

# Initial Environmental Examination

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## Maldives: Accelerating Sustainable System Development Using Renewable Energy Project

### Main Report

Prepared by the Ministry of Finance, Government of Maldives for the Asian Development Bank.

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## **CURRENCY EQUIVALENTS**

(as of 24 March 2023)

Currency unit	-	rufiyaa (Rf)
Rf1.00	=	Rf15.45
US\$1.00	=	US\$0.065

## **LIST OF ABBREVIATIONS**

ADB	–	Asian Development Bank
ASSURE	–	Accelerating Sustainable System Development Using Renewable Energy
BESS	–	battery energy storage systems
CFC	–	chlorofluorocarbons
COVID-19	–	coronavirus disease
EIA	–	environmental impact assessment
EHS	–	Environmental Health and Safety
EPA	–	Environmental Protection Agency of Maldives
EMP	–	environmental management plan
ESMS	–	environmental and social management system
EPC	–	engineering, procurement, and construction
FENAKA	–	FENAKA Corporation Limited
GDP	–	gross domestic product
GFP	–	grievance focal point
GHG	–	greenhouse gas
GRC	–	grievance redress committee
IBA	–	important bird areas
IBAT	–	Integrated Biodiversity Assessment Tool
IEE	–	initial environmental examination
IFC	–	International Finance Corporation
ILO	–	International Labor Organization
IUCN	–	International Union for Conservation of Nature
KBA	–	key biodiversity areas
kWp	–	kilowatt peak
MOECCT	–	Ministry of Environment, Climate Change and Technology
MWh	–	megawatt hour
MWp	–	megawatt peak
PCB	–	polychlorinated biphenyl
PIU	–	project implementation unit
PMC	–	project management consultants
PMU	–	project management unit
POISED	–	Preparing Outer Islands for Sustainable Energy Development Project
PPP	–	public-private partnership
REA	–	rapid environmental assessment
STELCO	–	State Electric Company Limited
WHO	–	World Health Organization

## **NOTES**

- (i) The fiscal year (FY) of the Government of Maldives ends on 31 December. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2021 ends on 31 December 2021.
- (ii) In this report, "\$" refers to US dollars.

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## EXECUTIVE SUMMARY

1. The Government of Maldives has approached the Asian Development Bank (ADB) for financial support to assist in the implementation of the Accelerating Sustainable System Development Using Renewable Energy Project. An initial environmental examination for the proposed Project in Maldives has been carried out in compliance with ADB's Safeguard Policy Statement (2009) requirements and with reference to national environmental, health and safety requirements and obligations under international agreements. The project aims to support Maldives electricity sector to attain energy security and a sustainable transition. Specifically, the project is expected to (i) increase private sector investments in renewable energy; (ii) de-risk solar independent power producer projects; (iii) increase renewable energy penetration, using emerging technologies and net metering; (iv) strengthen the capacity of the Ministry of Environment, Climate Change and Technology (MOECCT), State Electric Company Limited (STELCO), and FENAKA Corporation Limited (FENAKA); and (v) promote and pilot the use of disaster-resilient, innovative, and gender- and socially inclusive renewable energy-based farming technologies.

2. The physical interventions proposed for funding under the project cover 22 outer islands (12 atolls) of the Maldives and are:

- (i) Installation of Battery Energy Storage Systems (BESS) (a total of 44 megawatt hours (MWh) plus energy management systems and upgrading of island distribution grid system in 20 outer islands, thereby ensuring the outer island grids are ready for high renewable energy penetration by the private sector.
- (ii) Installation of a pilot wind power generation component comprising up to six wind turbines of up to 150 kilowatts (kW) rated power in Manadhoo island.
- (iii) Installation of a pilot ocean power generation component of four small-scale 25 kW hydrokinetic energy systems to generate up to 100 kW of rated power in one of the three possible islands i.e., Muli or Mulah or Komandhoo island.
- (iv) Installation of rooftop solar installations of 2.5-megawatt peak (MWp) through net metering for at least 1,000 domestic and commercial consumers; and
- (v) Agricultural interventions including installation of a pumped, drip crop irrigation system to be supported by a 192-kW peak ground mounted solar photovoltaic plant with BESS and upgrading of the island distribution grid, and potentially cold storage and shade houses in Thoddoo island with the exact scope of this output to be determined during project implementation.

3. The Project places an emphasis on increasing private sector investments in renewable energy, including terrestrial and marine photovoltaic systems. It will mobilize but not directly fund private sector investments in floating and terrestrial solar photovoltaic systems of at least 20 MWp capacity covering 20 outer islands by ensuring the distribution grids on 20 outer islands are ready for renewable energy penetration, as well as de-risking private sector investment through the provision of financial instruments. The floating and terrestrial solar photovoltaic systems will be funded by the private sector as a third party to MOECCT. The initial environmental examination (IEE) addresses the potential impacts and risks of the above Project-funded components in depth whilst the attached due diligence addresses the potential impacts and risks of these ensuing terrestrial and marine photovoltaic system private sector investments as associated facilities of the project. For the private sector associated facilities and/or financial instrument backed components a due diligence report has been prepared including frameworks for the preparation of environmental management plans, biodiversity action plans, and biodiversity offset management plans by the private sector contractor for approval by the government. The

associated facilities will be implemented through a public-private partnership (PPP) and the request for proposal will require compliance with ADB's Safeguard Policy Statement (2009) and these frameworks. An environmental and social management system (ESMS) is to be adopted by the government to ensure these requirements are met before the independent power producer can gain access to the financial instruments being funded by the project. Other components including capacity development will have no or minimal environmental impact.

4. The Ministry of Finance of Maldives is the executing agency for the project and MOECCT, Government of Maldives is the implementing agency of the project. Once constructed, all the project-funded interventions will be operated by FENAKA except for the pilots which will be operated for a year by the contractors, and the agricultural intervention where the irrigation system and any cold storage or shade houses constructed by the project will be handed over to the island community after installation.

5. The project is classified as ADB environment category B as determined by the project's most environmentally sensitive component, which is the ocean energy pilot to be sited in the marine environment on one of the following islands: Mulah, Muli, or Komandhoo following a feasibility study by the contractor. Both natural and critical marine habitat are present, but no significant impacts are anticipated given the scale of the pilot. Coral and seagrass will be avoided to ensure no net loss can be achieved without offset. The most environmentally sensitive terrestrial component is pilot wind power generation. It will be designed to achieve 35dB at 10m/s wind speed at 10m height as LA90 at the nearest residential receiver, as well as shadow flicker and safety (including set-back in case of any blade or tower failure) requirements in line with the International Finance Corporation (IFC) Environmental Health and Safety (EHS) Guidelines on Wind Energy such that no significant impacts are anticipated. Accordingly, this IEE is prepared to meet the requirements of ADB's Safeguard Policy Statement (2009) requirements for an environment category B project. It is also prepared with reference to national environmental, health and safety requirements although the environmental assessments required for national environmental approval will be separately prepared by MOECCT for submission to the Environmental Protection Agency (EPA) of Maldives. Under national regulations, the BESS, energy management systems, upgrading of the grid, and rooftop solar installations are unlikely to require any national EIA or IEE to be prepared. However, the wind and ocean energy systems will likely require a national EIA or IEE prior to approval whilst the need for a national EIA or IEE for the agricultural interventions will depend on the exact scope. Once detailed designs are available MOECCT has to screen in consultation with EPA the project-funded components that will require either a national EIA or IEE as this depends on the location, nature and scale of each component and the EPA's view on potential for significant impacts to occur. In all cases national environmental approval will be obtained by MOECCT prior to the commencement of works on the ground. MOECCT will also obtain Island Council approvals for use of land, and other required approvals such as for tree cutting prior to the commencement of works.

6. The assessment of environmental, health, safety and social impacts and risks has been carried out based on the review of the pre-feasibility reports for the project components and technical specifications for the proposed wind and ocean energy systems. Field visits, surveys and consultations with key stakeholders and communities have also been undertaken as part of this assessment. This IEE was prepared during the pre-feasibility and technical studies between the months of August 2021 to March 2023. Technical studies have been completed and the Project is currently in the bid preparation stage. In case of any changes in the project design or locations of components during the detailed design stages, following ADB project approval, this IEE will be updated for ADB's review and clearance in compliance with ADB's Safeguard Policy



Statement (2009) prior to commencing any works. The IEE and environmental management plan (EMP) will also be updated following the studies for the pilot ocean power generation and agriculture interventions since the locations and exact scope are still to be studied.

7. In addition to the impacts of the ocean and wind energy systems mentioned above the main anticipated impacts and risks of the project-funded components relate to short-term (approximately 3–5 days for smaller works and 2–3 months for larger works i.e. wind turbine installation) disruption and disturbance during construction; pollution risks; and health and safety risks to workers and local communities, for example, island roads will be blocked and noise and dust emissions will be created from the operation of construction machinery such as concrete mixers, bulldozers, dump trucks, cranes etc. Such impacts and risks can be easily mitigated by the contractors following national requirements and international good practice mitigation. All sites for the terrestrial project facilities have been selected by MOECCT with due consideration to environmental and social aspects including habitats, legally protected areas, and physical cultural resources. BESS will be installed on 20 outer islands within the premises of existing powerhouses in a small building or container. Upgrading of the existing distribution grids on 20 outer islands will involve the installation of underground cables—23 kilometers (km) of 400 kilovolts (kV) cable and 14.9 km of 11 kV cables—along existing island roads, control panels, distribution boxes, 29 package substations or ring main units, and 17 transformers in the existing powerhouses. There is natural coastal and forest habitat and physical culture resources (mosques) adjacent some of these existing powerhouses but they themselves support modified habitat. Total capacity of the rooftop solar installations will be up to 2.5 MW peak—the solar home systems will be installed by FENAKA Corporation Limited on rooftops of the individual buildings or houses of the customers on consumer priority basis; being on existing rooftops they will have limited environmental impacts, but occupational and community health and safety risks and waste generation still need to be managed. Outside of the existing powerhouses and rooftops there will need to be cutting and trimming of trees and vegetation from the project sites specifically from the proposed site for the wind turbine installation on Manadhoo Island where 24 trees including two coconut palms as well as a mangrove species are found. To ensure the project is in accordance with new (2022) national regulations, no trees or vegetation within 20 m of the outermost coastal tree will be cleared and no coconut palms will be cut without EPA permission. Trees cut will be compensated on the island in question with the same species at a ratio of 1:2 or 1:4 for coconut palms before works commence to ensure the space for this compensation planting can be found, since space is limited. There is a risk of resident or occasional migratory birds or fruit bats colliding with the wind turbines, but no threatened species are known to be supported by Manadhoo island. As a pilot, adaptive management such as curtailment of operations will be implemented as required. Similarly, if unanticipated impacts resulted from the ocean energy system it will be decommissioned, as is currently the plan with EPA approval required to make it into a permanent installation.

8. An EMP has been prepared for the project-funded components. Provided the EMP requirements are followed during detailed design and construction, and all the project-funded components are well maintained and operated by FENAKA, the project-funded components will not have any significant long-term adverse environmental impacts; in fact, the project will create long-term environmental benefits by reducing CO<sub>2</sub> emissions as well as reducing emissions of SPM, sulfux oxides, and nitrogen oxides plus noise from existing diesel generators. The EMP includes a monitoring plan, including monitoring of health and safety incidents and waste generation. The responsible entity for mitigation, monitoring and reporting is MOETCC with support of FENAKA, especially during operation. As the project involves existing facilities (powerhouses) environmental audits have been conducted and time bound corrective action

identified for implementation by FENAKA before contractors are granted access to the powerhouses for the project. Safe handling, storage, and disposal of diesel fuel, oil residues, and lubricating oil associated with existing diesel generators are an operational issue for the powerhouses and capacity building will be provided as part of the project's capacity building output. Environmental management will be assured by a program of on-site environmental supervision and monitoring to be conducted by MOECCT during the construction and operation stages. They will appoint a suitably qualified and experienced, dedicated environment safeguards officer and a suitably qualified and experienced, dedicated social (community liaison) officer, plus a firm of national environment and ecological consultants to support them with updating of the IEE, providing regular (monthly) on-site supervision during the construction period, and undertaking ecological field survey work, an international environment expert and an international marine ecology expert. The latter will also support the government in assessing the associated facilities of the private sector. Any unanticipated impacts or requirements for corrective action during implementation will be reported by MOECCT to ADB.

9. Local communities and stakeholders including women groups were involved in the process of environmental assessment through on-site discussions. In total 264 persons from the 22 islands were consulted including 35% women. As the project will mostly have limited environmental impacts whilst providing energy security and reducing dependence on diesel generation, local communities support it and are keen for it to be progressed. This IEE will be made available for consultation at the Island Council, powerhouse and construction site offices on each island and will be disclosed to a wider audience via the ADB and MOECCT websites. The consultation process will be continued and expanded during the further studies, detailed design, and construction to ensure that stakeholders are fully engaged in the Project and can participate in its development and implementation. A grievance redress mechanism will be established by MOECCT along with the Island Councils whilst consultations will help local communities understand that there is a process in place for them to air any grievances or complaints.

## **I. INTRODUCTION**

### **A. Background**

1. This initial environmental examination (IEE) for the proposed Accelerating Sustainable System Development Using Renewable Energy Project has been carried out in compliance with ADB's Safeguard Policy Statement requirements and with reference to national environmental, health and safety requirements and obligations under international agreements. The project aims to support Maldives electricity sector to attain energy security and a sustainable transition. Specifically, the Project is expected to (i) increase private sector investments in renewable energy, (ii) de-risk solar independent power producer projects; (iii) increase renewable energy penetration, using emerging technologies and net metering; (iv) strengthen the capacity of the Ministry of Environment, Climate Change and Technology (MOECCT), State Electric Company Limited (STELCO), and FENAKA Corporation Limited (FENAKA), and (v) promote and pilot the use of disaster-resilient, innovative, and gender- and socially inclusive renewable energy-based farming technologies. The Project cost estimated is \$100.47 million. To implement the project, the Government of Maldives has requested a grant not exceeding \$41.5 million from ADB's Special Fund resources (Asian Development Fund) to help finance the project. The government has also requested a concessional loan and grants from several trust funds, all to be administered by ADB. The ADB Climate Investment Fund will provide a concessional loan of \$10 million and grant of \$5 million, and the Climate Change Fund will provide a grant of 0.5 million. The Japan Fund for the Joint Crediting Mechanism will provide grant amounting to \$6.2 million whilst the Asia-Pacific Climate Finance Fund will provide \$3.8 million.

### **B. Project Rationale**

2. The Republic of Maldives with its 1,192 islands spread across 800 kilometers in the central Indian ocean, is one of the world's most geographically dispersed countries. Maldives has a population of around 515,000 people dispersed across 185 islands. This dispersion and the small size of most inhabited islands make it extremely challenging to generate electricity centrally and distribute it through a comprehensive grid network to realize economies of scale. Maldives has about 290 megawatts (MW) diesel generators, and more than 22 MW in renewable energy installations in 186 inhabited islands, and about another 144 MW diesel generators in resort islands. The cost of generation is unaffordable at \$0.30–\$0.70 per kilowatt-hour (kWh) (depending on the island) and requires government subsidies of over \$62 million or 1% of gross domestic product (GDP) in 2019. Fossil fuel imports account for about 10% of the country's GDP, about half of which is for electricity generation. The heavy diesel dependence of Maldives also makes its carbon emissions per unit of electricity among the highest in the region.

3. To improve energy security, the government has committed to increasing the use of renewable energy and promote energy efficiency. In 2014, the government has initiated two major programs: (i) Preparing Outer Islands for Sustainable Energy Development Project (POISED) project supported by the Asian Development Bank (ADB) to introduce solar photovoltaic battery-based hybrid systems in outer islands; and (ii) Accelerating Sustainable Private Investments in Renewable Energy supported by the World Bank to mobilize private sector investments in solar photovoltaic systems in the greater Malé region. ADB also approved a second additional financing on 30 October 2020 to expand the POISED project. In December 2020, the World Bank also approved additional support to accelerate the energy sector's transition to renewable energy through the Accelerating Renewable Energy Integration and Sustainable Energy project. These interventions will contribute to reducing the cost of electricity, the subsidy burden on the

government's budget, and emissions from diesel generation; and will diversify the power generation mix.

4. The country enjoys universal access to electricity, but it is entirely dependent on imported oil as the primary source of energy. The economy is exposed to fluctuations and increases in oil prices which are exacerbated by the lack of adequate fuel and other petroleum product storage facilities, resulting in extended supply chain risk and constraints on economic growth. The country is also exposed to climate change risks and has taken various initiatives to address these risks with the objective of becoming a carbon neutral country based on a zero-carbon electricity sector. The government policy approach is to take these challenges on as opportunities to develop a healthy economy based on renewable and sustainable energy resources and services. Hence Government of Maldives has approached ADB for financial support to assist in the implementation of the Accelerating Sustainable System Development Using Renewable Energy (ASSURE) Project.

### C. Proposed Project

5. The project is aligned with the following impact: energy security and sustainable transition of electricity sector in Maldives improved. The project will have the following outcome: share of renewable energy sources in power generation mix increased. Project interventions will support selected outer islands to attain high level of renewable penetration through technological advances, as well as by deepening engagement with project partners and civil society on mainstreaming gender equity and social inclusion in project implementation. The project will also introduce emerging renewable energy technologies and cross sectoral interventions that have high potential for future replication.

- (i) **Output 1: Private sector investments in renewable energy enhanced.** To enable private sector independent power producers (IPP) to invest in floating and terrestrial solar photovoltaic of at least 20 MWp capacity covering 20 outer islands, the project will support capital-intensive investments such as energy storage of about 44 megawatt-hours (MWh) capacity, energy management systems, and grid upgrades to ensure the island grids are ready for higher renewable energy penetration.<sup>1</sup>
- (ii) **Output 2: Solar independent power producer projects de-risked.** This output will develop and provide financial instruments in the form of (i) escrow account to provide liquidity support facility (or payment security fund), including an initial contribution into the fund, to mitigate delayed payment risk from FENAKA under the power purchase agreement with solar IPPs; (ii) a performance-based incentive scheme to support the solar IPPs, encouraging the developers to put into place an efficient system in a timely manner, as well as to reduce the financial costs of the tariffs in the remote islands. These two instruments are expected to help develop a bankable solar project structure that is attractive to private investors and demonstrate a robust public-private partnership model that can be further scaled up and expanded. The project is also considering the inclusion of (iii) political risk insurance from the Multilateral Investment Guarantee Agency<sup>2</sup>; and (iv) transaction

<sup>1</sup> ADB's Office of Public-Private Partnership (OPPP) will provide technical assistance to develop capacity of MOECCT and FENAKA in creating a conducive environment for private sector participation. Sovereign financing will be used to support the capital-intensive investments required in output 1.

<sup>2</sup> Multilateral Investment Guarantee Agency, subject to its approval, is considering providing a political risk insurance product covering expropriation, war and civil disturbance, foreign exchange inconvertibility, and breach of contract

advisory service<sup>3</sup> support to the solar IPP as further layer of project risk mitigation. These risk mitigation instruments will be offered to the solar IPP bidders in the bidding process to make them aware of their availability.

- (iii) **Output 3: Renewable energy penetration using new technologies, and net metering increased.** To increase the penetration of renewable energy, the project will (i) introduce emerging technologies<sup>4</sup> with replication potential such as ocean<sup>5</sup> and wind<sup>6</sup> energy in two outer islands; (ii) support rooftop solar installations through net metering for at least 1,000 domestic and commercial consumers;<sup>7</sup> and (iii) modernize grids to enable adoption of new technologies, net metering, expansion of hybrid system, and pilot-testing gender inclusive renewable energy-based farming.
- (iv) **Output 4: Capacity of the Ministry of Environment, Climate Change and Technology, power utilities and regulator strengthened.** To complement the ongoing capacity development under the project, the project will enhance the capacity of the Ministry of Environment, Climate Change and Technology (MOECCT), utilities and regulator in (i) systematic planning to outline investments, strategies, and policies to expand renewable energy through private sector; (ii) financial management and financial sustainability; (iii) effectively monitoring the project, and ensuring its technical, safeguard, procurement and fiduciary compliances as required; (iv) designing and implementing emerging renewable technology areas; and (v) conducting workshops, technical studies and assessments to support climate and disaster resilient renewable energy installations in resorts through private sector.
- (v) **Output 5: Productive use of disaster-resilient, innovative, and gender- and socially inclusive renewable energy-based farming technologies pilot-tested and promoted.** On a pilot basis, the project will support selected poor and vulnerable households in adopting farming technologies powered by disaster-resilient renewable energy systems. This involves (i) identifying and adopting innovative farming techniques to improve food security and support income-generation activities through gender and socially inclusive approaches; (ii) connecting farming units to renewable energy distribution grids to support farm activities and cold storage; and (iii) awareness-raising, skills training, provision of

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risk to the equity sponsor of the solar independent power producers (IPP) as a further layer of project risk mitigation. The winning bidder will be free to choose whether to use and if yes, the type of equity investment related political risk insurance cover, based on terms and conditions offered by Multilateral Investment Guarantee Agency.

<sup>3</sup> ADB (OPPP) and the Ministry of Environment, Climate Change and Technology (MOECCT) have signed a transaction advisory service agreement in December 2021, whereby ADB will assist MOECCT in the development, structuring, tendering, and signing of a 20 MW solar IPP (floating, rooftop, and land-based installations) in the outer islands of Maldives.

<sup>4</sup> Renewable energy technologies such as wind and ocean energy will be pilot-tested and introduced in potential outer islands. The capacity of wind turbines is expected to be between 100 kilowatts (kW) and 150 kW and ocean energy technology is about 100 kW during the pilot phase. The identification of islands and their location will be confirmed after the screening results.

<sup>5</sup> Installation of 100 kW capacity pilot ocean renewable energy system on one island. Based on the initial assessment it is recommended to implement the pilot in one of the three islands of Maldives i.e., Komandhoo island, Mulah Island, or Muli Island. Final island and site to implement the pilot project will be selected by the contractor based on the study of the marine environment. The project will supply four small-scale 25 kW hydrokinetic energy systems to generate up to 100 kW of power.

<sup>6</sup> 150 kW Pilot Wind Renewable Energy Hybrid Microgrid Project in Manadhoo Island, Maldives.

<sup>7</sup> Total capacity of the rooftop solar installations will be up to 2.5 Mega Watt peak (MWp)—the solar home systems will be installed by FENAKA Corporation Limited on rooftops of the individual buildings or houses of the customers on consumer priority basis.

start-up capital, and supporting market linkages, including identification of purchasers of agricultural products.

#### **D. Project Proponents**

Project Name : Accelerating Sustainable System Development Using Renewable Energy Project  
 Name of Proponent/s : Ministry of Finance, the Ministry of Environment, Climate Change and Technology, Government of the Republic of Maldives  
 Address of Proponent : Maafannu, Malé 20392, Republic of Maldives

6. The Ministry of Finance of Maldives is the executing agency for the Project and the Ministry of Environment, Climate Change and Technology (MOECCT) is the implementing agency of the Project. Once constructed, all the Project-funded interventions will be operated by FENAKA Corporation Limited except for the agricultural intervention where the irrigation system and any cold storage or shade houses constructed by the Project will be handed over to the island community after installation.

#### **E. Purpose and Objectives of the Initial Environment Examination**

7. Based on the likely types, sizes and location of the project facilities, the project has been classified by ADB as environment category B as determined by the project's most environmentally sensitive component, the wind energy which will have adverse environmental impacts both during construction as well as operation stages. This IEE has been prepared in accordance with ADB's Safeguard Policy Statement (2009) requirements and aims to ensure good environmental practices. The specific objectives of this IEE are to:

- (i) Provide an environmental and social baseline description of the project.
- (ii) Identify and describe the potential environmental and social impacts of the project.
- (iii) Design mitigation measures to minimize adverse impacts.
- (iv) Describe the public consultation process and grievance redress mechanism.
- (v) Provide an environmental management and monitoring plan for the project (including defining institutional responsibilities, capacity building and training, and the required budget).

8. MOECCT of Maldives as an implementing agency has prepared this IEE with support from international and national consultants. This IEE is prepared in the second quarter (Q2)–Q4 of 2022 i.e., during the pre-feasibility and technical study stages of the project. The technical studies have been completed and the project is currently in bid preparation. The purpose of this IEE is to assess potential environmental, health, safety, and social impacts of the proposed interventions in outer Islands and propose suitable mitigation measures where required. In case of any changes in the project design or locations of components during the feasibility and detailed design stages, following ADB project approval, this IEE will be updated for ADB's review and clearance in compliance with ADB's Safeguard Policy Statement (2009) prior to commencing any works. The IEE and EMP will also be updated following the studies for the pilot ocean power generation and agriculture interventions since the locations and exact scope are still to be studied.

## **F. Scope and Methodology of the Initial Environment Examination**

9. This IEE was prepared by staff and consultants employed by MOECCT, namely: (i) Sunil K. Choukiker (International Environment Specialist); (ii) Dr. Mizna Mohamad, (National Environment Specialist); and (iii) Ahmed Shukry (National Social Development Specialist). Jose Aguado and Ocean Pixel, Michael L.S. Abundo engaged under technical assistance (TA) of ADB provided the technical inputs to the project description of the IEE, to inform the assessment by the IEE team. Terrestrial ecology surveys of selected islands were completed by Water Solutions. The marine impact assessment for the ocean energy system conducted by Bluedot Associates Limited, Neil Cousins, International Marine Ecologist, and the noise and shadow flicker modelling for the wind turbine component conducted by Ocean Pixel, Michael L.S. Abundo, International Wind and Ocean Energy Specialist were funded by Technical Assistance of ADB on behalf of MOECCT.

10. Safeguard requirements for all projects funded by ADB are defined under ADB's Safeguard Policy Statement (2009) which establishes an environmental screening, assessment and management process to ensure that projects (i) avoid adverse impacts of projects on the environment and affected people, where possible; (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers and clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. All ADB projects must comply with the requirements of ADB's Safeguard Policy Statement (2009) and Operational Manual F1, 2013 to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. In the case of the ASSURE Project, it has been classified by ADB as environment category B as determined by the project's most environmentally sensitive component, which is the ocean energy pilot to be sited in the marine environment on one of the following islands: Mulah, Muli, or Komandhoo following a feasibility study by the contractor. Both natural and critical marine habitat are present, but no significant impacts are anticipated given the scale of the pilot. Coral and seagrass will be avoided to ensure no net loss can be achieved without offset. The most environmentally sensitive terrestrial component is pilot wind power generation. It will be designed to achieve 35 Db at 10 m/s wind speed at 10 m height as LA90 at the nearest residential receiver, as well as shadow flicker and safety (including set-back in case of any blade or tower failure) requirements in line with the IFC EHS Guidelines on Wind Energy such that no significant impacts are anticipated. Accordingly, the scope of this IEE is based on ADB's Safeguard Policy Statement (2009) requirements for an environment category B project and with reference to national environmental, health and safety requirements. To meet Government of Maldives environmental assessment requirements, MOECCT will prepare separate assessments for national EPA approval.

11. The scope of this IEE covers the physical interventions proposed for funding under the Project on 22 outer islands (12 atolls) of the Maldives as follows: the 44MWh BESS and upgraded distribution grid systems on 20 islands, ocean energy pilot, wind energy pilot, rooftop solar home systems, and agricultural interventions on Thoddoo including ground mounted solar photovoltaic linked to a crop irrigation system. The attached due diligence addresses the potential impacts and risks of the ensuing terrestrial and marine photovoltaic system private sector investments as

associated facilities of the Project. For the private sector associated facilities and/or financial instrument backed components a due diligence report (Appendix 6) has been prepared including frameworks for the preparation of environmental management plans, biodiversity action plans, and biodiversity offset management plans by the private sector contractor for approval by the government. The associated facilities will be implemented through a PPP and the Request for Proposal will require compliance with ADB's Safeguard Policy Statement (2009) and these frameworks. An environmental and social management system is to be adopted by the government to ensure these requirements are met before the independent power producer can gain access to the financial instruments being funded by the Project. Other components including capacity development will have no or minimal environmental impact. An environmental audit of existing facilities (powerhouses) has been carried out as part of the assessment and is included in Appendix 7.

12. The assessment of environmental, health, safety and social impacts and risks has been conducted based on the review of the pre-feasibility and technical reports for the project components and technical specifications for the proposed wind and ocean energy systems. Field visits, surveys and consultations with key stakeholders and communities have also been undertaken as part of this assessment.<sup>8</sup> Primary data was collected from the field visits, surveys and consultations and secondary information was collected from various sources. During site visits the team had consultations with local stakeholders including island council members and local executive powers for their opinions on the project. The results of the consultations with Island Council members and local communities as well as an evaluation of the institutional framework have been incorporated into this assessment. This IEE was prepared during the pre-feasibility studies between the months of August 2021 to March 2023 so there is limited information available on underground cable routes; the design of the ocean and wind energy systems; rooftops available for solar photovoltaic installations; and the design of the agricultural interventions. Technical studies have been completed and the Project is currently in the bidding stage; bid documents are being prepared including a detailed bill of quantities (BOQ) to support the technical specifications. Final detailed design will be carried out by the contractors and will be reviewed and approved by MOECCT and technical consultants supporting them before the commencement of work. In case of any changes in the project design or locations of components during the detailed design stages, following ADB project approval, this IEE will be updated for ADB's review and clearance in compliance with ADB's Safeguard Policy Statement (2009) prior to commencing any works. The IEE and EMP will also be updated following the detailed studies for the pilot ocean power generation and agriculture interventions since the locations and exact scope are still to be studied. Any update must ensure the Project continues to comply with the standards and measures specified in this IEE and the EMP and have the same or less environmental impact than is currently predicted by it e.g., no significant impacts are anticipated.

13. The scope of this IEE is limited to the islands where Project-funded components will be installed, it considers the footprint of the proposed sites, access to those sites, and related distribution grid works in respect of direct impacts and a wider corridor (islands and atolls) for indirect impacts. The IEE followed several steps:

- (i) review of available pre-feasibility and technical reports, and technical specifications related to the proposed project,

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<sup>8</sup> Site visits were undertaken by the national staff and consultants of MOECCT. Field data collection (including spot monitoring of noise levels) and consultations were conducted during the sites visits. Separate terrestrial ecological surveys were carried out by an external agency—Water Solutions (Appendix 15). Dates of site visits are given in consultation section.



