parameters required to be monitored subsequent to the implementation of the sub-project and prepare an environmental monitoring plan;

- Disclose the draft IEE at ADB website and prepare sub-project brief and/or FAQs in local language to be made publicly available at the offices of ME, FENAKA and Island Council Offices of the sub-project islands.

The IEE organized into sections which covers (i) sub-project description; (ii) description of the baseline environment; and (iii) impact assessment and mitigation measures. The IEE report has the following contents:

- Executive Summary
- Introduction
- Description of the sub-project
- Policy, legal, and administrative framework
- Existing environment
- Impact assessment and mitigation measures
- Analysis of Alternatives
- Consultation, Participation, and Information Disclosure
- Environmental Management Plan
- Conclusion

3 Description of the Sub-project

The sub-project includes addition of RE hybrid (diesel + solar PV) systems with grid support battery system in 12 inhabited islands on Thaa Atoll and installation of 4 Solar Powered Community Ice plants in 4 inhabited islands of three different atolls. The sub-project includes the following 4 components.

- Component 1: Installation of solar PV systems (ground mounted and roof top)
- Component 2: Refurbishment of distribution mini-grid systems (at PV grid connections)
- Component 3: Installation of 4 Solar Powered Ice Plants
- Component 4: Capacity building of PMU/FENAKA/STELCO staff on O&M of RE systems

This IEE covers Components 1-3. The hybrid systems have been custom designed for each individual island based on the current load, demographic, and energy use patterns of the island¹ (ILF Consulting Services, 2016). Each hybrid system includes diesel generators, solar PVs, and battery storage as required.

Table 2 shows details of the system to be established in each island. The total generator capacity of the system will be 11,978kW. The system also includes 2,490kWp of PV and a battery storage system of power 1,125kW and capacity 2,250kWh. The total estimated cost of the project is US\$ 5.46 M. The project also includes installation of 4 solar-powered ice plants with a total capacity of 50T/day of ice production and with 985 kWp solar power. The ice plants are estimated to cost about US\$ 2 million.

¹ ILF Consulting Services (2016). Feasibility study for Phase 5 hybrid systems and grids upgrade – Thaa. Male': Ministry of Energy.

Table 2. Summary of RE hybrid system for islands in Thaa Atoll

Island	System Type (see Table 4)	Size PV (kWp)	Battery power/capacity (kW/kWh)
Vilufushi	A	180	-
Madifushi	A	140	-
Dhiyamigili	A	90	-
Guraidhoo	A	180	-
Kan'doodhoo	C	300	200/400
Vandhoo	C	300	200/350
Hirilandhoo	A	180	-
Gaadhiffushi	C	150	150/300
Thimarafushi	A	220	-
Veymandoo	A	250	-
Kinbidhoo	C	300	225/450
Omadhoo	C	200	200/400
	TOTAL	2,490	975/1950

Commented [EFM1]: Please explain how many batteries this relates to (in relation to subsequent disposal)

Commented [MM2R1]: This information is not available at this stage. The Contractor will provide the number of individual battery systems during the detailed design.

3.1 Project location: RE hybrid systems

The of the sub-project is located in Thaa Atoll (also known as Kolhumadulu) in the central south of the Maldives. Figure 1 shows the location of the atoll and islands. The atoll is located between latitudes 2°07'N and 2°35'N and longitudes 72°52'E and 73°25'E. Thaa atoll is about 180km south of capital Male'. The atoll has 66 islands, of which 13 are inhabited. The capital of the atoll is Veymandoo. The nearest airport to the islands is in Thimarafushi of the atoll. The sub-project is located in 12 of the 13 of the inhabited islands. PV hybrid systems have been installed in Buruni in Phase 1 of the POISED project. Hence, Buruni is not included in the scope of component 1 and 2, but is included for component 3 . Geographic and demographic details of these 12 sub-project islands are given in

Table 3.

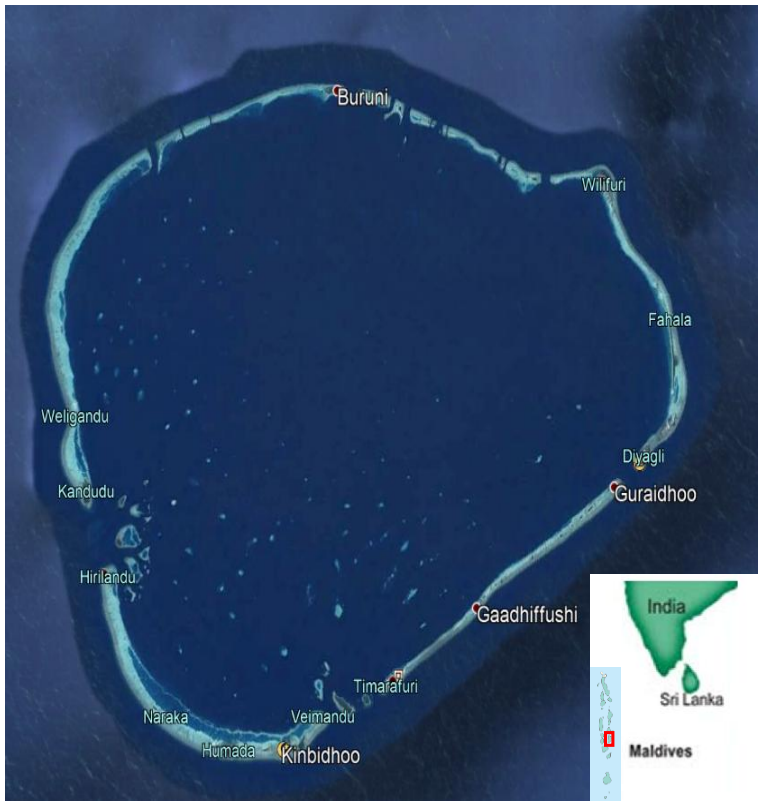


Figure 1. Map of Thaa Atoll (adapted from: Google Earth Pro map)

Table 3. Summary of existing features on each island in Thaa Atoll

Name of the island	Geographical Location	Total Land Area (km ²)	Distance from Male (km)	Distance from Nearest airport (km)	Population	Number of Households
Vilufushi	2°30'11"N 73°18'30"E	0.6	188.3	39.52	2,110	309
Madifushi	2°21'24"N 73°21'17"E	0.2	202.8	28.01	1,333	265
Dhiyamigili	2°20'21"N 73°20'13"E	0.3	206.5	25.37	890	129
Guraidhoo	2°19'30"N 73°19'9"E	0.3	208.5	22.65	2,060	310
Kan'doodhoo	2°19'15"N 72°54'59"E	0.8	217.8	28.75	663	110
Vandhoo	2°17'29"N 72°56'30"E	0.3	218.5	25.58	404	80
Hirilandhoo	2°16'15"N 72°55'54"E	0.3	222.6	24.98	1,183	255
Gadhiffushi	2°16'15"N 72°55'54"E	0.1	217.4	8.42	697	60
Thimarafushi	2°12'20"N 73°8'34"E	0.2	224.1	0	2,589	212
Veymandoo	2°11'12"N 73°5'42"E	0.4	227.1	10.15	1,305	291
Kinbidhoo	2°10'5"N 73°3'57"E	0.3	229.6	10.31	1,450	160
Omadhoo	2°10'3"N 73°1'25"E	0.4	230.9	14.81	777	247

Source: Island Councils of Th. atoll, 2019. Statistical Yearbook of Maldives 2017 and Island Electricity Data Book 2018, Ministry of Environment, Maldives, and <http://www.atollsofmaldives.gov.mv>.

3.2 Project Activities: RE Hybrid Systems

The main activities included in this IEE are the installation of RE hybrid systems in the 12 islands of Thaa Atoll and installation of 4 solar powered community ice plants in 4 islands from different three atolls. The power generation hybrid systems will constitute of PV panels, diesel generators, battery storage systems and energy management systems (EMS) as pre-identified in the feasibility study. The capacities for each component of the system (PV, generators and battery storage) have been individually set for each island by studying the energy load, current and projected energy demand of the islands. Three generic designs of hybrid systems have been developed to be implemented under the POISED project. Descriptions of the three generic designs Type A, type B and Type C are given in Table 4. Schematic diagrams of the hybrid designs are shown in Figure 2. Types A and C designs are used in Thaa Atoll. Type A is used to maximise utilization of available funds..

Table 4. Generic designs of RE hybrid systems for POISED project islands

Type A: Moderate renewable energy penetration	<ul style="list-style-type: none"> • Type A systems will consist of PV panels and gensets only. • There are no battery storage systems • Islands will usually operate in a hybrid mode during sunny hours • Used in islands with very high electricity consumption (e.g. cities)
Type B: High renewable energy penetration	<ul style="list-style-type: none"> • Uses PV panels, gensets and a battery storage system • Battery system is designed to give grid support system, when required, against sudden power fluctuations (e.g. cloud-shading effects in the PV panels), typically around 15 minutes • Used in islands medium electricity consumption
Type C: Very High or Full RE penetration (RE penetration higher than 80%):	<ul style="list-style-type: none"> • Has the same components of a Type B design but in Type C the battery storage capacity is higher than Type B • Most of the energy consumed by energy customers comes from RE. Gensets are installed for security reasons for supply security in case of failure or maintenance • Battery system is designed to give grid support as well as grid forming. The system can give energy support in case of long periods of lack of solar energy • Used in islands with low electricity consumption

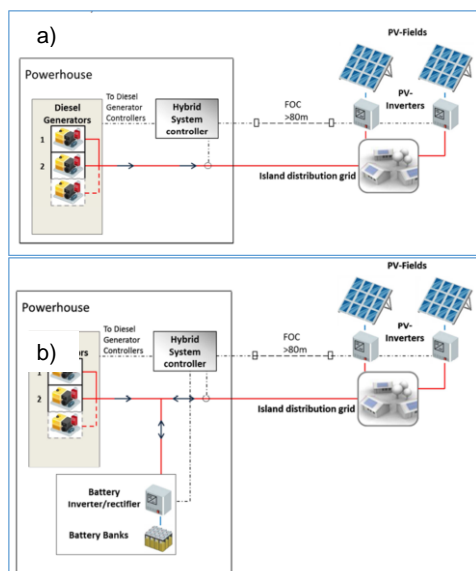


Figure 2. RE hybrid systems for POISED islands. a) Type A, b) Type B and Type C

3.2.1 Project Activities: Construction Phase of RE Hybrid Systems

Installation of PV panels will be the main construction activity carried out in the project. PV panels will be installed on rooftops of existing buildings and ground mounted structures where roofing is not available. As seen in Table 5, mainly rooftops and ground area within powerhouses will be used. Powerhouses in the islands are being moved to areas away from residential areas, where land is available, and these are separate plots of land with the whole block allocated to the powerhouse. These have walls around them to demarcate the powerhouse property. During site visits for revising feasibility new houses were being built in Thaa and only some had the wall around but they will be built when the area is completed in those islands that currently does not have a wall. Figure 3 shows a typical powerhouse. In Veymandoo, the rooftops of the school will be used for PV installation in addition to ground mounting in the powerhouse land. Where needed, in addition to the powerhouse land, Island Council owned land near the harbour, powerhouses and public buildings are utilised.

Due to lack of rooftops in many islands ground mounting structures have to be newly built on empty ground. The structures will be raised frames over which a roof will be placed. The PV

will be installed on the roof and the space underneath will be utilised for other purposes which varied in islands. Some wanted to use the space for storing bulky things, staff vehicle parking or even a space which can be used for as a recreational space for staff to hang around or additional office space. Ground mounting structures in public spaces like harbour areas are to be used as waiting areas, public meeting areas, small shop outlets, parking, or storage areas.



Figure 3. Omadhoo powerhouse showing rooftop PV and ground mount locations (Free field in yellow) with wall around the plot

Table 5. PV installation in Thaa Islands

Island	Roof top PV/kWp Area m ²		Ground PV/kWp Area m ²		
	powerhouse	school	powerhouse	council land	harbour
Vilufushi			180 1400		
Madifushi	60 4448		40 520		
Dhiyamigili	15 115			75 864	
Guraidhoo				180 1166	
Kan'doodhoo	40 2750		100 600	100 600	
Vandhoo	15 125.35		50* 345		35 250
Hirilandhoo			120 866		60 444
Gaadhiffushi					150* 1072.5
Thimarafushi			160 1380	60 600	
Veymandoo		155 1308	95* 810		
Kinbidhoo	34 275		170* 1250		
Omadhoo	22 176.4		100 756		

*Areas where some trees have to be removed.

The construction of ground mounting structures will involve some amount of civil works but would be of short duration. Many of the areas identified are empty fields with little or no vegetation. In these places some clearing of ground cover may be required. The trees within powerhouses (Vandhoo, Veymandoo, and Kinbidhoo) are areas that have yet to be cleared to develop the powerhouse. Large number of coconut trees (10 and 35 respectively) are in the powerhouse land of Veymandoo and Kinbidhoo (Figures 3 & 4). This land has been newly given land for building the powerhouse and at the time of the field visit the whole land area has not been cleared. Plans are to clear the rest of the powerhouse land for further development. Authorisations for clearing of vegetation and providing compensation for individuals have been carried out in the powerhouse development phase when the land was allocated for powerhouse development. So irrespective of the POISED project the trees in the area are planned to be removed. This area has mainly coconut plants and under the Maldivian law any coconut palms belong to a person has to be given monetary compensation if being cut. This will be checked during implementation and the required compensation will be paid through the Island Council process. Further, the PMU should ensure during project implementation that compensatory vegetation will be planted elsewhere on the island. The other area where large number of trees have to be removed is in the harbour area of Gaadhiffushi. The Island Council plans to build a series of shops and a waiting area for passengers in the proposed area. Hence, the trees are planned to be removed according to the island development plans.

As existing facilities of the powerhouses will be used, no facilities for battery storage will be built. In some islands grid upgrading may be required. In such cases there will be some civil works such as digging trenches for cable. This will be short term in duration.

Commented [EFM3]: Can you identify which islands this will be on?

Commented [MM4R3]: This was not specified in the feasibility study



Figure 5. Powerhouse area in Veymandoo



Figure 4. Powerhouse area in Kinbidhoo



Figure 6. Harbour area in Gaadhiffushi with proposed ground mounting area in red

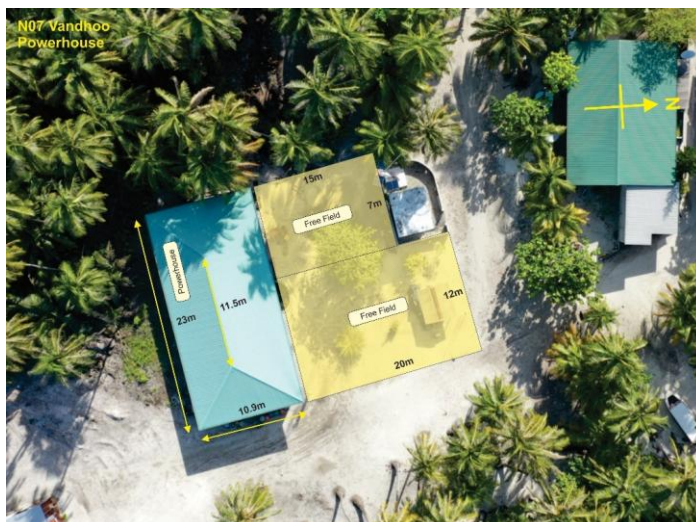


Figure 7. Vandhoo powerhouse (yellow areas indicate where trees will be removed for ground mounting structure)

3.2.2 Project Activities: RE Hybrid Systems Operational Phase

The operational phase does not require much physical activities. The PV panels supported by the battery storage system and diesel generators would provide cleaner, less fuel consuming electricity. The only anticipated work within the scope of the IEE is regular maintenance of the hybrid system. As there are no moving parts in the PV panels there will be minimal wear and tear and cleaning for dust and salt deposits would be the main maintenance work required. Ground water will be used for cleaning.