- (ii) review of the IFC EHS guidelines and other good international industry practices (GIIP) along with national requirements to identify standards and measures required,
- (iii) screening and scoping of the potential impacts,
- (iv) conduct field visits and surveys to collect primary or secondary data relevant to the project sites to establish the baseline environmental conditions,
- (v) assess direct, indirect, cumulative, and induced impacts and risks on biological, physical, social, and physical-cultural resources during the construction, operation, and decommissioning phases,
- (vi) explore opportunities for environmental enhancement and identify measures to address the impacts and risks identified following the mitigation hierarchy as required by ADB's Safeguard Policy Statement (2009) i.e., avoid, minimize, mitigate, and offset,
- (vii) prepare an environment management plan (EMP) including corrective actions for existing facilities, a mitigation plan outlining the measures for mitigating the impacts identified, and including the institutional arrangements,
- (viii) identify critical environmental parameters that are requiring to be monitored during project implementation and as a part of the EMP prepare an environmental monitoring plan, including the institutional arrangements,
- (ix) carry out consultation with local communities and stakeholders as well as administrative authorities to identify their perception on the Project, introduce project components and anticipated impacts and risks, and
- (x) disclose the draft IEE at ADB website and locally on the MOECCT website as well as in Island Council and powerhouse offices.

## **G. Structure of the Initial Environment Examination**

14. In compliance with ADB's Safeguard Policy Statement (2009) requirements, this IEE has been structured and consists of eight sections: (i) Introduction; (ii) Policy, Legal and Administrative Framework; (iii) Description of the Project; (iv) Description of the Environment; (v) Anticipated Environmental Impacts and Mitigation Measures; (vi) Consultation, Participation and Information Disclosure; (vii) Environmental Management Plan including the CAP for existing facilities (powerhouses); and (viii) Conclusion and Recommendation. The executive summary is also provided at the beginning of the IEE report.

15. The IEE report is supported by seventeen appendices which include (i) locations maps of project sites, (ii) island wide details of grid upgrade work, (iii) island wise maps of sensitive areas, (iv) photographs (consultations), (v) decision note for ASSURE project from EPA, (vi) due diligence of non-sovereign components, (vii) audit of existing facilities, (viii) land use maps of project islands, (ix) marine ecology assessment, (x) maps of the monitoring locations for air, water and noise quality, (xi) maps of the monitoring locations for noise quality during field visits, (xii) guidelines on Covid-19 preparedness measures, (xiii) template of environment monitoring report, (xiv) noise and shadow flicker assessment, (xv) ecological survey report, (xvi) environmental mitigation and monitoring plans, and, (xvii) environmental codes of practice.

## II. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

16. Environmental assessment of the project has been carried out in accordance with ADB's Safeguard Policy Statement (2009) considering the Government of Maldives' environmental, health, and safety policy and legislation requirements. The policies, laws, regulations, and guidelines applicable to this project-based on its location, design, construction, and operation are summarized in the subsequent sections. The administrative framework to implement these laws and regulations is also discussed.

### A. The Republic of Maldives Environmental Laws and Regulations

17. Some of the important acts and regulations of Maldives relevant to the proposed project focusing on environment, health and safety management are summarized in Table 1.

**Table 1: Summary of Relevant Environmental Laws and Regulations of Maldives**

Environmental Legislation	Year Passed	Objectives, Requirement and Relevance
<b>Constitution</b>		
Maldives Constitution	2008	Article 22 of the Constitution on environmental protection states that the State has a fundamental duty to protect and preserve the natural environment, biodiversity, resources, and beauty of the country for the benefit of present and future generations. The State shall undertake and promote desirable economic and social goals through ecologically balanced sustainable development and shall take measures necessary to foster conservation, prevent pollution, the extinction of any species and ecological degradation from any such goals. Of note in relation to labor are Articles 17, 20, 23 related to non-discrimination, equality, economic and social rights whilst Articles 25 and 30 relate to stopping forced labor and permitting freedom of association.
<b>Acts and Policies</b>		
Environment Protection and Preservation Act (Act No. 4/93) and 1st Amendment	1993 amended 2014	<p>The Environment Protection and Preservation Act of Maldives (Law No. 4/93) provides the basic framework for environmental management in Maldives including Environmental Impact Assessment Process which is being currently implemented by EPA on behalf of MOECCT. Articles 2, 4, 5, 6, 7, and 8 of the law are relevant to the ASSURE project.</p> <p>(i) Article 2 states that the concerned government authorities shall provide the necessary guidelines and advise on environmental protection in accordance with the prevailing conditions and needs of the country. All concerned parties shall take due considerations of the guidelines provided by the government authorities. The project proponent shall abide by any guidelines or advice given by the concerned Government authorities for the Project. The concerned Government authorities are identified in this Chapter.</p> <p>(ii) Article 4 states that the MOECCT shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protection and preservation. The proponent shall ensure that there is no negative impact from the proposed Project on any protected areas.</p> <p>(iii) According to Article 5 (a) of the Act, an Environmental Impact Assessment study shall be submitted to the MOECCT before implementing any activity that may have an impact on the environment. The project proponent will prepare and submit necessary screening and assessment documents to the EPA to fulfill the legal requirement stipulated in Act (4/93) Article 5.</p> <p>(iv) According to Article 6, the MOECCT has the authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation. The Project proponent is aware of this provision and will take all practical measures to ensure there is no irreversible and significant negative impact of the project.</p> <p>(v) Article 7 of the Act (Act No. 4/93) prohibits the disposal of wastes, oil and</p>

Environmental Legislation	Year Passed	Objectives, Requirement and Relevance
		<p>gases in a manner that will damage the environment. Wastes, oil, and gases have to be disposed of in areas designated by the Government. Hence, the project proponent shall use the Environmental Management Plan for the project which specifies how the wastes, oil and gases generated by the project will be disposed of.</p> <p>(vi) Article 8 of the Act No. 4/93) prohibits the disposal of hazardous wastes. Any hazardous wastes that may be generated from the project shall be transferred to the designated waste sites for disposal according to Government regulations and standards.</p>
Decentralization Act (Act No. 7/2010)	2010	States that the provision of electricity services along with other utilities and waste management are the responsibility of Island and City Councils; they are also responsible for the release of land for development.
General Laws Act (Act No. 4/68)	1968	The General Laws Act 4/68, Paragraph 7 stipulates that public property such as trees, coconut palms, farmland, households and such owned by public or private individuals, if required to be obtained by the Government, the property can be obtained by the High Court of the Maldives. The above shall be done only after the individual is fairly compensated for the property or by financial compensation proposed by the property holder. If the public property to be attained is a land plot or a household, the property holder shall be given adequate time for clearance of the area. If a private property belonging to one individual creates nuisance to another, for issues in Malé the matter shall be resolved by the Ministry of National Planning, Housing and Infrastructure for issues arising in the islands.
National Disaster Management Act (Act No. 28/2015)	2015	The Disaster Management Act aims to protect the country, residents, property and the natural and built environment from natural and man-made hazards. It also includes the role of the state and citizens in disaster management. The National Disaster Management Authority (NDMA) was established as the implementing body for disaster management.
Energy Act (Act No. 18/21)	2021	The Act details the duties and responsibilities of the respective institutions and places emphasis on the usage of renewable energy. The Act and Regulations made pursuant to the Act is intended to provide the framework for Maldives transitioning towards the net zero carbon goal by increasing the usage of renewable energy.
Utility Regulation Authority (URA) Act (Act No. 26/2020)	2020	URA has been given the responsibility to manage and monitor electricity utilities and other service providers and solar photovoltaic systems will need to follow any standards and guidelines that are set by them.
Maldives Energy Policy and Strategy	2016	<p>Development of renewable energy sector will help deliver on the 5 key policy statements:</p> <ul style="list-style-type: none"> <li>(i) Strengthen the institutional and regulatory framework of the energy sector.</li> <li>(ii) Promote energy conservation and efficiency.</li> <li>(iii) Increase the share of renewable energy in the national energy mix.</li> <li>(iv) Improve the reliability and sustainability of electricity service and maintain universal access to electricity.</li> <li>(v) Increase national energy security</li> </ul>
Waste Management Policy	2015	<p>The aim of the waste management policy is to formulate and implement guidelines and means for solid waste management to maintain a healthy environment. Accordingly, the key elements of the policy include:</p> <ul style="list-style-type: none"> <li>(i) Ensure safe disposal of solid waste and encourage recycling and reduction of waste generated.</li> <li>(ii) Develop guidelines on waste management and disposal and advocate to enforce such guidelines through inter-sectoral collaboration.</li> <li>(iii) Ensure safe disposal of chemical, hazardous and industrial waste.</li> </ul> <p>In the first instance during installation and O&amp;M MOECCT and their contractor(s) must prioritize reduction and recycling but for residual waste given Island Councils do not have the capacity for environmentally sound and safe disposal of solid and hazardous waste must retain responsibility for removing and disposing of all such wastes from the islands and not leave it on-</p>

Environmental Legislation	Year Passed	Objectives, Requirement and Relevance
		island. Despite national regulations due to lack of capacity the current disposal practices of the Island Councils do not protect human health and the environment. Contractor(s) can develop a Waste Management and Pollution Prevention Plan as a subplan to their CEMP to facilitate this.
Law No. 27/79 of historical and cultural properties of the Republic of Maldives (1979) Law No. 27/79 of historical and cultural properties of the Republic of Maldives (1979) Law No. 27/79 of historical and cultural properties of the Republic of Maldives	1978	This makes it an offence to damage, destroy or dismantle any objects or buildings that are of historical and cultural value found within the Republic of Maldives.
Heritage Act 2019	2019	This act ensures the documentation, preservation, and protection of cultural heritage; it states that acts resulting in the loss of items or sites of historical significance are criminal acts. The Ministry of Arts, Culture and Heritage maintains a list of items of sites and may be consulted to ascertain if any cultural heritage is of significance. Articles 28 and 29 provide details of the procedure to follow if in the event of a change find, within 48 hours the Island Council needs to have been informed and subsequently the council need to report to the national center within 48 hours. Article 36 sets out that impacts on cultural heritage need to be covered through the EIA undertaken for development projects.
Water and Sewerage Act (08/2020)	2020	The National Water and Sanitation Act (8/2020) aims to ensure accessibility to clean and safe water throughout the country. Water and sanitation services can only be provided after an Environmental Impact Assessment report is approved by EPA as stated in the EIA Regulations (2012/R-7).
Construction Act (Act No. 4/27)	2017	The act sets out the standards and parameters to be followed by all actors in the industry. The law explicitly governs construction sector work conducted by all actors recognized under the Act, including government institutions. However, tourism related construction work undertaken in islands allocated for tourism and, construction work of certain residential buildings located in the atolls are not governed by this Act.
Employment Act (Act No. 2/2008)	2008	This also deals with labor and specifies the rights and duties of employers and employees including that employers are required to create safe working environments and provide resources for carrying out work safely as well as training and PPE. Regular health checks, medical care and first aid are to be provided. It prohibits forced employment, and discrimination in granting of employment, increase in remuneration, provision of training, determination of conditions and manner of employment, dismissal, and resolution of other employment related issues; based on race, color, social standing, religion, political beliefs or affiliation with any political party, sex, marital status, family obligations, age or disability. All children are protected from employment that would have a detrimental effect on their health, education, safety, or conduct. MOECCT and their contractor(s) will need to be compliant with the act and contractor(s) can develop a Labor Management Plan as a subplan to their CEMP to facilitate this.
Rights of the Child Act	2019	Relates to the prevention of child labor. MOECCT and their contractor(s) will need to be compliant with the act and contractor(s) can develop a Labor Management Plan as a subplan to their CEMP to facilitate this.
Maldives Immigration Act (Act No. 1/2007)	2007	Outlines the rules for entry, departure and deportation of foreign nationals and should be considered in respect of labor management.
Anti-Human Trafficking Act (Act No. 12/2013)	2013	Makes forced and bonded labour and false recruitment a criminal offence. MOECCT and their contractor(s) will need to be compliant with the act and

Environmental Legislation	Year Passed	Objectives, Requirement and Relevance
		contractor(s) can develop a Labor Management Plan as a subplan to their CEMP to facilitate this.
Public Health Protection Act, (Act No. 7/2012)	2012	The purpose of the Public Health Protection Act is to establish policies for protection of public health, identify persons responsible for protection of public health, and define how public health protection policies will be implemented. The objectives of the Act also include establishing policies to respond to public health emergencies; classify situations which may be harmful to health and establish methods to act in such a situation; and establish roles and responsibilities of island, atoll, and city councils in protection of public health.
Prevention of Sexual Harassment Act (Act No. 16/2014)	2014	Prohibits employers and employees from subjecting those who work under them or their co-employees to any extent of any type of sexual harassment. Employers must take reasonable steps to ensure work environments are free from sexual harassment, they must publish a sexual harassment policy for the safety of staff.
Gender Equality Act (Act No. 18/2016)	2016	Employers are mandated to ensure gender equality in the workplace.
Maldivian Land Act (No. 1/02) 1 <sup>st</sup> to 7 <sup>th</sup> Amendments	2002 amended up to 2016	Governs the allocation of Maldivian land for different purposes and uses land is allocated for residential, commercial, social, environmental protection and for government. It also states the following in relation to articles found during the excavation of land: <i>except for coconut palms owned by the person, all other natural resources and gold, silver, jewelry, money, utensils, historical artifacts, and metals that do not have a legal owner shall be a property of the government.</i> The party who found the articles must inform without delay to the Ministry of Finance and Treasury if in Male' or if in any other part of the Maldives to the respective island office.
<b>Regulations</b>		
Regulation on the Preparation of Environmental Impact Assessment and 1 <sup>st</sup> to 5 <sup>th</sup> Amendment	2012 amended up to 2018	The main purpose of this Regulation is to provide step-by-step guidance for proponents, consultants, government agencies and general public on how to obtain approval in the form of an Environmental Decision Statement, for a Development Proposal. The Regulation sets out the criteria to determine whether a development proposal is likely to significantly affect the environment and is therefore subject to an EIA. Schedule D of the EIA Regulations defines the type of projects that would be subject to an Environmental Impact Assessment. The main purpose of this Regulation is to provide step-by-step guidance for proponents, consultants, government agencies and general public on how to obtain approval in the form of an Environmental Decision Statement.
Regulation for Determination of Penalties and Obtaining Compensation for Damages Caused to the Environment	2011	The main purpose of this regulation is to stop unlawful activities impacting on the environment by adequately implementing a fining procedure for violations as well as implementing a compensation mechanism on environmental damages. Its Schedules form the basis for levying fines on various environmental components and activities.
Protected Areas Regulation	2018	The regulation relates to Protected Areas and Environmentally Significant Areas (ESA) that are of potential to be protected. No act contrary to a protected area management plan must be undertaken within it, thus it must be ensured that no associated facilities are located within any such areas. MOECCT can be consulted regarding the latest list of sites.
Protected Species Regulation and 1 <sup>st</sup> to 4 <sup>th</sup> Amendment	2021 amended up to 2022	This regulation is formulated to support Article 22 of the constitution of the Maldives which identifies that the protection of the natural environment, biological diversity, natural resources, and beauty for the current and future generations is an obligation of the state. This regulation is applicable from the date it was gazette (17th February 2021) and abolishes the Regulation on Migratory Birds (2014). The species identified in Annex 1 of the regulation are protected species in the Maldives to which the assessment and project implement must give attention to avoid harm.
Regulation for the Protection and Preservation of Island	2022	The objective of this regulation is to increase the greenery and encourage tree planting and to protect and preserve the vegetation and flora on the islands in the Maldives specifically trees of over 50 year old. It also provides guidelines and procedures for cutting, lifting, digging, and moving trees on the islands. It

Environmental Legislation	Year Passed	Objectives, Requirement and Relevance
Greenery and Forestry in the Maldives		<p>also provides protection for all trees and vegetation growing within a 20 m wide area along beaches and coastlines. The main purposes are: to (a) increase and encourage the planting trees to enhance and maintain the green cover of the country; (b) protect and maintain old trees in the country to conserve them; (c) managing the decentralization of trees by monitoring the cutting down, removal, digging and relocating trees from one place to the other; (d) the negative effects on the greenery and forestry of Maldivian islands due to cutting down and digging trees, how to minimize these effects on the natural flora and fauna, environment and the living organisms in islands, hence, establishing special rules to follow when cutting down, digging, removal, relocating from one place to another and removing trees from islands.</p> <p>The regulation clearly mentions that the only way to allow cutting down, removal, digging and relocating trees from one place to another is when it is absolutely necessary or if there is no other way than to do it, it must be proven that it is beneficial to the society for essential needs, in which case there should be a way to check on the status and should be able to report any misuse of this.</p> <p>To cut 50 or fewer coconut palms with trunks, mature trees or other trees which are 30cm or taller with a 45 cm or larger circumference will require Island Council approval.</p> <p>If more than 50 trees then EPA permission is needed, if more than 200 trees are affected or the area of tree plantation is 4000 acres or more then EIA will be needed.</p> <p>It abolishes the Regulations of Conservation of Old Trees 2007 and regulations from 2006, 2014 and 2017 related to cutting of trees.</p> <p>Since the ASSURE needs removal of some of the trees, this regulation will be applicable to it. No trees must be cut for Project components either by the Island Council, MOECCT or their contractor(s) contrary to the regulation. MOECCT needs to get all permits and follow the conservation measures in compliance with this regulation.</p>
Waste Management Regulation, 1 <sup>st</sup> to 5 <sup>th</sup> amendment	2013 amended up to 2021	<p>The aim of the regulation is to protect the environment through the implementation of the national waste management policy by:</p> <ul style="list-style-type: none"> <li>(i) Minimizing the direct and indirect negative impact caused to human health and the environment due to waste</li> <li>(ii) Compiling the standards to be maintained in relation to waste management.</li> <li>(iii) Establishing an environmentally friendly, safe and sustainable waste management system through an integrated waste management structure</li> <li>(iv) Encouraging to minimize, reuse, recycle and recover waste.</li> <li>(v) Implementing polluters pay principle.</li> <li>(vi) Introducing extended producer responsibility</li> </ul> <p>In line with the polluters pay principle it is for the project developer to shoulder the cost of environmentally sound and safe disposal of solid and hazardous waste rather than leaving this for the Island Council to deal with.</p> <p>The regulation also defines special waste (including engine oil, batteries, paint and chemical solvent, electronics) and hazardous waste plus how they are to be stored, transported and disposed of.</p> <p>Hazardous waste must not be burnt under any circumstances or dumped in any area of Maldives. It will be transported from one place to another having ensured that it is packed in a leak-proof and sealed container. During transportation the said container will have a written notice and sign of hazardous waste attached to it.</p> <p>Solid waste must only be disposed in authorized areas and dumping of waste in the following areas is an offence: Protected Areas declared under Act No. 4/93, mangrove wetlands and marshes, lagoon area of islands, reefs, lagoons, sandbanks, beaches of islands, vegetation line of islands, harbors, parks, and roads. Dumping of waste on public community areas to save onto containers allocated for collection of waste is an offence.</p>

Environmental Legislation	Year Passed	Objectives, Requirement and Relevance
		<p>The following are included specific to construction waste:</p> <ul style="list-style-type: none"> <li>(i) Construction works must be planned and operated in such a manner so that less waste is generated.</li> <li>(ii) Special measures shall be enforced to minimize the waste during the construction phase.</li> <li>(iii) For the purpose of reducing demolition waste, reusable material contained in the waste shall be separated and reused.</li> <li>(iv) Demolition waste shall be kept within the demolished premises in a manner that would not cause inconvenience to anyone until disposal.</li> <li>(v) Construction and demolition works shall be undertaken using dust controlling methods and in a manner that would not damage the surrounding environment and cause inconvenience to neighbors surrounding the premises.</li> </ul> <p>MOECCT and their contractor(s) will need to be compliant with the regulations and the contractor(s) can develop a Waste Management and Pollution Prevention Plan as a subplan to their CEMP to facilitate this.</p>
Regulation on Fuel Storage, Handling and Usage	2015	<p>The Regulation on Fuel Storage, Handling and Usage (2015/R-160) came into effect recently on 12 August 2015. The following clauses of the regulation are of specific relevance to the proposed project.</p> <ul style="list-style-type: none"> <li>(i) Clause 4 deals with installation, registration and inspection of fuel storage facilities. The following sub-clauses in this clause are of relevance. a) Fuel storage facilities shall be established according to the Regulations and shall have appropriate fire safety and protection systems. b) All fuel storage facilities shall be registered with the Ministry of Defense and National Security as per the Regulations. c) The Ministry reserves the right to inspect the facilities prior to registration and every six months thereafter in the presence of the Developer or Developer's designate. In case of rectification.</li> <li>(ii) Clause 6 considers the requirements of petrol storage facilities. This may not be of relevance to the proposed project.</li> <li>(iii) Clause 11 states the design requirements for fuel/petrol storage tanks/containers. The maximum capacity allowed for underground tanks is given as 40,000 liters. The containers/ tanks should be separate from other buildings such as convenience stores. Requirements for overhead tanks are also provided.</li> <li>(iv) Clause 12 discusses the requirements for petrol dispensers and filling points and Clause 13 prohibits keeping wet cells, acids and pressurized containers in petrol sheds or petrol storage areas.</li> <li>(v) Clause 14 to Clause 17 states the requirements for the installation of diesel and kerosene storage and handling facilities. These are similar to those for petrol sheds and handling facilities.</li> <li>(vi) Clause 18 discusses the requirements for fuel delivery lines. Fuel delivery lines are required to be kept underground and the pipes are required to conform to BS EN10025 and BS EN10296 or similar international standards. The delivery line is required to be buried at safe depth from ground within a trench that can contain the entire volume of the pipeline in case of breakage.</li> <li>(vii) Clause 19 provides definitions and clause 20 penalties. The penalties vary from fines of MVR5000 to MVR25000 and withdrawal or cancellation of permits depending on the severity of the offense.</li> </ul> <p>The proposed project will follow these regulations in handling, storage and usage of oil and other fuels.</p>
Desalination Regulation	2002	<p>The Desalination Regulation states the requirements for application, plant capacity determination, intake and source water, plant operation and maintenance, brine discharge as well as water quality monitoring requirements.</p>
HCFC Regulations	2010	<p>Eliminates the use of HCFC in the Maldives by 2020 through import controls.</p>

<b>Environmental Legislation</b>	<b>Year Passed</b>	<b>Objectives, Requirement and Relevance</b>
Water Resources Conservation and Management Regulation	2021	The purpose of this regulation is to sustainably use, protect, develop and efficiently manage water resources. This regulation is implemented by URA.
Dewatering Regulation for Construction and Industrial Projects and 1st Amendment	2021 amended to 2022	Dewatering Regulation provides procedures/steps to minimize adverse environmental impacts from dewatering groundwater and pumping it into the ground or sea for building construction or industrial projects.
Construction Regulation for Islands and Lagoons with no Planning Regulation	2017	Regulates the construction activities through guidelines and standards on islands and lagoons which do not have any planning regulations.
Regulation Governing Reclamation and Dredging of Islands and Lagoons of Maldives	2013	Sets out guidelines to minimize the damage caused to the environment due to reclamation and dredging work. All dredging and reclamation activities require EPA approval through this regulation.
Stone, Coral, and Sand Mining Regulation	1990	This addresses sand mining from islands and bird nesting sand bars. Sand and aggregate mining from beaches of any island whether inhabited or uninhabited is banned for protection of the islands. Permissions must be obtained for sand and aggregate mining from other areas. The project developer and their contractor(s) will need to complete their own due diligence to ensure any stone or sand is sourced from suppliers who are compliant with these regulations.
Regulation on Coral Mining	1990	This addresses coral mining from the house reef of islands and the atoll rim reefs.
Regulation on Employment of Expatriates in Maldives	2011	No foreigner is allowed to work in the Maldives without a valid work permit and a work visa. Employers are required to treat their foreign employees in accordance with national laws, pay any fees related to the work permit or visa and of returning the worker home and thus it should be considered in respect of labor management.
Work Visa Regulation	2010	Requires foreign migrant workers to hold a work visa, in relation to child labor no one under the age of 18 can be issued with a work visa.
Regulation on Resolving Disputes between Employers and Employees	2011	Outlines the principles for employees to comply with in exercising the right to strike and abstain from work with a three-tier process to be followed first, the second tier is a Grievance Redress Committee with the third tier being the Labor Relations Authority. MOECCT and their contractor(s) will need to be compliant with the act and the contractor(s) can develop a Labor Management Plan as a subplan to their CEMP to facilitate this.
Construction Contractors Regulation	2019	Requires that contractors working in the construction industry are regulated.
Building Code	2008	The Building Code handbook of Maldives details the guidelines and standards that should be used for designing buildings in Maldives. All construction projects are required to meet the standards specified in the Building Code. All construction activities of the Project will follow the Building Code. Construction waste and debris disposal must be managed in accordance with the requirements of the Building Code.
Mosquito Control Regulation	2007	Requires developers prevent open waterlogged areas etc.
Construction Site Health and Safety Regulation	2019	This aims to provide minimum standards for safety and security for the community and labour force. If the value of a project exceeds 1.5 million MVR (\$100,000) health and safety aspects regarding the project need to be defined including an Emergency Response Plan and training and drills given to the labour force. There must be a first aid kit and a trained first aid person always available at the construction site for such projects, a site safety supervisor must also be provided by the contractor. Health and safety measures to be followed are stipulated such as providing pedestrian detours for works next to roads. It also states that precautionary measures must be taken such that neighboring households are not impacted with third party insurance taken out for damages. Records of accidents must be kept and reported to the police. MOECCT and their contractor(s) will need to be



Environmental Legislation	Year Passed	Objectives, Requirement and Relevance
		compliant with the act, the contractor(s) should carry out a risk assessment and develop an Occupational and Community Health and Safety Management Plan as a subplan to their CEMP to facilitate this.
Civil Aviation Regulation	2012	Since some islands support airports, it will be important to consult the airport operator to ensure no obstacle or hazard will be caused to their operations.
Construction material import and production control regulation	2019	The regulation controls the import of certain building materials without proper permissions. Six different construction materials require permission prior to import, creation, and construction. Materials imported and created without proper permission will not be allowed to undergo testing. This is to ensure that materials are of good quality when used in construction. The materials that require permission include cement, all grades of stone for concrete, all types of sand for concrete, structural metal, all grades of ready-mix concrete, and all stone and brick used for construction. Maldives Customs Service would seize all items imported without permission.
<b>Action Plans and Frameworks</b>		
National Biodiversity Strategy and Action Plan of the Maldives 2016-2025	2016	The principles of the National Biodiversity Strategy and Action Plan of the Maldives covering the period from 2016-2025 are: (i) The people of this generation and the generations to come reserves the right to access and share benefits of rich biodiversity and ecosystem services. (ii) Responsibility of conserving and sustainably using biodiversity lies on everyone's shoulders and shall be taken as a shared responsibility. (iii) Biodiversity shall be mainstreamed into all sectors and in a manner whereby monitoring progress and accountability is ensured. (iv) The project developer thus equally plays a role with MOECCT in helping the Maldives to meet the targets of this plan as they relate to the development of terrestrial and floating solar photovoltaic systems.
Maldives Climate Change Policy Framework	2015	This aims to foster and guide a national plan of action against the effects of climate change with strategic components based around low emission development to stabilize GHG concentrations at a level that prevents dangerous anthropogenic interference with the climate system, adaptation and opportunities including allowing ecosystems to adapt naturally to climate change and enabling economic development to proceed in a sustainable manner and meeting international obligations and commitments.
National Action Plan on Air Pollutants	2019	Sets out a mitigation plan for air pollution which the development of the Project components will help to deliver by supporting renewable energy over diesel generation.

Source: Environmental Protection Agency (EPA) of the Republic of Maldives under the Ministry of Environment, Climate Change, and Technology ([www.epa.gov.mv](http://www.epa.gov.mv)); other published sources.

## B. International and Regional Agreements and Conventions

18. Maldives is a signatory to several MEA including the Convention for the Protection of the World Cultural and Natural Heritage (12 May 1986). Although there are no Cultural or Natural World Heritage Sites in Maldives, "Unique Coral Stone Mosques" are on the tentative list. In relation to biodiversity, it has signed the Convention on Biodiversity (9 November 1992) and is a party to the Convention on International Trade in Endangered Species (CITES) (12 December 2012). However, it is not a party to the Ramsar Convention on Wetlands of International Importance or the Convention on Migratory Species although it still seeks to contribute to the goals of the latter through its National Biodiversity Strategy and Action Plan 2016-2025.

19. Maldives was an early signatory to the United Nations Framework Convention on Climate Change (9 November 1992), the Kyoto Protocol (30 December 1998) and Paris Agreement (12 April 2016). Its NDC highlights that it is dependent on fossil fuels and the need to develop domestic clean energy resources. In relation to pollution prevention, Maldives is a signatory to

the Montreal Protocol on Substances that Deplete the Ozone Layer (16 May 1989) for which circulars have been issued banning the import of ozone depleting substances, the Stockholm Convention on Persistent Organic Pollutants which includes polychlorinated biphenyl (17 October 2006), and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (28 April 1992). In addition to these international agreements, it is also part of the regional Malé Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia (1998).

20. Maldives has also ratified on 4 January 2013 the International Labor Organization (ILO) Forced Labour Convention, the Abolition of Forced Labour Convention, the Freedom of Association and Protection to the Right to Organize Convention, the Right to Organize and Collective Bargaining Convention, the Equal Remuneration Convention, the Discrimination (Employment and Occupation) Convention, the Minimum Age Convention, and the Worst Forms of Child Labour Convention. In addition to complying with national requirements MOECCT and their contractor(s) should consider ILO requirements and guidelines in developing a Labor Management Plan as a subplan to their CEMP such as the minimum standards for the provision of worker accommodation and facilities.<sup>9</sup>

21. The interventions proposed under the ASSURE project will need to be implemented in compliance with applicable international/regional agreements, conventions and declarations listed above.

### **C. Environmental Assessment Process in the Maldives**

22. Under the Maldivian regulatory framework (Environment Protection and Preservation Act No 4/93 and Regulation on the Preparation of EIA 2012 (amended up to 2018) all development activities must be referred to the EPA of the MOECCT. The energy department of MOECCT as the project proponent will be responsible for securing the Environmental Decision Statement, environmental assessment, and management planning for each site. Since none of the Project-funded components are listed as automatically requiring EIA and only rooftop solar<sup>10</sup> is specifically listed in the regulation as an EIA exempt activity it will be necessary to first submit a screening form to the EPA. After this the next steps will depend on their screening decision as shown in Figure 1. The energy department of MOECCT will then need to prepare requisite documents for each project component to fulfill the legal requirement stipulated in The Regulation on the Preparation of EIA.

23. If an IEE or EIA is required, the general format (table of contents) is set out in the Regulation on the Preparation of EIA. In preparing the assessment MOECCT will consider impacts on (1) fauna and flora, and living components of the environment, (2) soil, water, air, climate, the landscape and the non-living components of the environment, (3) the interaction between the factors in (1) and (2), (4) material assets and cultural heritage, (5) impacts on the project from the environment, and (6) human interactions and their interactions with the factors mentioned in paragraphs (1) to (5). Following an IEE, this will be reviewed by the EPA and EIA will be required if the project may cause significant impacts on the environment, otherwise only an environmental management plan is needed.

<sup>9</sup> [https://www.ilo.org/wcmsp5/groups/public/---ed\\_emp/---emp\\_ent/---multi/documents/publication/wcms\\_116344.pdf](https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---multi/documents/publication/wcms_116344.pdf)

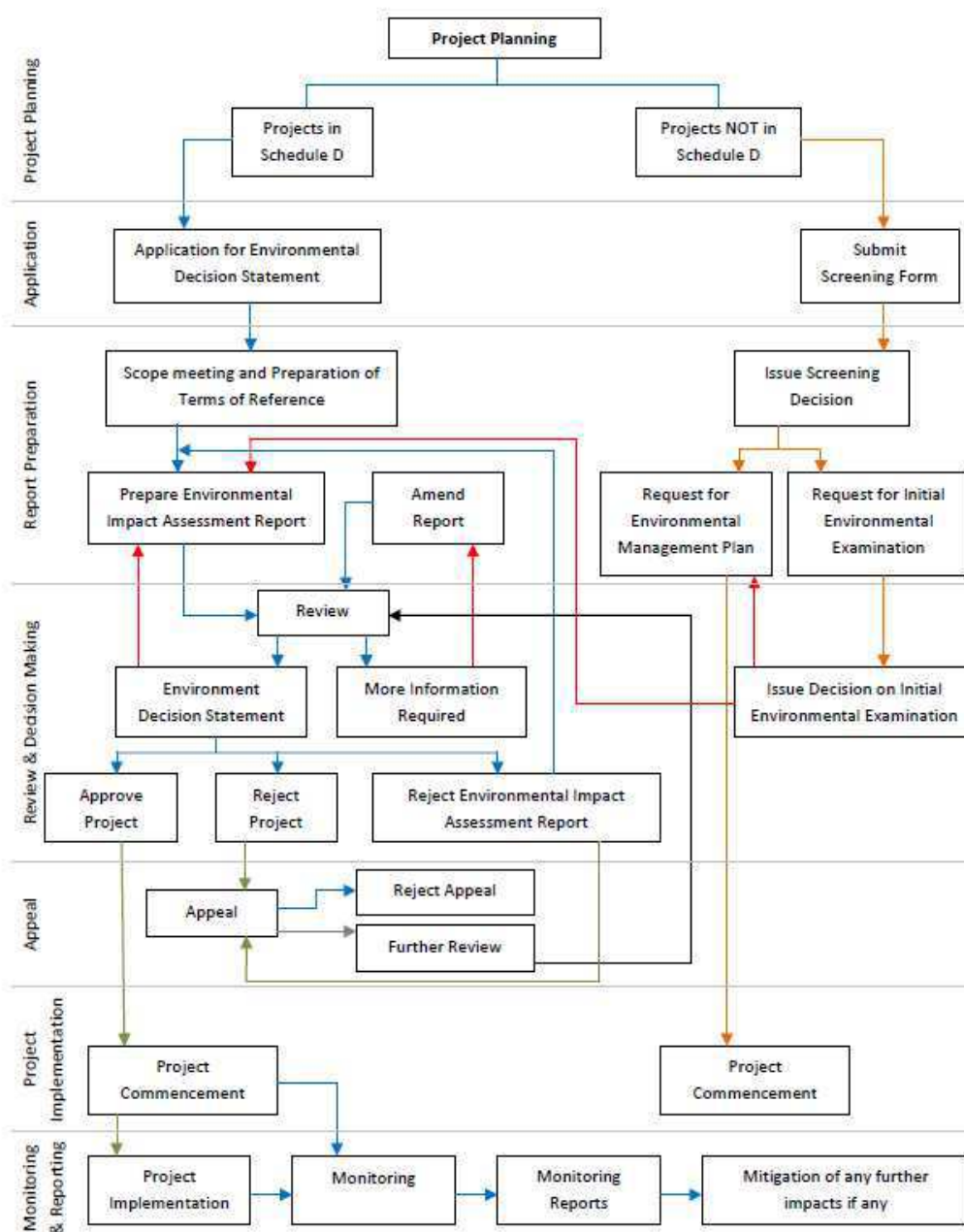
<sup>10</sup> Installing solar photovoltaic on rooftops of existing buildings

24. The EPA will issue a TOR for preparation of an EIA report if this is required. They have also published a guide to inform to the collection of baseline data.<sup>11</sup> Submitted EIA reports will be reviewed by at least two expert reviewers from the EPA roster whilst comments can be submitted from regulatory authorities and the public – for complex or controversial projects a public meeting may be convened although all projects should conduct public consultation in preparing the EIA report. At this stage a project may be rejected if it is considered to have irreversible damage to the environment.

25. For projects that the EPA has deemed will not have significant impacts on the environment, only an environmental management plan is requested. The general format (table of contents) is set out in the Regulation on the Preparation of EIA. Once the environmental management plan (EMP) is deemed acceptable by the EPA, MOECCT as the project proponent will be informed within 7 days that works can commence. If it is not acceptable, then within 7 days the EPA will inform that a revision is required. MOECCT and their contractor(s) will then need to implement the EMP bearing all the costs incurred in doing so.

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<sup>11</sup> <https://files.epa.gov.mv/file/619>

**Figure 1: Environmental Impact Assessment Process Flow Chart**

Source: Regulation on the Preparation of EIA Report 2012

## 1. Selection Factors

26. Project sites should be identified considering the following selection factors as detailed in the Regulation on the Preparation of EIA Report 2012:

- (i) Existence or absence of critical ecosystems—if the site/island or its surrounding reef, or any part of the island or its reef ecosystem is included in a Protected Area

on in the list of “Environmentally Sensitive Areas” maintained by the MOECCT then the site/island should not be considered.

- (ii) The islands should be at least 50,000 sq.m, and round or, if not, reasons are to be given for their selection.
- (iii) There must be sufficient space to maintain an undisturbed 20m wide band of vegetation (measures from the seaward edge in) as a no-development buffer zone designated as per Cairo Principles—if there is not sufficient space then the site/island should be removed from consideration.
- (iv) Historically stability of the natural environment of the site is to be considered in terms of (i) the entire island being covered with thick vegetation, (ii) the percentage of the island covered with mature trees, (iii) the side of the atoll the island is located, and (iv) the kind of impacts natural disasters have had on the island.
- (v) Marine access in terms of their being a natural harbor, an existing marine access channel, and/or an area suitable for anchoring.
- (vi) Beach erosion history in terms of whether there exists a continuous beach around the island (or the percentage of the coastline that has beach) and the presence of exposures of beach rock (and if so, the percentage of the coastline that has exposures of beach rock).
- (vii) The geographical location in terms of distance to the nearest airport, inhabited island, resort island, number of resorts in the atoll and province; and if there are any exceptional or unique features about the island which should be described.

## **2. Environmental Decision Statement (Note) and Project Implementation**

27. The most important environmental permit to initiate work is the Environmental Decision Statement (or Environmental Decision Note, as it may be referred to) since this governs the way the activities must be undertaken. Since the IEE or EIA report assists decision makers in understanding the existing environment and potential impacts and risks of a project, if an IEE or EIA is required the Decision Note may only be given to the MOECCT as project proponent after a review of IEE or EIA document following which the EPA may request for further information or provide a decision if further information is not required. In some cases, if there are no significant environmental impacts associated with the project, the EPA may provide the Environmental Decision Statement while at the same time requesting further information including the Environmental Management Plan. MOECCT as project proponent and their contractor(s) must follow exactly all the conditions given, and all the mitigation measures set out in the Environmental Management Plan. Environmental monitoring will be required as part of this—for EIA full monitoring reports will be submitted at least annually with summary reports submitted every two months; frequency for other projects is on agreement. An Environmental Decision Notice will be void if the works do not start within one year of it being issued. EPA enforcement officers may monitor environmental impacts and may issue a cessation notice if works started without an Environmental Decision Notice, there are breaches of conditions etc. Remedies for environmental damage will be at cost to MOECCT as the project proponent.

## **3. National Environmental Impact Assessment Requirements for Accelerating Sustainable System Development Using Renewable Energy Project**

28. None of the project-funded components are listed in the list of activities (Appendix D of the EIA Regulations 2012) that automatically require an EIA. Only rooftop solar<sup>12</sup> is specifically

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<sup>12</sup> Installing solar photovoltaic on rooftops of existing buildings.

listed in the regulation as an EIA exempt activity. Therefore, an Environmental Screening Form needs to be submitted to the EPA for each individual component or sites by MOECCT as the project proponent. After this the next steps will depend on their screening decision as shown in Figure 1. Table 2 summarizes the likely national environmental assessment requirements for the project components as currently understood based on past experience of MOECCT and similar projects although in all cases, except rooftop solar, the needed for EIA or IEE is still to be confirmed by the EPA.

29. MOECCT has submitted a letter to the EPA who have provided a response (Appendix 5) indicating that solar photovoltaic on existing roofs will be exempt from needing further assessment under the 2nd amendment of the EIA Regulation 2012 whilst ground mounted solar may also be exempt from EIA in areas without large trees. Other project-funded components are not discussed in the response so MOECCT needs to confirm if further assessment will be required of them, EPA has informed MOECCT that it is unable to do so until project implementation. MOECCT will need to prepare requisite documents for each project component to fulfill the legal requirement stipulated in The Regulation on the Preparation of EIA. For all Project-funded components, even if exempt from future assessment MOECCT as the project proponent must have an EMP acceptable to the EPA in place.

**Table 2: National Environmental Impact Assessment Requirements for the Project-Funded Components**

<b>ASSURE Project Component</b>	<b>Screening Submitted</b>	<b>Likely EIA Required (Yes/No)</b>	<b>Likely IEE Required (Yes/No)</b>	<b>EMP Required</b>	<b>Remarks</b>
Battery Energy Storage System	No	No	No	Yes	Unlikely based on similar past projects but need for EIA or IEE still TBC and MOECCT to obtain screening opinion from the EPA with specific reference to each individual component/sites; EMP included in this IEE can be submitted to EPA.
Energy Management System	No	No	No	Yes	
Grid Upgrade	No	No	No	Yes	
Ocean Energy System Pilot	No	Yes	Yes	Yes	MOECCT to obtain screening opinion from the EPA, undertake marine ecological surveys and prepare national EIA or IEE as required, incorporating the EMP included in this IEE.
Wind Energy System Pilot	No	Yes	Yes	Yes	MOECCT to obtain screening opinion from the EPA, undertake terrestrial ecological surveys and prepare national EIA or IEE as required, incorporating the EMP included in this IEE.
Rooftop solar	No	No (exempt)	No	No	Exempt per the EIA Regulations.

ASSURE Project Component	Screening Submitted	Likely EIA Required (Yes/No)	Likely IEE Required (Yes/No)	EMP Required	Remarks
Ground mounted solar photovoltaic (Thoddoo)	No	No (on Thoddoo there are no trees to be cut)	Yes	Yes	MOECCT to obtain screening opinion from the EPA with specific reference to each individual component or sites; IEE may need to be prepared to confirm no trees to be cut. EMP included in this IEE can be submitted to EPA.
Irrigation system	No	Yes	Yes	Yes	MOECCT to obtain screening opinion from the EPA with specific reference to each individual component or sites; EMP included in this IEE can be submitted to EPA.
Cold storage	No	No	No	Yes	
Shade houses	No	No	No	Yes	

#### D. Permits and Approvals Required

In addition to the Environmental Decision Statement from the EPA, MOECCT as the project proponent or their contractor(s) will be required to obtain all applicable permits and approvals from Island Councils as well as other relevant national and island agencies or departments as set out in Table 3. These include permissions from Island Councils for land use for the project-funded components on islands; permissions from relevant agencies such as from Ministry of Education, Ministry of Health, and Island Councils for installation of solar photovoltaic on rooftop of public buildings; and permission for tree cutting in line with the new (2022) national regulation.

**Table 3: Other National Requirements for the Project-Funded Components**

ASSURE Project Component	Other Permits and Approvals Required	Remarks
Battery Energy Storage System	None	BESS and EMS will be inside the powerhouse premises so do not need island councils land use permission for their installation
Energy Management System	None	
Grid Upgrade	Permission from island councils	
Ocean Energy System Pilot	Permission from island councils	
Wind Energy System Pilot	Permission from island councils for land use Permission for the tree cutting from Council if <50 trees and from the EPA if >50 trees	It is anticipated only 24 trees maximum to be cut
Rooftop solar	Permissions from relevant agencies owning the public buildings	E.g., from Ministry of Education, Ministry of Health, and island councils
Ground mounted solar photovoltaic (Thoddoo)	Permission from island council	
Irrigation system	Permission from island council	
Cold storage	Permission from island council	
Shade houses	Permission from island council	

## E. ADB's Environmental Safeguard Requirements

30. This IEE is carried out in accordance with Appendix 1 of ADB's Safeguards Policy Statement (2009) to ensure that potential adverse environmental impacts are identified, avoided where possible, and managed when avoidance is not possible. As per the ADB's Safeguards Policy Statement (2009), the objective of environmental safeguard is to ensure the environmental soundness and sustainability of the project and to support the integration of environmental considerations into the project decision-making process. To help achieve the desired outcomes, ADB adopts eleven policy principles for guiding the assessment of projects that have environmental impacts and risks.

31. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. Projects are assigned to one of the following four categories accordingly to the significance of likely impacts:

- (i) **Category A.** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.
- (ii) **Category B.** A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required.
- (iii) **Category C.** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.
- (iv) **Category FI.** A proposed project is classified as category financial intermediary if it involves investment of ADB funds to or through a FI.

32. In accordance with ADB's Safeguards Policy Statement (2009) the proposed ASSURE Project to be implemented in the outer islands of Maldives is categorized as an environment Category B project and requires an IEE. Accordingly, this IEE including EMP has been prepared for the project.

33. **Gap analysis.** A gap analysis between ADB's Safeguards Policy Statement (2009) and Maldives Environment Protection and Preservation Act which deals with environmental assessment and management planning has been carried out for the IEE. The key gaps in the Maldives Environment Protection and Preservation Act are (i) there is no reference in Maldives EIA legislation regarding the need to assess impacts on vulnerable groups and gender issues; (ii) there is no explicit reference to "assessment of trans-boundary impacts" in the legal framework; (iii) there is no explicit reference to the conduct of strategic environmental assessment in the legislation; (iv) the EMP is required to provide for manpower requirements for its implementation, it is not explicit in terms of requiring institutional or organization arrangements for its implementation; (v) the requirement for capacity development and training for implementation of EMP is implicit, rather than explicit in the legislation; (vi) there is no explicit reference to the polluter pay principle; (vi) there is no clear timeline established when consultation should occur, if consultation should take place throughout project implementation and the means for resolution



of any affected person's concerns; (vii) there is no reference in the legislation to the stages and timing of consultations; (viii) there is no explicit reference to establishment of a grievance redress mechanism at the project level; (ix) there is no guidance on the disclosure of a draft EIA report and EMP document, including timing, location and language; (x) there is no guidance in the legislation regarding the disclosure of the final EIA report and EMP document, although the decision of approval or environmental clearance has to be disclosed; (xi) there is no requirement for public disclosure of the monitoring results, disclosure is limited to submission to government agencies; and (xii) there is no guidance on how to deal with "chance finds". To ensure the Project is fully aligned with ADB's Safeguards Policy Statement 2009 this IEE considers impacts on vulnerable groups and gender issues, transboundary impacts mostly related to waste management, the EMP includes institutional arrangements, capacity development requirements, and chance find procedures. Project consultations and information disclosure have been undertaken in accordance with ADB's Safeguard Policy Statement (2009) and a grievance redress mechanism will be established by MOECCT.

34. ADB's Safeguard Policy Statement (2009) includes a prohibited investment activities list (PIAL)<sup>13</sup>. The project will also comply with the PIAL. Thus, any use of CFCs, PCBs, and asbestos containing materials will be prohibited. There will be no forced labor permitted and, in relation to child labor, considering capacity for health and safety supervision, no under 18s will be permitted to work on the construction site or operational areas due to the hazardous nature of work involved.

## **F. Institutional Arrangements**

35. The main government institutions that have roles and responsibilities for implementing the environmental policy and legal framework of Maldives as relevant to the proposed ASSURE project are:

### **1. Ministry of Environment, Climate Change, and Technology**

36. The Ministry of Environment, Climate Change and Technology (MOECCT) is the implementing agency of the project. Its energy department is responsible for formulating relevant laws and regulations, policies, and strategies. As a project proponent the energy department of MOECCT has no ESMS to ensure national requirements are followed nor has it an established safeguards unit, safeguard staffing is usually set up on a project-by-project basis. MOECCT is also the primary environmental institution in Maldives. It is mandated for formulating policies, strategies, laws, and regulations concerning environmental management, protection, conservation, and sustainable development. Additionally, separate sections of MOECCT are responsible for formulating relevant laws and regulations, policies and strategies concerning water and sanitation, waste, and infrastructure.

### **2. Environmental Protection Agency of Maldives**

37. EPA is the key regulatory body on environment, it is an autonomous body formed under the umbrella of MOECCT. It is mandated with implementing the Environment Act and subsequent regulations on behalf of MOECCT, including the EIA process in Maldives, and, regulating water and sanitation, biodiversity conservation, waste management and coastal zone management. The head of the EPA within MOECCT gives the environmental approval by an Environmental

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<sup>13</sup> ADB Prohibited Investment Activities List - Appendix 5 of the Safeguard Policy Statement (2009).

Decision Statement. It is also responsible for developing environmental standards and guidelines in the country.

### **3. FENAKA Corporation Limited**

38. FENAKA is a state-owned utility company providing electricity, water, and sewerage to the island communities of the Maldives. It is providing services to over 150 inhabited islands in the Maldives. As a project proponent FENAKA has an in-house ESMS with Standard Operating Procedures to ensure national requirements are followed although this is not an ISO certified system. It has an established environment department (Water, Sewerage and Environment Department) which considers environment safeguard matters and has formed a health and safety committee. FENAKA engineers on each island would be the ones responsible for environment, health, and safety matters.

### **4. Utility Regulatory Agency, Maldives**

39. The Utility Regulatory Authority (URA) is the national energy, water, waste, and sanitation sector regulatory agency of Maldives. It plays a vital role in developing, spreading awareness, and providing information about the various laws and regulations related to the energy, water, waste, and sanitation sector. It is responsible for the regulations and licensing related to public utility services. As part of its mandate, it is required to ensure that renewable energy is used to the maximum extent possible in the establishment and operation of utility services established after its creation in 2020. For the project components FENAKA already has a license so no further URA permissions are required.

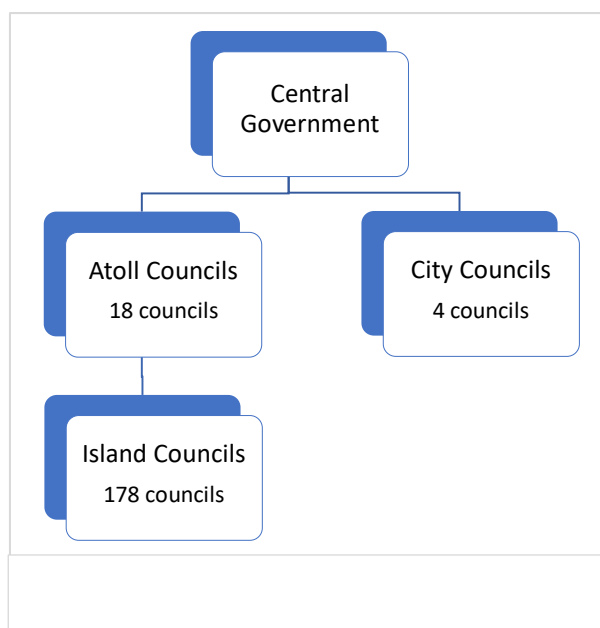
## **G. Other Ministries and Departments**

40. Other government agencies are charged with the management and/or protection of environmental resources, social development, public health, and economic development. If a project would have an impact on one or more of these sectors, the agencies responsible should have an opportunity to raise issues and provide input. These government agencies are as follows:

- (i) The Ministry of Health and the Health Protection Agency under this Ministry have an important role in evaluating the health impacts of projects.
- (ii) Ministry of National Planning, Housing and Infrastructure, which undertakes overall land use planning and land allocation in the Maldives in addition to provision of certain infrastructure.
- (iii) Labour Relations Authority established by the Employment Act (2/2008) under the Ministry of Economic Development.

## **H. Atoll and Island Councils**

41. Each atoll has its own capital, and it is governed by an atoll council whilst each inhabited island has its own island council. Under the Maldives Decentralization Law, elected Island Councils have been formed as regulatory bodies dealing directly with island issues. In this regard, some development projects are subject to approval of these councils through a public consultation process. For the proposed ASSURE project, a public consultation process has been performed with the Island Council members of the project islands as part of the IEE. Figure 2 shows the basic administrative structure.

**Figure 2: Basic Administrative Structure of Councils in Maldives**

Source: Project management unit.

## I. Environmental Standards

42. Environmental management in the Maldives is still at infancy and lacks the necessary environmental standards. Surface water quality, groundwater quality, marine water quality, air quality and noise standards are based on international guidelines or standards of developed countries.

43. For water quality WHO guidelines relate to water usage rather than ecological condition. Drinking water quality standards are published by EPA (URA) which are based on WHO and other international standards. Table 4 presents the drinking water quality standards applicable to the project. Maldives has yet to establish ambient water quality standards. Consequently, the most appropriate international standards will have to be employed in evaluating and monitoring project impacts. The EPA 'EIA Data Collection Guidelines' in the case of marine water quality establish the optimum guidelines to be used for the Maldives (Appendix 9) which have been adopted from Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA)<sup>14</sup> and other related references.

**Table 4: Applicable Drinking Water Quality Standards**

Group	National Standards for Drinking Water <sup>a</sup>			WHO Guidelines for Drinking-Water Quality, 4th Edition, 2011 <sup>b</sup>	Applicable to Project
	Parameter	Unit	Standard		
Physical	Turbidity	NTU	<1	-	<1
	pH	-	6.5 to 8.5	-	6.5 – 8.5
	Color	-	Clear and colorless	-	Clear and colorless

<sup>14</sup> Great Barrier Reef Marine Park Authority. 2009. Water quality guidelines for the Great Barrier Reef Marine Park. Great Barrier Reef Marine Park Authority, Townsville

Group	National Standards for Drinking Water <sup>a</sup>			WHO Guidelines for Drinking-Water Quality, 4th Edition, 2011 <sup>b</sup>	Applicable to Project
	Parameter	Unit	Standard		
	Taste and Odor	-	-	-	-
	Electrical conductivity	µs/cm	<1,000	-	<1,000
	TDS	mg/l	<500	-	<500
	Suspended Solids	mg/l	5 – 750	-	5 – 750
Chemical	Iron	mg/l	<0.3	-	<0.3
	Manganese	mg/l	0.1	-	0.1
	Arsenic	mg/l	<0.01	0.01	<0.01
	Boron	mg/l	<0.3	-	<0.3
	Bromine	mg/l	0.05 – 4.50	-	0.05 – 4.50
	Cadmium	mg/l	<0.003	0.003	<0.003
	Chromium	mg/l	<0.05	0.05	<0.05
	Cyanide	mg/l	<0.07	-	<0.07
	Fluoride	mg/l	<1.5	1.5	<1.5
	Hydrogen Sulfide	mg/l	0.05	-	0.05
	Lead	mg/l	<0.01	0.01	<0.01
	Phosphate	mg/l	<5	-	<5
	Potassium	mg/l	0 - 50	-	0 - 50
	Ammonia	mg/l	<0.02 – 2.50	-	<0.02 – 2.50
	Chloride	mg/l	<200	-	<200
	Sulphate	mg/l	<250	-	<250
	Nitrate	mg/l	<50	50	<50
	Copper	mg/l	<2.0	2	<2.0
	Total Hardness	mg/l	<75	-	<75
	Calcium Hardness	mg/l	<60	-	<60
	Mercury	mg/l	<0.001	0.006	<0.001
	Free Chlorine	mg/l	0.04 – 0.2	-	0.04 – 0.2
	Anionic detergents	mg/l	0.002 – 0.275	-	0.002 – 0.275
	Phenolic compounds	mg/l	0.002 – 0.2	-	0.002 – 0.2
	Sodium	mg/l	<200	-	<200
	Total petroleum hydrocarbon	mg/l	0	-	0
Microbiological	Total coliform	Counts per 100ml CFU	0	-	0
	Fecal coliform	Counts per 100ml CFU	0	-	0
	Enterococci	Counts per 100ml CFU	0	-	0
	Salmonella Typhi	Counts per 100ml CFU	0	-	0
	Shigellaspp.	Counts per 100ml CFU	0	-	0
	Vibrio Cholerae	Counts per 100ml CFU	0	-	0

<sup>a</sup> Maldives Environmental Protection Agency Supply Quality Standard.

<sup>b</sup> Health-based guideline values.

44. For air quality, Maldives has yet to establish ambient air quality standards to serve as a basis for air quality management. Consequently, the international guidelines will have to be employed in evaluating and monitoring project impacts on air quality. Standards vary for different countries depending on their circumstances. However, it is important to note that the people of Maldives outer islands are usually subject to less atmospheric pollution than those living in the industrialized world. In Maldives, for reference purposes, the air quality standards of the WHO (Table 5) are used and will be taken for the proposed ASSURE project.

**Table 5: Applicable Ambient Air Quality Standards**

Parameter	Maldives Ambient Air Quality Standard (µg/m <sup>3</sup> ) <sup>a</sup>	Averaging Time	WHO Air Quality Guidelines (µg/m <sup>3</sup> ) <sup>b</sup> 2005	WHO Air Quality Guidelines (µg/m <sup>3</sup> ) 2021	Applicable to Project (µg/m <sup>3</sup> )
PM10, µg/m <sup>3</sup>	-	24 – hour	50	45	45
PM10, µg/m <sup>3</sup>	-	1 – year	20	15	15
PM2.5, µg/m <sup>3</sup>	-	24 – hour	25	15	15
PM2.5, µg/m <sup>3</sup>	-	1 – year	10	5	5
SO <sub>2</sub> , µg/m <sup>3</sup>	-	10 – min	500	-	500
SO <sub>2</sub> , µg/m <sup>3</sup>	-	24 – hour	20	40	40
NO <sub>2</sub> , µg/m <sup>3</sup>	-	1 – hour	200	-	200
NO <sub>2</sub> , µg/m <sup>3</sup>	-	24 – hour	-	25	25
NO <sub>2</sub> , µg/m <sup>3</sup>	-	1 – year	40	10	10
CO	-	24 – hour	-	4000	4000
Ozone (O <sub>3</sub> ), µg/m <sup>3</sup>	-	8 – hour	100	100	100

<sup>a</sup> Maldives currently does not have national ambient air quality standards set.

<sup>b</sup> WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Global update 2005 and WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide 2021.

45. Similarly, there are no national standards for noise. In the absence of local standards, internationally acceptable noise guidelines (Table 6) will be followed for the project, which are similar to European standards.

**Table 6: Applicable Noise Standards**

Receptor/ Source	Maldives National Noise Level Standards <sup>a</sup> (dBA)		WHO Guidelines Value for Noise Levels Measured Out of Doors <sup>b</sup> (One Hour LAeq in dBA)		Applicable to Project (dBA)	
	Day	Night	07:00 – 22:00	22:00 – 07:00	Day time	Nighttime
Residential, institutional, educational	-	-	55	45	55	45
Industrial, commercial	-	-	70	70	70	70

<sup>a</sup> Maldives currently does not have noise level standards.

<sup>b</sup> Guidelines for Community Noise. WHO, 1999.

46. **International Finance Corporation Environmental, Health and Safety Guidelines.** The EHS General Guidelines (30 April 2007) will be applicable for this project. In addition, the IFC EHS Guidelines for Electric Power Transmission and Distribution (30 April 2007) and IFC EHS Guidelines for Wind Energy (07 August 2015) also needs to be considered while designing the

grid upgrade components and wind energy pilot system respectively. The former requires consideration of terrestrial and aquatic habitat alteration, electric and magnetic fields, hazardous materials, occupational health and safety and community health and safety. The latter requires consideration of landscape, seascape and visual impacts, noise, biodiversity, shadow flicker, water quality, occupational health and safety and community health and safety and gives the following standards with respect to noise, shadow flicker and set-back:

- (i) To preclude detailed modelling a preliminary model must confirm turbine noise at all sensitive receptors likely to be below an LA90 of 35 decibels (dB) (A) at a wind speed of 10 meters/second (m/s) at 10 m height during day and night times
- (ii) predicted duration of shadow flicker effects experienced at a sensitive receptor not to exceed 30 hours per year and 30 minutes per day on the worst affected day, based on a worst-case scenario<sup>15</sup>
- (iii) minimum setback distance is 1.5 x turbine height (tower + rotor radius)

47. The project is required to comply with these guidelines regarding assessment of potential impacts and management measures, performance indicators and monitoring guidelines. As a project proponent, MOECCT shall follow the IFC EHS Guidelines as well as other (GIIP) for this project and shall also ensure that all appointed contractor(s) do so.