The battery storage systems do not require regular maintenance but will need to be disposed at the end of life. Currently Maldives does not have facilities for disposal of such hazardous waste. Therefore, contractors are required under Contract agreement to remove batteries out of Maldives to dispose in a hazardous waste management facility. Regular use according to given guidelines would ensure use of batteries to full lifetime. The lithium ion batteries used in the sub-project are estimated to have a life of 8 years. Regular and routine maintenance of diesel generators will be carried out as part of the powerhouse operations and is beyond the scope of this IEE.

3.3 Project Activities: Solar-Powered Ice Plants

The subproject also includes implementation of 4 solar-powered community ice plants in 4 islands. Three ice plants of capacity 15T/day will be installed each in Noonu Landhoo, Thaa Madifushi and Thaa Vilufushi. An ice plant of 5T/day capacity will be installed in Thaa Buruni. The details of the 4 ice plants are given in Table 6. Figure 8 shows the schematics of the ice plant to grid and powerhouse connection for the 3 15T/day ice plants and Figure 9 shows the schematics for the 5T/day capacity ice plant in Buruni.

The installed PV will feed Ice making machine in normal operation. Any PV excess will be injected to the main grid following Maldivian net metering regulations. The PV plant will be controlled by the existing EMS at the powerhouse (either already installed, or installed as part of the RE hybrid system). During sunny hours the PV plant will provide energy to the ice making plant and any PV excess will be evacuated to the main distribution grid following Net Metering regulations. For those periods when there is not enough PV energy, the ice making machine will also be fed from the main distribution grid. The ice plants are located near the harbour area of the islands where it will be easy access for fishing boats. Figures 8-11 show the location of these plants in the 4 islands. Some large trees are within the marked area for the site in Noonu Landhoo. Depending on the building location within the allocated land these may need to be removed. The PMU should ensure that land for the building tries to avoid removal and if this is unavoidable, compensation vegetation should be planted elsewhere in the island.

Commented [EFM5]: Correct?

Commented [MM6R5]: yes

Table 6. Summary of technical details of ice plants

Island	Ice Plant Capacity (T/day)	PV plant (kWp)	Battery capacity (kW/kWh)	EMS	Grid upgrading
D07 Landhoo	15T/day 80kW	100*	-	-	1 lot
N01 Buruni	5T/day 30kW	100	100/50	1 unit	1 lot
N03 Madifushi	15T/day 80kW	100	-	-	1 lot
N02 Vilufushi	15T/day 80kW	100	-	-	1 lot
TOTAL		400	100/50		

*Some trees may need to be cut

Commented [EFM7]: Please detail the area of land as well as the kWp
If this PV plant is part of the ice making machine works (additional to PV for the RE hybrid system) it is having nearly as much impact as the ground mounted solar (unclear why this component categorized as C)

Commented [MM8R7]: The area size is not provided in the technical specifications

Commented [EFM9]: Please clarify how many batteries this relates to

Commented [MM10R9]: Will be available in detailed design

Commented [EFM11]: So is this a new EMS being installed under the project? Above it says the EMS are existing...

Commented [MM12R11]: Yes. In the pilot

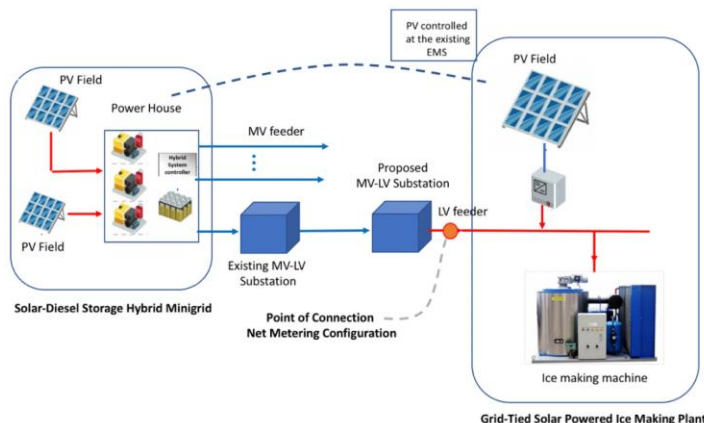


Figure 8. Schematics of 15 T/day capacity ice plant

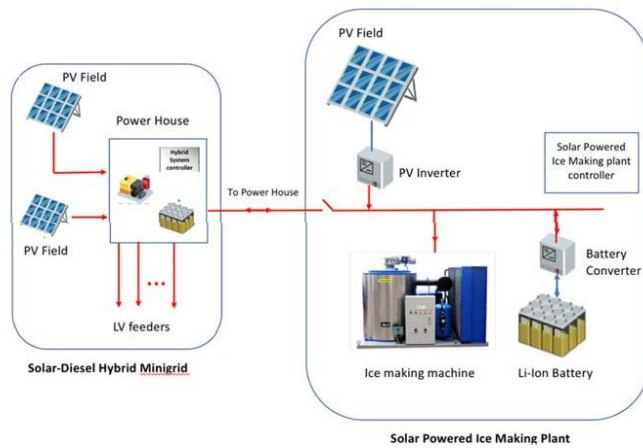


Figure 9. Schematics of 5T/day ice plant in Buruni.

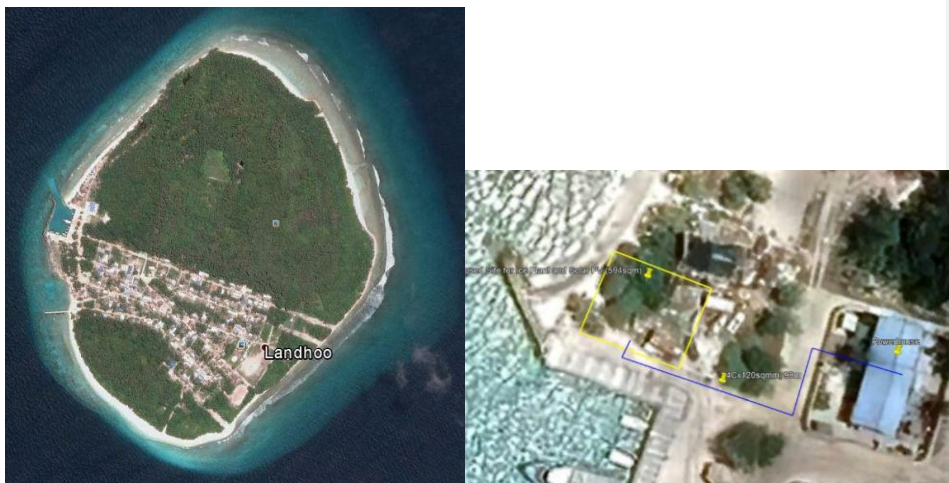


Figure 10 Landhoo island (left) and close up of harbour area showing location of ice plant



Figure 11. Land allocated for community ice plant in Buruni



Figure 12. Madifushi island showing ice plant location



Figure 13 Vilufushi island (left) and ice plant location (right)

3.4 Project Management and Implementation Plan

The Ministry of Finance (MOF) of Maldives is the executing agency for the POISED project and sub-projects. The Ministry of Environment (ME), and FENAKA are key implementing agencies for this sub-project. State owned STELCO and FENAKA are the main electricity utilities responsible for supplying electricity to the communities in inhabited islands. A Project Steering Committee (PSC) comprising of the Ministry of Environment, Ministry of Finance, Ministry of Economic Development, FENAKA and STELCO oversee the implementation of the project activities. A Technical Committee comprising of members from the ME, PMU, utilities, and other stakeholders was formed to provide technical support as needed. Implementation work is carried out by a Project Management Unit (PMU) and Project Implementation Unit (PIU) housed under the Energy Department of ME and utilities, FENAKA and STELCO, respectively.

3.5 Project budget

The total estimated budget for the sub-project in Thaa is US\$ 5,460,000. Component level details of the budget are given in Table 7. In addition, the 4 community ice plants will be costing an estimated US\$ 2 million.

Table 7. Estimated Budget for Implementing RE Hybrid Systems in Thaa Atoll

Component	CAPEX in Hybrid
	M\$
PV (2.49 MWp)	2.82
Storage (1.90 MWh)	1.85
EMS	0.6
Grid and PV feeder upgrade	1.06
Total	5.46

4 Legal policy and administrative framework

The environmental assessment of the sub-project has been carried out in accordance with Project Administration Manual (PAM) and Environmental Assessment and Review Framework (EARF) prepared for the POISED Project. It also complies with ADB's Safeguard Policy Statement (SPS) 2009 and the Government of Maldives's legislations and requirements.

The Environment Protection and Preservation Act of Maldives, EPPA (Law No. 4/93) provides the basic framework for environmental management in Maldives. According to Article 5 (a) of the Act, an Environmental Impact Assessment study shall be submitted to the Ministry of Environment before implementing any activity that may have an impact on the environment. Articles 2, 4, 6, 7, and 8 of the law are relevant to the POISED sub-projects.

The Environmental Impact Assessment (EIA) Regulation is the main regulation of relevance for this sub-project (Section 4.1). This IEE is the environmental assessment as per requirements of the EIA Regulations 2012. Other relevant laws and regulations are Environmental Damage Liabilities Regulation (2011), National Biodiversity Strategy and Action Plan (2002), Waste Management Policy, Waste Regulations (2013), Regulation on Fuel Storage, Handling and Usage (2015) and Regulations of Conservation of Old Trees. The stipulations of these laws and regulations will be adhered to during the implementation of the sub-project.

4.1 EIA Process of the Maldives

The EIA Regulation, which came into force in 2007 and was revised in 2012, provides step-by-step guidance for proponents, consultants, government agencies and the general public on how to obtain approval for development projects in the form of an Environmental Decision Statement. An initial screening determines if an EIA is required or not for the proposed project. Those projects not requiring a full EIA will have to provide further information to the Ministry of Environment and Energy. Based on this additional information, the Ministry will request either an Environmental Management Plan, an IEE or both.

For those projects requiring a full EIA, the Ministry then decides the scope of the EIA, which is discussed with the proponent and the EIA consultants in a "scoping meeting". The consultants then undertake the EIA starting with baseline studies, impact prediction and finally reporting the findings with impact mitigation and monitoring program. Based on the full EIA report submitted, the EPA will issue an EIA Decision Note stating whether approval for the project is given or not. As a condition of approval, appropriate environmental monitoring may be required, and the proponent shall have to report monitoring data at required intervals to the EPA.

4.1.1 Government Requirements for proposed Phase 5 sub-project

Projects involving implementation of PV systems do not require a full EIA under the EIA Regulations, 2012 of the Maldives. Under the 2nd Amendment to the EIA Regulation of 2012 (2015/R-174), published on 30th August 2015, installation of solar PV on roofs of existing buildings can be carried out without an EIA or EMP. Nevertheless, an Environmental Screening Form was submitted to the EPA by the project proponent (ME) to check whether such sub-project requires an EIA or not. After reviewing the scope of such sub-projects, the EPA issued a decision for POISED Project stating the sub-project activities are mainly solar PV system installation; therefore, EIA is not required for these activities. However, it stated that project proponent has to have an EMP in place to mitigate any unforeseen impacts. Also, if any sub-project requires removal of more than 10 trees from a single site, it has to submit an EIA to the EPA. The Decision Note issued by EPA for POISED Project (in Dhivehi language and a translation) is attached as Appendix 1. For any change in scope including change in location, ME shall submit screening form to EPA to check whether any further study is required to fulfil government requirements. The

Commented [EFM13]: In this case more than 10 trees are being removed, so please confirm that the EIA was prepared for the Thaa atoll subproject

Commented [MM14R13]: The required legalities regarding vegetation clearing for powerhouse land has been already cleared before the POISED work.

Thaa PV sub-components are following the same activities and has no change in scope. Hence, a EIA screening was not submitted. However a screening meeting was held with EPA for the ice-making plant and PMU was advised that a full EIA will need to be done once the final designs are finalised.

4.2 Environmental Safeguards Requirements

This environmental assessment is carried out in accordance with EARF prepared for the POISED Project. It complies with Appendix 1 of SPS 2009 so as to ensure that potential adverse environmental impacts are identified, avoided where possible and managed or addressed.

4.3 Environmental Standards

Environmental management in the Maldives is still at an infancy and lacks the necessary environmental standards and the institutional capacity to manage. Water quality, air quality and noise standards are usually taken from international standards or standards of developed countries.

Water quality standards are based on the WHO guidelines for drinking water and other international standards.

In the absence of local noise standards, internationally acceptable noise standards such as those of the US EPA have been adopted in reducing noise emanating from powerhouses.

Table 8 gives the ambient noise standards included in the World Bank/IFC EHS guidelines which are applicable to the sub-project. The subproject will need to ensure that the industrial noise levels are met at the powerhouse boundary and that the residential noise levels are met at the nearest property to it, or, if they are already exceeded, as a LAeq 1 hour, background noise levels increase by <3dB(A).

For air quality, the Maldives has yet to establish ambient air quality standards to serve as a basis for air quality management. Consequently, the standards of other countries will have to be employed in evaluating sub-project impacts on air quality. In the Maldives, for reference purposes, the ambient air quality standards of the World Bank/IFC EHS guidelines are used (Table 9). For emission standards of diesel generators, the World Bank/IFC EHS guidelines are also used.

Table 8. Some Selected Noise Standards

Country / Agency	Standard in dB(A)	Averaging Times
US EPA	< 65	Day time
	< 55	Night time
World Bank / IFC	<70	Industry or Commercial
	< 55	Day time Residential
	< 45	Night time Residential
Germany	> 55	Day time

Country / Agency	Standard in dB(A)	Averaging Times

Table 9. Ambient Air Quality Standards of WHO/WB EHS

Ambient Air Quality Parameter	Averaging Period	WB Guideline Value	
Sulphur dioxide (SO ₂) (ug/m ³)	24-hr	125	(Interim target 1)
		50	(Interim target 2)
		20	(guideline)
	10 min	500	(guideline)
	Annual	None	
Nitrogen dioxide (NO ₂) (ug/m ³)	1 Year	40	(guideline)
	24 Hour	None	
	1 Hour	200	(guideline)
PM10 (ug/m ³)	1 Year	70	(Interim target 1)
		50	(Interim target 2)
		30	(Interim target 3)
		20	(guideline)
	24-hr	150	(Interim target 1)
		100	(Interim target 2)
		75	(Interim target 3)
		50	(guideline)
PM2.5 (ug/m ³)	1 year	35	(Interim target 1)
		25	(Interim target 2)
		15	(Interim target 3)
		10	(guideline)
	24-Hour	75	(Interim target 1)
		50	(Interim target 2)
		37.5	(Interim target 3)
		25	(guideline)
Ozone (O ₃) (ug/m ³)	8-hr daily max	160	(Interim target 1)
		100	(guideline)

5 Existing Environment

The sub-project will be implemented in 12 islands of Thaa Atoll and in Landhoo in Noonu Atoll.

Table 3 gives some geographical and demographic features of the 12 islands. The islands are in the same geographic region and share many similarities in terms of climatic conditions, physical environmental as well as social and cultural characteristics. Therefore, the description of the existing environment will be generic for all 12 islands with any unique characteristics in individual islands highlighted within the description.

5.1 The Physical Environment

Figures 13-24 give maps of the 12 islands where PV hybrids will be installed. The maps show the general physical environment (both the natural and built environments) and the locations where PV panels will be installed (roof PV in red and ground mounting in yellow). Ice plants will be installed in the harbour area of Buruni, Madifushi and Vilufushi, and in Landhoo. A map of Noonu Lndhoo island is provided in Figure 10 and a map of Thaa Buruni is provided in Figure 26.