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<sup>15</sup> There is continual sunshine and permanently cloudless skies from sunrise to sunset. There is sufficient wind for continually rotating turbine blades. Rotor is perpendicular to the incident direction of the sunlight. Sun angles less than 3 degrees above the horizon level are disregarded (due to likelihood for vegetation and building screening). Distances between the rotor plane and the tower axis are negligible. Light refraction in the atmosphere is not considered.

### III. DESCRIPTION OF THE PROJECT

#### A. Type and Location of the Project

48. The components assessed for this IEE comprise of installation of battery storage system (a total of 44 MWh) plus energy management systems and upgrading of island distribution grid system in 20 outer islands; installation of a pilot wind power generation component of 150 kW rated power in Manadhoo island; installation of a pilot ocean power generation component of 100 kW rated power in one of three possible islands; installation of 2.5 MWp rooftop solar home system installations through net metering; and agricultural interventions including installation of a solar powered irrigation system in Thoddoo island. All the physical components covered under ASSURE project IEE report are located on 22 outer islands (12 Atolls) of Maldives. Figure 3 shows the location of project islands on Google-earth image. Detailed maps showing locations of individual islands are provided in Appendix 1.

**Figure 3: Location of Project on Country (Maldives) Map**



Source: Consultant work on Google earth image.

## B. Project Components

### 1. Installation of Battery Energy Storage Systems, Energy Management Systems and Distribution Grid Upgrade

49. **Battery energy storage systems and energy management systems.** Under BESS component a total of 44 MWh of Battery Energy Storage Systems along with Energy Management Systems will be installed in 20 outer islands of Maldives. Table 7 presents the island wise details of the BESS.

**Table 7: Details of Battery Energy Storage Systems Installations**

Sl. No.	Atoll	Island	Expected BESS Capacity (kWh)	Type	Location of BESS	Any Grid Upgrade Requirement (Yes/No)	Private Sector Solar (Associated Facilities)
1	Ha	Dhidhdhoo	3000	Flow	Powerhouse	Yes	Ground Rooftop
2	Hdh	Hanimaadhoo	2000	Li	Powerhouse	Yes	Ground Rooftop
3	Sh	Milandhoo	2500	Li	Powerhouse	Yes	Ground Rooftop
4	N	Manadhoo	3000	Li	Powerhouse	Yes	Ground
5	N	Holhudhoo	1200	Li	Powerhouse	Yes	Ground
6	N	Velidhoo	3000	Li	Powerhouse	Yes	Ground
7	R	Alifushi	1850	Li	Powerhouse	Yes	Floating
8	R	Hulhudhuffaaruu	1500	Li	Powerhouse	Yes	Floating
9	B	Dharavandhoo	2250	Li	Powerhouse	Yes	Ground
10	B	Thulaadhoo	3000	Li	Powerhouse	Yes	Ground
11	M	Mulah	2000	Li	Powerhouse	Yes	Floating
12	M	Muli	2000	Li	Powerhouse	Yes	Floating
13	M	Raimandhoo	500	Li	Powerhouse	Yes	Floating
14	M	Veyvah	500	Li	Powerhouse	Yes	Floating
15	F	Nilandhoo	3000	Flow	Powerhouse	Yes	Floating
16	Th	Guraidhoo	2500	Li	Powerhouse	Yes	Ground
17	Th	Thimarafushi	3000	Li	Powerhouse	Yes	Ground Rooftop
18	Ga	Maamendhoo	1000	Li	Powerhouse	Yes	Floating
19	Gdh	Faresmaathoda	3000	Li	Powerhouse	Yes	Ground mounted in shallow water
20	Gdh	Gahdhoo	2500	Li	Powerhouse	Yes	Floating

50. A battery energy storage system (BESS) is an electrochemical device that charges (or collects energy) from the grid or a power plant and then discharges that energy at a later time to provide electricity or other grid services when needed. It comprises hardware components along with low-level and high-level software. The main BESS parts (Figure 4) include:

- (i) **A battery system.** It contains individual battery cells that convert chemical energy into electrical energy. The cells are arranged in modules that, in their turn, form battery packs.



- (ii) **A battery management system.** A battery management system (BMS) ensures the safety of the battery system. It monitors the condition of battery cells, measures their parameters and states, such as state-of-charge, and state-of-health, and protects batteries from fires and other hazards.
- (iii) **An inverter or a power conversion system.** This converts direct current produced by batteries into alternating current supplied to facilities. Battery energy storage systems have bi-directional inverters that allow for both charging and discharging.
- (iv) **An energy management system.** This is responsible for monitoring and control of the energy flow within the BESS. An energy management system (EMS) coordinates the work of a BMS, a power conversion system, and other components of a BESS. By collecting and analyzing energy data, an EMS can efficiently manage the power resources of the system.

**Figure 4: Key Components of a Typical Battery Energy Storage System**



BMS = battery management system, J/B = Junction box.

Source: Handbook on Battery Energy Storage System, ADB (2018)

51. The project will use conventional lithium-ion batteries except on two islands (Dhidhdhoo and Nilandhoo) where flow-based batteries will be piloted by MOECCT. Flow-based batteries are much larger than lithium-ion batteries; they store energy in an electrolyte liquid such as vanadium,<sup>16</sup> zinc/bromide or iron kept in external tanks and not the battery cell. Flow-based batteries may be more easily reused and are thought to have a longer life of 20–25 years than lithium-ion of 7–10 years, although as a new technology the lifespan is still theoretical. The Japan Fund for the Joint Crediting Mechanism consultants, report the environmental benefits of flow BESS compared to lithium-ion include (i) less risk of environmental pollution as a result of recyclable and non-hazardous electrolyte and longer battery lifespan; and (ii) avoidance of additional greenhouse gas emissions from heating or cooling the battery itself as there is no need for additional energy consumption for an air conditioning installation. Training on the operation and maintenance of the lithium ion and flow batteries will be provided by the EPC contractor to

<sup>16</sup> Vanadium is anticipated to be specified.

the FENAKA operators. The social benefits of piloting the flow BESS include FENAKA obtaining new and advanced BESS technology know-how for facilitating further renewable energy penetration in Maldives in the form of renewable mini grids; and safer BESS operation environment for workers and residents, as result of deployment of flow BESS with less potential for causing fire incident (electrolyte is incombustible). The disadvantage of flow BESS is the high upfront capital investment and being a new technology few suppliers in the market, hence the project will use lithium-ion batteries in most of the islands and pilot flow-based technology on two islands. In both cases at end of life the batteries will need to be exported from Maldives for reuse, recycling and/or disposal which will be assured through a battery disposal agreement that will be part of the contractual arrangements with the suppliers.

52. The footprint of a BESS is very small and will be installed inside an existing powerhouse room or a small building (max 14m x 6m x 3m size) to be constructed inside the premises of the existing powerhouses. However, the flow BESS system will be installed in a container also cited in the premises of the existing powerhouses. A typical BESS building and containerized solution in Maldives is shown in Figure 5.

**Figure 5: Typical Battery Energy Storage System Building and Containerized Solution**



Top image: containerized BESS system; Bottom image: BESS building  
Source: MOECCT

53. **Distribution grid upgrade.** Under the distribution grid upgrade component, the existing distribution grid on 20 outer islands (Table 8) will be upgraded. The typical island power distribution networks consist of low voltage (LV) three phase and neutral, Polyvinyl Chloride (photovoltaicC) insulated and sheathed cables buried underground along the side of the sandy roads. Distribution cables originate from the powerhouse main control panel and terminate on distribution boxes for household connections.

**Figure 6: Photograph of a Typical Ring Main Unit**



Source: Source:CG Power and Industrial Solutions. On-line available at [https://www.cgglobal.com/our\\_business/Power/Switchgear-Products-MV-HV-EHV-UHV/MV-Switchgear/RMU-Up-To-36-kV](https://www.cgglobal.com/our_business/Power/Switchgear-Products-MV-HV-EHV-UHV/MV-Switchgear/RMU-Up-To-36-kV)

54. The distribution grid upgrade under the proposed ASSURE project includes underground cable works along existing sandy roads, and related distribution equipment in the grounds of the powerhouse i.e., control panels, distribution boxes, package substations or ring main units, power transformers etc. The packaged substations are basically a ring main unit (Figure 6) which will be installed in their own standalone kiosk within the powerhouse grounds. In this case they are air-insulated, hermetically sealed units that do not require any maintenance by FENAKA during their lifespan. The transformers for the project will be dry (cast resin) type installed in the existing powerhouse buildings and there will not be any oil filled transformers purchased under the project. Table 8 provides details of the distribution grid upgrade work. Island wise breakup is provided in Appendix 2.

**Table 8: Details of Distribution Grid Upgrade Works**

Sl. No.	Item Description	Quantity	Unit
	<b>1.1 Supply and Installation of Cable Works</b>		
1.1.1	4C x 35 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	533	23,000 m

Sl. No.	Item Description	Quantity		Unit
1.1.2	4C x 50 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	1,731		m
1.1.3	4C x 70 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	1,370		m
1.1.4	4C x 95 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	2,285		m
1.1.5	4C x 120 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	1,048		m
1.1.6	4C x 150 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	741		m
1.1.7	4C x 185 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	1,690		m
1.1.8	4C x 240 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	550		m
1.1.9	4C x 300 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	1,520		m
1.1.10	4C x 400 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	925		m
1.1.11	1C x 500 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	300		m
1.1.12	1C x 630 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 400V	10,315		m
1.1.13	3C x 70 sq.mm, Cu. photovoltaicC, XLPE, LV CABLE, 11kV	14,885	14,885	m
<b>1.2 Supply and Installation of Distribution Equipment</b>				
1.2.1	Supply, Installation and Testing and commissioning of Powerhouse LVDB Extension Panel and associated works (Control Panel)	20	20	Nos.
1.2.2	Supply, Installation and Testing and commissioning of Replacement of Distribution Box	28	28	Nos.
1.2.3	630kVA, 11/0.415kV, 3p, 50Hz, Package Substation	17	29	Nos.
1.2.4	800kVA, 11/0.415kV, 3p, 50Hz, Package Substation	1		Nos.
1.2.5	1000kVA, 11/0.415kV, 3p, 50Hz, Package Substation	2		Nos.
1.2.6	1250kVA, 11/0.415kV, 3p, 50Hz, Package Substation	5		Nos.
1.2.7	1500kVA, 11/0.415kV, 3p, 50Hz, Package Substation	4		Nos.
1.2.8	2000kVA, 0.415/11kV, 3p, 50Hz, Power Transformer	8	17	Nos.
1.2.9	2500kVA, 0.415/11kV, 3p, 50Hz, Power Transformer	8		Nos.
1.2.10	3500kVA, 0.415/11kV, 3p, 50Hz, Power Transformer	1		Nos.


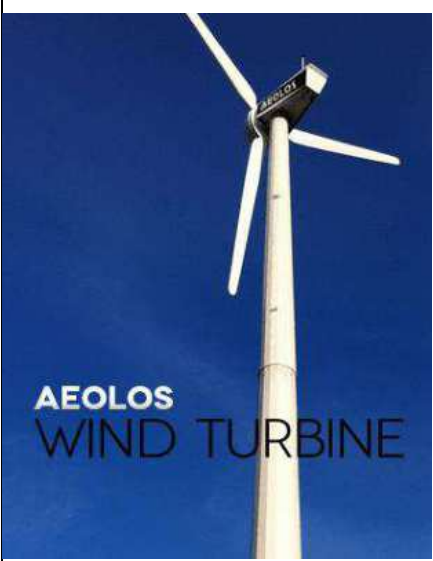
Source: BOQ, 2022.

## 2. Introducing Emerging New Renewable Energy Technologies


55. Under this component, the project will introduce emerging new renewable energy technologies by piloting wind energy and ocean energy systems in two outer islands of Maldives. The wind energy pilot will be installed on Manadhoo island whereas an ocean energy pilot will be installed on one of their possible islands i.e., Mulah, Muli, or Komandhoo. The feasibility study and detailed design for each pilot system will be undertaken by the EPC contractor(s) on behalf of MOECCT.

56. **Manadhoo wind energy pilot.** The scope includes installation of a 150kW Pilot Wind Renewable Energy Hybrid Microgrid in Manadhoo Island, Maldives. The aim is to integrate wind turbines with the existing hybrid power plant (diesel + solar photovoltaic + BESS) of Manadhoo Island. The key components of the pilot (Table 9) consist of the wind turbine system, lithium-ion BESS, integration of the system into the existing AC-LV distribution system, and connection to the existing grid infrastructure with the provision of underground cabling to the powerhouse. The projected lifespan of the pilot is 20 years after which it will be decommissioned unless it is not successful, in which case it will be decommissioned earlier. If successful there is potential for the wind energy system to be expanded to 250-500 kW in the future, subject to further assessment and EPA environmental approval.

**Table 9: Details of Wind Energy Pilot 150 Kilowatts**

Island	System Type	Rated Power
Manadhoo	Type B-4	150 kW (25 kW x 6)
Parameters	<p>25 kW (VERGNET) turbine</p>  <p>Source:  <a href="https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/WindEnergy_buyersguide_ENG.pdf">https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/WindEnergy_buyersguide_ENG.pdf</a></p> <p>Other similar wind turbines:</p> 	



Island	System Type	Rated Power
		<p>Source: <a href="https://www.neicjapan.com/wp/wp-content/uploads/2020/11/Aeolos-H-20kW-BrochureNew.pdf">https://www.neicjapan.com/wp/wp-content/uploads/2020/11/Aeolos-H-20kW-BrochureNew.pdf</a></p>  <p>Source: <a href="https://www.solid-group.dk/media/1991/swp-25kw-folder-a4-10_v1_web.pdf">https://www.solid-group.dk/media/1991/swp-25kw-folder-a4-10_v1_web.pdf</a></p>
Weight (kg)		875
Hub height (m)		18
Diameter (m)		10
Separation distance (m)		40 (4 x diameter)
Foundation type		Gravity-based foundation is feasible, and the preferred option assessed in this IEE. If piling is used drill piling is to be selected over driven piles; piling will only be permitted if demonstrated compliant with environmental safeguards requirements (no noise and groundwater impacts). <sup>17</sup> Foundation designs must meet local building codes and GIIP for seismic/structural requirements (Paragraph 60).
Setback Requirement		34.5 m from FENAKA buildings (1.5 x total height (tower + rotor radius) in line with the IFC EHS guidelines on wind energy but subject to an OHS risk assessment, acceptability of risk to FENAKA will depend on the extent the area in the precautionary set back is used by its personnel. 100 m from non-FENAKA buildings (over 3 x total height as a precautionary setback for community health and safety since this is a pilot wind energy project) Nearest non-FENAKA property is at 130 m distance from the current layout
Noise Limit		35 dB at 10 m/s at 10 m height as LAeq90
Shadow Flicker Limit		30 hours per day; 30 minutes maximum per day on worst day at non-FENAKA buildings No restriction on shadow flicker occurrence at FENAKA buildings subject to an OHS risk assessment, acceptability of risk to FENAKA will depend on the extent the impacted area is used by its personnel, the orientation of windows, and the ability of its personnel to close blinds during shadow flicker periods etc.
Extra BESS capacity		Yes (small size in range 25–30 kWh) Location: in small cabinet under or near to solar power plant beside the FENAKA buildings

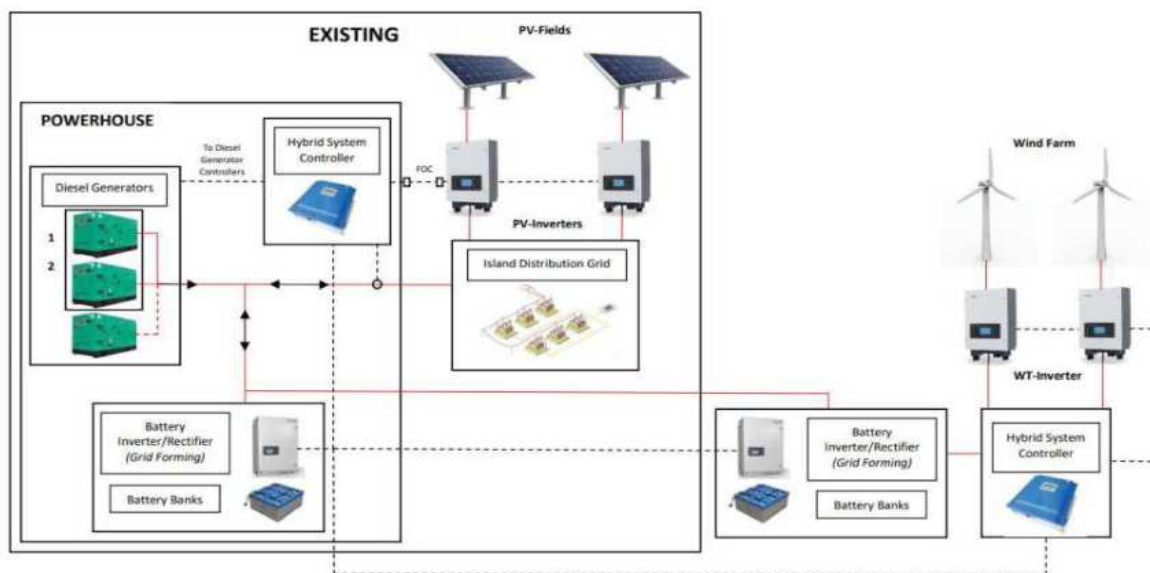
<sup>17</sup> If following ground investigations piling is required for seismic/structural reasons the IEE will need to be updated as the assessment is based on the technically feasible and preferred option of gravity-based foundation to minimize the noise and vibration impact on the adjacent receptors.

Island	System Type	Rated Power
Grid Connection Required	Yes. Components: underground connection cable about 100m to connect to the powerhouse.	

BESS = battery energy storage system, dB = decibel, FENAKA = FENAKA Corporation Limited, IEE = initial environment examination, kw = kilowatt, kWh = kilowatt hour, m = meter, m/s = meter per second.

57. The wind energy system will use a Vergnet wind turbine Type B-4: VSWT-synchronous generator and converter with a rated power of 150 kW in total (25 kW x 6 turbines) (Table 9). The technical specifications of each turbine are as Table 9. The wind turbines will be connected to a hybrid system controller which will send power to the BESS to charge the battery bank. A grid tie inverter will then convert the stored energy into 3-phase AC power which will then be synchronized to the grid. Figure 7 shows the schematic of the hybrid system incorporating the wind energy system.

**Figure 7. Schematic Block Diagram of Hybrid System**



Source: PMU Consultant Team

58. **Proposed site.** Site assessment was done to determine feasible sites within N. Manadhoo Island, Maldives for wind turbines following setback and wake effect considerations. The sites were selected considering (i) a minimum setback of 100 m from non-FENAKA establishments and a minimum of 34.5m (equal to 1.5 x total height (tower + rotor radius)) to the FENAKA buildings , (ii) a minimum distance between turbines of 40m: 4 x turbine diameter, and (iii) a setback of 20 m from the coastal vegetation line plus an additional 5 m buffer to allow for clearing of vegetation for construction. A 20m buffer from the coast is required since legally no trees or vegetation can be cut within it. The selected site is located on southeast corner of the Manadhoo Island, Maldives (5.7663138° N, 73.4065515° E). The proposed layout has been decided considering the latest regulation from the EPA concerning the protection of trees within 20m from the coastal vegetation line; the locations where wind turbines can be sited (blue color in the map) is 20m away from the coastal vegetation line. Specific coordinates of the proposed locations for the 6 wind turbines are of the following 1) 5°46'7.64" N, 73°24'55.23" E, 2) 5°46'7.25" N, 73°24'56.48" E, 3) 5°46'6.82" N, 73°24'57.74" E, 4) 5°46'5.18" N, 73°25'0.21" E, 5) 5°46'3.93" N, 73°25'0.57" E, and 6) 5°46'1.40" N, 73°24'59.36" E. The site is open land with some trees and

vegetation cover and owned by the island council. The nearest building, an island solar power plant operated by FENAKA, is 34.5m from the wind turbine locations. The nearest residential building is about 130 m away from them. There are no protected areas around the proposed site. Figure 8 shows the location map of the proposed site and site conditions.

59. **Array configuration.** The pilot is aiming to install multiple small wind turbine units. Based on the site assessment and analysis of the noise and shadow flicker (Appendix 14) at residential receptors 25 kW x 6 turbines configuration is recommended. The southernmost turbine is set back from the beach and whilst within 20m of the coast is on an area with minimal vegetation cover (bottom photo of Figure 8) where no trees or other coastal scrub vegetation will need to be cleared. Photographs of the proposed sites for the six wind turbines are shown in Figure 9. The wind turbines shall be designed and installed based on the IFC EHS Guidelines and IEC 61400 standards. Techno-economically speaking, a system with more installed capacity has positive implications on the levelized cost of energy (LCOE). Multiple units also allow for better resiliency and for partial capacity operation when some generating units are undergoing maintenance. The more challenging logistics for larger single wind turbine units as compared to smaller systems are also anticipated.

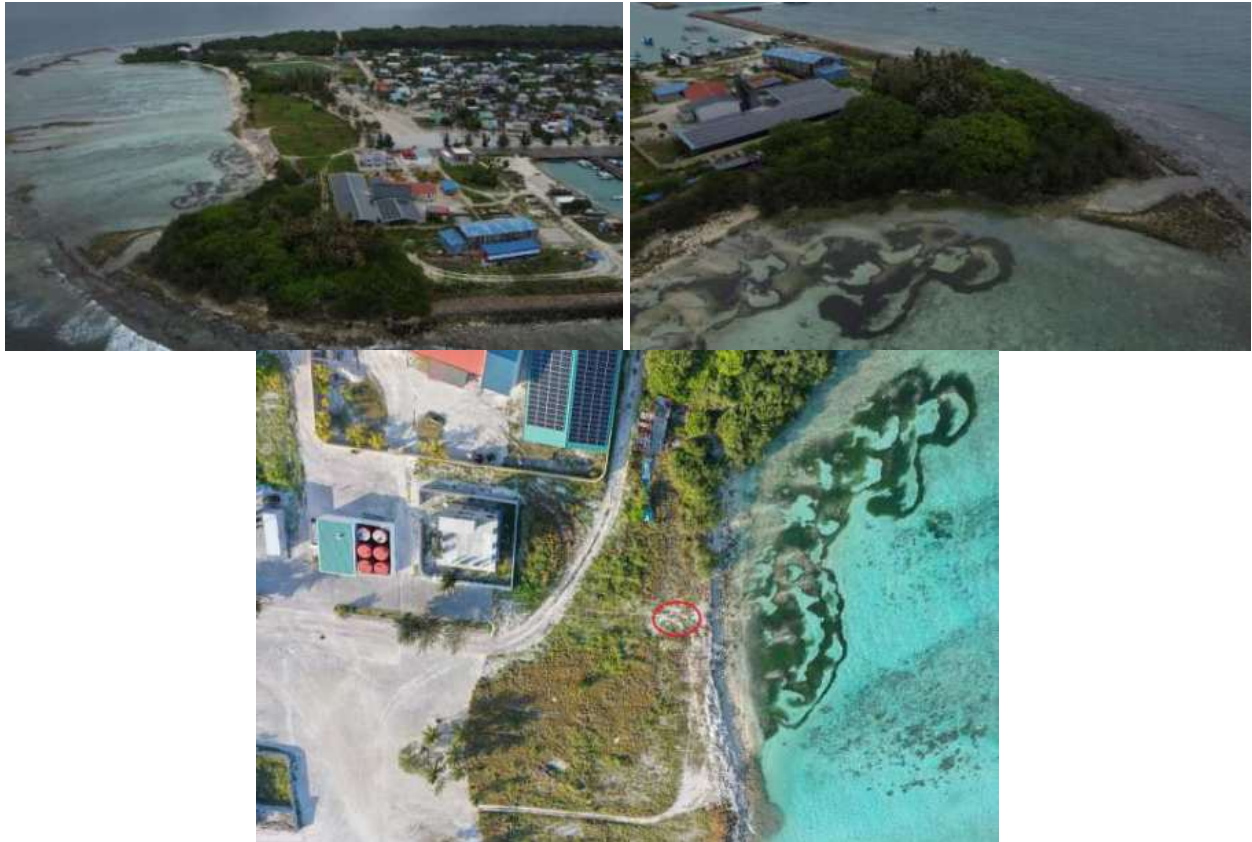
**Figure 8: Location Map and Proposed Site for Wind Pilot Project**











Source: Site assessment report by Ocean Pixel

**Figure 9: Photographs Around Proposed Site for the Wind Energy Pilot**



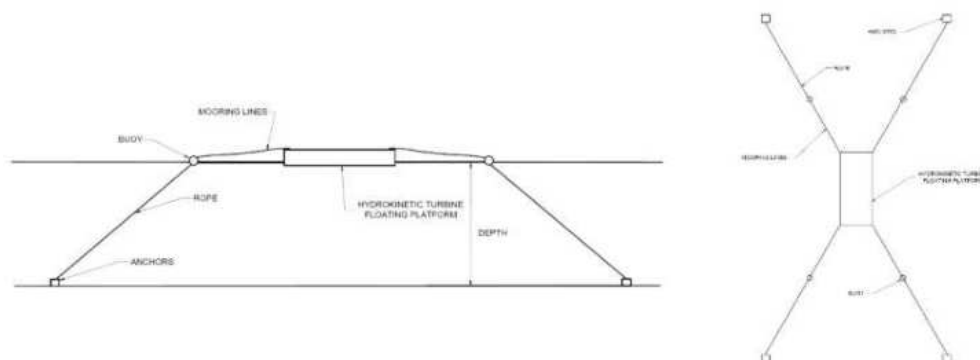
Source: Site assessment report by OceanPixel.

60. **Ocean energy pilot.** The scope includes installation of a 100 kW capacity pilot ocean renewable energy system on one outer island—tidal energy technology will be used for the pilot. Based on the initial assessment it is recommended to implement the pilot in one of the three islands of Maldives i.e., Komandhoo island, Mulah Island, or Muli Island. The contractor will be responsible for conducting the feasibility survey including the collection of tidal and other data.

The final island and site to implement the pilot will be selected by the contractor based on the study of marine environment constraints. The pilot will be decommissioned after one year. If it is successful and MOECCT wishes to retain it as a permanent installation this will be subject to further assessment and EPA approval.

61. **General description.** The aim is to place as many turbine units as possible as this lowers the LCOE as well as contributing to resiliency and redundancy of the technology. Also, it is a good opportunity to test the possibility of an array configuration of the system. The project will supply four (4) small-scale 25 kW hydrokinetic energy systems to generate up to 100 kW of power. Each floating platform supports a vertical or horizontal axis hydrokinetic turbine. Currently, two types of hydrokinetic turbines are used, the vertical axis and the horizontal axis turbine. The technical specifications for the hydrokinetic turbines are listed in Table 10. Each floating platform will be secured on a four-point mooring anchored by anchors or clump-weights. These hydrokinetic energy systems are mobile (easy to deploy, install or move). Figure 10 shows a sample illustration of the proposed deployment of a single floating platform.

**Figure 10. Profile of Hydrokinetic Turbine Platform on Four-Point Mooring System (Left) And Plan View (Right)**



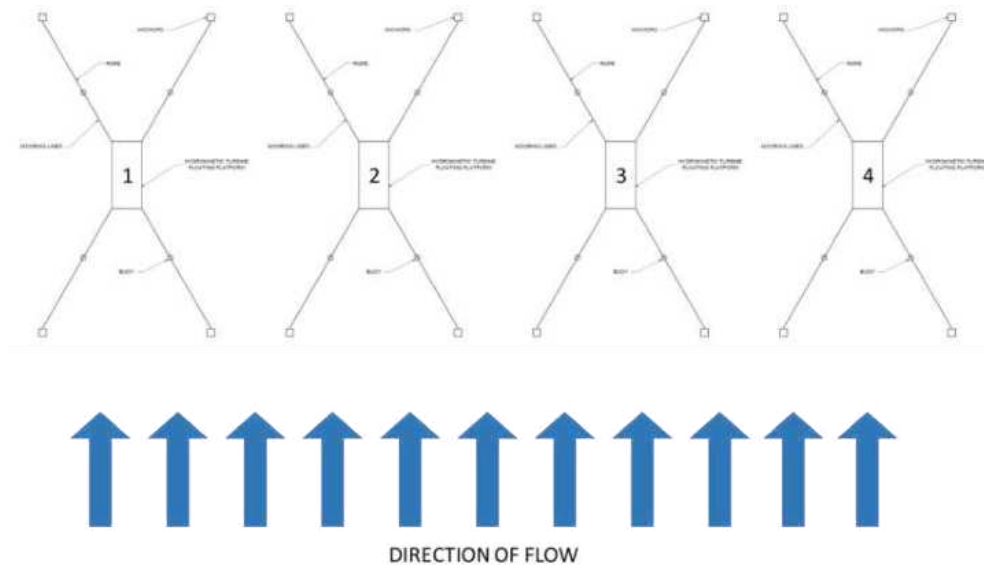
Source: Site assessment report by OceanPixel.

62. **Hydrokinetic turbine arrays.** The design of efficient hydrokinetic turbine arrays relies on the adopted spacing between turbines and their mutual interplay. Hydrodynamic modelling is needed to determine the exact spacing of the array by following the marine standards from IEC62600-200, DNV-ST-0164, EMEC (European Marine Energy Centre) and other acceptable marine operation standards. Figure 11 illustrates the spacing dynamics of the 4 x 25kW Hydrokinetic Turbines.

**Table 10: Technical Specifications for the Hydrokinetic Turbines**

Item	Characteristics
Maximum Rotor Diameter	2-6.3 m for a standard horizontal axis hydrokinetic turbine. ~1.7 m x ~3.4 m (height and width, or vice versa, depending on supplier and configuration) for a vertical axis hydrokinetic turbine
Speed of Rotation	60-140 rpm for 1.5-2.5 m/s water flow
Bottom Clearance	25% of the water depth or 5 m, whichever is greater
Device Spacing	Lateral spacing: 2.5 times the length of the rotor diameter (2.5d); Downstream spacing: 10 times the length of the rotor diameter (10d)

**Figure 11. Plan View of the Proposed 4x25 Kilowatts Floating Hydrokinetic Turbine Arrays on 4-Point Mooring System Per Floating Platform**

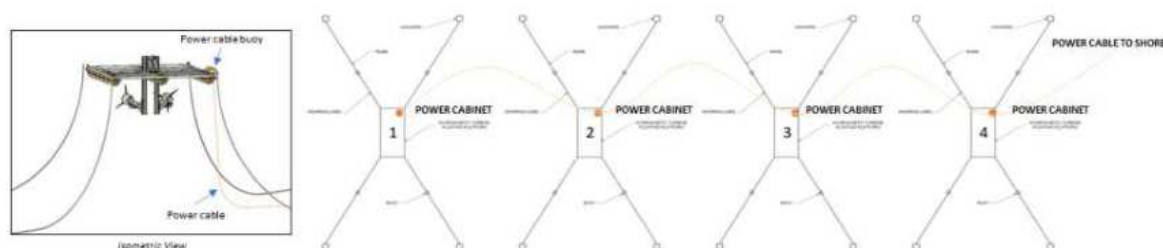


Source: Site assessment report by OceanPixel.

63. **Marine power cable distribution.** During the pilot the ocean energy system will not be connected to the shore with the power used for communications and control. However, the location will need to be planned on the basis that it may become permanent if successful as power distribution to shore will be limited to 200m and will need to avoid seagrass and coral habitat. The tapping point of the cables will be the power cabinets of each floating platform. Power will be integrated into one system before it transmits power to shore. The contractor will do hydrodynamic modelling for this to design a cabling system that considers the operational environment, cable bends, potential hazards, etc. Marine cable standards from ANSI, CSA, IEC, IEEE, ISO, and UL will be the references for the feasibility study and system implementation. Figure 12 shows the proposed plan of power cable distribution between floating platform (or array) which if it becomes permanent will then, subject to further assessment and EPA environmental approval, be connected to the shore and powerhouse.

64. The option for connecting cables to shore shall be assessed during the feasibility stage. If it is not possible to connect to shore, subject also to further assessment and EPA environmental approval, power can be utilized offshore and in applications such as lighting, battery charging, cold storage, ice making, water desalination, electric boat charging, etc. Hybrid system modelling would be needed to determine the correct sizing of any additional components that will be integrated into the pilot system to sustain the load for 24-hour operation.

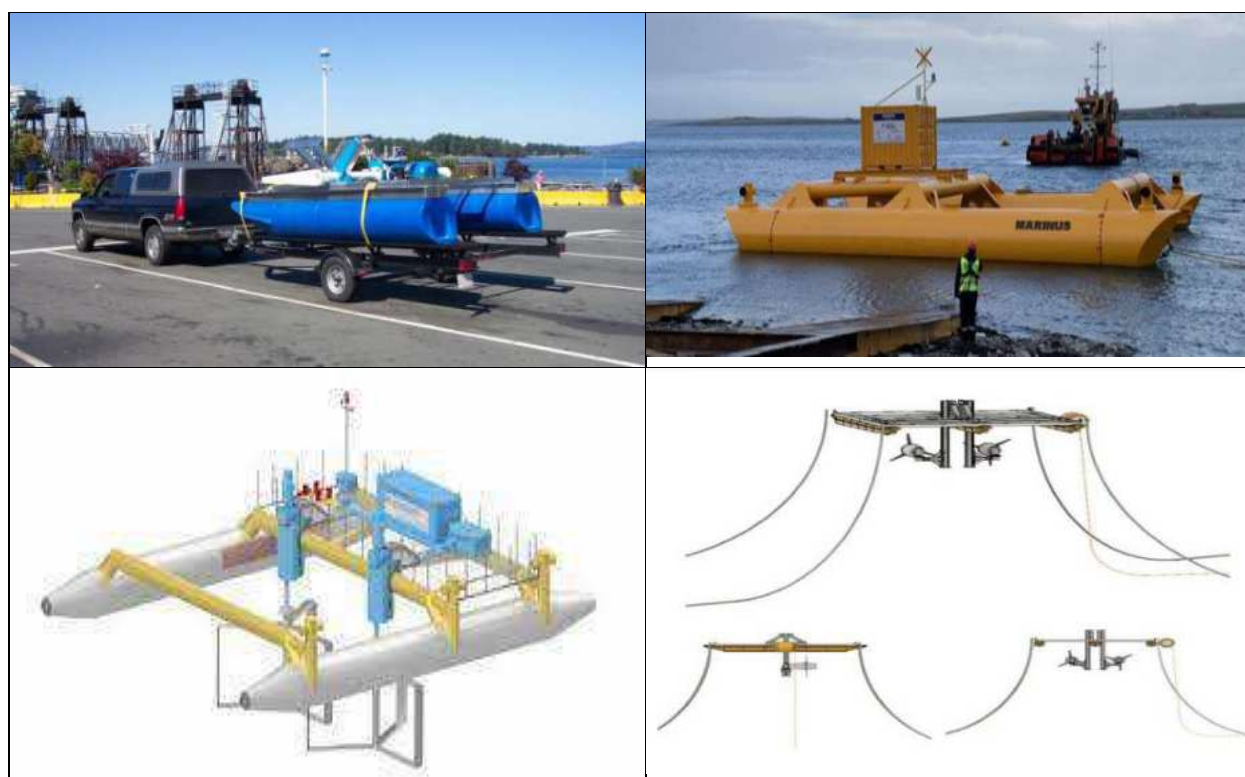
**Figure 12. Isometric and Plan View of Power Cable Distribution from Floating Platform to Shore or Powerhouse**



Source: Site assessment report by OceanPixel.

65. **Hydrokinetic floating turbine deployments.** Figure 13 shows some of the existing projects from all over the world which are also applicable in the application in Maldives. Deployments were done in tropical marine environments such as West Papua in Indonesia and as a demonstration project in Singapore. There were also deployments in Japan and Australia using 5-10 kW tidal turbines.

**Figure 13: Typical Small-Scale Hydrokinetic Energy Systems**

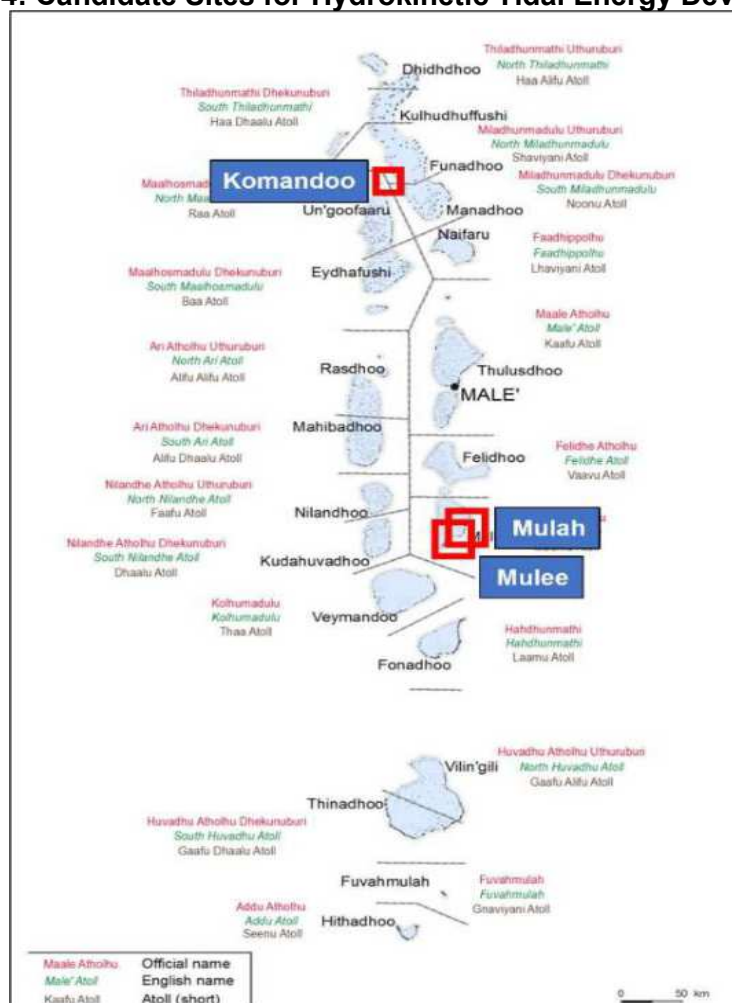


Source: Site assessment report by OceanPixel

66. **Ocean energy pilot proposed site.** Figure 14 shows the three candidate sites for further tidal current renewable energy studies for possible deployment of the pilot. Table 11 contains the relevant data for the assessment of the candidate sites.



Figure 14: Candidate Sites for Hydrokinetic Tidal Energy Development



Source: Site assessment report by OceanPixel.

Table 11: Data for the Assessment of the Candidate Sites

Parameters	Value and Units			Remarks
	Mulah	Mulee	Komandhoo	
Current Resource	~1.5 m/s at site B	~1.2 m/s	~0.5 m/s spot measurement	
Channel Width	150 m - 1 km	1.18 km	400 - 500 m	
Channel Depth	1 - 20 m	13 - 14 m	8 - 15 m	
Grid Proximity	1 km	150 - 500 m	500 m	
Lat Long Location	2°56'52.80" N, 73°35'26.35" E	2°55'59.71" N, 73°35'6.36" E	6°3'18.47" N, 73°2'56.55" E	
Marine Traffic	Low	Low	Low	
Priority for Site Measurement	1	2	3	

67. **Environmental concerns.** The three proposed sites share the concern for impacts on marine ecology and marine protected areas in the vicinity of the target areas that will need to be considered by the contractors in finalizing the island and location of the installation on that island. The islands of Mulah and Muli have island reclamation plans that may affect the pilot development. The island of Komandhoo has a major bridge construction that may be a point of concern. Marine ecology surveys to ensure seagrass and coral habitat is avoided, and consultations with the local stakeholders need to be done by MOECCT and the contractor as part of the feasibility study to address these said considerations.

### 3. Rooftop Solar Home System Supply

68. Under this component the project will supply rooftop solar home system (Figure 15) to FENAKA (state owned utility) to be installed through net metering for at least 1,000 domestic and commercial consumers. The total capacity of the rooftop solar installations will be up to 2.5 MWp. Solar home systems will be supplied to domestic and commercial consumers from islands on consumer priority basis and installed by FENAKA on the rooftops of the individual buildings/houses of the customers. The photovoltaic panels are connected to an inverter and from there to the property's incoming distribution meter. This component has minimal environmental impacts being based on existing rooftops, but occupational and community health and safety and waste management implications need to be considered.

**Figure 15: Typical Rooftop Solar Home System**



Source: [www.gogreensolar.com](http://www.gogreensolar.com)

### 4. Agricultural Intervention

69. The scope of this intervention will be determined during a feasibility study undertaken during project implementation to develop the irrigation schemes in discussion with the farmers. A consultancy firm will be engaged to do a detailed needs assessment before finalizing the scope of this intervention. However, the current anticipated scope of the physical interventions is as per Table 12. This agricultural intervention will be implemented by the energy department of MOECCT.

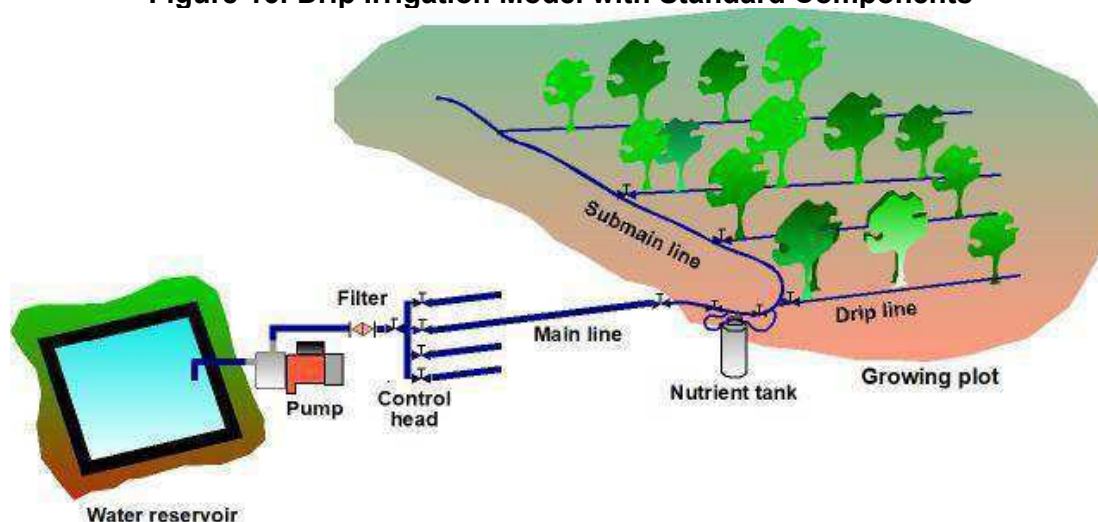
**Table 12: Details of Proposed Agricultural Intervention**

Island	Renewable Energy System	Other Physical Interventions (Connected to the Renewable Energy system)
Thoddoo	Ground mounted solar (192 kWp = 1,538 m <sup>2</sup> solar photovoltaic field) Battery Storage (626 kWh) Distribution Grid Connection: 500 m cable from solar photovoltaic site to connect to existing distribution grid.	Pumped, Drip Irrigation (using the existing groundwater source in more efficient manner to conserve both energy and water resources) = (i) water storage in tanks, (ii) pump unit, (iii) control head, (iv) main and submain lines, and (v) emitters or drippers Cold Storage Facilities (TBC) Shade Houses (TBC)

IEE = initial environment examination, kWp = kilowatt peak, kWh = kilowatt hour, m<sup>2</sup> = square meter, TBC = to be confirmed.

70. Under this component the project will deploy an efficient pressurized irrigation system to reduce water consumption in Thoddoo Island. The ground water which will be used is the current irrigation source for farmers and this intervention will help to use the ground water more efficiently. There will be no new water source developed or increase in demand. The ground water is extracted from the ground using existing high-pressure pumps (these may be replaced with more efficient pumps if required). 192 kWp of ground mounted solar photovoltaic with a 626-kWh battery storage will provide the energy to run the irrigation system. It will be connected to the island grid to offset the energy used by the irrigation system, whilst supplying any excess energy generated to the distribution grid. There is also a possibility cold storage facilities and shade houses will be provided.

71. Currently, Thoddoo Island cropping is in soil with furrow or sprinkler irrigation. Drip irrigation at Thoddoo will be implemented as a single system serving all farming plots from water storage tanks to be constructed by the project. Pressure to make drip lines operational will be provided by a pump that will be connected to the hybrid photovoltaic/battery storage system while every farmer will control their watering needs by acting the valve at the arriving pipe of their land parcel. The drip irrigation model will incorporate standard components being: i) water storage at tanks, ii). pump unit, iii) control head, iv) main and submain lines and v) emitters or drippers as shown in Figure 16.

**Figure 16: Drip Irrigation Model with Standard Components**

Source: Feasibility Study for Solar Powered Reverse Osmosis Water Desalination System for Irrigation in Thoddoo Island (North Ari Atoll) in Maldives (July 2022), IP Tech



72. The off-grid hybrid photovoltaic/battery mini-grid is designed to power the irrigation system. It consists of a 192 kWp photovoltaic power plant which will take up a space of 1,538m<sup>2</sup> hybridized with a 626 kWh Lithium-ion battery storage. The estimated annual energy production is 301.357 MWh/y. The estimated (solar) annual water production is 54,860 m<sup>3</sup>/y – from a water source already used for irrigation. The main components of the off grid photovoltaic installation are as follows with design parameters in Table 13:

- (i) **Polycrystalline solar photovoltaic panels** divided in several strings, depending on the current and voltage conditions.
- (ii) **Photovoltaic field structures** in anodized aluminum. The photovoltaic field will be ground-mounted and either totally or partially installed over a pergola using the area beneath it to locate the irrigation pumping station and the water tank (there is also potential to install rainwater harvesting to collect water from the pergola to wash the solar photovoltaic panels). The array will be less than 3 m high at its peak and will be on a fixed 20 degree angle facing due north.
- (iii) **Maximum power point tracking charge regulators** connected to a low voltage battery bank including inverters/charger installed in a small building (similar to that required for the BESS component) sited next to the solar photovoltaic panels for connection to the existing powerhouse (diesel generator).
- (iv) **Solar grid-tie inverters** connected to a 3-phase grid with high voltage battery bank, installed in the building together with the low voltage battery bank.
- (v) **Two Li-ion solar battery banks** will be provided to ensure operation without irradiation.
- (vi) **Sensors, control, and supervisory control and data acquisition** electric panels to be installed in the building housing the battery banks. The control system maximizes the operating hours using solar energy, according to the following guidelines (i) hourly operating range, (ii) batteries voltage, and (iii) energy required.

**Table 13. Design Parameters for Photovoltaic-Battery Plant**

Parameter	Value	
photovoltaic panels	468	Un. (nominal voltage)
	410	W
	2.008 x 1.002	m <sup>2</sup>
Total photovoltaic power	191.9	kWp
Total photovoltaic area	942	m <sup>2</sup> (only photovoltaic modules)
	1,538	m <sup>2</sup> (total horizontal area using the ratio 8m <sup>2</sup> /kWp)
Daily energy for loads	705.4	kWh (10 h/d operation)
Regulators	MPPT	
	250	A
	18	Un.
	5.8	kW
Inverters/charger	9	Un.
	90	kVA
Grid-tie inverters	hybrid	
	12	Un.
	120	kVA
Battery bank (low voltage)	51	Un.
	Capacity: 96	kWh
	16	kWh per module
	2x3	module
	Location: small building within solar photovoltaic site	
Battery bank (high voltage)	460	Un.
	Capacity: 530	kWh

Parameter	Value	
	22.1 2x12 Location: small building within solar photovoltaic site.	kWh per module Module configuration
Distribution Grid Connection	About 500m cables to be connected to existing grid.	

MPPT: Maximum Power Point Tracking

73. **Proposed site.** Around 1,538 m<sup>2</sup> is required for the setup of the solar photovoltaic plant. The proposed site (Figures 17 and 18) is owned by the island council. At the end of the project, the solar photovoltaic will be managed by FENAKA, but the irrigation and other facilities will be handed over to be maintained and operated by the island council.

**Figure 17: Thoddoo island (North Ari Atoll, Maldives)**



Source: Feasibility Study for Solar Powered Reverse Osmosis Water Desalination System for Irrigation in Thoddoo Island (North Ari Atoll) in Maldives (July 2022), IP Tech

**Figure 18: Location of Proposed Site for Photovoltaic and Battery Energy Storage Systems (yellow rectangle) on Thoddoo Island Map**



Source: Consultant work on Google earth map

### C. Climate Change Adaptation Considerations

74. Climate risk profile for Maldives indicates that the main impacts of climate change are expected to be high sea levels, extreme rainfalls, extreme winds, and extreme high air and water temperatures. Maldives is vulnerable to sea level rise because of its low elevation. The higher the sea level the more frequently the islands will be washed over by storms. Sea level rise would also cause coastal erosion and landmass submergence. Best estimates of long-term, systematic changes in the average climate for Maldives indicate that sea level is likely to have increased by 36 centimeters 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 climate risk and adaptation assessment (CRA) for the project has been carried out. According to the CRA, under the SSP2-4.5 scenario, the average temperature is expected to rise by 0.75°C for the period 2030s; 1.3°C for 2050s and 1.78°C for 2070s, relative to the average temperature for 1995–2014.

75. The project will need to be implemented with detailed designs resilient to climate change using compact and preassembled systems where possible that are resistant to extreme weather conditions. Table 14 provides the summary of project components, addressing greenhouse emissions and the climate change adaptations MOECCT will adopt. The incremental cost of adaptation is \$23.13 million. The climate mitigation financing for the project is \$77.35 million. CO<sub>2</sub> emission reductions due to project interventions have been estimated at 21,940 tons per year from project components.

**Table 14: Project Components Addressing Climate Change**

<b>Adaptation Activity</b>	<b>Justification for Climate Adaptation Finance</b>
BESS installed at height of 1m above the ground level	To protect the BESS in the event of flooding due to cyclones, storms, heavy rainfall events/water logging by seawater due storm surges and sea level rise.
Installing underground power distribution cables	For protection of distribution infrastructure against increased wind speeds and storminess.
Galvanization/ protective coating of acrylic sealers/ water repellent sealers of metallic structures on solar photovoltaic installations, wind turbine installations, BESS, inverters, control panels etc.	Incremental cost for additional protective corrosion resistant coating due to risk of corrosion from prolonged exposure to high humidity, high salinity sea water, etc.
Solar photovoltaic installation at least 3m from ground level	Incremental cost for increased height of base to improve airflow beneath mounting structure to reduce the temperature of the solar photovoltaic panels, increase their = efficiency and life span. If the temperature is reduced by 1° C, the output power can be increased by 0.5% and the power generation can be 10% to 15% higher than those of ground-level or rooftop solar photovoltaic panels in the same area. This also provide protection in the event of flooding due to cyclones, storms, heavy rainfall events/water logging by seawater due storm surges and sea level rise
Wind Turbine Design	Incremental cost for designing wind turbines to withstand expected increase in wind–sea wave forces thus providing protection to tower/foundations of wind turbines
Automatic weather stations (8 Nos.) and wave data sensor or wave buoy for the ocean energy pilot to inform feasibility of island locations.	These installations will allow MOECCT to capture data and accurately forecast weather conditions with respect to the feasibility of the ocean energy pilot. Weather and wave data will help in mitigating the risks associated with natural disasters for this component.
R&D, training, and capacity building support on disaster resilient practices	This support will help to understand the specific issues faced at Thoddoo Island and enable design of project components to be resilient.

Source: Adapted from CCA.

## D. Design and Construction Activities

76. Civil works (earthworks) will be required to construct foundations for the BESS and grid upgrade component, the wind energy pilot system, and the ground mounted solar photovoltaic system for the agricultural intervention. Other components will only involve mechanical and electrical installation work, no earthworks are needed. Component-wise details of activities are described in the following sections.

77. **Battery energy storage systems and energy management systems.** The BESS system will be installed within the premises of the existing powerhouses. The transportation of construction materials and equipment will be done through vessels up to the existing island wharf or jetty (or beach in the case of Raimandhoo)<sup>18</sup> and through vehicles from the jetty/beach to the project site. The pre-assembled systems will be supplied (transported by sea) directly by the suppliers. They will be installed in an existing room or small building on a concrete pad foundation with a maximum footprint of 14 m x 6 m (84 square meters [sqm]). Such buildings will be constructed on open land within the premises of the existing powerhouse on each island. It will require 2–3 weeks to construct. Flow-technology BESS will be installed in containers mounted on a concrete foundation instead of rooms/buildings on open land within the premises of the existing powerhouses in Nilandhoo and Dhidhdhoo islands. No trees will be cut down. The contractor/supplier will do the site surveys and detailed design. Local civil contractors (subcontractors) will install the foundations/buildings using cement and other materials obtained from existing authorized sources. Since these are primarily pre-assembled systems establishment of a construction site, storage area, and labor camp are not required. Some small quantities of material will be stored within the powerhouse premises. Labour will be hired locally from the islands. Construction water will be taken from the existing island council supply and existing sanitation facilities at the powerhouse used by labor. Waste generated (mostly packaging material) will be taken back by the contractor/supplier and not disposed of at the Island waste disposal site.

78. **Distribution grid upgrade.** The equipment required under this component will be supplied and installed by contractors and/or suppliers. The transportation of construction materials and equipment will be done through vessels up to the existing island wharf and/or jetty (or beach in the case of Raimandhoo) and through vehicles from the jetty to the project site. The civil work is only required for laying of underground cables along the side of the existing sandy roads and constructing a concrete platform (maximum 15 sqm) for installation of packaged substations and/or ring main units and power transformers on bare ground within the premises of the existing substations. Local civil contractors (subcontractors) will install the foundations using cement and other materials obtained from existing authorized sources. No trees will be cut down. The pre-assembled package substations/power transformers will be supplied (transported by sea) directly by the suppliers.

79. Trenching (0.5-1 meter deep and 45 cm wide) is required for underground cable laying. The work will be of short duration of about a week for each island and it is generally carried out manually by a team of 4-5 workers. No heavy machinery will be operated. Trenches on roads will be filled back and the road returned to its previous standard on the same day. Figure 19 shows the typical cable laying work being done in one of the islands under POISED project. Since these are small works, establishment of a construction site, storage area, and labor camp is not

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<sup>18</sup> There is a jetty seen in aerial photographs of Raimandhoo but this is reported to only be used for travelers and loading and unloading and is not suitable for project use; therefore, materials and equipment imported by sea will need to be transferred to smaller boats to enable landing on the beach.

required. Some small quantities of material will be stored within the powerhouse premises. Labour will be hired locally from the islands. Construction water will be taken from the existing Island council supply and existing sanitation facilities at the powerhouse used by labor. Waste generated (mostly packaging material) will be taken back by the contractor and/or supplier and not disposed of at the Island waste disposal site.

**Figure 19: Ongoing Trenching for Cable Work under POISED Project in Goidhoo Island**



Source: MOECCT

80. **Wind energy pilot system.** The key activity under this component is the supply and installation of wind turbines and batteries. The wind turbines will be supplied in sections directly to the island by the supplier (transported through sea) as will the batteries which will be installed in a small cabinet. The transportation of construction materials and equipment will be done through vessels up to the existing island wharf/jetty and through vehicles from the jetty to the project site. Civil work will be required for preparation of foundations and laying of underground cables (as per the distribution grid upgrade work) for connection to the grid. Local civil contractors (subcontractors) will install the foundations using cement and other materials obtained from existing authorized sources.

81. The process will include:

- (i) **Site establishment and preparation.** The proposed site will be demarcated first. Appropriate signs will be erected to warn the public and to identify the project, construction site and the contractor at the site. The site will be cleared by removing vegetation and cutting down the trees. The cutting of the trees will be done in consultation with the island council and only following receipt of permission under the new (2022) national regulations having demonstrated it is absolutely necessary or there is no other way than to do it and proving that it is beneficial to the society for essential needs. A temporary storage area for materials (likely the existing staff football ground area adjacent to the powerhouse) will be established. Excess bulk material will be transported and stored in this area which will also be demarcated and signed. Higher value material and small plants and equipment will be stored in secure storage within the site boundary itself. Temporary service connections for electricity and water will not be required as existing ones are available at the adjacent powerhouse and can be used. Temporary welfare (clean eating and rest



area) and administrative facilities will make use of existing facilities such as cafés and guest houses near the construction site.

- (ii) **Workforce and services.** An estimated number of around 15-20 staff including laborers, engineers and supervisors will be required to be stationed on the island. These staff will be housed in existing local accommodation, so no labor camp is required. It is not expected locals from the island will be required for the construction works. However logistical services from locals may be utilized. Food and catering will be sourced locally from existing businesses.
- (iii) **Equipment mobilization.** Mobilization of equipment including excavators (up to 30T capacity), onsite concrete mix barrel, dump truck and pile drilling equipment if necessary. Materials to be brought to site from local authorized suppliers may include sand, cement, aggregate and reinforcement bar. If drilled piles were used there may be steel casings to be imported to enable the piles to be cast. Wind tower elements including anchor base and tower steel pieces, turbine, and blades will be imported by the supplier. Heavy (25T for 25kW turbines) cranes are to be used for turbine assembly.<sup>19</sup> Figure 20 is a picture of a 25T crane required to installed 25kW turbines.

**Figure 20. Typical 25 T heavy crane**



Source: <http://www.hummacranes.com.au/humma-cranes/humma-uv25-25-25t-crane>

82. It is assumed that the current port facilities are adequate for import of the wind turbine components and cranes since the telecommunications structure in Manadhoo is successfully installed. Similarly, MOECCT engineers are of the opinion that the roads are strong enough to accommodate the oversized loads. However, whilst the port has the geometric capacity to accommodate the size of crane required; the loading capacity must be confirmed by the contractor, and it also needs to be confirmed by the contractor if the access roads are strong enough to take load. There may be some vegetation clearing requirement along the access route from the port, this would be done in consultation with the island council and only following receipt of permission under the new (2022) national regulations having demonstrated it is absolutely

<sup>19</sup> If larger wind turbines were to be installed a heavier crane will be needed e.g., 160 T for a 50 kW wind turbine and the additional impact would need to be assessed through an update of the IEE which is based on 6x25 kW wind turbines.

necessary or there is no other way than to do it and proving that it is beneficial to the society for essential needs. Figure 21 is a map of the proposed routes (green and yellow) from the harbor and port to the turbines. The areas that are not accessible (red lines) are either damaged and need repair or too narrow for the transport vehicles. Areas with yellow lines need vegetation to be cleared to gain access to the turbines.

**Figure 21: Proposed Routes from Port to Turbine Locations**



Source: Consultant work on Google earth map (OceanPixel)

- (iv) **Foundation works—gravity based.** Excavation of footing holes approximately 4.3m x 14.3m at surface battered to base 2.3m below ground surface will be undertaken. Support materials of required sizes will be installed, with the center mucked out. Excavated material (inert) will be used for landscaping or disposed of in a suitable location on the island in coordination with the Island Council as per national and local regulations. Lean mixed concrete will be placed in the base and then filled with stuffing sand to a level 2m, a reinforcement cage will be placed on top to be cast as part of the footing. Lean mixed concrete base will be poured before positioning the anchor block. A steel reinforcement cage tied in the footing inside formwork will provide the required shape of the footing. Concrete will be made on site and poured from a mobile barrel.
- (v) **Turbine assembly and installation.** Once the foundation is cured, tower elements will be delivered ready for assembly using two cranes. The turbine (nacelle) will be positioned on top of the tower and the blades added. The procedure of works for the full structure assembly, installation and erection is given below:
  - (a) Step 1 Anchor installation. Height, position adjustment using small (25T) crane or excavator.
  - (b) Step 2 Tower components unloading and temporary placement using 25T crane.