Figure 15. Vilufushi



Figure 14. Madifushi



Figure 17. Dhiyamigili



Figure 16. Guraidhoo



Figure 19. Kandhoodhoo



Figure 18. Vandhoo



Figure 20 Hirilandhoo



Figure 21. Gaadhiffushi



Figure 22. Thimarafushi



Figure 23. Veymandoo



Figure 25. Kinbidhoo



Figure 24. Omadhoo



Figure 26. Thaa Buruni

5.1.1 Meteorology and Climate

The climate of Maldives and in Thaa atoll is tropical and monsoonal. Two seasons dominate Maldives' weather: the dry season (December to April) associated with the northeast monsoon and the rainy season (May to October) brought by the summer southwest monsoon. The southwest monsoon sees the arrival of heavy rain and sometimes very windy weather, while the northeast monsoon is dry and calm. Rainfall at Hulhule² shows that in the northern atolls there is an annual average of 1,966 mm of rain. More rainfall is experienced May-January while there is less rainfall from February to March.

The location of the Maldives near the equator and surrounded by sea means that there is very little temperature variation throughout the year. The temperature of Maldives ranges between 25°C and 31°C throughout the year. According to meteorological data from Hulhule, the warmest period in the central atolls are from March through to May.

The wind direction over central atolls vary between west-southwest and west-northwest of which predominant winds blow in a westerly direction. Winds follow the traditional definition of monsoon with seasonal reversal of wind direction by more than 120° occurs between the months January and July.

² Hulhule is the central meteorological station of Maldives and is in Kaafu Atoll.

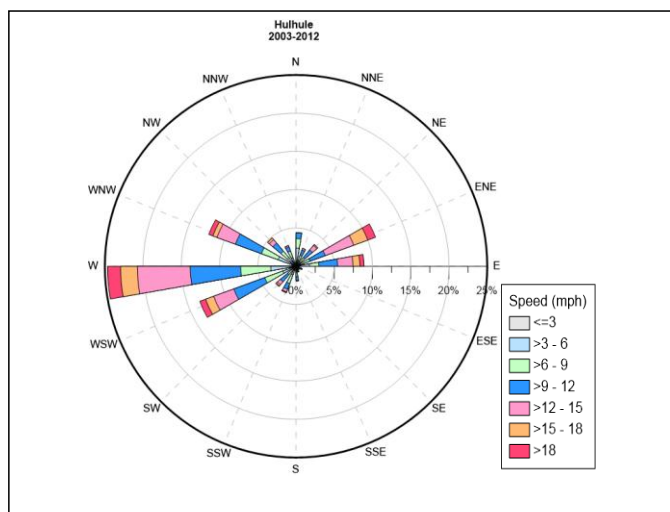


Figure 27. Wind rose for Hulhule' station in the centre, 2003-2012

The Maldives is outside the main area of tropical cyclones and therefore gales are uncommon and cyclones are very rare. However, during the southwest monsoon season strong winds and storms may hit the archipelago and can cause severe damage. A climate risk profile for Maldives³ indicates that the main impacts of climate change are expected to be high sea levels, extreme winds, and extreme high air and water temperatures. Best estimates of long-term, systematic changes in the average climate for Maldives indicate that sea level is likely to have increased by 36 centimetres and the frequency of severe short sea level rise resulting from storm surge (2.2 meters above mean sea level) will increase from a one in 580-year event to a one in 5-year event by 2050. The project will provide solar PV systems with resilience to climate change through compact and preassembled systems resistant to marine environment.

5.1.2 Geology, Soils and Mineral Resources

The soils of the Maldives are geologically young and consist of substantial quantities of the un-weathered coral parent material, coral rock and sand. In most of the places, soils are coarse in texture and shallow in depth with a top layer of brown soil (0 to 40 cm in depth) followed by a transition zone on top of the underlying parent material of coral reef limestone. In some low-lying areas and areas subjected to significant mechanical breakdown from human activity, fine deep soils are found with accumulated deposits of clay. In many places, top layers of the soils have a weakly developed structure and at times a 30cm thick hard-pan layer cemented with calcium carbonate is present, preventing penetration of the roots of most plants except large trees. The water-holding capacity of the soil is very poor due to high porosity and very high infiltration rates.

The soils of the Maldives are generally alkaline with pH values between 8.0 and 8.8. This is mainly due to the presence of excess calcium and, soils containing higher levels of humus, as in depressions and wetlands, are less alkaline. The soils are generally poor and deficient in

³ Climate Risk Profile of Maldives prepared by MEE, 2006, and Disaster Risk Profile of Maldives prepared by UNDP, 2006

nitrogenous nutrients, potassium and several micronutrients particularly iron, manganese and zinc. Though the phosphorus content of the soils is high it is present mostly in the form of calcium phosphate and, thus, remains unavailable to plants.

5.1.3 Water Resources

There are no rivers or streams in any of the islands of Maldives, and only a few wetlands or freshwater lakes locally known as *kulhi* exists in few islands. These are not used as sources of water by the communities. There are no wetland areas in Thaa Atoll according to the State of the Environment reporting by the Ministry of Environment. Similar to other islands of the country, the main source of freshwater is groundwater and rainwater. Groundwater is found in basal aquifers, generally unconfined in nature and extending below sea level in the form of a thin freshwater lens. They are vulnerable to saline intrusion owing to the freshwater-seawater interaction and need to be carefully managed to avoid over-exploitation.

Rainwater is generally used for drinking and cooking and groundwater for most other domestic needs. Rainwater is tapped from roofs and collected and stored in various types of tanks. All the islands have individual household as well as community tanks. According to the Second National Communication of the Maldives to the UNFCCC, Thaa has a high rainwater storage capacity of 701-800 litres per capita. Despite this during elongated dry periods, some islands in Thaa Atoll need to be supplied with emergency freshwater.

Trans-boundary air pollution, known as the Atmospheric Brown Cloud, from the Indian sub-continent is of concern to the rainwater quality in the Maldives. Measurements at Hanimaadhoo Climate Observatory show an increase of pollutants (SO_x, NO_x, and Ammonium) and an overall decrease in pH in rainwater is observed in December and January. Being in the central southern part of the country, Thaa may be less impacted from this.

5.1.4 Biodiversity

Terrestrial Flora and Fauna. Maldives has limited terrestrial biodiversity due to the lack of land, salinity, alkaline soils, and salt laden winds⁴. Despite this there is a rich coastal vegetation compared to the fauna. Islands of Thaa have flora and fauna characteristics similar to the other islands of the Maldives. Vegetation in a typical Maldivian island can be broadly categorized into beach crest and inner island vegetation⁵. The beach crest contains species such as *Scaevola taccada* (sea lettuce), *Pemphis acidula* (ironwood), *Tournefortia argentea* (octopus bush), *Pandanus* (pandanus varieties such as screw pine), *Guettarda speciose* (beach gardenia), *Cordia subcordata* (sea trumpet), *Hibiscus littoreus* (Portia tree) and *Hibiscus tiliaceus* (sea hibiscus).

In many islands the forest area adjacent to the beach crest contains coconut as the dominant species. This may be mixed with other coastal vegetation such as *Morinda citrifolia* (noni tree), *Guettarda speciose* (beach gardenia), *Cordia subcordata* (marer), *Calophyllum inophyllum* (Alexandrian laurel), *Barringtonia asiatica* (fish poison tree) and *Terminalia catappa* (Indian almond). In many islands the original distribution of trees and shrubs has been greatly disturbed by the establishment of extensive coconut plantations. In addition, in many inhabited islands fruit trees such as breadfruit, mango, papaya, guava, variety of citrus and native vegetables are grown.

⁴ Sujanapal, P. & Sankaran, K.V. (2016). *Common plants of Maldives*. Bangkok: Food and Agriculture Organization and Kerala Forest Research Institute.

⁵ Selvam, V. (2007). *Trees and shrubs of the Maldives*. Bangkok, Maldives: Food and Agriculture Organization and Ministry of Fisheries and Agriculture

Figure 28 shows the percentage cover of vegetation in the 12 islands of Thaa atoll. The average vegetation cover in the islands is 28%. Only 2 of the islands maintain more than 50% of the natural vegetation. Four islands (Vilufushi, Madifushi, Guraidhoo, Thimarafushi) have less than 10% of its natural vegetation. Vilufushi island had been severely destroyed by the Indian Ocean tsunami of 2004 and has been rebuilt after clearing the damaged vegetation and houses. These islands contain a large built environment. The islands Madifushi, Guraidhoo and Thimarafushi has had large areas of the island reclaimed; close to 70%, 60% and 80% respectively. Hence the low natural vegetation percentage. Among the islands where ice plant are to be established, except for Landhoo, the islands have low natural vegetation, as can be seen from the maps. Landhoo has a large area of the island in pristine condition and as can be seen in Figure 10 the settlements are only about a third of the island. Almost half of the island is untouched vegetation.

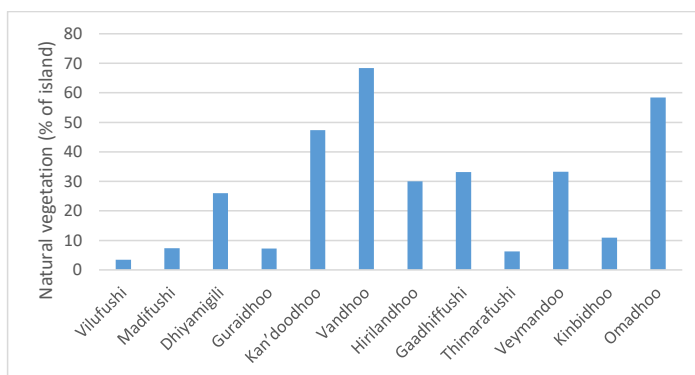


Figure 28. Percentage vegetation cover⁶ in the islands of Thaa Atoll, Maldives

The diversity of native terrestrial fauna is poor compared to the flora. The bulk of the fauna includes sea birds, 167 species recorded¹⁰. Among other animals there are some insects, 2 species each of geckos, snakes, and lizards, 1 type of frog and the fruit fly the only native mammal.

Marine biodiversity. With the larger portion of Maldives comprising of marine areas, there is a rich marine biodiversity. The marine environment is rich with algae species from 4 phyla, 258 different species of corals, over 1200 species of fish, 40 species of sharks, over 400 species of molluscs, over 350 species of marine crustaceans, 6 species of seagrass, 5 species of turtles, 16 species of rays, 23 species of whales and dolphins, 36 species of sponges and over 80 species of echinoderms exists.

5.1.5 Protected areas

There are no nationally protected areas within Thaa Atoll. However, there are 12 sites identified as ecologically sensitive areas by the EPA. These are mainly seabird roosting areas and some wetlands and a turtle nesting island. Two of these sites are on the islands of Veymandoo and Kan'doodhoo, which are project islands. The mangrove areas in these 2 islands are considered ecologically important. However, as seen in Figure 30 PV locations do not coincide with these areas. In addition the marshy mangrove area of Landhoo, one of the islands where an ice plant will be installed, is also considered an ecologically sensitive area by the EPA and these

⁶ Percentage vegetation cover is roughly estimated by estimating the area in Google Earth Pro.

areas are about 0.3km away from the ice plant site. In Veymandoo the PV locations are well away from the marshy area, distances ranging from 0.25-0.65km while in Kandoodhoo the sensitive areas are about 1km from the PV locations. Six varieties of mangrove trees including the mangrove apple and the much rarer cedar mangrove are found there. These sites will not be impacted by the PV hybrid systems or ice plant development.

In addition, there are a number of species of fauna protected in the whole of Maldives including Thaa atoll. These include 103 species of birds, all species of turtles and rays and skates protected under the EPPA 4/93. In addition, dolphins, Napoleon wrasses, giant clams, black coral, whale sharks, conch shells, whales, sharks, berried female lobsters and lobsters less than 25cm in total length are protected under the Fisheries Act 5/87. In addition, there are a number of large trees which are protected under the Regulations of Conservation of Old Trees.



Figure 29. Ecologically sensitive areas in Thaa Atoll



Figure 30. Location of sensitive areas in Veymandoo and Kandoodhoo



Figure 31. Ecologically sensitive area in Noonu Landhoo (green icon)

5.2 The social environment

This section entails a brief description of the social environment of Thaa atoll. A detailed socio-economic and gender assessment has been conducted for the POISED Thaa Atoll PV and PV ice plants sub-project and is reported separately. This section gives a brief overview of the social environment in Thaa Atoll and Noonu Landhoo. A detailed social assessment of Noonu Landhoo is provided in the social assessment for Noonu Atoll sub-project.

The islands consist of small communities with populations ranging from 404 to 2,589 (

Table 3). Landhoo has a registered population of 1025 with 292 households. The islands Vilufushi, Guraidhoo and Thimarafushi have quite large populations of over 2,000. Excluding these 3 islands, the rest of the islands have an average population of about 967. Only 1 island (Kan'doodhoo) has a population less than 500 (Figure 32). However, Kan'doodhoo has a high foreign worker population with the highest ratio of local to foreign workers (4:1) in the atoll (Figure 33). Typical of Maldivian lifestyle, in Thaa Atoll also there are number of foreign workers in all islands of Thaa Atoll (Figure 32). Landhoo has a foreign worker population of about 50 individuals. The high ratio in Kan'doodhoo is due to the island being an agricultural island and hence, many workers are engaged in farming. Guraidhoo which is also an island engaged in fish processing has a large number of foreign workers, the highest in absolute numbers in the atoll (Figure 32).

Primary level health services, including pharmacies are available on all 13 islands in the atoll and in Landhoo. The Atoll Hospital, in Veymandoo provide secondary medical care for the community in Thaa Atoll. In terms of educational facilities, pre-primary to secondary level education is available in all islands of the sub-project including Landhoo. Education up to high secondary levels is provided in Vilufushi, Guraidhoo and Thimarafushi. Those seeking tertiary level education have to go to the capital.

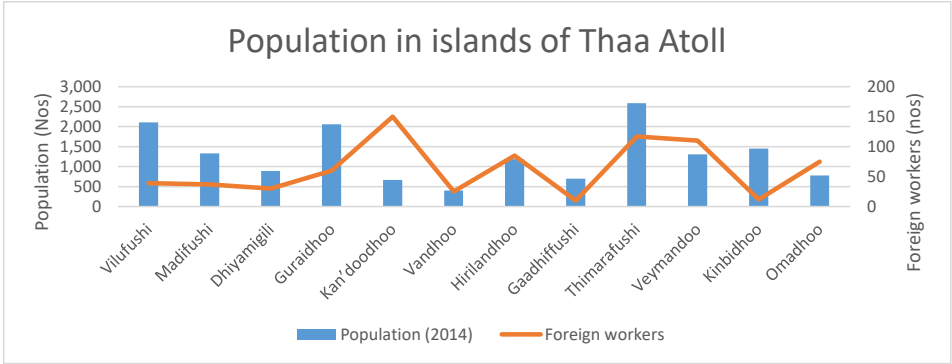


Figure 32. Distribution of local and foreign population in islands of Thaa Atoll

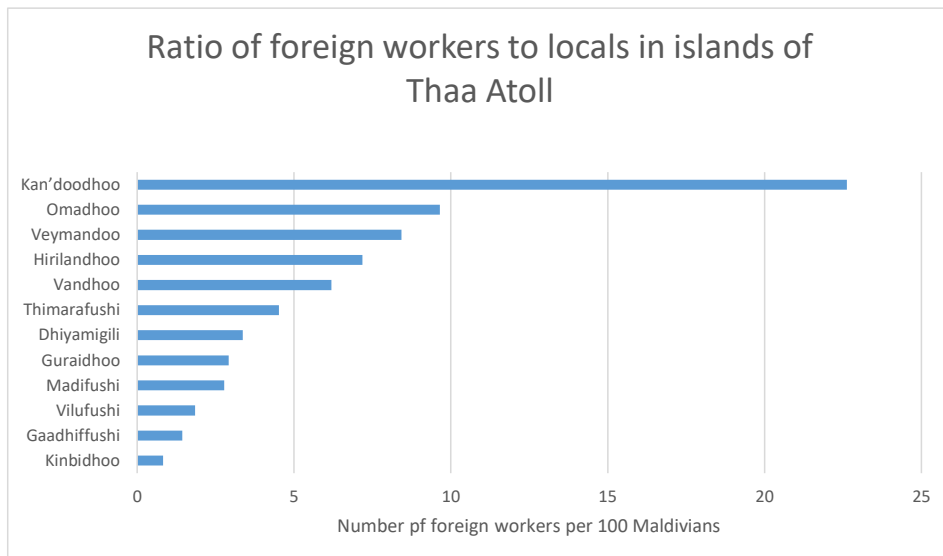


Figure 33. Ratio of foreign workers to Maldivians in islands of Thaa

The major livelihood activities for the 12 islands are government employment, building construction, agriculture, fishing and fish processing, boat building, and thatch and coir rope weaving. Youth are mainly engaged in tourism, construction, and fishing. Thatch weaving and coir rope making are common in all islands with the elderly and women being involved in this. The few skilled occupations available include jobs in the health, education, and power generation sectors. Many households in Thaa Atoll also supplement needs with locally cultivated crops or from home garden crops. The 4 islands chosen for the ice plants are based on the involvement of the communities in fishing. Fishing is the main livelihood of the people in these islands. The location of the islands is also based on regions where there are a number of fishing communities.