- (c) Step 3 Tower block turning and erection using 25T crane. Electrical equipment installation. Step assembly.
- (d) Step 4 Nacelle erection using 25T crane.
- (e) Step 5 Blade rotor assembly on the ground.
- (f) Step 6 Lift and placement of rotor at the nacelle using 25T crane.
- (vi) **Digging of trenches.** Trenches need to be dug for the electrical cables which run from the turbine to the control unit and inverter which will be installed in the existing powerhouse. These will be as discussed above for the distribution grid upgrade.
- (vii) **Connection to electricity grid.** An electrical engineer or electrician will connect the wind turbines DC output to the control box and then the inverter. The AC output from the inverter will be connected to the electricity supply and the electricity grid. Other electrical components such as isolators are installed for safety, and a generation meter will be placed after the inverter. The wind turbine system will be connected to the grid in coordination with the island grid operator (FENAKA).
- (viii) **Final checks.** The contractor will perform final electrical safety and performance checks before commissioning the system.

83. Construction water will be taken from the existing island council supply. Waste generated (mostly packaging material) will be taken back by the contractor/supplier and not disposed of at the island waste disposal site.

84. The implementation schedule for the wind energy pilot is 3 months following detailed design as per Table 15.

**Table 15: Implementation Schedule for the Wind Energy Pilot Project**

Tasks/Quarterly Timeframe	Year 1				Year 2				Year3			
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
<b>Pre Development Activities (6-12 months)</b>												
Site Assessment												
Resource Assessment												
Front End Engineering Design												
Detailed Engineering Design												
Permitting and Consenting												
<b>Procurement and Construction (6-12 months)</b>												
Procurement												
Installation												
Testing												
Commissioning												
<b>Pilot Project Operations and Monitoring (6-12 months)</b>												
Operations and Monitoring												

Source: Consultant work

85. **Ocean energy system.** No civil work is required under this pilot. This is a small-scale hydrokinetic (system) floating device to be anchored on the sea floor by 4-point mooring system. The tidal energy device and all system materials will be removed from the selected location after the pilot phase. The transportation of construction materials and equipment will be done through vessels up to the existing island wharf/jetty and from there moved the marine environment. Below is a list of a sample marine operations for installation of a single platform using tugboats or similar:

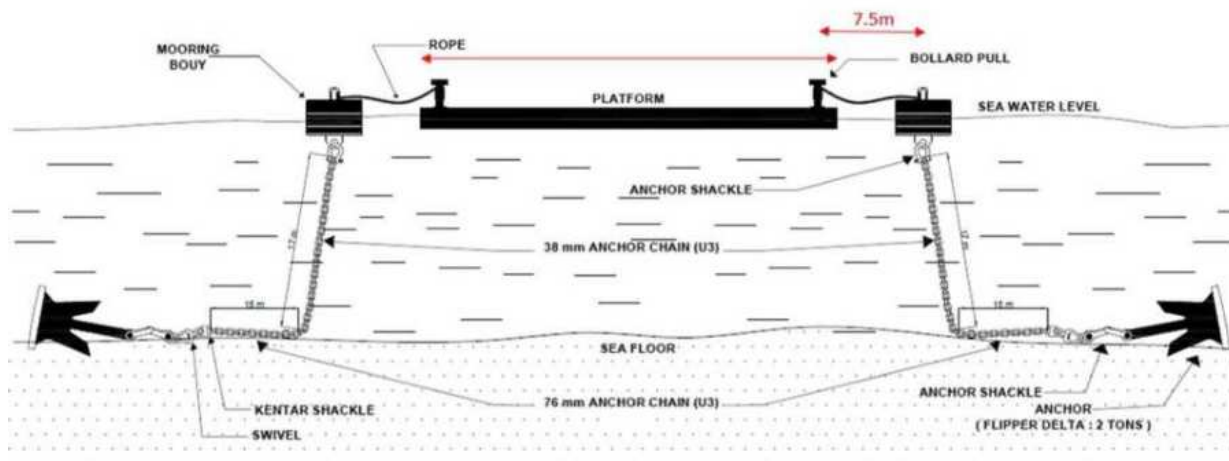
- (i) Confirm global positioning system location to place mooring blocks.
- (ii) With vessel alongside quay: 1) attach wire riser to mooring block; 2) attach the other end of wire riser to the winch wire; 3) lift the mooring block with 25T crane



- (to be imported to the island) and hang over the stern (or bow) of the vessel; 4) take the weight of the mooring block with the winch wire so the mooring block is hanging from the winch wire over the stern in the water; and 5) remove the crane.
- (iii) The vessel proceeds to the location of slack water and when it first drops position, lower the mooring block to the seabed.
  - (iv) When the mooring block is on the seabed, continue to lower the back of the slack on the riser wire.
  - (v) Disconnect the riser wire from the winch wire and attach the buoy.
  - (vi) Jettison the buoy over the side and return to the quay for the next one.
  - (vii) When all four moorings are in place and it is slack water, the vessel tows the floating platform to the middle of the moorings.
  - (viii) The line boat attaches the mooring line to the buoy and takes the other end to the barge where it is secured.
  - (ix) The process is repeated with the three other mooring lines until the floating platform is secure in the center of the mooring spread.

86. Figure 22 shows the typical example of the mooring and anchoring plan for one of four platforms that will make up the 100 kWp hydrokinetic energy system.

**Figure 22: Typical Mooring and Anchoring Plan for a 100 kWp Hydrokinetic Energy System**



Source: Site assessment report by OceanPixel

87. The contractor and/or supplier will do the site surveys and detailed design. Site surveys will involve the placement of an integrated sensor system (i.e., with devices such as Acoustic Doppler Current Profiler [ADCP], tide gauge etc.) to measure tidal currents etc. Figure 23 is an illustration of the ADCP instrument and its setup at the bottom of the ocean floor in measuring tidal current data, etc.

**Figure 23: Acoustic Doppler Current Profiler Equipment (Left) and the Arrangement of the Instruments in Measuring Tidal Current Data, etc. (right)**



Source: <https://scientificservices.eu/item/direct-reading-acoustic-doppler-current-profiler/1519>; <https://www.hydro-international.com/content/article/technology-in-focus-acoustic-doppler-current-profiler-adcp>

88. Since these are pre-assembled systems establishment of construction site, storage area, and labor camp are not required. Labour (about five to six persons—three divers and two to three boat crew) will be hired locally from the islands. Sanitation and welfare facilities at existing powerhouses will be used. Waste generated (mostly packaging material) will be taken back by the contractor/supplier and not disposed of at the island waste disposal site. The implementation schedule for the tidal current energy project is shown in Table 16. Once 100 kW capacity is installed it will be operated for one year.

**Table 16: Implementation Schedule for the Tidal Current Energy Project**

Activities and Milestones	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Alignment Meeting/Project Kick-Off												
Preliminary Site Assessment												
Site and Resource Assessment												
Permitting and Consenting												
Installation Planning, Design, and Engineering												
Procurement of Equipment: Buoys and Sensors, Turbine, Mooring System and Cables, etc.												
Local Fabrication: Platform, Frame, Other Parts												
Deployment and Installation of Equipment												
Installation of Tidal Current / Hydrokinetic Turbine System			*	*		**		***				
Testing and Commissioning												
Operations and Monitoring												
Reporting												

\*In Year 1, there is a planned deployment of a pilot system (perhaps with 1 to 2 turbine units (each with 5kW to 25kW) on a floating platform) in one of the sites identified.

\*\* In Q6, should the Year 1 pilot system need to be moved to another site (for a valid reason – e.g., bad results, major concerns arising, etc.), the Q6 activity refers to an installation of the same Year 1 pilot system to another site. If the Year 1 pilot has good results, the Q6 activity refers to a scale up (i.e., adding more capacity (another 1 to 2 turbines, each 5kW to 25kW) to the overall system) to bring it up to 100kW installation.

\*\*\* In Q8, the final set of tidal turbines will be installed

Note that this phased/progressive development approach is to address multiple objectives spanning technical aspects, training/capability development of MOECCT and FENAKA, risk management and other considerations.

Source: Consultant work

89. **Rooftop photovoltaic installation.** The transportation of construction materials and equipment will be done through vessels up to the existing island wharf/jetty (or beach) and through vehicles from the jetty to the project site. No civil works required under this component. The project will only supply photovoltaic panels for solar home systems which will be installed by FENAKA on the rooftop of existing individual buildings. Since these are small works, establishment of a construction site, storage area, and labor camp are not required. Labour will be hired locally from islands. The installation is of short duration, it takes on average 2 hours per panel for skilled workers to install. Waste generated (mostly packaging material) will be taken back by the contractor/supplier and not disposed of at island waste disposal sites.

90. **Agricultural intervention.** The civil works involved in this component included construction of footings for the ground mounted solar photovoltaic system. The proposed site will be demarcated first. Appropriate signs will be erected to warn the public and to identify the project, construction site and the contractor at the site. The site will be cleared by removing vegetation – no trees will be cut. Site preparation will involve only minor levelling and given the small scale of the installation will not change the drainage pattern. The civil works will involve earthworks and installation of the concrete foundation after which the ground mounted racking system on top of which the solar photovoltaic panels will be installed. A small building will be constructed adjacent to the batteries as per the BESS component. Cabling will be connected from the solar photovoltaic panels to the inverter and then to the distribution grid.

91. The irrigation system will also require installation of tanks, high-pressure pumps, and pipes. No trenching is involved, the pipes will be placed on the surface for easier O7M as preferred by the Island Council. Mechanical and electrical works will take place at various locations across the agricultural landscape.

92. Once the needs assessment has been completed by consultants the contractor/supplier will do the site surveys and detailed design. The transportation of construction materials and equipment will be done through vessels up to the existing island wharf/jetty and through vehicles from the jetty to the project site. Since these are small works, establishment of a construction site, storage area, and labor camp are not required. Labour will be hired locally from the island. Given the size of the agricultural intervention less than 10 people will be required for a period of 3–4 months for installation. Construction water will be taken from the existing island council supply. Waste generated (mostly packaging material) will be taken back by the contractor/supplier and not disposed at the island waste disposal site. Temporary welfare (clean eating and rest area) and administrative facilities will make use of existing facilities such as cafés and guest houses near the construction site.

## **E. Operational Phase**

93. After the commissioning of each component by the contractors and/or suppliers, all the interventions under the project will be handed over to FENAKA for operations except for the agricultural intervention where the irrigation and other facilities will be handed over to the island community after installation and after providing necessary training and capacity building for its operation and maintenance. FENAKA is the main operator in Maldives and has staff and an ESMS system in place. The ocean energy system will be decommissioned after one year and only the equipment will be handed over to FENAKA.

94. The BESS, EMS, and solar photovoltaic systems do not require regular maintenance by FENAKA, but the batteries and solar photovoltaic panels will need to be stored and disposed of at the end of life. Regular use according to supplier guidelines would ensure use of batteries to full lifetime. The lithium-ion batteries to be used in the project are estimated to have a life of 7–10 years which may go up to 15 years with advanced technology whilst the flow batteries are estimated to have a life of 20–25 years although this is currently unconfirmed as a new technology. Defunct batteries and solar panels will be stored undercover on an impermeable surface by FENAKA at the powerhouses for onward disposal in accordance with national regulations and the Basel convention. No batteries or photovoltaic panels will be disposed of at the island waste disposal sites. Batteries will be classified as hazardous waste and cannot be disposed of within the Maldives as the country does not have hazardous waste management facilities available for this. A battery disposal agreement will be signed with the BESS suppliers including decommissioning and disposal (or reuse/recycling if possible) of the batteries at the end of their lifespan. Use of photovoltaic containing hazardous metals will be avoided so that the solar photovoltaic panels will not be classified hazardous waste although they may still be shipped transboundary for disposal (or reuse/recycling purposes if possible). FENAKA will be responsible for identifying a third party for disposal of photovoltaic panels which offers the best price for the used photovoltaic panels in the future.

95. For the wind energy pilot, the wind turbines are designed for automatic operation having an automatic monitoring (Supervisory Control and Data Acquisition or SCADA) system to ensure operational reliability so that they can be run without operating personnel. Labor costs for dedicated wind turbine operating staff would be economically prohibitive but additional FENAKA staff employed on top of the existing powerhouse staff with respect to the grid upgrade works will multitask to undertake operational monitoring and for maintenance purposes such as annual checkups. A major maintenance or overhaul is needed every 5 years. Major maintenance will require external assistance from the wind turbine servicing team of the wind turbine supplier, FENAKA will need to establish a service agreement with the supplier at the end of 3 years once

the pilot has been confirmed to be successful. There will be training and capacity development activities by the contractor for FENAKA staff for undertaking operation and maintenance activities.

#### **F. Decommissioning Phase**

96. The ocean energy system will be decommissioned after the one-year pilot. After the useful life of the wind turbines and solar photovoltaic these will also be decommissioned. The lifespan of the wind turbines is 20 years and for solar photovoltaic system is 25 years. Decommissioning will involve similar activity to construction although undertaken in reverse. All waste will be removed by the contractor/supplier or FENAKA and no waste will be disposed of at the island's waste disposal sites.

97. There will be issues with disposal of batteries and solar photovoltaic panels after their useful life as discussed under the operational activities section. As part of procurement procedures for the battery suppliers, MOECCT will ensure that the supplier has an environmentally sound and safe system in place for the management and disposal of used batteries. Dismantling of the solar photovoltaic panels will be handled by contractors/suppliers of FENAKA that offer the best price for the used photovoltaic panels in the future and they will accept the decommissioned solar photovoltaic panels for recycling based on the technology installed.

#### **G. Local Infrastructure Required**

98. The local infrastructure required for the project are the roads, wharfs or jetties and the pre-existing energy grid and water supply system. The existing roads and wharfs or jetties will be needed to transport necessary materials and equipment during construction. It is estimated that maximum 2–3 trucks will be moving daily for a maximum 3–4 days (for solar photovoltaic work) up to 2–4 weeks (for wind turbines) during peak construction time in the islands. All 22 islands have wharfs/jetties (except Raiymandhoo where beach landing will be used to import materials and equipment) and project sites are accessible by existing roads from them. Therefore, the project will not require construction of any new access roads or wharfs. The renewable energy systems will be connected to the existing grid and will feed it energy with batteries to be installed as part of the project to ensure smooth transition from solar or wind to the grid. All the existing islands also have water supply systems that can be used, as well as available accommodation for the supervising engineers and staff required.

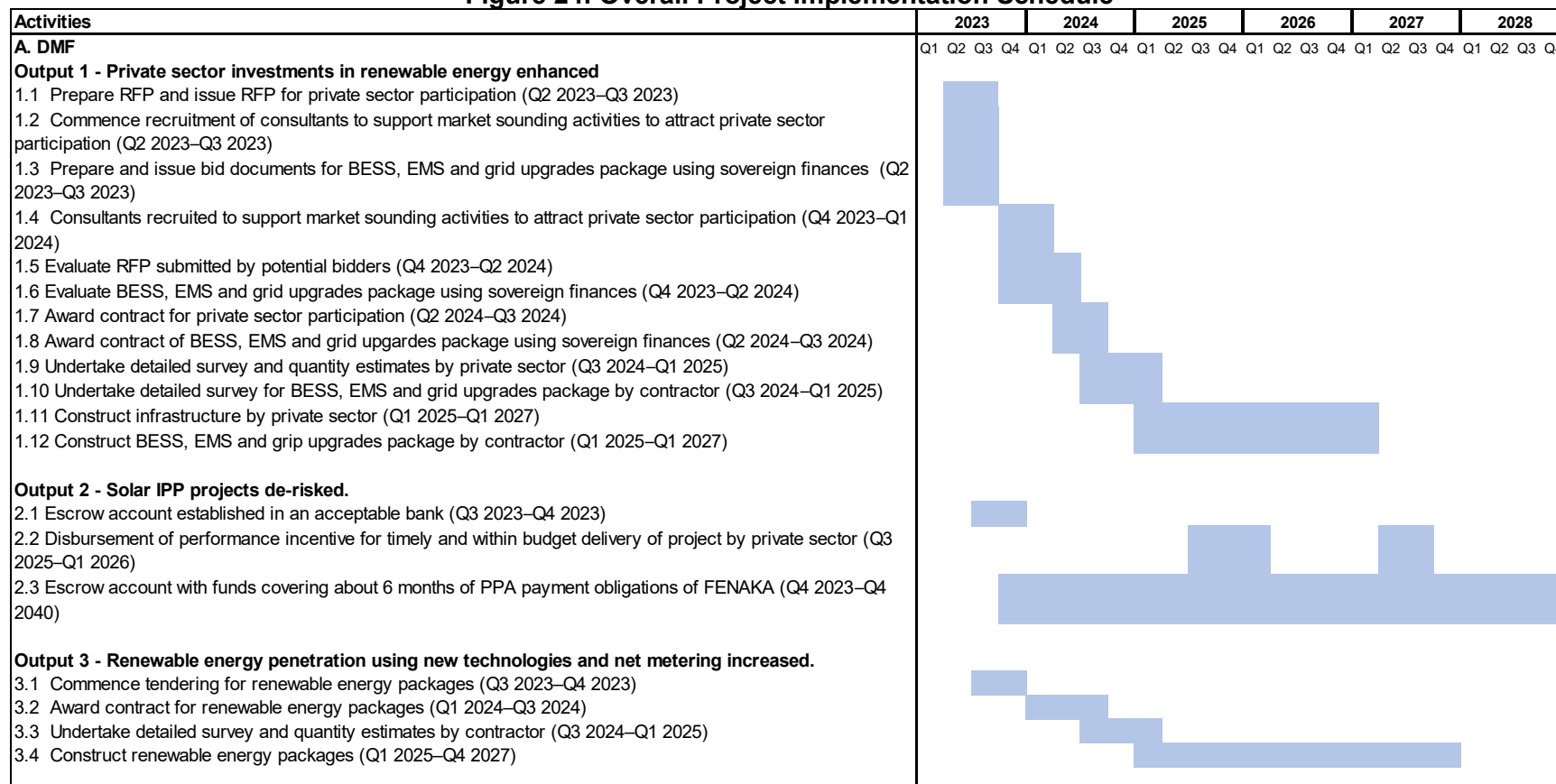
#### **H. Contract Packaging, Project Cost, Implementation Arrangement, and Schedule**

99. All the physical project components are packaged into seven works contract packages and two goods contracts as shown in Table 17. The total cost of the project is estimated at about \$100.47 million. The project is currently at bid preparation stage and the project will be for implementation over a period of 5 years (from 2023–2028) from the date of approval. Table 17 presents the component wise cost and implementation period. Figure 24 shows the overall implementation schedule of the project.

**Table 17: Component Wise Cost and Implementation Schedule**

<b>Project Component</b>	<b>Contract Packages</b>	<b>Implementing Agency</b>	<b>Cost (million USD)</b>	<b>Implementation Period (months)</b>
Battery Energy Storage Systems (BESS) and Energy Management System	(i) P-1: Battery Energy Storage Systems and its associated investments	MOECCT	38.5	24

Project Component	Contract Packages	Implementing Agency	Cost (million USD)	Implementation Period (months)
	(ii) P-2: Advanced Battery Energy Storage Systems and its associated investments for 2 islands (flow batteries)			
Distribution Grid Upgrade	(iii) G-1: Distribution network and its associated equipment for grid upgrades (goods only) (iv) W-2: Installation and commissioning of distribution grids covering 20 islands (in 3 or 4 lots depending on the solar photovoltaic installation by private sector)	MOECCT	14.5	24
Pilot Wind Energy System	(v) P-3: Wind -battery hybrid system and its associated investments	MOECCT	3	36 including O&M
Pilot Ocean Energy System	(vi) P-3: Ocean (Tidal/Wave) energy system and its associated investments	MOECCT	1.5	36 including O&M
Rooftop photovoltaic Installation	(vii) G-1: Solar photovoltaic panels, inverters, and its associated equipment for rooftop applications (goods only) (viii) W-1: Installation of rooftop solar panels to support net metering (in 3 or 4 lots depending on solar photovoltaic purchase)	MOECCT	4.5	24
Agricultural Intervention	(ix) P-4: Renewable energy-based farming system and its associated equipment	MOECCT	4.5	24

**Figure 24: Overall Project Implementation Schedule**

Source: PAM

Activities	2023	2024	2025	2026	2027	2028
<b>A. DMF</b>	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4
<b>Output 4 - Capacity of MOECCT, STELCO and FENAKA strengthened.</b>						
4.1 Commence recruitment of consultancy firms for implementation support, financial management and technical support (Q3 2023–Q4 2023)						
4.2 Prepare submission 1 for consultancy firms for implementation support, financial management and technical support (Q4 2023–Q1 2024)						
4.3 Prepare submission 2 and 3 for consultancy firms for implementation support, financial management and technical support (Q1 2024–Q2 2024)						
4.4 Award contracts for implementation support, financial management and technical support consultancy firms (Q2 2024–Q3 2024)						
<b>Output 5 - Productive use of disaster-resilient, innovative, and gender- and socially inclusive renewable energy-based farming technologies pilot tested and promoted.</b>						
5.1 Commence recruitment of consultancy firm for implementation support (Q3 2023–Q4 2023)						
5.2 Prepare submission 1 for consultancy firm for implementation support (Q4 2023–Q1 2024)						
5.3 Prepare submission 2 and 3 for consultancy firm for implementation support (Q1 2024–Q2 2024)						
5.4 Commence tendering for turnkey contract for renewable energy-based farming package (Q2 2024–Q3 2024)						
5.5 Contract Award of consultancy firm for implementation support (Q2 2024–Q3 2024)						
5.6 Award of turnkey contract for renewable energy-based farming package (Q3 2024–Q4 2024)						
5.7 Undertake detailed survey and quantity estimates by contractor (Q4 2024–Q1 2025)						
5.8 Construct renewable energy-based farming package (Q1 2025–Q1 2027)						
<b>B. Management Activities</b>						
Procurement plan key activities to procure contract packages						
Consultant selection procedures						
Environment management plan key activities						
Gender action plan key activities						
Communication strategy key activities						
Annual and/or midterm review						
Project completion report						

DMF = design and monitoring framework, BESS = battery energy storage system, EMS = energy management system, FENAKA = FENAKA Corporation Limited, PPA = power purchase agreement,

Q = quarter, RFP = request for proposal.

Source: Asian Development Bank



100. **Implementation arrangement:** The Ministry of Environment, Climate Change and Technology (MOECCT) will be the implementing agency for the project. A Project Management Unit (PMU) will be established within MOECCT with staff from MOECCT and FENAKA. This PMU will be responsible for overall intra-agency and intra-department coordination; project design and environmental assessment; bid management, project management, project implementation, safeguards supervision, monitoring and reporting; monitoring and evaluation of project outputs and results. It will provide project implementation support to the contractors. It will also be responsible for organizing training programs for building institutional capacity of FENAKA for operation and maintenance of the upgraded grids and the Island Councils where they will have responsibilities during the operational phase. A team will be established as the Project Management Consultant (PMC) to support MOECCT. The PMC will support the project implementation, PMU and conduct training and capacity building.

## I. Associated and Existing Facilities

101. **Associated facilities.** Associated facilities of an ADB project must achieve an outcome consistent with the requirements applied to the project, i.e., no significant irreversible environmental impacts, environmental assessment, planning and management, consultation and participation, grievance redress, monitoring and reporting etc. The outputs 1 and 2 of the proposed ASSURE project places an emphasis on private sector investments in floating and terrestrial solar photovoltaic systems in the outer islands. It will mobilize but not directly fund private sector investments for a total of about 20 MWp—this solar photovoltaic installation will be carried out across 20 outer islands of Maldives—by ensuring the distribution grids on 20 outer islands are ready for renewable energy penetration, as well as de-risking private sector investment through the provision of financial instruments. The details of the proposed floating and terrestrial solar plants are presented in Table 18.

**Table 18: Breakdown of Private Sector Investment Components in ASSURE Project**

Sl. No.	Atoll	Island	Ground Mounted photovoltaic (kW)	Roof top photovoltaic (kW)	Floating photovoltaic (kW)	Total photovoltaic (kW)
1	HA	Dhidhoo	1978	200	0	2178
2	HDH	Hanimaadhoo	1300	300	0	1600
3	SH	Milandhoo	813	187	0	1000
4	N	Manadhoo	1150	0	0	1150
5	N	Holhudhoo	600	0	0	600
6	N	Velidhoo	1200	0	0	1200
7	R	Alifushi	0	0	1000	1000
8	R	Hulhudhuffaar	0	0	600	600
9	B	Dharavandhoo	1000	0	0	1000
10	B	Thulaadhoo	1150	0	0	1150
11	M	Mulah	0	0	1000	1000
12	M	Muli		0	1000	1000
13	M	Raimandhoo	0	0	175	175
14	M	Veyvah	0	0	250	250
15	F	Nilandhoo	0	0	1200	1200

Sl. No.	Atoll	Island	Ground Mounted photovoltaic (kW)	Roof top photovoltaic (kW)	Floating photovoltaic (kW)	Total photovoltaic (kW)
16	TH	Guraidhoo	1000	0	0	1000
17	TH	Thimarafushi	690	360	0	1050
18	GA	Maamendhoo		0	600	600
19	GDH	Faresmaathoda	0	0	1000 (ground mounted in shallow water)	1000
20	GDH	Gahdhoo	0	0	1250	1250
		<b>Total photovoltaic (kW)</b>	<b>10881</b>	<b>1047</b>	<b>8075</b>	<b>20003</b>

Source: ADB TA Consultant

102. Given that these photovoltaic installations are not funded by the project but will be developed by the private sector as a third party to MOECCT part of delivering the overall benefits of the ASSURE project, the floating and terrestrial solar is considered as an associated facility of the project. Due diligence of the proposed floating and terrestrial solar photovoltaic plants has been carried out as part of the overall environment safeguards assessment. The complete due diligence report along with frameworks for the preparation of environmental management plans, biodiversity action plans, biodiversity offset management plans by the private sector contractor for approval by the government, to manage the potential risks is provided in Appendix 6 of this IEE Report. The associated facilities will be implemented through a PPP and the Request for Proposal requirements will include compliance with ADB's Safeguard Policy Statement (2009) and these frameworks; an environmental and social management system (ESMS) is to be adopted by government to ensure these requirements are met before the independent power producer can gain access to the financial instruments being funded by the project.

103. **Existing facilities.** The project components will be connected to the existing grid system at the powerhouses of each island. Although the work at powerhouses will only involve the installation of BESS, EMS, package substations, transformers, and connections to the existing system (no additional capacity enhancements or changes to the diesel generation sets) these are considered as existing facilities of the project. An audit of the existing facilities (powerhouses) has been carried out and corrective actions have been proposed for FENAKA implementation before the contractors are given access to the powerhouses. The audit report is provided in Appendix 7 of this IEE Report.

## J. Analysis of Alternatives

The analysis of alternatives has been carried out including the with and without project alternative, alternate locations for the project components, and alternative technologies. These are discussed in the following sections.

104. **With and without project alternative.** This alternative was analyzed, and it is found that the Republic of Maldives (and outer islands) would continue to pay heavy price for diesel import which will affect the overall economic development of the country and the islands. Implementation of the 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 a decrease in noise and smoke particles from the diesel generator sets and hence improved health conditions. Environmental benefits will be

from a reduction in emissions from diesel generator sets as well as reducing the need for diesel transport and storage and thus leaks and spills; there will also be a reduction in noise levels from diesel generator sets being currently operated. As part of capacity building local FENAKA technicians will benefit from learnings from the construction and operation of project.

105. **Alternate locations and sites.** No alternate sites were analyzed for the BESS, EMS and grid upgrade components as these components will be installed in the grounds of existing powerhouses.

106. For the pilot wind energy system, the island was first selected by assessing the wind resources available on various islands of the Maldives. This also included screening of the islands for any environmental sensitivity such as the presence of protected areas or key biodiversity areas/important bird areas. Manadhoo Island was finally selected based on these assessments. Following the selection of the island, a detailed site assessment was carried out to determine feasible sites within Manadhoo Island for wind turbines following setback and wake effect considerations.

107. Two sites were considered for placing of the wind turbines, one on the northeast side (near powerhouse) and another one on southeast (dump yard) corner as shown in Figure 25. The key limitation considered was a setback of 150 m from establishments,  $> 3x$  the hub height of all turbines, minimum distance between turbines ( $5x$  of turbine diameter). Both these sites were analyzed considering the wind speed data, the number of feasible turbines and total capacity of wind turbines at different rated turbine capacities. The turbines are considered based on capacity, diameter and manufacturers. From 10kW to 300 kW capacity turbines were analyzed for the proposed sites (Figure 25). Based on this analysis the northeast site (near powerhouse) has been selected.

108. The proposed site was further analyzed for noise and shadow effects on the community. The final selection of the wind turbine and array configuration was carried out based on noise and shadow flicker analysis (Appendix 14) with respect to wind speed and nearest receptors for different scenarios (total 4 scenarios). This identified 6 x 25 kW wind turbines could be accommodated. The final layout was further refined considering that the new (2022) national regulation requires that no trees or vegetation within 20m of the start of coastal vegetation band are permitted to be cleared and to avoid installing turbines on the beach which would be prone to erosion and/or increase downdrift erosion if erosion protection works installed. Gravity based foundations are the preferred foundation option.

**Figure 25: Alternative Sites or Technology Considered for Pilot Wind Energy Project**

Source: Site Assessment Report by OceanPixel

109. For the ocean energy pilot, the selection of the islands was primarily based on the current and wave resources assessment and screening for marine protected areas. Based on these an initial list of three priority islands (namely Mulah, Muli, and Komandoo) were selected. These islands will be further studied for technical and ecological aspects and accordingly one island will be selected for piloting the ocean energy system.

110. The site for the ground mounted solar photovoltaic under the agricultural intervention at Thoddoo Island was selected in consultation with the island council considering technical, environmental, and well as social aspects.

111. As discussed above various alternatives have been considered but the proposed selected sites were considered the best locations for the project facilities as these sites are away from environmentally sensitive areas, adjacent or near to the existing powerhouses with security and operational workforce that will reduce capital and operating costs, have easy access to the existing distribution network, have available existing facilities such as access roads etc. The land

at selected sites has low residential value given the current land use and existing power generation operations.

112. **Technology options.** Various technologies for the battery storage system (lithium-ion vs flow storage), as well as wind turbine technologies and ocean energy technologies have also been considered.

113. **Lithium-ion vs flow storage option.** Flow BESS has several advantages over lithium ion BESS as discussed earlier in this chapter. Since this is the latest technology and very few reliable suppliers are there in the market flow batteries will be piloted on two islands with the rest using lithium ion that FENAKA have experience of.

114. **Solar photovoltaic technology.** For the solar photovoltaic installation at Thoddoo, options such ground and roof-top installations were analyzed. Based on technical requirements, space availability, and environmental and social aspects, the final option of ground mounted raised on a pagoda has been selected. There are different types of solar photovoltaic panel available but given the lack of hazardous waste management facilities in Maldives the contractor will not be permitted to use panels that include heavy metals.

115. The contractors will review the potential wind turbine, ocean energy technology and agricultural intervention options and the best technologies and configurations that would meet both the technical specifications and environment safeguard requirements would be selected for government endorsement before proceeding with works. If there are any changes to the proposed components as presented in this chapter MOECCT will consult with ADB and as needed the IEE will be updated for review, clearance, and disclosure by ADB before the government allows the contractor to proceed.

#### IV. DESCRIPTION OF THE ENVIRONMENT

116. This section presents the description of the environmental baseline of the project areas. Considering the nature of the proposed works and geographical spread the environmental conditions of the overall region are presented first followed by the site-specific description of the environmental baseline the proposed locations of the project components. The baseline data has been established based on the collection and review of the secondary sources which included government publications, published reports, technical and research reports, data available at EPA and other government web sites. Primary data collected through field visits, surveys, and consultations was also used to establish the baseline environmental conditions of the project areas. The baseline was assessed for the islands where Project-funded components will be installed, it considers the footprint of the proposed sites, access to those sites, and related distribution grid works in respect of direct impacts and a wider corridor (islands and atoll) for indirect impacts notably in relation to marine ecology impacts.

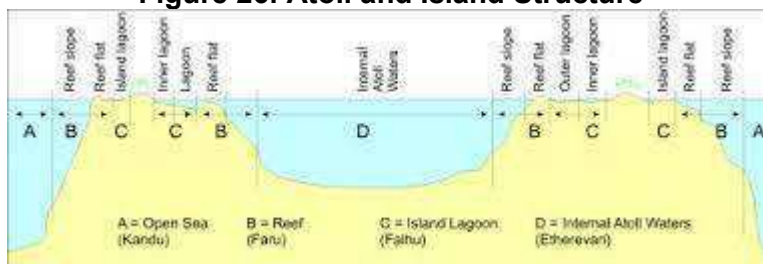
##### A. Physical Resources

##### 1. Physiography

117. Maldives is a country of South Asia, situated in the Indian Ocean, south-southwest of India. Geographically it lies between a latitude of 07°06'30" north to 00°41'48" south and between longitude of 72°32'30" east to 73°45'54" east, west side of India and Sri Lanka. In total there are assumed to be 119220 islands and islets with a combined land area estimated to be in the region of 300 sq.km. The islands are of extremely low elevation with an average of 1.8 m above mean sea level and the topography of all 22 project islands is flat.

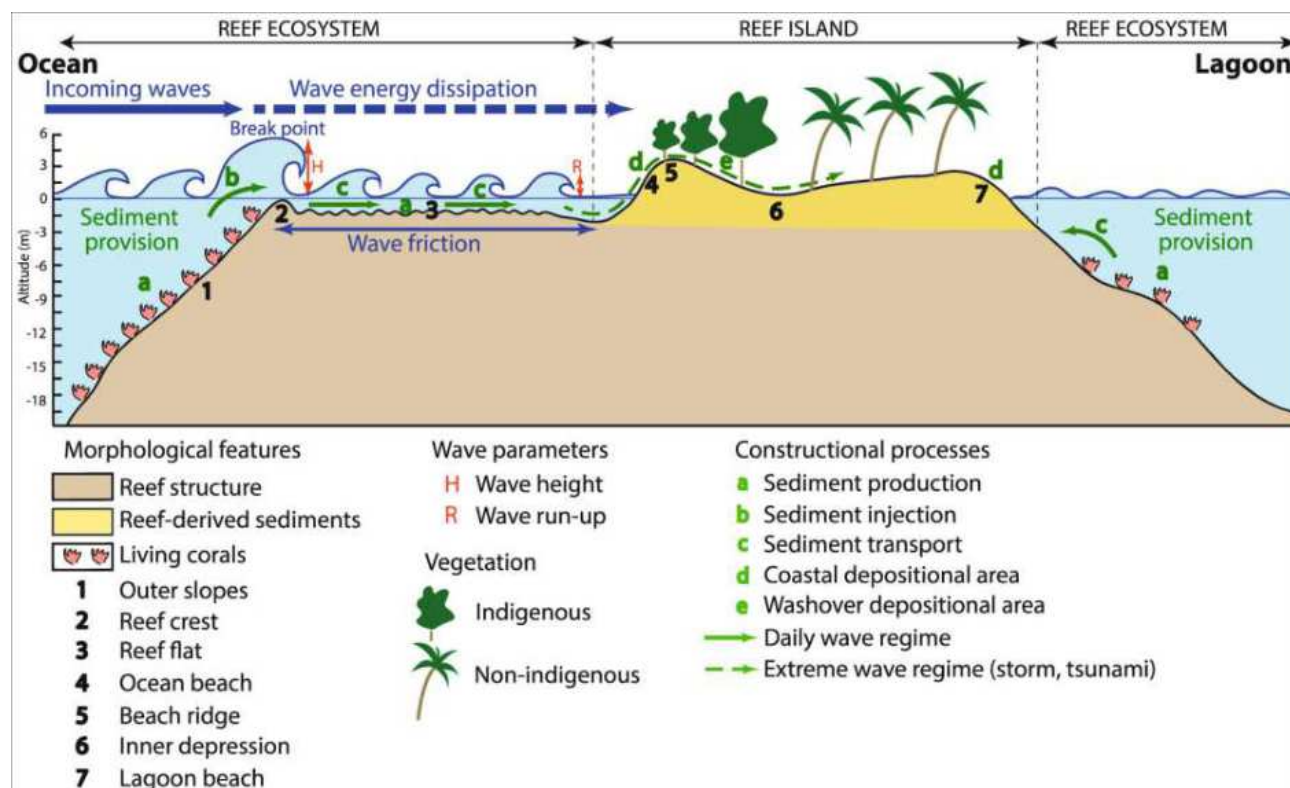
118. The Maldivian archipelago comprises an 860 km long, north-south orientated, chain of atolls forming a single chain that opens in the center to form a double-chain of up to 130 km in width. In all, there are 23 atolls and 3 solitary islands that comprise this isolated nation. Strictly speaking, in oceanographic terms, the Maldives comprises 16 atolls, 5 oceanic faros and 4 oceanic platform reefs. The atolls found here are among the largest found on earth with Thiladhunmathee-Miladhunmadulu (3,680 km<sup>2</sup>) and Huvadhu (3,200 km<sup>2</sup>) being the worlds' largest and second largest, respectively. They are only eclipsed in overall size by sunken atoll formations such as the 13,000 km<sup>2</sup>, and largely submerged, Great Chagos Bank. The basic atoll and island structure showing the key elements of reef slope, crest and flat and morphological processes are shown in Figure 26.

**Figure 26: Atoll and Island Structure**



<sup>20</sup> It varies from document to document. In some documents it is mentioned as 1,196 islands.





Source: <https://unfccc.int/resource/docs/natc/maldnc1.pdf> and Rapid human-driven undermining of atoll island capacity to adjust to ocean climate-related pressures | Scientific Reports (nature.com).

119. The islands, reefs and lagoons cover an area of around 21,000 km<sup>2</sup>, with some 4,500 km<sup>2</sup> of reefs. Of these reefs, 538 are rim and oceanic reefs, covering 3,700 km<sup>2</sup> and 1,500 are patch reefs occurring within the lagoons, covering 791.92 km<sup>2</sup>. Islands are, on average, very small—the vast majority being less the 0.5 km<sup>2</sup> in area. The largest islands include Gan (5.166 km<sup>2</sup>) on Hadhdhunmathee atoll, Hithadhoo (4.673 km<sup>2</sup>) on Addu City, Fuvahulah (4.2 km<sup>2</sup>), Isdhoo (2.937 km<sup>2</sup>) on Hadhdhunmathee atoll, Kaashidhoo (2.765 km<sup>2</sup>), Gan on Addu atoll (2.649 km<sup>2</sup>), Gan on Huvadhoo atoll (2.636 km<sup>2</sup>), Hanimaadhoo (2.595 km<sup>2</sup>) on Thiladhunmathee-Miladhunmadulu atoll, Baarah (2.488 km<sup>2</sup>) on Thiladhunmathee-Miladhunmadulu atoll and Filladhoo (2.256 km<sup>2</sup>) also on Thiladhunmathee-Miladhunmadulu atoll. Each island (a residential area surrounded by water within the administrative atoll) is governed by an island council. Due to the limited area available for development on the islands there is increased reclamation work on them which is affecting their natural physiography by changing the morphology of the system. Harbor construction also alters the morphology. Land reclamation extends longitudinal coastal structures (seawalls) to stabilize the reclaimed areas whilst harbor construction involves groin construction on downdrift shoreline sections affected by sediment depletion. The direct effects of these activities include the mechanical destruction of the reef flat, affecting sediment production, and the disruption of longshore and cross-shore sediment transport causing the complete disappearance of some geomorphic features e.g., lagoon beaches, reducing sediment injection into the island system, and altering constructional processes.<sup>21</sup>

<sup>21</sup> Rapid human-driven undermining of atoll island capacity to adjust to ocean climate-related pressures | Scientific Reports (nature.com).

120. The physical interventions proposed under the ASSURE Project are located on 22 outer islands from 12 atolls of Maldives. Table 19 presents the physiographical features of the islands that form the project area. Maps of each island showing locations of individual buildings are provided in Appendix 1.

**Table 19: Physiographical Features of the Project Islands**

No.	Atoll	Name of the island	Geographical Location	Total Land Area (km <sup>2</sup> )	Distance from Malé (km)	Distance from Nearest airport (km)	Nearest airport	Elevation (amsl)	Topography
1	Haa Alifu (HA.)	Dhidhdhoo	6° 53' 13" N 73° 6' 48" E	0.60	305	17.6	Huvarafushi	1.0 - 2.5	Plain
2	Haa Dhaalu (HDh.)	Hanimaadhoo	3° 7' 5" N 72° 59' 3" E	3.11	287.8	0	Hanimaadhoo	1.0 - 2.5	Plain
3	Shaviyani (Sh.)	Milandhoo	3° 4' 42" N 72° 57' 50" E	0.20	136.7	15.87	Funadhoo	1.0 - 2.5	Plain
4	Noonu (N.)	Manadhoo	5° 45' 56" N 73° 24' 38" E	1.1	176.3	9.74	Maafaru	1.0 - 2.5	Plain
5	Noonu (N.)	Holhudhoo	5° 45' 17" N 73° 15' 46" E	0.2	178.2	24.82	Maafaru	1.0 - 2.5	Plain
6	Noonu (N.)	Velidhoo	5° 39' 50" N 73° 16' 27" E	0.4	166.9	27.83	Maafaru	1.0 - 2.5	Plain
7	Raa (R.)	Alifushi	5° 58' 2" N 72° 57' 12" E	0.6	206.1	29.53	Ifuru	1.0 - 2.5	Plain
8	Raa (R.)	Hulhudhuffaar	5° 45' 43" N 73° 0' 44" E	0.6	184.5	6.06	Ifuru	1.0 - 2.5	Plain
9	Baa (B.)	Thulhaadhoo	5° 1' 23" N 72° 50' 23" E	0.25	119.8	35.67	Dharavandhoo	1.0 - 2.5	Plain
10	Baa (B.)	Dharavandhoo	5° 9' 28" N 73° 7' 49" E	0.54	115.6	0	Dharavandhoo	1.0 - 2.5	Plain
11	Meemu (M.)	Mulah	2° 55' 15" N 73° 34' 52" E	0.70	137.2	84.35	Kudahuvadhoo	1.0 - 2.5	Plain
12	Meemu (M.)	Muli	2° 55' 15" N 73° 34' 52" E	0.40	140.9	83.78	Kudahuvadhoo	1.0 - 2.5	Plain
13	Meemu (M.)	Raiymandhoo	2° 55' 15" N 73° 34' 52" E	0.30	121.1	95.76	Kudahuvadhoo	1.0 - 2.5	Plain
14	Meemu (M.)	Veyvah	2° 55' 15" N 73° 34' 52" E	0.40	137.4	85.69	Kudahuvadhoo	1.0 - 2.5	Plain
15	Faafu (F.)	Nilandhoo	3° 3' 21" N 72° 53' 22" E	0.60	144.3	52.60	Maamingili Airport	1.0 - 2.5	Plain
16	Thaa (Th.)	Guraidhoo	2°19'30"N 73°19'9"E	0.30	208.5	22.65	Thimarafushi	1.0 - 2.5	Plain
17	Thaa (Th.)	Thimarafushi	2°12'20"N 73°8'34"E	0.20	224.1	0	Thimarafushi	1.0 - 2.5	Plain
18	Gaafu Alifu (GA.)	Maamendhoo	0°42'50"N 73°26'21"E	0.50	385.4	2.53	Kooddoo	1.0 - 2.5	Plain
19	Gaafu Dhaalu (GDh.)	Faresmaathodaa	0°11'58"N 73°11'13"E	0.40	444.1	38.76	Kaadeddhoo	1.0 - 2.5	Plain
20	Gaafu Dhaalu (GDh.)	Gadhdhoo	0°17'20"N 73°27'21"E	0.30	433.4	7.95	Maavarulu	1.0 - 2.5	Plain



No.	Atoll	Name of the island	Geographical Location	Total Land Area (km <sup>2</sup> )	Distance from Malé (km)	Distance from Nearest airport (km)	Nearest airport	Elevation (amsl)	Topography
21	North Ari Atoll	Thoddoo	4°26'13"N 72°57'34"E	1.62	67.0	67.0	Velana	1.0 - 2.5	Plain
22	Lhaviyani Atoll	Komandoo	6° 3' 14" N 73° 3' 15" E	0.10	213.4	38.4	Ifuru	1.0 - 2.5	Plain

Source: Island Councils, Statistical Yearbook of Maldives 2016 and Maldives Energy Outlook for Inhabited Islands 2013, Ministry of Environment and Energy, Maldives, and <http://www.atollsofmaldives.gov.mv>.

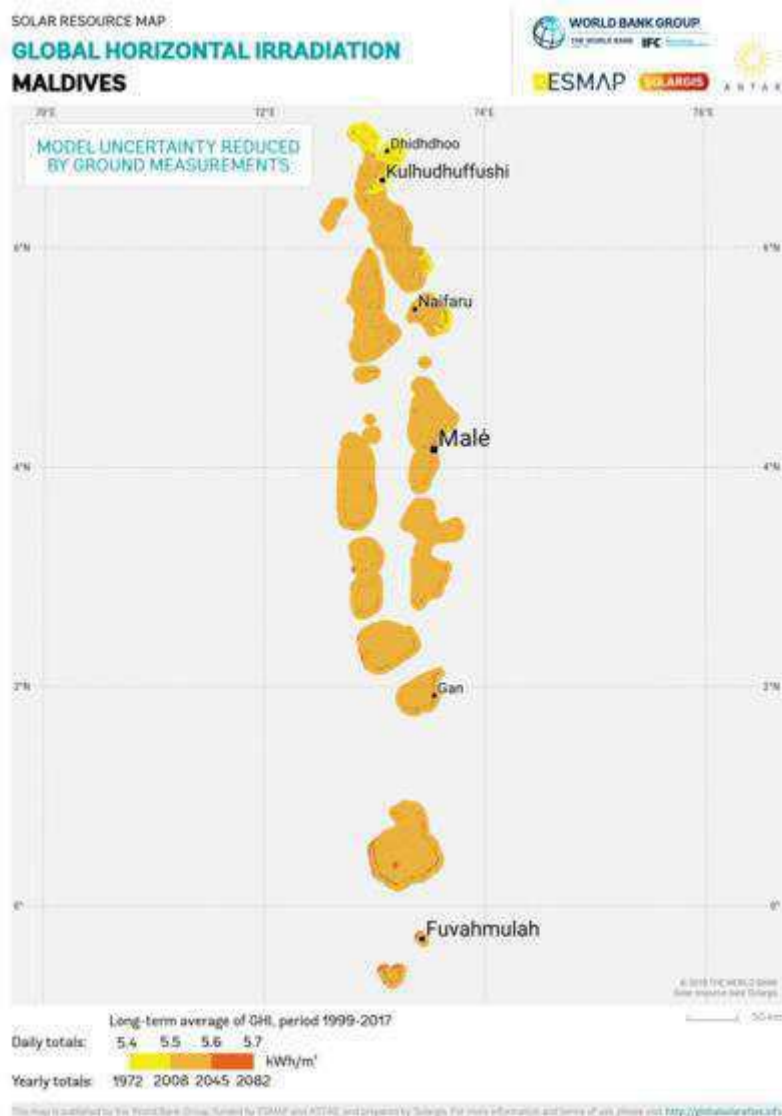
## 2. Meteorology, Climate, and Natural Hazards

121. The climate of Maldives 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 is highest in the south, where 1,924 mm may fall; the north is slightly drier with an annual rainfall of 1,786 mm. The annual rainfall averages 1,800 mm (100 in) in the north and 2,200 mm (150 in) in the south.

122. The location of 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 24°C and 33°C throughout the year. Annual average daily maximums of 30.4°C and average daily minimums of 25.9°C are typical. Although the humidity is relatively high, the constant sea breezes help to keep the air moving. Maldives undergoes seasonal reversal in wind directions with North-Easterlies prevailing from December to March and South-Westerlies prevailing from April to November on average. In the Northern most islands, the South-Westerlies last from May to October. The wind speeds peak in the Northern region is in June and in the southernmost islands is in December.

123. In relation to solar energy the solar resource (global horizontal irradiation) is shown in Figure 27.

**Figure 27: Maldives Global Horizontal Irradiation**



Source: <https://solargis.com/maps-and-gis-data/download/maldives>

124. In relation to wind energy Figures 28 and 29 show the wind resource map and average wind speeds. From a study by NREL North Maalhusmadulu, South Maalhusmadulu, North Miladhunmadulu, South Miladhunmadulu, and Faadippolhu Atolls are estimated to have the best resource in the Maldives. This level of resource is estimated to be good for small-scale applications and moderate for large-scale applications. North and south of this area the wind resource is slightly lower but still considered good for small-scale and moderate for large-scale wind applications. These areas include the North Thiladhunmathi and South Thiladhunmathi Atolls at the northern end of the Maldives, and North Ari and Malé Atolls. The wind resource gradually decreases from Malé southwards but is still considered moderate for small-scale applications and favorable locations for wind energy projects may still be found as far south as Addu Atoll. The highest wind resource in the Maldives is located where the northeast monsoon is strongest. The west monsoon weakens in the southern part of the Maldives but still is of moderate strength down to Addu Atoll. The northeast monsoon decreases rapidly in strength south of Malé and is barely present at Addu Atoll. The extreme northern part of the Maldives has a wind climate

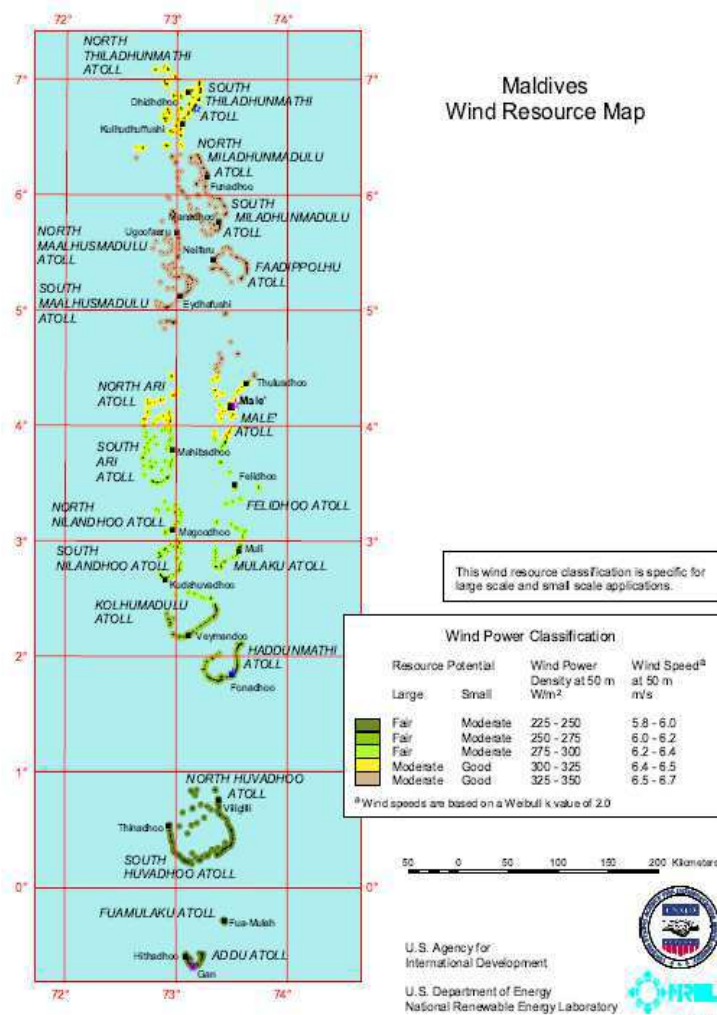
featuring a strong west monsoon from May through August and a moderate northeast monsoon from December through February. The ocean wind speeds during June, July, and August are strong with wind speeds from 6 m/s to 7.5 m/s at 10 m above the surface. The northeast monsoon is of moderate strength (4 m/s to 5 m/s) from December through February. Although the other months of the year can be considered inter-monsoon months, there is a prevailing northwest wind direction at this time. September and October have significantly stronger northwest winds than March and April. The highest resource area in the Maldives that extends from just north of Malé to the North Miladhunmadulu Atoll experiences a stronger northeast monsoon from December through February than areas to its north and south. The stronger northeast monsoon has its origins in the accelerated flow around the southern tip of India. The west monsoon lasts from May through October with November being a transition month with characteristics of both monsoon flows. The northwest winds are not as evident as they are further north, with April, September, and October having the most northwest winds. March and April are the months with the lowest winds. The northeast monsoon weakens south of the Malé area and by Addu Atoll at the southern extreme of the Maldives the prevailing direction is westerly most of the year. During December through March the winds are from the northwest replacing the northeast winds observed further north. The northwest winds also re-appear in July and August, though in some years southerly winds prevail during these months. Winds more from the due west prevail from April through June and in October and November. September is a transition month with characteristics of the westerly and northwesterly flow. The strongest winds occur during the months when the winds are most westerly.<sup>22</sup>

125. The biggest challenge for agriculture is the temperature and the high humidity. Because the temperature difference year-round, and during the day and night is small, many fruits and vegetables cannot grow so Maldives is highly dependent on imports.

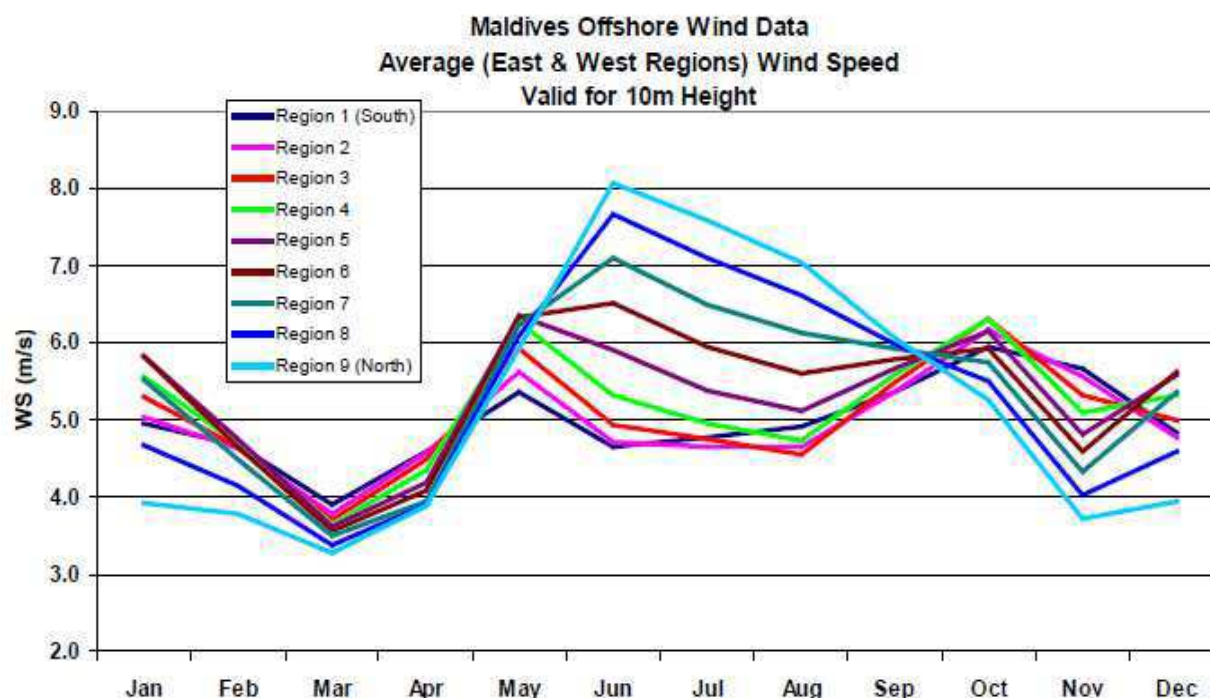
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<sup>22</sup> [https://digital.library.unt.edu/ark:/67531/metadc1411295/m2/1/high\\_res\\_d/15004471.pdf](https://digital.library.unt.edu/ark:/67531/metadc1411295/m2/1/high_res_d/15004471.pdf).

Figure 28: Maldives Wind Resource Map



Source: Wind Energy Resource Atlas of Sri Lanka and the Maldives

**Figure 29: Average Wind Speeds**

Source: [https://www.preventionweb.net/files/11145\\_MaldivesDisasterRiskProfileFinalRep.pdf](https://www.preventionweb.net/files/11145_MaldivesDisasterRiskProfileFinalRep.pdf)

126. **Extreme events.** Maldives is one of the lowest countries in the world, and hence, is greatly threatened by sea level rise, coastal storm surges, and associated flooding. In recent years, many inhabited islands in Maldives have experienced severe weather events such as strong winds, flooding, rough seas, and storm surges resulting in severe beach erosion hazards and coastal infrastructure damage. Agriculture is also affected by extreme weather events. Along with sea-level rise, local records have also indicated a long-term increase in sea surface temperatures and hourly maximum tide levels. This may greatly amplify coastal storm surge and wave-heights. The reported maximum storm surge height in Maldives is around 1.3 m which by itself is sufficient to inundate small and medium sized atolls. Wind speeds can reach over 100 km/hour during extreme weather.

127. Hydrological hazards including tsunamis, storm surges, and high waves (known locally as udha) are among the more severe natural hazards in Maldives.<sup>23</sup> According to detailed risk assessments for Maldives, tsunamis may be the most destructive natural hazard observed, with predicted maximum wave heights between 3.2 to 4.5 m over mean sea level in parts of the country, followed by swell waves and storm surges. 39 islands were significantly damaged among 200 inhabited islands and nearly a third of the Maldivian people were severely affected by the Indian Ocean Tsunami on 26 December 2004. Severe damage was caused to houses, tourist resorts, boats and other fishing equipment, schools, health facilities, transport and communication equipment, water and sanitation, and electricity infrastructure. There has also been substantial

<sup>23</sup> UNDP (2007). Detailed Island Risk Assessment in Maldives. Disaster Risk Management Programme UNDP Maldives. URL: <https://www.geonode-gfdrrlab.org/documents/827>.

damage to agricultural crops and perennial trees. Farms, homestead plots, and aquifers have become salinized.<sup>24</sup>

128. Coastal inundation associated with high waves and heavy rainfall in Maldives is often experienced during the interim period between the two monsoons that is during April and December. The swells and wind waves are typically strongest between April and July and occur more frequently in the southern regions. From 1975 to 2010, several extreme rainfall events were recorded. This includes events in Hulhule with 175.9 mm/day, Gan with 188.3 mm/day, Kadhoo with 178.2 mm/day, Hanimadhoo with 146.9 and Kadeddhoo with 219.8 mm/day. Notable floods in the year 2020 also caused damage to properties.

129. Maldives is less prone to tropical cyclones because of its location within the equatorial region of the Indian Ocean. It is outside the main area of tropical cyclones and therefore gales are uncommon, and cyclones are very rare. Only 11 cyclones crossed the islands in the span of 128 years (1877–2004) and were formed between October and January except one, which was formed in the month of April. The northern islands are occasionally affected by weak cyclones that are formed in the southern part of the Bay of Bengal and the Arabian Sea. From historical records, it is also evident that the northern region of Maldives has experienced significant tropical cyclone activity in the past. The damages caused by these cyclones have resulted in up to 18 northern islands becoming uninhabited. The northern atolls have a greater risk of cyclonic winds and storm surges. This reduces gradually to very low hazard risk in the southern atolls. The maximum probable wind speed in Zone 5 is 96.8 knots (180 kilometers per hour) and the cyclonic storm category is a lower Category 3 on Saffir–Simpson scale. At this speed, high damage is expected from wind, rain, and storm surge hazards.<sup>25</sup>

130. During the southwest monsoon season strong winds and storms may hit the archipelago and can cause severe damage. On average, it is reported that thunderstorms hit the Maldives on 23 days per year and strong winds on 12 days per year. In May 1991 tidal waves, created by violent monsoon winds, caused damage to thousands of houses, jetties, and piers, and flooded arable land with seawater.