Out-migration to Male' is fairly high in the atoll as observed and reported by the informants. Those who leave the islands are leaving for employment, education and seeking for other services.

Distance to nearest residential property from sub-project components

Island	Ground Mounted PV (m)	Powerhouse (m)	Ice Making Plant (m)	Comments
Th. Vilufushi	150	150	10	
Th. Madifushi	40	40	140	Madifushi has been reclaimed due to lack of residential space
Th. Dhiyamigili	50	45	-	
Th Guraidhoo	40	40	-	
Th Kan'doodhoo	170	150	-	
Th Vandhoo	Area 1 – 120 Area 2 - 30	110	-	
Th Hirilandhoo	50	15	-	
Th Gaadhiffushi	35	55	-	
Th. Thimarafushi	45	45	-	
Th Veymandoo	50	80	-	
Th Kinbidhoo	100	140	-	
Th Omadhoo	125	125	-	
Th Buruni	-	-	90	
N. Landhoo	-	-	155	

6 Impacts assessment and mitigation measures

This section assesses the potential impacts of the sub-project. Both direct and indirect impacts as well as positive and negative impacts of the project will be assessed. Impacts are examined separately for the planning, construction, and operational phases of the sub-project. Table 10 shows the potential impacts from the activities of the sub-project. A (+) indicates a positive impact, (-) a negative impact and (0) indicates no or negligible impact. The level of impact can be further determined as small, medium to large depending on the magnitude, duration, and frequency of the impact.

The significance of impacts is further evaluated using criteria; 1) Sensitivity, 2) Recoverability, 3) Importance and 4) Spatial distribution given in Table 11. The scoring for each criterion is based on the values given in Table 11. Expert opinion is used to give relevant scores for each impact. The significance is measured as an aggregate of the scores given for each of the four criteria. The lower the score, the less significant the impact. For a positive impact the sensitivity criteria gives a score of -1, the negative sign indicating a benefit. Hence, for a positive impact further scores for recoverability, importance and spatial distribution are not given. Significance scores are interpreted as follows

- Score < 0: A positive impact/benefit
- Score 1-5: A minor impact
- Score 6-9: A moderate impact
- Score 10-12: A major impact

For example, during the technical assessment of potential PV installation sites a drone is used for aerial photography. The drone may collide with birds in the area and cause some harm. Such collisions may have a low frequency of occurrence as there are very few birds, the duration of the impact will be short, and the magnitude may be low. In this case the impact could be said to have a low but adverse impact. The Sensitivity score looks at how sensitive the receptor (in this case the birds) are to the impact. Using the criteria in Table 11, scores were given as follows:

- Sensitivity: low (1)
- Recoverability: medium (2)
- Importance: low if the birds are pests in community (1)
- Spatial distribution: local (1)

Adding the scores for the four criteria gives a significance score of 5. This means the impact is minor.

Table 10. Impacts matrix for the Phase 5 sub-project in Thaa Atoll and Noonu Landhoo

Environmental components:	Physical environment									Biological Environment								Social Environment														
	Air Quality	Noise level	Topography	Soil	Surface water quality	Surface water quantity	Ground water quality	Groundwater quantity	Lagoon water quality	Wetlands and mangroves	Terrestrial flora	Terrestrial fauna	Avifauna	Coral reefs	Marine fauna	Protected areas	Protected species	Agricultural land	Human settlement	Employment	Human health	Occupational health	Recreational land	Aesthetics	Cultural/religious sites	Cultural/religious values	Local economy	Knowledge and awareness	Local tourism	Financial cost/benefit to community	Safety	
Project components																																
I. Planning Phase																																
Assessment of island power system condition (powerhouse, grids etc)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	
Selection of sites for roof top PV panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	
Selection of sites for ground mounting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	
Aerial recording of sites using a drone	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	
School awareness sessions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	
Househol social and gender assessment survey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	
Focus group meetings (women, council etc)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	
Field visit for IEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	
II. Construction Phase																																
Roof installation of PV panels	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	+	0	-	0	-	0	0	+	+	0	+	-	
Clearing of trees and vegetation for ground mounting of PV panels	0	-	-	-	0	0	0	0	0	0	-	-	0	0	0	0	0	0	0	+	0	-	0	0	0	0	+	+	0	+	-	
Refurbishment of grid	0	-	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	+	0	-	0	0	0	0	+	+	0	+	-	
installment of battery storage units	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	+	0	-	0	0	0	0	+	+	0	+	-	
Replacement of old diesel generators	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Installation of ice making plants	0	-	-	-	0	0	0	0	-	0	-	0	0	-	-	0	0	0	-	+	0	-	0	-	0	0	+	+	0	+	-	
III. Operational Phase																																
Running of PV panels	+	+	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	+	+	-	0	-	0	0	0	0	0	0	0	
Cleaning and maintenance of PV panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	
maintenance of battery storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
disposal of PV panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
disposal of battery storage	-	0	0	-	-	-	0	0	-	0	-	-	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
running of ice plant	+	+	0	0	0	0	0	0	-	0	0	0	-	0	0	0	0	0	0	+	+	-	0	-	0	0	+	0	0	+	0	
+ beneficial impact; - adverse impact; 0 negligible or non-existent impact																																

Table 11. Criteria for evaluating significance of impacts

Criteria	Scale	Attribute
Sensitivity <i>How sensitive the receptor is to the impact</i>	-1	Positive Effect
	0	Not sensitive
	1	Low
	2	Medium
	3	High
Recoverability <i>How long it would take for the receptor to recover from the impact</i>	1	Short
	2	Medium
	3	Non-recoverable
Importance <i>The importance of the receptor to the environment</i>	1	Low
	2	Medium
	3	High
Spatial Distribution <i>Distribution of impact</i>	1	local scale
	2	regional scale
	3	global scale

6.1.1 Impacts and mitigation: Planning phase

There seems to be little negative impacts from the planning stage. Most activities include visits to the sub-project sites for technical, environmental and gender and social assessments. This involves teams from the Project Management Unit travelling to carry out the necessary assessments. Most impacts are positive and includes financial benefits to small businesses (guesthouses, cafes, shops etc.) and increased awareness of the community about the project and renewable energy.

The only anticipated negative impacts are disturbances to avifauna and human settlements from aerial photography using drones. Crows are the most frequently sighted birds in the settlements and are considered as a pest. Other types of birds usually stay away from settlements and may be found near sand banks or quieter areas away from the residential areas. Another issue of drones will be the disturbances to residents and intrusion of their privacy.

As the prospective sites are close by in the small island communities, aerial photography of the sites would take less than half an hour. In the larger islands it may take about an hour for all sites. To minimize impacts to residents, the time for the survey will be decided in consultation with the island council. In addition, residents will be informed of the time and duration of the activity.

The planning phase is super critical in the mitigation of negative impacts. Avoidance of negative impacts is the first step in mitigation. Careful planning can avoid unnecessary negative impacts from the project. Site selection during the planning phase considers negative social and

environmental impacts. The sites in the islands have been chosen to avoid relocation of residents, loss of agricultural and recreational lands and cutting of large trees including those protected under the Regulations of Conservation of Old Trees. None of the trees to be cut during the sub-project fall under the Regulation of Conservation of Old Trees.

Ground mounting will need to be done in most islands due to lack of available roof space. Where roof spaces are available, priority will be given to use these areas. Empty spaces which are already cleared of trees for use have been considered as much as possible for ground mounting, to avoid removing vegetation. Elevated frames will be constructed with a roof to mount the PV panels (Figure 34). Once the PV is installed on the roofs of the ground mounting structures, the space underneath will be utilised as storage areas, vehicle parking or office and indoor recreational spaces in the powerhouses. Ground mounting structures in public spaces like harbour areas are to be used as waiting areas, public meeting areas, small shop outlets, parking or storage areas.



Figure 34. Ground mounting structure in Lhaviyani Kurendhoo

However, trees have to be removed in 4 of the islands; Vandhoo, Veymandoo, Kinbidhoo and Gaadhiffushi (Table 5). The proposed locations in all 4 islands are areas where the clearing of land has been planned in the Island Development Plan of the islands. So irrespective of the POISED project the trees in the area were planned to be removed. The powerhouse areas in Vandhoo, Veymandoo and Kinbidhoo are newly allocated plots for developing the powerhouses. Therefore, the land area has not been yet cleared of the woody trees at the time of field visits. There are approximately 10 and 35 coconut trees, respectively to be removed from the powerhouse land in Veymandoo and Kinbidhoo (Figures 3 & 4). In Vandhoo, there is 1 large tree and 3 small trees within the powerhouse plot that will need to be removed. The other area where large number of trees have to be removed is in the harbour area of Gaadhiffushi. The Island Council plans to build a series of shops and a waiting area for passengers in the proposed area. Hence, the trees are planned to be removed according to the island development plans. The area has 10 mature coconut trees and 3 small coconut trees and 9 large trees. Compensations will be provided to trees owned by individuals according to the compensation regulations. In total about 45 trees will be removed for the sub-project. The project will ensure that for each tree cut two replacement trees will be planted elsewhere on the island.

With regards to ice plants, all of the ice plants will be located near the harbour of the islands, and these already have empty areas where ice plants can be set up without having to cut any further vegetation. The only island where some clearance of vegetation will occur is in Landhoo (Figure 35), where it will be mainly ground cover and small shrubs. Site selection stage

Commented [EFM15]: Use of “most islands” implies that on some islands this has not been possible? Please confirm

Commented [MM16R15]: It's a general express used. None of the sites have relocation of people, loss of agricultural land or recreational land and there are no large Protected trees cut. Have changed accordingly

Commented [EFM17]: In the aerial it looks like overlapping with some vegetation at Buruni?

Commented [MM18R17]: Checked in an unmarked photo and area has no overlapping trees. It looks overlapping because of the large area marked.

Commented [EFM19]: Do you not have a photo from your site visit, it does look like some trees are present from the aerial photo

Commented [MM20R19]: Sites were selected through communication with the Ministry of Fisheries. PMU did not visit site for selection and the sites selected for earlier PV did not include this area.

will ensure minimal disturbance to vegetation and also locations with least impact to the community when laying grid connections to powerhouse.



Figure 35. Landhoo recent drone photo of ice plant location

6.1.2 Impacts and mitigation: Construction phase

The main activities to be carried out in the construction stage are:

- Installation of PV on rooftops
- Installation of ground mounted PV
- Establishment of battery storage systems
- Installation of solar powered community ice plants

PV Hybrid Systems: All islands will have rooftop and ground mounted PV panels installed and battery storage system installed. Some level of grid refurbishment will be done at connection points. As recommended in Section 6.1.1, sites have been identified after consultation with the Island Councils.

In general, other than the ground mounting any impacts of concern to the environment and communities would be arising from the civil works related to installation of roof top and ground mounted PVs and battery storage systems. Detailed significance assessment of impacts is done for PV installation and presented in Table 12. Storage of battery systems require a small space and would be installed in existing powerhouses. Therefore, no additional civil works or space will be required. Since the impact is expected to be low, further assessment using the significance criteria was not carried out for battery storage.



Figure 36. Batterage storage area inside powerhouse

Analysis of impacts of PV installations are very minor as can be seen from Table 12. The impacts to the natural environment are minimal with some impact on trees during the installation of ground PVs. As a mitigation measure, the sites have been carefully chosen to avoid cutting of large trees or any protected trees⁷. In cases where there is a large tree in the vicinity (i.e. with some branches reaching the selected roofs), trimming of these branch extensions will be done. No further impacts are anticipated to terrestrial flora. All sites are far away from marine waters to cause any impact to coral reefs or aquatic animals. No temporary facilities will be set up within 50m of marine water. There will be some minor impacts on the aesthetics during construction work, but this will be restored almost fully upon completion. Transport of materials are through the normal sea vessels travelling to Thaa Atoll, which are informal ferries operated by private sector to transport goods from Male to the atolls. Ferries will not be hired separately for transport of goods to the sites.

While there are no main negative impacts to the natural ecosystems from PV panels and grid works, there are moderate level of impacts to residential areas. This includes noise disturbances, movement of vehicles to and from project site, difficulty to access some roads for

⁷ The large areas of vegetation to be removed in Veymandoo, Vandhoo and Kinbidhoo are pre-allocated land for the powerhouse and has been planned for removal irrespective of POISED activities. Similarly the area in Gaadhiffushi harbour is a pre-planned area for building harbour shops.

short periods of a few days. There will be full recovery to the original conditions once the work is completed. Based on the importance of the receptor (the communities) the impacts are deemed moderate from the scoring. These disturbances are unavoidable when such work is being carried out in communities that are spatially distributed in a very small space. However, work is planned to be carried out with minimal impact on the residents.

Disposal of construction waste will be an issue. Contractors will bear the responsibility of waste disposal in consultation with the Island Councils, records of all waste generated and where and how it was disposed will be kept by the contractors. In cases where environmentally sound and safe disposal facilities are not available on the island, the contractors will have to take the waste to a waste management centre like Thilafushi to dispose of properly. In most islands of Maldives it is common to burn or bury waste for disposal. Therefore, especially for hazardous waste it is important that Contractors remove it from the island to avoid harm to the environment. The Contractors will ensure that all waste has been removed from the island before completing the works, it will not be left for the Island Council to recycle or dispose of it. This work will be carefully overseen by powerhouse managers at each island. Careful monitoring of workers will be conducted by the management to ensure waste is not disposed into marine waters. Separate temporary facilities to house workers will not be developed in any of the islands. Workers will be staying in rental accommodation in the island, and use local cafés for food. Therefore, they will be using the piped water to the household room and toilets. There will not be separate domestic wastewater generated from staff living areas.

Waste management issues have been raised in all islands in this sub-projects. Most of the islands have designated waste management centres for waste disposal but there needs to be more improvements in the disposal methods. While most islands in Thaa still follow typical waste management methods, work is underway under the Maldives Clean Environment Project to establish integrated waste management centres to improve solid waste management in Thaa Atoll, in 5 islands of Thaa Atoll; Buruni, Madifushi, Thimarafushi, Kinbidhoo and Omadhoo.

Other issues of social concern are the influx of workers and possible social disturbances and issues of safety. Currently all islands in Thaa has expatriates working in the communities (Figure 32) and the communities are well adjusted to such situations. There are no reported issues or conflicts with foreign workers in the communities. Therefore, this is not seen as a major impact. On the contrary, visit of outsiders is seen as a positive impact which will benefit local business (cafes, guesthouses, shops etc.). Furthermore, the communities anticipate that the construction phase will bring in some opportunities for work for locals. The communities will also benefit from increase knowledge and awareness of renewable energy, energy efficiency and energy conservation.

There may arise some occupational health issues. Such concerns cannot be foreseen but careful training and detailed instructions to workers to make them aware of possible health hazards and how to avoid them can minimize such issues. There is potential danger for community members, from construction activities such as accidents if members were in the construction zone. This will be voided by signs to prevent people from entering the sites. Temporary closure of partial areas of roads will be done during excavation of roads for cable laying to avoid accidents to community members.

Community ice plants: The construction of ice plants will include civil works that will have some short-term impacts like noise, dust dispersion and generation of solid waste similar to the PV hybrid systems. In addition, the installation of pipes to the lagoon for seawater intake may have some very low-level impacts having short term disturbances to the lagoon floor. Seawater intake is usually from around a depth of 2m and the length of pipe will vary. These will be identified in the detailed design of the ice plants. Since the location is near the harbour of the islands these are already areas where harbours have been built through dredging and hence, there will not be

much coral in these areas. For ice making plants pipes will only be installed where the lagoon is totally devoid of coral or seagrass; this will be confirmed by a marine ecologist who will supervise the pipeline installation and undertake a photographic record of before and after. A detailed impact assessment will need to be conducted after design is finalised. Similar risks of occupational health and safety to the PV hybrid installations will be there for ice plants.

Mitigation of construction impacts. Overall, the impacts from construction are minor to moderate. Mitigation matters considered to reduce impact from construction activities are as follows:

- Conduct work after consultation with the Island Councils to choose a time that will cause minimal disturbances to community. For schools construction work should be planned for school holidays and or after hours.
- Construction activities only undertaken during the day between 6:00 am and 10:00 pm and local communities informed of the construction schedule.
- Selection of construction techniques and machinery seeking to minimize ground disturbance and noise vibrations.
- Noise level at nearest residential property or other sensitive receptor not to exceed EHS guideline levels (or <3dB(A) increase if already exceeded and baseline noise monitoring was conducted to inform this)
- Proper maintenance and operation of construction equipment.
- Existing roads and tracks used for construction and access to the cable route / site will be maintained in good condition wherever possible to minimize increase in airborne dust particles.
- Soil excavated from foundation footings disposed of at designated places.
- Fuel and other hazardous materials securely stored at least 100m from high tide line on impermeable bunded surface e.g. drip trays.
- Protect /preserve topsoil and reinstate after construction completed.
- Safe handling and disposal of phased out equipment including DG sets.
- Contractor to arrange for health and safety training sessions and clear warning signs where required.
- Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements.

Commented [EFM21]: I hope there will be no coral impacted, these ice plants are meant to be Cat C

Commented [MM22R21]: The harbour construction areas will not have almost any corals since these were dredged to remove sand and make the harbour deep.

Commented [EFM23]: Has this been confirmed during site visit?

Commented [MM24R23]: Not confirmed as site selection was not done through site visits. This can be added to be confirmed as you have suggested. The harbour areas are completely dredged/reclaimed areas

Commented [EFM25]: I am concerned about this, it really has not been given enough consideration...

Table 12. Significance analysis of Impacts of PV installation in Thaa Atoll

Environment	Potential impact	Vulnerability	Sensitivity	Recoverability	Importance	Spatial distribution	Impact Significance	
		Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
Physical	Air Quality	Negligible						
	Noise level	Yes (-)	2	1	2	1	6	Moderate
	Island topography	Yes (-)	1	1	1	1	4	Minor
	Soil	Yes (-)	1	1	1	1	4	Minor
	Ground water	Yes (-)	1	1	1	1	4	Minor
	Marine waters	No						
Ecological	Wetlands and mangroves	No						
	Terrestrial flora (trees, beach vegetation)	Yes (-)	1	1	1	1	4	Minor
	Terrestrial fauna (land animals)	Yes (-)	1	1	1	1	4	Minor
	Avifauna (birds)	No						
	Coral reefs	Yes (-)	1	1	1	1	4	Minor
	Marine fauna	Yes (-)	1	1	1	1	4	Minor
	Protected areas	No						
	Protected species	No						
Social	Agricultural land	No						
	Residential areas	No						
	Employment opportunities in the island	Yes (+)						
	Human health of community	Yes (-)	1	1	2	1	5	Minor
	Occupational health of worker's	Yes (-)	1	2	3	1	7	Moderate
	Recreational land of community	No						
	Aesthetics	Yes (-)	1	1	2	1	5	Minor
	Cultural/religious sites	No						
	Cultural/religious values	No						
	Local economy (e.g. for businesses)	Yes (+)						
	Knowledge and awareness	Yes (+)						
	Local tourism	No						
	Financial cost/benefit to community	Yes (+)						
	Safety in the community	No						

6.1.3 Impacts and mitigation: Operational phase

PV Hybrid Systems: Once construction is completed a hybrid system including PV panels, diesel generators and battery storage will be providing cleaner less fuel consuming electricity. The activities within the scope of this IEE for the operational phase are:

- Operation of the hybrid system
- routine maintenance and end of life disposal of the PV panels
- routine maintenance and end of life disposal of battery storage

Negative Impacts

The impacts and disturbances from the construction phase will diminish and operation of powerhouse will go back to as usual. Disturbances such as noise from construction, movement of traffic and access to road and buildings will go back to normal operational levels. Contribution to noise by solar panel in the vicinity will be undetectable and definitely insignificant compared to that of the adjacent diesel generators.

All current powerhouses have been established after a due EIA process following government regulations. As such noise levels are below 72dB(A) at 1m from the powerhouse and below 65dB(A) at the nearest residential development. It is anticipated there will not be further deterioration of noise levels as the sub-project will be having a positive impact on noise levels. However, this can only be determined through pre-construction and post-construction noise monitoring.

All powerhouses in the Maldives can be registered after an environmental clearance. The environmental clearance checklist sets the ambient air quality reference level for PM₁₀ as 50µg/m³ (averaging time of 24 hours), NO₂ levels of 200µg/m³ (averaging time of 1 hour), and SO₂ levels of 500µg/m³ (averaging time of 10 minutes). The improved levels of air emissions is expected to positively affect the health of the community. However, improvements in air quality can only be determined through pre-construction and post-construction noise monitoring.

No major impacts are envisaged to the physical or biological environment. Careful site selection at the planning stage eliminates impacts on agricultural land, recreational land, and other sensitive areas such as mangroves. Site selection also minimises disturbances to residential areas. The significance analysis shows a minor negative impact on avifauna. This is due to possible glare from PV panels. The number of birds in the areas are few so the occurrence of this will be low. The most common bird the crow is considered a pest in communities.

The other major concern is occupational hazards from the battery storage. The possibility of battery explosions is rare but is a concern for powerhouse staff. Lithium batteries will not cause major damage if people come into contact with the solution as it is not corrosive like lead-acid batteries. But the lithium solution will be harmful if ingested. All battery units will be installed with nearby fresh water taps in case staff do come into contact. The batteries bought for the project will be of high quality and thus will minimise possibility of explosions. The batteries bought for the projects come in a prefab casing that can be kept separate from other buildings and also has a built in automatic fire alarm system, fire extinguishers and sand buckets will also be provided. Access to battery storage need to be only made for maintenance and hence is not a place regularly visited by staff. Therefore, there are sufficient mitigation measures in place to minimise such an impact. Figure 36 shows battery storage inside a powerhouse.

The batteries used in the hybrid system will have to be replaced after 7-8 years. Improper disposal of batteries can cause chemical contamination to soil and water. The contractors to implement the system are required to properly dispose the batteries as hazardous waste requiring

transboundary disposal under the Basel Convention since facilities do not exist on the Maldives. The Contractor will be under contractual obligation to arrange with the Manufacturer to take back the used batteries. Once O&M period is over, FENAKA will be responsible for export of used batteries to the Manufacturer. The replaced batteries will be stored by FENAKA in leak proof battery collection system until they are sent to authorised handlers / manufacturers for recycling and further management. Only dry batteries will be transported to avoid possible leakages. The handling, storage and disposal of used batteries shall be done in compliance with Waste Management Policy and Waste Regulations (2013) of Maldives as well as in compliance with Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (1989). With these mitigation measures in place, there is likely to be minimal impact from the battery handling and disposal. Disposal of used PV panels will also be an issue in the future. Currently Maldives does not have a regulation on disposal of used PV panels. This should be developed to guide the numerous upcoming renewable energy projects. The PMU should initiate discussions with the MECCT to develop and implement such guidelines. FENAKA should ensure safe disposal of used panels at the end of life.

The other possible impact is to ground water from washing of PV panels. When required, ground water will be used for washing of the solar panels and water will be drained normally through the existing gutter systems. No detergent will be used. The cleaning of PVs would be mainly from dust deposited on the panels and there will not be any hazardous chemicals in the wastewater. Cleaning of currently installed panels are done biannually or as needed depending on dust. Washing of dust will occur naturally too with the rainfall. Access to ground water will not be an issue in all of the existing public buildings since there would be easy access to water taps whenever needed. As groundwater is a scarce resource in the islands, priority will be given to use rainwater and groundwater will only be used during dry seasons. There will not be much requirement to use groundwater as there is abundant monsoonal rainfall. Further, cleaning of panels will be scheduled to coincide with rainy days to avoid stress on the groundwater. The used water will drain back to the ground and recharge the groundwater. Most islands have few vehicles, less than 70 and over 90% are motorcycles. Therefore, issue of vehicle emission and dust settling will not be a big issue in these islands. The issue of vehicle emissions would be an issue in the islands with more vehicles (Guraidhoo, Kan'doodhoo, Hirilandhoo and Veymandoo which have about 105-158 vehicles) and hence, more cleaning may be required in these islands.

An additional problem that has been noticed in the pilot island of Th. Buruni is bird droppings on the panels. This will require more detailed cleaning. This problem may be localised and may not be reported in all islands. The Maldives National University has a PV panel installed in their Addu Atoll campus and in the last two years, there has not been such incidences (pers. comm. with Principal Investigator). It is recommended that monthly monitoring of panels be conducted and if necessary do additional cleaning for bird dropping. Records of these incidences can help in future planning and mitigation.

Storage and handling of diesel generator fuel, residual oil from separator and lubricating oil storage will be an issue and the current practices at power houses are inadequate. As part of new installations these practices need to be improved. FENAKA will prepare and implement a plan for fuel and oil storage and handling. This will include (i) improvements to the existing bunded structure at the fuel storage tanks so that it will be protected from rain and will store spilt or leaked fuel for pump-out and proper disposal; (ii) redesign and construction of the existing oil-separator; and (iii) construction of a bunded concrete area for the storage of empty lubricant oil drums. Additionally, work practices and site environmental management needs to match and this requirement to ensure that no fuel, oil or other lubricant is allowed to enter the external environment. Contractors' emergency response plan including occupational health and safety plan approved by PSC will be adopted to handle emergency situation during the operation period. Workers will be trained to deal with the emergency situations

Community Ice Plant: The operation of the ice plants will have low to negligible negative impacts on the environment. The seawater intake will be from the harbour basin and the disposal of reject water will be also into the basin. Reject water will be small amounts of cooling water. Any impacts may be if there is a breakage in pipes and there is leakage of saltwater inland into the groundwater. This will be at project site and short-term as such incidences will be addressed in O&M. The use of existing diesel generators are planned only in case of low sunshine as the plant will be powered by solar PV. Therefore, the impacts of fuel usage and associated GHG emissions during operation will be low. The occupational and health risks will also be low.

Positive impacts

Overall, the benefits of the project outweigh the minor negative impacts. The community benefits from improved air quality, lowered noise levels from powerhouse which is expected to positively impact community health. Other benefits could be increased knowledge and awareness of benefits of renewable energy by communities. Local businesses also have potential of benefits with possible new renewable energy related businesses emerging in islands. The new hybrid system also may possibly provide long-term employment for locals from the island. The use of solar PV to power the ice plants will also have a positive environmental impact due to reduced fossil fuel and hence, less GHG emissions. The ice plant is a planned need for the fishing community which otherwise would be running on diesel power only. The development of the ice plant through this project allows less fuel to be used. Though the use of generator may increase use of fossil fuels and GHG emissions compared to a no ice plant scenario, the ice plant if developed without the help of the additional funding will have a much higher fuel consumption and GHG emission. The cost of running the ice plant will also be reduced due to lowered use of fuel. This will in the long-term benefit fishermen.

Table 13. Significance Analysis of Impacts from Operation of Hybrid System in Thaa Atoll

Environment	Potential impact	Vulnerability	Sensitivity	Recoverability	Importance	Spatial distribution	Significance	
		Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
Physical	Air Quality	Yes (+)	-1					
	Noise level	Yes (+)	-1					
	Island topography	No						
	Soil	No						
	Ground water	Yes (-)	1	1	2	1	5	Minor
	Marine waters	Yes (-)	1	1	2	1	5	Minor
Ecological	Wetlands and mangroves	No						
	Terrestrial flora (trees, beach vegetation)	No						
	Terrestrial fauna (land animals)	No						
	Avifauna (birds)	No						
	Coral reefs	Yes (-)	1	1	2	1	5	Minor
	Marine fauna	Yes (-)	1	1	2	1	5	Minor
	Protected areas	No						
	Protected species	No						
Social	Agricultural land	N/A						
	Residential areas	Yes (-)	2	1	3	1	7	Moderate
	Employment opportunities in the island	Yes (+)	-1					
	Human health of community	Yes (+)	-1					
	Occupational health of worker's	Yes (-)	1	1	3	1	6	Moderate
	Recreational land of community	No						
	Aesthetics	Yes (-)	0	1	2	1	4	Minor
	Cultural/religious sites	No						
	Cultural/religious values	No						
	Local economy (e.g. for businesses)	No						
	Knowledge and awareness	Yes (+)	-1					
	Local tourism	Yes (-)	1	1	3	1	6	Moderate
	Financial cost/benefit to community	Yes (+)	-1					
	Safety in the community	Yes (-)	1	3	3	1	8	Moderate

7 Alternatives analysis

With and without project alternatives were analysed and it is found that the Republic of Maldives would continue to pay heavy price for diesel import which will affect the overall economic development of the country and the islands. Implementation of sub-project will bring positive economic, social, and environmental benefits. Economic benefits will be from the reduction in import of diesel for power generation. Social benefits will be from sustainable electricity supply to the consumers and decrease in smoke particles and hence improved health conditions. Environmental benefits will be from reduction in emission from diesel generator sets by reducing diesel transport, storage, spills, and emissions of gases; reduction in noise levels from diesel generator sets being currently operated by power stations. Also, as part of capacity building of local technicians in implementation and operation of solar and other renewable energy projects, future projects will benefit from the learning from the construction and operation of the site.

Alternative sites (2-3 sites for ground-mounted PV plants in each Islands and several public buildings) were considered, but the proposed selected sites in each island were considered the best locations for the solar power plants as these are adjacent to the existing generation diesel power generation plants, easy access to distribution network, providing existing facilities (network, access roads), security and operational workforce that will reduce capital and operating costs. The land at selected sites has low environmental or residential values, given the current land use and existing power generation operations. Rooftop is given main priority for PV panel mounting as this is most cost effective, safer than the ground and no additional land will be lost from agricultural, recreational, or residential land. Where ground mounting is to be done the areas have been chosen after considering areas which can give dual benefits to community. E.g. constructing of areas where shading is needed or alternate areas which can be utilised for storage or recreational activities.

The sub-project's technical team will also consider the different types of PV panels and battery suppliers and the best configurations that would meet desired locational requirements would be selected. This will include environmental and safety considerations. PV panels that contain heavy metals will not be used.

Similarly for the ice-plant, alternative site locations were considered but the current location near the harbour is the most practical and least impactful in terms of negative environmental impacts.

8 Consultation, Participation and Information Disclosure

As part of sub-project preparation for the extension of RE hybrid system in Thaa Atoll and community ice-plants, stakeholder and community consultations have been carried out in each island. Due to travel restrictions at the time online consultations with the Island Council and Women's Development Committees were held for the community ice-plants. Table 14 gives a list of stakeholders consulted for the IEE and other assessments of the project. A detailed list of attendees from each island is provided in Appendix 2 and photos of the consultations are given in Appendix 3. In addition to island level stakeholders, others such as the Ministry of Environment and Energy, Environment Protection Agency, utilities companies and Waste Management Agency were consulted. Summary of issues discussed during the consultations are provided in Section 8.1.

Information on the environment and social conditions of the island were gathered through meetings with Island Councils, Women's Development Committees (WDC)⁸, utilities companies, school and other individuals and organisations in the island.

In addition to consultation information dissemination and awareness sessions were conducted for the same groups and school students, teachers, and parents. The sessions included importance of economising electricity, energy efficiency and renewable energy. These are helpful to inform the community about the sub-project and about renewable energy. Consultation will continue at next stages i.e. after finalization of detailed design and before start of the actual implementation stage. Consultations will also continue during sub-project operations.

Table 14. List of stakeholders consulted

Stage	Stakeholders consulted
Technical assessments	<ul style="list-style-type: none"> – Ministry of Environment (ME) – Ministry of Fisheries, Marine Resources and Agriculture – Maldives Energy Authority – STELCO – FENAKA – Island Councils
Social, gender and environmental assessments	<ul style="list-style-type: none"> – Environmental Protection Agency (EPA) of Maldives – Island Councils – Island Power Plant managers and staff – Women Development Committees – General public – Waste Management Agency of Maldives – Schools (students, teachers, and parents)

8.1 Summary of consultations

Overall, the community is positive and welcomed the installation of the PV hybrid installation. Many members stated their wish to start the project as soon as possible. The communities view the project as environmentally friendly and envisaged a reduction in noise and air pollution due to reduced use of diesel. Though they view there will be some disturbances to the community during the construction phase, they find it minor compared to the long-term benefits of the project. The communities are particularly receptive of the project as they believe this will improve the quality of the service and hope to reduce the costs of electricity.

⁸ 8 of the 12 islands had WDCs. In the 4 islands (Madifushi, Thimarafushi, Omadhoo and Vandhoo) where WDCs were not present, women were also consulted

Table 15. Issues discussed during stakeholder consultations in Thaa Atoll

	Positives	Negatives
Social	<ul style="list-style-type: none"> – improved health due to improved air quality – shading in public waiting areas like harbour where ground mounting structures will be built – in some areas where ground mounting is done will provide shading for recreational spaces 	<ul style="list-style-type: none"> – few were concerned whether in cases solar energy is not available there may be power failures. The community was reassured that since this is a diesel hybrid system, there will be diesel generators which will operate and give power if the PV is not sufficient. – some minor disturbances during construction stage
Economic	<ul style="list-style-type: none"> – anticipated benefits through reduced fuel consumption and power bills 	<ul style="list-style-type: none"> – some concerns if there would be an increase in power bills but were assured this will not be the case
Environmental	<ul style="list-style-type: none"> – improved air quality – reduced noise levels – reduced waste oil disposal from powerhouses as less diesel will be used 	<ul style="list-style-type: none"> – some concern was raised over waste disposal

The issue of waste management was raised in most islands. All island councils assured that waste that is normally disposed in the islands can be dealt with through the current mechanisms. In cases where the waste cannot be disposed on the islands it is a big issue due to limited space for storing. Island councils specially noted that during the rain seasons the waste disposal area is a breeding ground for mosquitoes and subsequent health issues. Waste from the islands can be taken to the regional waste management centres for better disposal. The nearest facility for disposal of these items is in Male' atoll. There is an upcoming project by the government to build a regional waste management centre and this may lessen the burden. The councils were assured that the contractors would be responsible for disposing of any such waste that cannot be managed on the island. Similarly, for used batteries the suppliers are contracted to dispose these and after the O&M period, FENAKA will be responsible for exporting them to manufacturers. As mentioned earlier, the issue of used PV panels will also come up in the future and hence, guidelines for disposal of these need to be developed immediately. Consultations with EPA assured that the sub-project will be implemented in full compliance with government requirements and options for the safe disposal of used batteries such as sending back to the suppliers and sending to authorized recyclers in neighbouring countries.

8.2 Information Disclosure

All environmental documents are subject to public disclosure, and therefore, will be made available to the public. This IEE will be disclosed on MECCT website. In addition, hard copies of the IEE, with Dhivehi translations, will be made available in the MECCT, utilities offices in Male and at islands as well as in Island Councils. Both MECCT and utilities companies will ensure that meaningful public consultations, particularly with project affected persons', if any, are undertaken through the entire project cycle, the design, installation and operation phases. The Environmental Management Plan (EMP) includes a grievance redress mechanism (GRM) so that any concerns raised during construction or operation can be addressed.

9 Environmental management plan

The mitigation hierarchy; avoid, minimize, compensate; has been used to guide the mitigation of environmental and social impacts from the sub-project. Careful site selection at the

planning stage avoids impacts on sensitive biodiversity, agricultural and recreational land in the islands. The proposed mitigation strategy focuses on minimizing the minor to moderate impacts of the sub-project. There are minor impacts to the physical and natural environment but the moderate impacts are to the social environment. These include possible occupational hazard risks, disturbances such as noise, lack of access to roads during construction stage. An environmental management plan (EMP) and environmental monitoring plan (EMoP) have been developed to ensure these impacts are minimized. Table 16 and

Project activity /stage	Potential impact	Proposed mitigation measure	Mitigation Cost	Institutional responsibility	Implementation schedule
A. Pre-construction					
Location	Encroachment into precious ecological and protected areas	Careful site selection to avoid encroachment of ecological sensitive areas including protected areas and areas of historical and cultural importance. On Veymandoo, Kan'doodhoo and Landhoo no permanent or temporary project facilities will be sited within 50m of the ecologically sensitive areas identified by EPA. No works will commence until MEECT has submitted screening form for Thaa atoll to EPA and they have confirmed if any further study is required. If more than 10 trees on an island will be cut, EIA will be submitted to the EPA and decision notice obtained before any works start on site. No trees protected under the Regulations of Conservation of Old Trees will be cut. For each tree cut two replacement trees of locally native species will be planted elsewhere on the island. For ice making plants pipes will only be installed where the lagoon is totally devoid of coral or seagrass; this will be confirmed by a marine ecologist who will supervise the pipeline installation and undertake a photographic record of before and after	Project Cost	EA, IA through PMC	Detailed design
	Topography and visual impacts	Careful selection of site away from inhabited areas.	Project Cost	EA, IA through PMC	Detailed design

Access	Impacts due to construction of new access roads and wharfs	Proposed sites are accessible by existing wharf and road network. Therefore, no need to construct new access roads or wharfs. In case requirement arises for new roads/wharfs, this EMP will be updated to address associated impacts.	Project Cost	EA, IA through PMC	Detailed design
Project design	Negligence of environmental mitigation measures	Ensure that EMP is included in the bidding documents	Project cost	EA, IA through PMC	Tendering process
	Updating EMP	Mitigation measures defined in this EMP will be incorporated into the detailed design to minimize adverse impacts. If any modifications in the design need to be made, the EMP will be reviewed to see if any updates need to be made and in the event the EMP needs to be updated, this will be updated with ADB clearance and shared with Contractor for implementing.	Project cost	EA, IA through PMC	Detailed design
		Prepare environmental contract clauses for contractors, namely the special conditions (e.g. reference EMP and monitoring table)	Project cost	EA, IA through PMC	Tendering process
Climate Change	Risk of climate change	Provided solar PV plants with resilience to climate change through compact and preassembled systems resistant to marine/coastal environments. Foundations and racking system will be designed to withstand powerful cyclones and hurricanes, which will limit the probability of generation unavailability as well as reducing any potential hazard of panels being lifted up and blown onto adjacent properties.	Project cost	EA, IA through PMC	Detailed design
Equipment design and selection	Release of toxic chemicals and gases in receptors (air, water, land) Noise from equipment/machineries	<ul style="list-style-type: none"> The new and replacement diesel generators will be designed to comply with World Bank/IFC's EHS guidelines for small combustion facilities and EHS guidelines for ambient noise both for day time and night time. Ensure equipment and machinery used for construction will not release any toxic chemicals, such as CFCs. All battery units will be installed with nearby fresh water taps in case 	Project Cost	EA, IA through PMC	Tendering process

		<p>staff do come into contact with the lithium solution.</p> <ul style="list-style-type: none"> Batteries bought for the project will be of high quality and come in prefab casing with built in automatic fire alarm system, fire extinguishers and sand buckets will also be provided 			
Statutory clearances/ permits	Delay in the project process	Ensure that all necessary permits and clearances i.e. environmental permit from EPA, Island Environment Authority) are obtained prior to commencement of civil work.	Project Cost	EA, IA through PMC	Prior to commencement of civil work
Involuntary resettlement or land acquisition	Social inequities	Compensation paid for temporary/permanent loss of productive land as per entitlement framework and its process, if necessary.	Project Cost	EA, IA through PMC	Prior to commencement of civil work
Site clearing	Cutting/trimming of trees and removal of vegetative cover	Compensatory afforestation as per government policies.	To be included in EPC Contractor cost.	EPC Contractor & PMC	Preparation of site prior to civil work
B. Construction					
Construction of access road	<ul style="list-style-type: none"> Increase in airborne dust particles Increased land requirements for temporary accessibility 	All proposed sites are accessible with existing road. These roads will be used for construction and access to the cable route/sites will be maintained in good condition wherever possible to avoid dust emission.	To be included in Contractor cost.	EPC Contractor, EA/IA through PMC	During civil work construction
Installation of Solar Panels, and Storage of construction material and movement of vehicles	Topography and visual impacts	Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction
Construction activities	Generation of dust by construction activities	<ul style="list-style-type: none"> Vehicles carrying soil, sand, or other fine materials to and from the sites must be covered. Water will be spread on construction sites and access roads each day. Soil excavated from foundation footings disposed of at designated places. Protect /preserve topsoil and reinstate after construction completed. 	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction

Construction debris and wastewater	<p>Adverse impacts on surrounding environment due to construction waste.</p> <p>Pollution of water bodies due to disposal of waste material into water bodies.</p>	<ul style="list-style-type: none"> - Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time. - Provision of facilities for handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements. - Purchase of perishable construction materials such as paints incrementally to ensure reduced spoilage of unused materials. - Use of building materials that have minimal packaging to avoid the generation of excessive packaging waste. - Use of construction materials containing recycled content when possible and in accordance with accepted standards. - Dispose construction related waste in consultation with the Island Council, records of all waste generated and where and how it was disposed will be kept - On the completion of works, no waste will be left on the island for the Island Council to recycle or dispose of - Construction waste that cannot be reused will be regularly transported offsite for disposal at the waste management center like Thilafushi, and not allowed to accumulate on site over long periods. - Careful monitoring of workers will be conducted by the management to ensure waste is not disposed into marine waters. 	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction

		<ul style="list-style-type: none"> - Fuel and other hazardous materials securely stored at least 100m from high tide line on impermeable bunded surface e.g., drip trays. - Safe handling and disposal of phased out equipment including DG sets. - Provision of adequate drainage system including controlled collection and preliminary treatment of wastewater. 			
Movement and operation of construction equipment	Noise generated from operation and movement of trucks and cranes	<ul style="list-style-type: none"> - Construction techniques and machinery selection seeking to minimize ground disturbance. - Conduct work after consultation with the Island Councils to choose a time that will cause minimal disturbances to community - Solar panel installations at schools will be scheduled to avoid class disturbance. - Construction activities only undertaken during the day between 6:00 am and 10:00 pm and local communities informed of the construction schedule. - Noise level at nearest residential property or other sensitive receptor not to exceed EHS guideline levels (or <3dB(A) increase if already exceeded and baseline noise monitoring was conducted to inform this) - Workers not to be exposed to machines noise level not more than 85 dB(A) at average 8 hrs or be provided with hearing protection. 	To be included in EPC Contractor cost.	EPC Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction
	Visual impacts from storage and haulage of construction material	Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.	To be included in EPC Contractor cost.	EPC Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction
Transportation of equipment and construction material.	Dust and particulate emission from movement of construction vehicles transporting equipment and construction material.	<ul style="list-style-type: none"> - Truck wheels cleaning - Road covering (if possible), cleaning and spraying water (if necessary) and watering 	To be included in EPC Contractor cost.	EPC Contractor	During land clearing and civil work construction

Cutting of trees and clearing / trimming of trees and vegetative cover	Loss of trees and vegetative covers	<ul style="list-style-type: none"> - Removal of only those trees, which are necessary. - Marking of trees to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance. - Transplanting of trees if this is possible. - Prohibiting illegal cutting of trees by construction workers for domestic uses. - Planting of trees in coordination with the Island Authorities of target island 	To be included in EPC Contractor cost.	EPC Contractor	During land clearing and civil work construction
Public access	Hindrance to public access due to project construction activities	<ul style="list-style-type: none"> - Consultation with residents to reach agreements - Development of temporary access roads and traffic diversion plan, if required - Adequate safety measures like traffic controller, erect and maintain barricades, signs, markings, flags, lights etc. 	To be included in EPC Contractor cost.	Contractor, PMC, Island Council	During land clearing and civil work construction
Occupational Health and Safety	Impacts on workers health due to working with trucks and piling cranes, Building construction, high voltage work	<ul style="list-style-type: none"> - Provide Safety Manual - Provide Safety Plan - Supervision and Inspection - Protection PPEs/gears - Contractor to arrange for health and safety training sessions and clear warning signs where required. - Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements. - To minimize health impacts, following additional measures would be implemented. - Construction activities only undertaken during the day and local communities informed of the construction schedule. - Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities. - Protect /preserve topsoil and reinstate after construction completed. - Contract provisions specifying minimum requirements for workers camps. - Contractor to prepare and 	To be included in EPC Contractor cost.	Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction

		<p>implement a health and safety plan including safety manual.</p> <ul style="list-style-type: none"> - Contractor to arrange for health and safety training sessions. - World Bank's EHS guidelines will be followed to ensure health and safety of workers. 			
Construction activities	Unexpected environmental impacts	If unexpected environmental impacts occur during project construction phase, the PMC will update the EMP, and the environmental protection measures will be designed and resources will be utilized to cope with these impacts.	Project cost	EA, PMC	During construction
C. Operation and Maintenance					
Reflection and glare from Solar arrays	Visual impacts and glare	Design of solar arrays to absorb incident solar radiation. Proper orientation of arrays.	To be included in EPC Contractor O&M cost.	EPC Contractor	During tendering, operation and maintenance
Cleaning of Solar Panels	Wastewater Generated from cleaning of solar panels	Provision and cleaning of adequate drainage system. Groundwater will not be used for cleaning PV panels, harvested rainwater or dry-cleaning method will be used. Otherwise, the water to be used for washing of the solar panels will be taken from outside sources. No detergent will be used in washing of solar panels. If bird droppings are soiling panels increase the frequency of washing.	To be included in EPC Contractor O&M cost.	EPC Contractor	During operation and maintenance
Natural Disasters	Damage from cyclones and strong winds.	Design of foundations and racking system to withstand powerful cyclones and strong winds, which will reduce any potential hazard of panels being lifted up and blown onto adjacent properties.	To be included in EPC Contractor O&M cost.	EPC Contractor	During construction and operation and maintenance
Health and Safety	Health hazards in the event of accidents (cyclones, weather related events) and emergency	Emergency Response Plan Health and Safety Plan World Bank's EHS Guidelines will be followed.	O&M Cost	EPC Contractor	Emergency during operation and maintenance
Disposal and management of batteries	Impacts from used batteries and panels	Properly dispose the batteries as hazardous waste requiring transboundary disposal under the Basel Convention since facilities do not exist on the Maldives	O&M Cost	EPC Contractor	During operation and maintenance

		Replaced batteries will be stored in leak proof battery collection system provided by FENAKA until they are sent to authorised handlers / manufacturers for recycling and further management Only dry batteries will be transported to avoid possible leakages.			
Disposal and management of used PV panels		PV panels that contain heavy metals will not be used since they could constitute hazardous waste.			
Storage and transport of diesel fuel		FENAKA will prepare and implement a plan for fuel and oil storage and handling. This will include (i) improvements to the existing bunded structure at the fuel storage tanks so that it will be protected from rain and will store spilt or leaked fuel for pump-out and proper disposal; (ii) redesign and construction of the existing oil-separator; and (iii) construction of a bunded concrete area for the storage of empty lubricant oil drums. Contractors' emergency response plan including occupational health and safety plan approved by PSC will be adopted to handle emergency situation during the operation period. Workers will be trained to deal with the emergency situations			
Operation of project facilities	Unexpected environmental impacts	If unexpected environmental impacts occur during project operation phase, the IA will update the EMP, and the environmental protection measures will be designed in compliance with World Bank's EHS Guidelines and resources will be utilized to cope with these impacts.	O&M Cost	IA	During operation
D. Decommissioning					
Dismantling of PV panels	Impacts from disposal of PV panels and batteries.	Contract agreements with PV panel suppliers for dismantling and disposal of panels and batteries.	Maintenance cost	EA	Post operation

Table 17 shows the proposed EMP and EMoP, respectively.

The main institutions that will be involved in environmental management activities are the Ministry of Finance as the executing agency (EA); Ministry of Environment, Climate Change and Technology (MECCT) and FENAKA as implementing agencies (IAs) of the Project, project management consultant (PMC), EPC contractor(s), and line agencies including the Environment Protection Agency (EPA) and Waste Management Division within EPA. EA has overall responsibility for EMP/EMOP implementation through the project management unit (PMU) which is already established. EA will ensure the environmental management and monitoring budgets are available and utilized as necessary for timely implementation of EMP/EMOP. The estimated cost of the environmental management for the sub-project including implementation and monitoring is US\$ 3000.

Support for efficient project implementation related to the turnkey contract will be provided by the PMC. PMC will be responsible to approving contractors' management plan, emergency plan, and occupational health and safety plan as well as to ensure on-ground implementation of the EMP/EMOP. Cost of capacity building is already included in the capacity building component of the Project.

The Contractor will be informed their responsibility to comply with the EMP/EMOP and the requirements of ADB. There are specific responsibilities for EMP compliance during construction phase that will rest with the Contractor who will be monitored by the environmental staff of the project. The Contractor will be required to have one staff with experience in environmental management. This staff will be responsible for preparing plans such as emergency preparedness plan, occupational health and safety plan, day-to-day implementation of EMP. The EMP and EMoP will form part of the contract document together with General Environment, Health & Safety (EHS) Conditions of Contract (CoC). The EMP shall form the basis for the contractor to prepare site specific construction environmental management plan (CEMP).

The EA will submit environmental assessment report to EPA or Island Authority, as applicable for review and approval as per the Act No. 4/93 of Maldives. If required EA with support from PMC environmental expert will update this IEE and EMP to meet the EPA requirements. Under the national EIA Regulations, PV panel installations on existing roofs of building are exempt from EIAs and can be carried out without submission for EIA screening. PV installation with construction of ground mounting structures will need an IEE. Ice plants will require a full EIA report submission.

Table 16. Environmental Management Plan for Thaa subproject including PV hybrid systems and ice making machines

Project activity /stage	Potential impact	Proposed mitigation measure	Mitigation Cost	Institutional responsibility	Implementation schedule
A. Pre-construction					
Location	Encroachment into precious ecological and protected areas	<p>Careful site selection to avoid encroachment of ecological sensitive areas including protected areas and areas of historical and cultural importance.</p> <p>On Veymandoo, Kan'doodhoo and Landhoo no permanent or temporary project facilities will be sited within 50m of the ecologically sensitive areas identified by EPA.</p> <p>No works will commence until MEECT has submitted screening form for Thaa atoll to EPA and they have confirmed if any further study is required.</p> <p>If more than 10 trees on an island will be cut, EIA will be submitted to the EPA and decision notice obtained before any works start on site.</p> <p>No trees protected under the Regulations of Conservation of Old Trees will be cut.</p> <p>For each tree cut two replacement trees of locally native species will be planted elsewhere on the island.</p> <p>For ice making plants pipes will only be installed where the lagoon is totally devoid of coral or seagrass; this will be confirmed by a marine ecologist who will supervise the pipeline installation and undertake a photographic record of before and after</p>	Project Cost	EA, IA throughPMC	Detailed design

	Topography and visual impacts	Careful selection of site away from inhabited areas.	Project Cost	EA, IA through PMC	Detailed design
Access	Impacts due to construction of new access roads and wharfs	Proposed sites are accessible by existing wharf and road network. Therefore, no need to construct new access roads or wharfs. In case requirement arises for new roads/wharfs, this EMP will be updated to address associated impacts.	Project Cost	EA, IA through PMC	Detailed design
Project design	Negligence of environmental mitigation measures	Ensure that EMP is included in the bidding documents	Project cost	EA, IA through PMC	Tendering process
	Updating EMP	Mitigation measures defined in this EMP will be incorporated into the detailed design to minimize adverse impacts. If any modifications in the design need to be made, the EMP will be reviewed to see if any updates need to be made and in the event the EMP needs to be updated, this will be updated with ADB clearance and shared with Contractor for implementing.	Project cost	EA, IA through PMC	Detailed design
		Prepare environmental contract clauses for contractors, namely the special conditions (e.g. reference EMP and monitoring table)	Project cost	EA, IA through PMC	Tendering process
Climate Change	Risk of climate change	Provided solar PV plants with resilience to climate change through compact and preassembled systems resistant to marine/coastal environments. Foundations and racking system will be designed to withstand	Project cost	EA, IA through PMC	Detailed design

		powerful cyclones and hurricanes, which will limit the probability of generation unavailability as well as reducing any potential hazard of panels being lifted up and blown onto adjacent properties.			
Equipment design and selection	Release of toxic chemicals and gases in receptors (air, water, land) Noise from equipment/machineries	<ul style="list-style-type: none"> • The new and replacement diesel generators will be designed to comply with World Bank/IFC's EHS guidelines for small combustion facilities and EHS guidelines for ambient noise both for day time and night time. • Ensure equipment and machinery used for construction will not release any toxic chemicals, such as CFCs. • All battery units will be installed with nearby fresh water taps in case staff do come into contact with the lithium solution. • Batteries bought for the project will be of high quality and come in prefabricated casing with built-in automatic fire alarm system, fire extinguishers and sand buckets will also be provided 	Project Cost	EA, IA through PMC	Tendering process
Statutory clearances/permits	Delay in the project process	Ensure that all necessary permits and clearances i.e. environmental permit from EPA, Island Environment Authority) are obtained prior to commencement of civil work.	Project Cost	EA, IA through PMC	Prior to commencement of civil work
Involuntary resettlement or land acquisition	Social inequities	Compensation paid for temporary/permanent loss of productive land as per entitlement framework and its process, if necessary.	Project Cost	EA, IA through PMC	Prior to commencement of civil work

Site clearing	Cutting/trimming of trees and removal of vegetative cover	Compensatory afforestation as per government policies.	To be included in EPC Contractor cost.	EPC Contractor & PMC	Preparation of site prior to civil work
B. Construction					
Construction of access road	- Increase in airborne dust particles - increased land requirements for temporary accessibility	All proposed sites are accessible with existing road. These roads will be used for construction and access to the cable route/sites will be maintained in good condition wherever possible to avoid dust emission.	To be included in Contractor cost.	EPC Contractor, EA/IA through PMC	During civil work construction
Installation of Solar Panels, and Storage of construction material and movement of vehicles	Topography and visual impacts	Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction
Construction activities	Generation of dust by construction activities	<ul style="list-style-type: none"> - Vehicles carrying soil, sand, or other fine materials to and from the sites must be covered. - Water will be spread on construction sites and access roads each day. - Soil excavated from foundation footings disposed of at designated places. - Protect /preserve topsoil and reinstate after construction completed. 	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction

Construction debris and wastewater	<p>Adverse impacts on surrounding environment due to construction waste.</p> <p>Pollution of water bodies due to disposal of waste material into water bodies.</p>	<ul style="list-style-type: none"> - Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time. - Provision of facilities for handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements. - Purchase of perishable construction materials such as paints incrementally to ensure reduced spoilage of unused materials. - Use of building materials that have minimal packaging to avoid the generation of excessive packaging waste. - Use of construction materials containing recycled content when possible and in accordance with accepted standards. - Dispose construction related waste in consultation with the Island Council, records of all waste generated and where and how it was disposed will be kept - On the completion of works, no waste will be left on the island for the Island Council to recycle or dispose of - Construction waste that cannot be reused will be regularly 	To be included in EPC Contractor cost.	EPC Contractor & PMC	During civil work construction
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		<p>transported offsite for disposal at the waste management center like Thilafushi, and not allowed to accumulate on site over long periods.</p> <ul style="list-style-type: none"> Careful monitoring of workers will be conducted by the management to ensure waste is not disposed into marine waters. Fuel and other hazardous materials securely stored at least 100m from high tide line on impermeable bunded surface e.g., drip trays. Safe handling and disposal of phased out equipment including DG sets. Provision of adequate drainage system including controlled collection and preliminary treatment of wastewater. 			
Movement and operation of construction equipment	Noise generated from operation and movement of trucks and cranes	<ul style="list-style-type: none"> Construction techniques and machinery selection seeking to minimize ground disturbance. Conduct work after consultation with the Island Councils to choose a time that will cause minimal disturbances to community Solar panel installations at schools will be scheduled to avoid class disturbance. Construction activities only undertaken during the day between 6:00 am and 10:00 pm and local communities informed of the construction schedule. Noise level at nearest residential property or other sensitive receptor 	To be included in EPC Contractor cost.	EPC Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction

		not to exceed EHS guideline levels (or <3dB(A) increase if already exceeded and baseline noise monitoring was conducted to inform this) - Workers not to be exposed to machines noise level not more than 85 dB(A) at average 8 hrs or be provided with hearing protection.			
	Visual impacts from storage and haulage of construction material	Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.	To be included in EPC Contractor cost.	EPC Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction
Transportation of equipment and construction material.	Dust and particulate emission from movement of construction vehicles transporting equipment and construction material.	- Truck wheels cleaning - Road covering (if possible), cleaning and spraying water (if necessary) and watering	To be included in EPC Contractor cost.	EPC Contractor	During land clearing and civil work construction
Cutting of trees and clearing / trimming of trees and vegetative cover	Loss of trees and vegetative covers	- Removal of only those trees, which are necessary. - Marking of trees to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance. - Transplanting of trees if this is possible. - Prohibiting illegal cutting of trees by construction workers for domestic uses. - Planting of trees in coordination with the Island Authorities of target island	To be included in EPC Contractor cost.	EPC Contractor	During land clearing and civil work construction

Public access	Hindrance to public access due to project construction activities	<ul style="list-style-type: none"> - Consultation with residents to reach agreements - Development of temporary access roads and traffic diversion plan, if required - Adequate safety measures like traffic controller, erect and maintain barricades, signs, markings, flags, lights etc. 	To be included in EPC Contractor cost.	Contractor, PMC, Island Council	During land clearing and civil work construction
Occupational Health and Safety	Impacts on workers health due to working with trucks and piling cranes, Building construction, high voltage work	<ul style="list-style-type: none"> - Provide Safety Manual - Provide Safety Plan - Supervision and Inspection - Protection PPEs/gears - Contractor to arrange for health and safety training sessions and clear warning signs where required. - Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements. - To minimize health impacts, following additional measures would be implemented. - Construction activities only undertaken during the day and local communities informed of the construction schedule. - Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities. - Protect /preserve topsoil and reinstate after construction completed. - Contract provisions specifying minimum requirements for workers 	To be included in EPC Contractor cost.	Contractor (preparation and implementation) PMC (approval)	During land clearing and civil work construction

		camps. Contractor to prepare and implement a health and safety plan including safety manual. Contractor to arrange for health and safety training sessions. World Bank's EHS guidelines will be followed to ensure health and safety of workers.			
Construction activities	Unexpected environmental impacts	If unexpected environmental impacts occur during project construction phase, the PMC will update the EMP, and the environmental protection measures will be designed and resources will be utilized to cope with these impacts.	Project cost	EA, PMC	During construction
C. Operation and Maintenance					
Reflection and glare from Solar arrays	Visual impacts and glare	Design of solar arrays to absorb incident solar radiation. Proper orientation of arrays.	To be included in EPC Contractor O&M cost.	EPC Contractor	During tendering, operation and maintenance
Cleaning of Solar Panels	Wastewater Generated from cleaning of solar panels	Provision and cleaning of adequate drainage system. Groundwater will not be used for cleaning PV panels, harvested rainwater or dry-cleaning method will be used. Otherwise, the water to be used for washing of the solar panels will be taken from outside sources. No detergent will be used in washing of solar panels. If bird droppings are soiling panels increase the frequency of washing.	To be included in EPC Contractor O&M cost.	EPC Contractor	During operation and maintenance

Natural Disasters	Damage from cyclones and strong winds.	Design of foundations and racking system to withstand powerful cyclones and strong winds, which will reduce any potential hazard of panels being lifted up and blown onto adjacent properties.	To be included in EPC Contractor O&M cost.	EPC Contractor	During construction and operation and maintenance
Health and Safety	Health hazards in the event of accidents (cyclones, weather related events) and emergency	Emergency Response Plan Health and Safety Plan World Bank's EHS Guidelines will be followed.	O&M Cost	EPC Contractor	Emergency during operation and maintenance
Disposal and management of batteries	Impacts from used batteries and panels	Properly dispose the batteries as hazardous waste requiring transboundary disposal under the Basel Convention since facilities do not exist on the Maldives Replaced batteries will be stored in leak proof battery collection system provided by FENAKA until they are sent to authorised handlers / manufacturers for recycling and further management Only dry batteries will be transported to avoid possible leakages.	O&M Cost	EPC Contractor	During operation and maintenance
Disposal and management of used PV panels		PV panels that contain heavy metals will not be used since they could constitute hazardous waste.			
Storage and transport of diesel fuel		FENAKA will prepare and implement a plan for fuel and oil storage and handling. This will include (i) improvements to the existing bunded structure at the fuel storage tanks so that it will be protected from rain and will store spilt or leaked fuel for pump-out and proper disposal; (ii) redesign and construction of the			

		existing oil-separator; and (iii) construction of a bunded concrete area for the storage of empty lubricant oil drums. Contractors' emergency response plan including occupational health and safety plan approved by PSC will be adopted to handle emergency situation during the operation period. Workers will be trained to deal with the emergency situations			
Operation of project facilities	Unexpected environmental impacts	If unexpected environmental impacts occur during project operation phase, the IA will update the EMP, and the environmental protection measures will be designed in compliance with World Bank's EHS Guidelines and resources will be utilized to cope with these impacts.	O&M Cost	IA	During operation
D. Decommissioning					
Dismantling of PV panels	Impacts from disposal of PV panels and batteries.	Contract agreements with PV panel suppliers for dismantling and disposal of panels and batteries.	Maintenance cost	EA	Post operation

Table 17. Environmental Monitoring Plan for Thaa sub-project

Table 17: Environmental Monitoring Plan for Maad sub-project						
Sl. No.	Environmental Features	Aspect to be Monitored	Time and Frequency of Monitoring	Location	Responsible party	
					PMU/Utility staff	Contractor
PRE-CONSTRUCTION STAGE						
1	All design related mitigation measures	<ul style="list-style-type: none">Inclusion in the project design.Tender Design Review	<ul style="list-style-type: none">As needed before tendering	-	Initial review of tender design	/A
2	Approval of contractor's Construction Environmental Management Plan to ensure compliance with EMP and contract document.	<ul style="list-style-type: none">Document review	<ul style="list-style-type: none">One month after signing of construction contract	-	Initial review of tender design	/A
3	Baseline Data	<ul style="list-style-type: none">Air: Qualitative reporting of emission impacts from powerhouse to residential areasNoise level: The nearest residence where the nearest residence is less than 100m from the construction site.	<ul style="list-style-type: none">During initial surveys for feasibility study		Collect during initial field visits	/A
4	Vegetation	<ul style="list-style-type: none">For all potential sites identify types and amount of vegetation to minimize removal of vegetation	<ul style="list-style-type: none">During initial surveys for feasibility study		Collect during initial field visits	/A
5	Protected areas and trees & ecologically and culturally sensitive areas	<ul style="list-style-type: none">Ensure potential sites do not contain protected trees or are ecologically and culturally sensitive areas	<ul style="list-style-type: none">During initial surveys for feasibility study		Collect during initial field visits	/A
CONSTRUCTION STAGE						
6	Noise	<ul style="list-style-type: none">Noise levels in dB(A)	<ul style="list-style-type: none">At the start of concerned activities.At least 3 times during construction period.	All construction sites	Spot checks to be undertaken by Powerhouse staff	Report in bi-weekly report
7	Air	<ul style="list-style-type: none">Qualitative visual reporting of emission of dust and particulate matter	<ul style="list-style-type: none">At the start of concerned activities.At least 3 times during construction period.	All construction sites	Spot checks to be undertaken by Powerhouse staff	Report in bi-weekly report

Sl. No.	Environmental Features	Aspect to be Monitored	Time and Frequency of Monitoring	Location	Responsible party	
					PMU/Utility staff	Contractor
8	Physical Works Progress	<ul style="list-style-type: none"> As specified in contractors' plan Including records of tree cutting, waste generated and disposal methods 	<ul style="list-style-type: none"> Bi-weekly 	All construction sites	Spot checks to be undertaken by Powerhouse staff	Report in bi-weekly report
9	Health and safety	<ul style="list-style-type: none"> As specified in project OHS plan prepared by Contractor 	<ul style="list-style-type: none"> Bi-weekly 	All construction sites	Spot checks to be undertaken by Powerhouse staff	Report in bi-weekly report
OPERATION STAGE						
10	Noise Level	<ul style="list-style-type: none"> Noise levels on dB (A) scale 	<ul style="list-style-type: none"> At least 2 times in a year. 	At operation sites	Powerhouse staff to take reading and report to PMU	N/A
11	Air quality	<ul style="list-style-type: none"> Visual impact of emissions reported qualitatively 	<ul style="list-style-type: none"> At least 2 times in a year. 	At operation sites	Powerhouse staff to take reading and report to PMU	N/A
12	Health and safety	<ul style="list-style-type: none"> Incidences of health and safety 	<ul style="list-style-type: none"> Monthly 	At operation sites	Powerhouse staff to take reading and report to PMU	N/A
13	PV panel	<ul style="list-style-type: none"> Need to be cleaned (e.g. bird droppings) 	<ul style="list-style-type: none"> Monthly for the 1st year or as required 	At operation sites	Powerhouse staff to oversee and do after O&M by contractor ends	Under O&M in the 1 st year
14	Hazardous Waste	<ul style="list-style-type: none"> Hazardous waste including used batteries and PV panels should be recorded with their disposal methods. Monitor shipping and transportation routes. 	<ul style="list-style-type: none"> Once a year 	At operation site	Powerhouse staff to oversee and do after O&M by contractor ends	Under O&M in the 1 st year

EPC - Engineering, Procurement and Construction

PMU - Project Management Unit

9.1 Grievance Redress Mechanism

In order to receive and facilitate the resolution of affected peoples' concerns, complaints, and grievances about the project's environmental and social safeguards performance a Grievance Redress Mechanism (GRM) was proposed for the POISED Project (Table 18). This Phase 5 sub-project will follow this GRM. This mechanism will be used for addressing any complaints that may arise during the construction and operation of the sub-project. The Project Management Unit (PMU) will appropriately inform communities of the mechanism before commencement of any civil works.

The PMU will have a designated staff member to address all potential complaints from the public for both installation and operation phases of the sub-project. Any complaint will be recorded and investigated by the PMU working with the installation and operations managers (as appropriate). A complaints register will be maintained which will show the details and nature of the complaint, the complainant, the date and actions taken as a result of the investigation. It will also cross-reference any noncompliance report and/or corrective action report or other relevant documentation.

Table 18. Grievance redress process

Stage	Process	Duration
1	Affected Person (AP)/village elected chief takes grievance to PMU through PIU	Any time
2	PMU review and find solution to the problem in consultation with village chief and relevant agencies	2 weeks
3	PMU reports back to village chief/AP	1 week
If unresolved		
4	AP/village chief take grievance to Island Council	Within 2 weeks of receipt of decision in step 3
5	Island Council refers matter to relevant national agency (EPA/MoHI/Legal Department)	2 weeks
6	National agency refers to an internal committee	4 weeks
7	National agency reports back to AP/village chief	1 week
If unresolved or at any stage if AP is not satisfied		
AP/village chief can take the matter to appropriate court		As per judicial system

All corrective actions and complaints responses carried out on site will be reported back to the PMU through field level Project Implementation Unit (PIU). The PMU will include the complaints register and corrective actions/responses in its progress reports to the ADB and EIB. In the whole progress, the Maldivian national agencies (EPA for environment related grievances and Ministry of Housing and Infrastructure for social/resettlement related grievances) will be always available for public complaints and advice on the PMU's performance for grievance redress.

10 Conclusion

This sub-project Phase 5 of the POISED project is for the implementation of a RE hybrid system in 12 islands of Thaa atoll and 4 solar-powered ice plants. The scope of the IEE includes installation of solar PV systems, battery storage, replacement of inefficient diesel generators and implementation of solar powered ice plants.

The findings of this IEE establish that the project activities do not pose significant environmental or social impacts to the communities. Improved air quality, reduced noise levels and subsequent health benefits are among the many potential benefits that deem this project a great need for the community. Reduction in spending on diesel would create economic benefits throughout the life of the project. Any negative impacts are seen as minor or moderate, without lasting impacts. It is recommended that the proposed EMP and EMoP are followed and careful monitoring be done at both construction and operational stages.

Appendices

Appendix 1: EIA Decision Note for POISED projects

(insert new letter from EPA and translation)

Appendix 2: Attendance sheets for Thaa Atoll island consultations

Hirilandhoo (4/7/19)			
Name	Gender	Age	Role/group
Mohamed Jalal	Male		Island Council
Ahmed Haisham	Male		Island Council
Mohamed Amir	Male		Island Council
Ibrahim Shimal	Male		Island Council
Mohamed Azmeen	Male		FENAKA
Mohamed Shiham	Male		FENAKA
Raof Adil	Male		FENAKA
Ali Jaufar	Male		FENAKA
Ahmed Nazim	Male		FENAKA
Ali Ahushal	Male		FENAKA
Ahmed Rameez	Male		FENAKA
Ahmed Fazeel	Male		FENAKA
Ahmed Riyaz	Male		FENAKA
Ahmed Faarish	Male		FENAKA

Kandoodhoo (7/7/19)			
Name	Gender	Age	Role/group
Ali Mohamed			Director island council
Adam Naseer			Station manager
Mariyam Maazina Adam	Female		Project officer
Shahid Ibrahim			Supervisor
Mohamed Nawal?	Male		Island Council
Imaad? Ismail			A. Manager
Ali Nasihu	Male		Island Council
Ahmed Ashham Yoosuf Nizar	Male	12	School
Mohamed Maaish	Male	12	School
Ahmed Abaan Amir	Male	13	School
Mohamed Aiham	Male	14	School
Ahmed Ailaan	Male	15	School
Rana Asraar	Female	13	School
Mohamed Mishal	Male	12	School
Mohamed Mishwaan	Male	14	School
Ahmed Raaidh Easa	Male	13	School
Aishath Rana	Female	13	School
Aishath Rixna	Female	13	School
Rauha Qasim	Female	12	School
Aminath Imna Ismail	Female	13	School
			Fenaka staff list
Risala Ali	Female	45	Women
Nasrath Mohamed	Female	41	Women
Aminath Shaza	Female	32	Women
Yashfa Hussain	Female	33	Women
Aishath Vishna	Female	38	Women
Ihusana Abdul Rahman	Female	43	Women
Hawwa Majidha	Female	31	Women
Waheedha	Female	60	Women
Mariyam Sarahath	Female	32	Women

Hafsa Umar	Female	48	Women
Salwa Ali	Female	37	Women
Saeedha Ibrahim	Female	52	Women
Ramziyya Abdul Rahman			Women's Development Committee
Ramiza Ibrahim			Women's Development Committee
Badhoora Mohamed			Women's Development Committee

Island/Date	Name	Gender	Age	Role/group
Gaadhiffushi (8/7/19)	Hassan Shinaan	Male		Island Council
	Abdul Muhaimin	Male		Island Council
	Ibrahim Shiyaz	Male		Island Council
	Mariyam Rasheed	Female		
Guraidhoo (9/7/19)	Aishath Rishmee	Female		Island Council
	Thawfeeg Ali	Male		Island Council
	Ahmed Rashad	Male		Island Council
	Ali Rasheed	Male		Island Council
	Shahula Ahmed	Female		
	Faheema Abdul Wahab	Female		
	Fariyaal Abdulla	Female		
	Ulfa Ahmed	Female		
	Aneesa Mohamed	Female		
Dhiyamigili (15/7/19)	Nahid Abbas	Male		Island Council
	Mohamed Muneer	Male		Island Council
	Yahya Rasheed	Male		
	Hussain Habeeb	Male		
	Polash Das			EESL
	Saumya Tiwari	Female		EESL

Appendix 3: Photos from community consultations



Figure 37: Meeting with Th. Thimarafushi Women



Figure 238: Meeting with FENAKA Team at Th. Thimarafushi branch



Figure 3: RE and career guidance session to Th. Thimarafushi school students, teachers and parents



Figure 39: Meeting with Th. Thimarafushi council



Figure 4: RE and career guidance session to Th. Thimarafushi school students, teachers and parents



Figure 6: Meeting with Th. Thimarafushi Women



Figure 7: RE and career guidance session to Th. Thimarafushi school students, teachers and parents



Figure 9: RE and career guidance session to Th. Thimarafushi school students, teachers and parents



Figure 8: Session for Th. Veymandoo staff



Figure 10: Meeting with Th. Veymandoo council



Figure 401: Session for Th. Veymandoo WDC



Figure 13: Sessions for Th. Veymandoo school children, teachers and Parents



Figure 12: Session for Th. Kinbidhoo FENAKA staff



Figure 14: Sessions for Th. Kinbidhoo School children and teachers



Figure 15: Sessions for Th. Kinbidhoo WDC



Figure 17: Meeting with Th. Kinbidhoo council



Figure 16: Session for the Th. Kinbidhoo Women



Figure 1841: Meeting with Th. Omadhoo Council



Figure 19: Session for the Th. Omadhoo FENAKA



Figure 21: Session for Th. Omadhoo students



Figure 20: Meeting with Th. Hirilandhoo WDC



Figure 22: Sessions for Th. Hirilandhoo students, parents and teachers



Figure 23: Session for Th. Hirilanhoo FENAKA



Figure 25: Meeting with Th. Vandhoo Council



Figure 24: Session for the Th. Vandhoo women



Figure 26: Sessions for Th. Vandhoo students, teachers and parents



Figure 27: Meeting with Th. Kandoodhoo Council



Figure 29: Sessions for Th. Kandoodhoo students



Figure 28: Meeting with Th. Kandoodhoo WDC



Figure 30: Session for the Th. Kandoodhoo women



Figure 31: Session for Th. Kandoodhoo FENAKA



Figure 33: Meeting with Th. Gaadhiffushi council



Figure 32: Sessions in Th. Gaadhiffushi school



Figure 34: Session in Th. Gaadhiffushi FENAKA



Figure 35: Session for Th. Gaadhiffushi community



Figure 37: Meeting with Th. Guraidhoo FENAKA



Figure 36: Meeting with Th. Guraidhoo school



Figure 38: Sessions for the Th. Guraidhoo students



Figure 39: Meeting with Th. Guraidhoo council and WDC



Figure 41: Meeting with Dhiyamingili council



Figure 40: Sessions for the Th. Dhiyamingili students, teachers and parents



Figure 42: Meeting with Th. Dhiyamingili FENAKA staff



Figure 43: Meeting with Th. Dhiyamingili council and WDC



Figure 45: Meeting with Th. Modifushi FENAKA



Figure 44: Sessions for Th. Madifushi students, teachers and parents



Figure 46: Meeting with Th. Vilufushi FENAKA staff

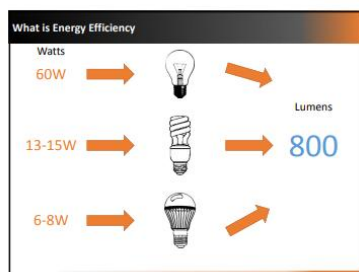
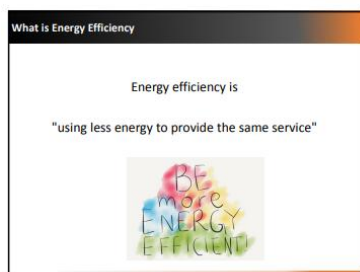
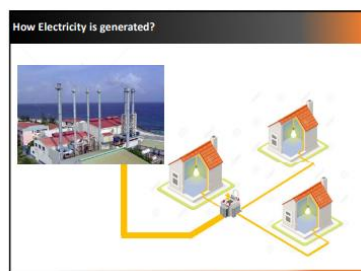


Figure 47: Meeting with Th. Vilufushi council and WDC



Figure 48: Sessions for Th. Vilufushi students, teachers and parents


Appendix 4: Slides presented at community consultations – Energy efficiency and Gender mainstreaming sessions




Efficiency vs. Conservation

- Efficiency**
 - Energy efficiency involves the use of technology that requires less energy to perform the same function.
 - Focuses on the equipment or machinery being used
- Conservation**
 - Energy conservation includes any behavior that results in the use of less energy.
 - Focuses on the behavior of people


How we waste energy!




Standby Loss



Running of non-essential appliances



Inefficient lighting

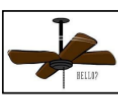


Inefficient and excessive air conditioning

How we waste energy!




Keeping the refrigerator door open unnecessarily



Fans On in empty rooms

Benefits of Energy Efficiency and Energy Conservation

- To reduce energy consumption in order to reduce the energy demand
- To reduce the cost of electricity generation
- To import and burn less quantities of fossil fuels
- To reduce CO2 emission



How can we save electricity?



Shutdown the computer when not use



Switch off non-essential appliances from the plug



Use Energy Efficient Air conditioning



Use LED for lighting



Turn off the lights when not in use!



Turn off electrical appliances when not in use!

How can we save electricity?



Turn the air conditioners off when you aren't using it




How can we save electricity?



- Temperature is often set to 26°C
- One degree of additional cooling results in a 5% increase in the energy consumption.

How can we save electricity?

- Use daylight as much as possible




How much does it cost?

Total Number of kWh used: 180 kWh

Band	Rate (a)	Units (b)	MPV (c%)
1-100	6.00		
101-200	7.00		
201-300	8.00		
301-above	12.50		
Fuel surcharge	2.66		
Total			

අගය	අංශ	ප්‍රතිශතය
6.00	180	අගය 1-100
7.00	100	අගය 100-200
8.00	100	අගය 200-300
12.50	4300	අගය 300-1000
0.00	0	අගය 1000-10000
2.66	9	අගය 10000-100000







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