131. Maldives is frequently affected by local thunderstorms and thunder squalls. Sometimes, storms accompanied by rainfall and high waves affect the southern parts of islands during April and December, which is the interim period between the NE and SW monsoons. Hazards associated with thunderstorms are strong winds (often exceeding 100 kmph), heavy rainfall, lightning, and hail. Maldives' close proximity to the equator makes thunderstorms quite frequent but less violent. Strong winds generated by severe local storms generate larger wind driven waves, which are hazardous to lives and infrastructure along the coast.

132. Heavy rainfall occurs during the monsoon season and during storms. Failure of monsoon leads to drought like conditions since rainwater is the major source of drinking water for many islands. Historical data shows the 219 mm rainfall a day is the highest recorded in Kadeddhoo and the country. 175 mm/day and 188.3 mm/day were extreme events recorded in Hulhule and Gan respectively. The (limited) rainfall data in Maldives suggests a standard deviation of about 16%. With low average rainfall during the dry season, numerous islands are left in a drought every year meaning they rely on desalination. The southern Maldives is less prone to drought and floods

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<sup>24</sup> Maldives tsunami impact and recovery: Joint needs assessment, World Bank-Asian Development Bank-UN System—Maldives | ReliefWeb.

<sup>25</sup> [https://www.preventionweb.net/files/11145\\_MaldivesDisasterRiskProfileFinalRep.pdf](https://www.preventionweb.net/files/11145_MaldivesDisasterRiskProfileFinalRep.pdf)

compared to northern Maldives, although frequency of flood and drought years is small (about 15% to 16% of the years).

133. **Climate change.** A climate risk profile for Maldives<sup>26</sup> 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 cm 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.

134. Based on the climate risk assessment (CRA)<sup>27</sup> carried out for the project the average temperature is expected to rise by 1.3°C for 2050s and the annual average rainfall is expected to rise by 562.7 mm for 2050s. The cyclone (hurricane or typhoon) hazard for Maldives is classified as low, meaning that there is a 1% chance of potentially damaging wind speeds for the islands in the next 10 years. The assessment also indicated an increase in sea level rise ranging from 8.2 to 9.5 cm across the various atolls for 2080s.

135. Climate change is threatening food and water security because of damages to fishery and agricultural livelihoods. Crop production already has and will likely continue to be negatively impacted by climate change because of reduced water availability and the salinization of aquifers; loss of (already limited) land through sea-level rise; heat stress on plants via higher temperatures; and changes in rainfall patterns. Climate change will negatively impact fisheries via two main mechanisms. First, warmer air and higher sea temperatures alter ocean currents, which will degrade the coral reef ecosystem, leading to loss of habitat for reef organisms and a reduction in fish population. Second, rising global sea surface temperature will impact tuna feeding grounds in the open seas and, therefore, the migratory behavior of tuna, causing decreases in tuna stocks. Food storage (emergency and long-term) is virtually absent in the atolls and limited to only Malé and nine other islands.<sup>28</sup>

### 3. Geology, Soils, and Mineral Resources

136. The geology of the Maldives formed as a hotspot which produced the Deccan Traps in India. The atolls make the foundation on which the islands of the Maldives lie. They formed upon a Laccadive-Chagos submarine ridge rising from the ocean. This ridge is as a result of sediment build up on the submerged crowns of ancient volcanic mountains. The Maldivian atolls are characterized by coral reefs encircling a lagoon. Within this enclosure, there are deep channels driving the coral rings. These channels allow a string of islands to form within the atoll rings, with each island's reef also encircling the island lagoon. The low-lying islands are formed of accumulations of biogenic material provided exclusively by the local reef platform.

137. The soils of the Maldives are geologically young and consist of substantial quantities of the unweathered 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 a lagoon environment (locally called

<sup>26</sup> Climate Risk Profile of Maldives prepared by MOECCT, 2006, and Disaster Risk Profile of Maldives prepared by UNDP, 2006.

<sup>27</sup> CRA Report for ASSURE project, 2022.

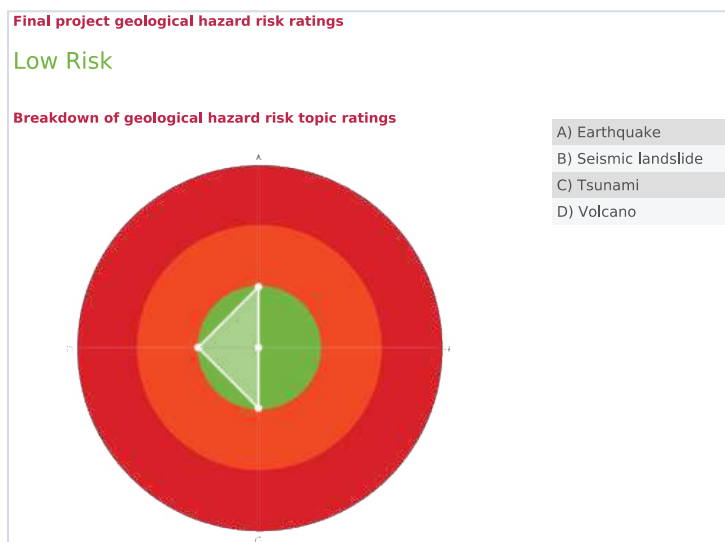
<sup>28</sup> [https://www.climatecentre.org/wp-content/uploads/RCRC\\_IFRC-Country-assessments-MALDIVES-3.pdf](https://www.climatecentre.org/wp-content/uploads/RCRC_IFRC-Country-assessments-MALDIVES-3.pdf).

kulhi) the depth of the clay may be substantial due to the accumulation of material from marine and biological sources over a long period of time. In many places, top layers of the soils have a weakly developed structure and at times a 30 cm 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.

138. Soils on islands are highly permeable. 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 lagoons, are less alkaline. The soils are generally poor and deficient in 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. The soils are generally infertile and has limited crop growing capacity. In comparison, the soil of Thoddoo island is very fertile and it is known for major producer of watermelons in Maldives and other vegetables, fruits, and spices. The size of this island means that plants can thrive away from the sea decaying to form fertile humus away from the coast.

139. Geological hazard risk screening carried out for the project summarizes that the project has low probability of geological hazards. Figures 30 to 32 show the geological hazard risk of each topic (i.e., earthquake, seismic landslide, tsunami, volcano) and its rating. However, the vulnerability is high. Except for Seenu, Gnaviyani and Gaafu atolls, earthquake hazard is low across the country. The probable maximum modified mercalli intensity is estimated between 7-8 in Zone 5. This level of modified mercalli intensity can cause moderate to high damage. Historically, Maldives has been affected by three earthquakes which had their sources in the Indian Ocean. Maldives faces tsunami threat largely from the east and relatively low threat from the north and south. So, islands along the eastern fringe are more prone to tsunami hazard than those along the northern and southern fringes. Islands along the western fringe experience a relatively low tsunami hazard. The probable maximum tsunami wave height is estimated at 4.5 m in Zone 5.<sup>29</sup>

**Figure 30: Geological Hazard Risk Rating of Project**

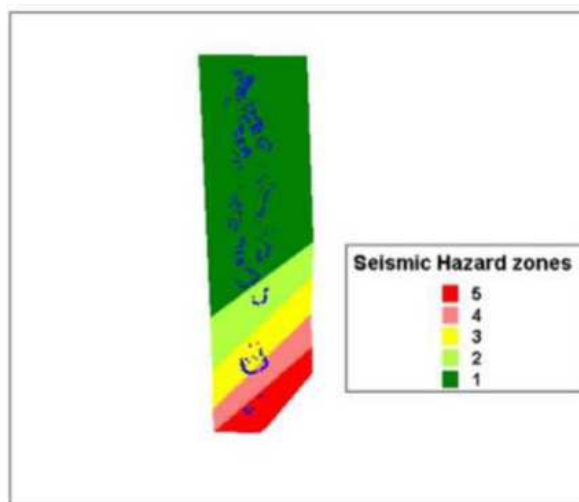


Source: AWARE for ProjectsReport

<sup>29</sup> [https://www.preventionweb.net/files/11145\\_MaldivesDisasterRiskProfileFinalRep.pdf](https://www.preventionweb.net/files/11145_MaldivesDisasterRiskProfileFinalRep.pdf).



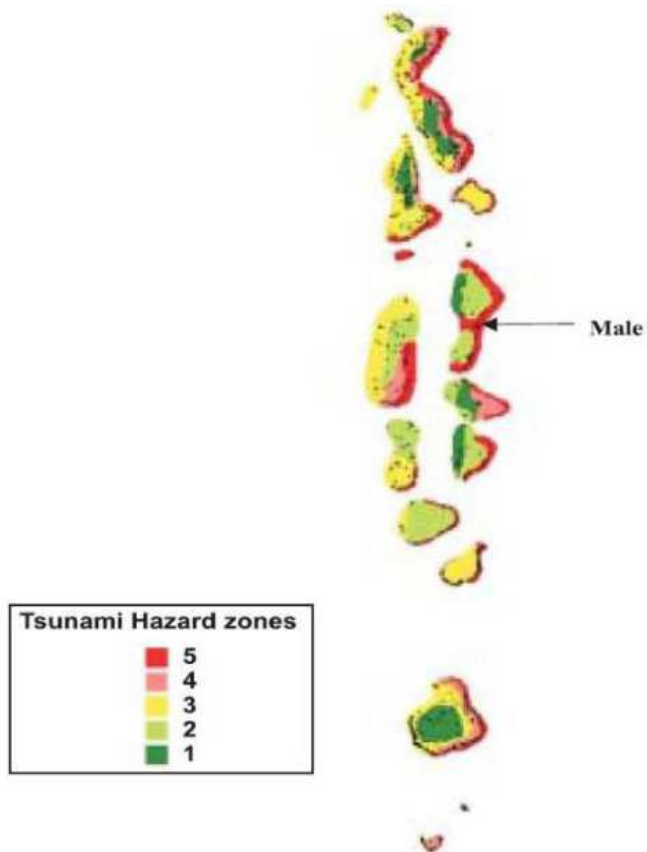
**Figure 31: Seismic Hazard Zones of Maldives**



Source:

[https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fnctr.pmel.noaa.gov%2Feducation%2FITT%2Fusgs%2Fseismic-tsunami-training-maldives%2FTsunami %26 EQ.ppt&wdOrigin=BROWSELINK](https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fnctr.pmel.noaa.gov%2Feducation%2FITT%2Fusgs%2Fseismic-tsunami-training-maldives%2FTsunami%20EQ.ppt&wdOrigin=BROWSELINK)

**Figure 32: Tsunami Hazard Zones of Maldives**



Source: [https://www.preventionweb.net/files/11145\\_MaldivesDisasterRiskProfileFinalRep.pdf](https://www.preventionweb.net/files/11145_MaldivesDisasterRiskProfileFinalRep.pdf)

#### 4. Water Resources

140. Maldives has few surface water resources and there are no rivers or streams in any of the islands of Maldives. Only a few wetlands or freshwater lakes, locally known as Kulhi exist in few islands thought to have formed when lagoons were closed due to coral growth. Of the project islands Milandhoo island is the only one to support a surface water body. The country's freshwater resources exist as groundwater 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. The country's islands are very low-lying—there is no point in the country higher than 3 m above sea level—and the water table is found at very shallow depths—usually no more than 2 m below the ground surface. In addition, the freshwater lens on each island is usually very thin. Figure 33 shows a typical aquifer of the island. The horizontal extent of aquifers is limited by the surface area and the width of islands. The vertical extent of the islands also affects the aquifer capacity. Although there is a dry season, it is not the dry season that limits the volume of freshwater in each island, as groundwater levels experience seasonal variability. The surface area of the islands limits the volume of rain intercepted and the storage capacity of the Holocene aquifer controls how much of the intercepted rainwater can be retained. Once the aquifer is full the excess rainwater then drains direct to the sea.

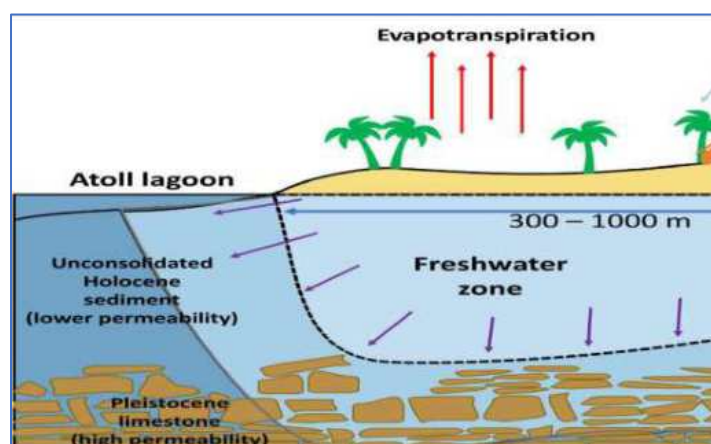
141. Outer islands depend mainly on rainwater for drinking and cooking and groundwater for most other domestic needs. Rainwater is tapped from roofs and collected and stored in various types of tanks. All the islands have individual households as well as community tanks. However, the situation is different in the capital island Malé where the whole population has access to desalinated water distributed through a piped network. In Malé it is common for people to use desalinated water for drinking as well as for domestic purposes due to high contamination of groundwater. As in Malé, many islands are now facing groundwater contamination problems caused by human activities such as over abstraction and sewage pollution. Thus, many project islands utilize desalination plants operated by the island councils or privately to supply water.<sup>30</sup> A study<sup>31</sup> of groundwater resources in terms of freshwater lens thickness, total volume of fresh groundwater, and safe yield indicated that the average current lens thickness, groundwater volume, and per capita safe yield is approximately 4.6 m, 1300 million liters, and 300 l/day, and that these values will decrease by approximately 10%, 11%, and 34%, respectively, by the year 2030. It concluded that groundwater, in terms of quantity, is a viable source of water for the islands of the Maldives both now and in coming decades, particularly for islands with large surface area and low population.

142. There are no freshwater sources on project islands. Rainwater collected in wells and tanks is being used for domestic purposes whereas bottled (desalinized) is being used for drinking purposes.

<sup>30</sup> The 14 project islands out of 23 with desalination plants are Dharavandhoo, Thulhaadhoo, Gahdhoo, Dhidhoo, Mulak, Holhudhoo, Manadhoo, Velidhoo, Hulhudhuffaaruu, Milandhoo, Guraidhoo, Hanimaadhoo, Komandhoo and Thoodoo.

<sup>31</sup> Ryan T. Bailey, Abedalrazq Khalil, Vansa Chatikavanij. 2015. Estimating Current and Future Groundwater Resources of the Maldives. *Journal of the American Water Resources Association*, 51(1), 2015-02.

**Figure 33: Typical Aquifer of the Islands**



Source: Water 2020 ([www.mdpi.com/journal/water](http://www.mdpi.com/journal/water))

## 5. Bathymetry

143. Detailed baseline of the bathymetry of the project sites with marine components is presented separately in Appendix 9.

144. The tidal regime in the Maldives is semi-diurnal and shows diurnal inequalities (i.e., each day there are two high tides and two low tides of different heights) (CUSP, 2011). The tidal range in the Maldives is relatively small at around 1 m. Tidal ranges vary on a monthly cycle with spring tides showing the maximum range and neap tides showing the minimum range. The time between successive spring tides is approximately 14 days (CUSP, 2011).

145. Currents in the Maldives are formed by the interaction of oceanic currents, tidal currents (related to the size of the tidal range) and localized wind induced currents (CUSP, 2011). Waves and local bathymetry can also influence localized current speed and direction. On a broad seascape scale, surface currents are primarily influenced by winds during the monsoon seasons (see Section 1.2 above) (Brewer et al., 2015; CUSP, 2011). The current direction switches between the monsoon seasons with east to west flows seen during the north-east monsoon (NE monsoon) and west to east flows seen during the south-west monsoon (SW monsoon). The transitional period between the two monsoon seasons is characterized by changing wind directions, and therefore, surface currents during these periods tend to be more variable (Brewer et al., 2015).

146. Waves in the Maldives are generated by the local monsoonal winds and swells from distant storms. Waves are stronger on the south-west side of islands during the SW monsoon and north-east side of islands during the NE monsoon. Waves generated by monsoonal winds are generally strongest during the south-west monsoon period. The dominant direction of ocean swells is from the south. Rinaldi et al. (2019) reported that significant wave heights vary between 0.1 and 5 m, with the most frequently occurring at 1.2 m. Depending on where islands are situated within an atoll, nearby waves may be diffracted by other islands.

## 6. Environmental Quality (Air, Noise, and Water) on Project Islands

147. There are no environmental quality monitoring stations available in the project islands. Secondary data reported in various studies (mostly previous EIA reports published on EPA

website, <https://drive.google.com/drive/folders/1zGA-ks8l85d9GEtjrpPjzXAYuxGxdwoO>), have been used in order to assess the baseline conditions of the project areas.

148. **Air quality.** Air quality is generally good as there are no industrial activities causing the emissions except powerhouses. The existing data collected from various studies is shown in Table 20 along with details of the monitoring locations. Monitoring locations are also shown on the map of the individual islands and some are provided in Appendix 10. Data are collected by agencies/consultants certified by EPA to conduct the EIA thus it is assumed that the methodologies they follow are as per EPA baseline requirements.

149. Table 20 confirms the all the air quality parameters (particulates as well as gaseous pollutants) are well within the permissible limit except for marginal exceedances of  $PM_{2.5}$  on five islands i.e., Holhudoo, Alifushi, Hulhudhuffaar, Thulhaadhoo, Dharavandhoo and larger exceedances of  $PM_{2.5}$  and  $PM_{10}$  on two islands i.e., Gahdhoo and Komandoo where the particulate concentrations are more than the WHO Air Quality guideline values of 15 and 45  $\mu g/m^3$  respectively. The larger exceedances may be due to the exhaust emission from the existing power houses which are close to the monitoring locations. Seasonality will influence particulate matter levels which will be higher in the dry season from January to March and lower in other months due to rainfall. To provide a baseline for measuring improvements in air quality because of the project, grid upgrade contractors will obtain baseline data at the powerhouses in the dry season.

**Table 20: Existing Air Quality Levels on the Project Islands (24 hours)**

Islands	Date of monitoring	Location (within Island)	Location (Coordinates)	Air Quality Levels (µg/m3)					Data Source
				SO2	NO2	CO	PM 2.5	PM 10	
1.Dhidhdhoo	09/01/21	Powerhouse	6°53'16.57"N 73°6'47.80"E	0	0	1.5	5	12	EPA (20210715_EIA for the proposed powerhouse relocation at Ha.Dhidhoo.pdf)
2.Hanimaadhoo	06/09/22	Residential Area	6.76°N 73.18°E	0	0	-	14	29	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
3.Milandhoo	06/09/22	Residential Area	6.28°N 73.25°E	0	0	-	8	14	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
4.Manadhoo	06/09/22	Residential Area	5.77°N 73.41°E	0	0	-	11	25	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
5.Holhudhoo	06/09/22	Residential Area	5.75°N 73.26°E	0	0	-	20	40	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
6.Velidhoo	06/09/22	Residential Area	5.66°N 73.27°E	0	0	-	21	40	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
7.Alifushi	06/09/22	Residential Area	5.97°N 72.95°E	0	0	-	19	30	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
8.Hulhudhuffaaruu	06/09/22	Residential Area	5.76°N 73.01°E	0	0	-	20	40	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
9.Thulhaadhoo	06/09/22	Residential Area	5.02°N 72.84°E	0	0	-	18	28	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
10.Dharavandhoo	06/09/22	Residential Area	5.16°N 73.13°E	0	0	-	17	29	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
11.Mulah	16/03/22	Island Center	2°56'50.5"N 73°35'03.3"E	0.14	0.01	0.9	10.2	16.7	EPA (20220316_EIA for the proposed Road development at M.Mulah .pdf)
12.Muli	06/09/22	Residential Area	2.92°N 73.58°E	0	0	-	14	27	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
13.Raiymandhoo		No data available		-	-	-	-	-	
14.Veyvah	06/09/22	Residential Area	2.96°N 73.6°E	0	0	-	15	25	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
15.Nilandhoo	06/09/22	Residential Area	3.06°N 72.89°E	0	0	-	14	28	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
16.Guraidhoo	06/09/22	Residential Area	2.32°N 73.32°E	0	0	-	14	27	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
17.Thimarafushi	23/9/20	School	2.2054°N 73.1429°E	0	0.01	1.47	5.8	62.2	Thimarafushi Road Asphaltting EIA 23.9.2020 (low res) - Hana Saeed

Islands	Date of monitoring	Location (within Island)	Location (Coordinates)	Air Quality Levels (µg/m3)					Data Source
				SO2	NO2	CO	PM 2.5	PM 10	
18.Maamendhoo		No data available		-	-	-	-	-	
19.Faresmaathodaa	05/09/22	Residential Area	0°12'0.00"N 73°11'24.00"E	0	0	-	11	20	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
20.Gahdhoo	26/02/22	Near Powerhouse	0°17'14.83"N 73°27'16.83"E	0.08	-	0.3	86.3	84.5	EPA (20220226_EIA for the proposed relocation of powerhouse at GDh.Gahdhoo)
21.Thoddoo Island	02/11/21	Residential Area	4°26'12.26"N 72°57'38.52"E	0	0.02	18.83	2.78	16.24	EPA (20210211_EIA for the proposed construction and operation of powerhouse in AA.Thoddoo)
22.Komandoo	13/01/22	Residential Area near powerhouse	6° 3'16.45"N 73° 3'15.45"E	0.01	-	0.4	42.1	52.1	EPA (20220113_EIA for the proposed powerhouse relocation at Sh.Komandoo.pdf)
Standards (WHO AQG Level 2021)		Standards (WHO AQG Level 2021)		40	25	4000	15	45	

- = no data available.

Source: Data was taken from the EIA reports published by EPA for various projects in each island and online data sources (<https://www.meteoblue.com/>). It is understood the data is reported on a 24-hour basis. These reports are available at [https://drive.google.com/drive/folders/1dgvjrMTlzxMzjreInE2D7aT\\_VZZjYnZM](https://drive.google.com/drive/folders/1dgvjrMTlzxMzjreInE2D7aT_VZZjYnZM) (link to EPA, Maldives website.)

150. **Noise quality.** In general waves from the sea and wind are the main source of noise on the islands. There are no industrial activities and traffic is also low on outer islands. The operation of diesel generators is the main source of noise, but this is limited to the powerhouse and surrounding areas.

151. The existing data noise collected from various studies is shown in Table 21 along with details of the monitoring locations. Monitoring locations are also shown on the map of the individual islands and some are provided in Appendix 11. Data are collected by agencies/consultants certified by EPA to conduct the EIA thus it is assumed that the methodologies they follow are as per EPA baseline requirements. Some dates of noise monitoring are not included in the EPA EIA reports, it is understood samples are taken in the daytime. Whilst maximum and minimum readings are given the averaging period over which readings were taken is unclear and so the results provided might not be directly comparable to 1-hour guideline levels.

152. Table 21 confirms general noise quality on the islands is good except for the locations of the powerhouses. The maximum noise levels on islands away from the powerhouses varies from 64 to 45 dBA (away from the powerhouse the maximum levels may be influenced by passing motorbikes etc.) whereas the minimum noise levels on island varies from 54 to 30 dBA which is in normal daytime range of 55 dBA 1-hour LAeq for ambient noise guideline of WHO. However, in and around powerhouses the noise levels are far higher than the WHO noise guideline of 70 dBA 1-hour LAeq for industrial areas and can also exceed the occupational noise exposure levels due to noise from powerhouse operations. To provide a baseline for measuring improvements in air quality because of the project, grid upgrade contractors will obtain baseline data at the powerhouses whilst the wind energy contractor will obtain noise levels from the nearest residential receptor.

**Table 21: Existing Noise Level on the Project Islands**

Islands	Date of Monitoring	Islands	Coordinates	Noise Levels (dBA)		Data Source
				Maximum	Minimum	
1.Dhidhdhoo	09/01/21	Existing powerhouse	6°53'16.57"N 73° 6'47.80"E	86	80	EPA (20210715_EIA for the proposed powerhouse relocation at Ha.Dhidhdhoo.pdf)
2.Hanimaadhoo	01/10/21	Council Office	6°45'54.57"N, 73°10'43.87"E	64	42	EPA (20211027_EIA for the Proposed Establishing a regional laboratory at Hdh.Hanimaadhoo)
3.Milandhoo	2021	On Island Road	6°17'12.95" N 73°14'49.34" E	78	54	EPA (EIA for the Proposed Road Development in Sh.Milandhoo)
4.Manadhoo	2021	Island Center	5°46'1.75"N, 73°24'43.79"E	60	53	EPA (20210921_EIA For the Establishment of Water Network in 4 Islands - HA. Kelaa HA. Baarah Sh. Funadhoo N. Manadhoo)
5.Holhudhoo	2020	Pump station 1	5°45'22.1"N 73°15'45.4"E	53	40	Final EIA report for water supplying system in Noonu Holhudhoo - Ismail Giyaas
6.Velidhoo		No data available		-	-	
7.Alifushi	05/2021	No data available		-	-	
8.Hulhudhuffaaruu	05/2021	Island Center	5°45'54.90"N 73° 0'44.30"E	45	39	EPA (20220605_EIA for the Proposed Road Development project at R.Hulhudhuffaaruu)
9.Thulhaadhoo		No data available		-	-	
10.Dharavandhoo	2021	Residential Area	5° 9'28.93"N 73° 7'57.64"E	63	41	EPA (20210629_EIA for the Proposed development of Sewerage Network at B. Dharavandhoo)
11.Mulah	2020	Island Center	2°56'57.27"N 73°34'54.39"E	60	30	EPA (20220316_EIA for the proposed Road development at M.Mulah .pdf)
12.Muli	2021	Island Center	2°55'16.71"N, 73°34'49.29"E	60	56	EPA (20210627_EIA- Establishment of Water Network in 4 Islands - M. Kolhufushi M.Muli, F.Bilehdhoo and Dh.Meedhoo)
13.Raiymandhoo	2022	Pump Station	3° 5'26.84"N 73°38'19.25"E	80.4	30	EIA for the Proposed Water and Sewerage System in M Raiymandhoo - amir musthafa



Islands	Date of Monitoring	Islands	Coordinates	Noise Levels (dBA)		Data Source
				Maximum	Minimum	
14.Veyvah	2022	Control Site	2°57'27.52 "N 73°35'59.0 0"E	50	30	EPA (20220111_EIA for the proposed Water and Sewerage Project at M. Veyvah.pdf)
15.Nilandhoo	2018	Island Center	3° 3'23.46"N 72°53'21.66"E	50	30	EIA for the Proposed Water Supply System in F Nilandhoo - Final draft.pdf
16.Guraidhoo		No data available		-	-	
17.Thimarafushi	2020	School	2°12'19.61"N 73° 8'34.61"E	72	52	Thimarafushi Road Asphaltting EIA 23.9.2020 (low res) - Hana Saeed
18.Maamendhoo	01/2021	Island Center	0°42'57.12"N, 73°26'20.44"E	56	46	EPA (20210901_EIA for the Proposed Establishment of Water Network in 4 Islands - GA. Dhaandhoo, GA. Gemanafushi, GA. Maamendhoo, GDh. Madaveli)
19.Faresmaathoda a	2021	Residential Area	0°12'6.32"N 73°11'6.61"E	46	30	EPA (20211010_EIA For the Proposed Establishment of Water and Sewerage Network in 2 Islands - GDh Faresmathoda GDh Hoadedhoo)
20.Gahdhoo	2022	Powerhouse	0°17'14.83"N 73°27'16.87"E	104.6	104.3	EPA (20220226_EIA for the proposed relocation of powerhouse at GDh.Gahdhoo)
21.Thoddoo Island	2021	Residential area close of powerhouse	4°26'12.26"N 72 57'38.52"E	60.1	59.1	EPA (20210211_EIA for the proposed construction and operation of powerhouse in AA.Thoddoo)
22.Komandoo	2022	Powerhouse	6° 3'16.06"N 73° 3'15.40"E	109	100	EPA (20220113_EIA for the proposed power house relocation at Sh.Komandoo.pdf)
WBG EHS WHO Guidelines (dBA)		Residential; institutional; educational		55 daytime, 45 nighttime 1-hour LAeq		
		Industrial; commercial		70 daytime and nighttime 1-hour LAeq		
		OHS standard		85* over 8-hours		

- = no data available.

\*\*If exceeded ear defenders must be worn

Source: Data was taken from the EIA reports published by EPA for various projects in each island. These reports are available at [https://drive.google.com/drive/folders/1dgvjrMTIzxMzjreInE2D7aT\\_VZZjYnZM](https://drive.google.com/drive/folders/1dgvjrMTIzxMzjreInE2D7aT_VZZjYnZM) (link to EPA, Maldives website.)

153. Additionally in order to know the existing noise levels at key locations on the islands, noise level monitoring (spot monitoring for a few minutes using handheld noise meters so not directly comparable to 1-hour guideline levels) has been carried out during field visits to the outer islands. The noise levels were monitored at powerhouses (inside and outside) as well as at residential areas away from but within 100m of the powerhouse at some locations. The details of the noise monitoring locations are shown in Figure 34 and provided on individual island maps (Appendix 10). Table 22 presents the noise levels in and around the powerhouses in project islands.

**Figure 34: Noise Monitoring Locations Map**



Source: Consultant Work

**Table 22: Noise Level Monitoring on the Project Islands**

Island/Location	Sampling Date and Time	Coordinates of Powerhouse	Monitored Noise Level dB(A)		
			Inside Powerhouse	Outside Powerhouse	Residential/Open Area
1.Dhidhdhoo	28/08/2021 4:12 pm	6°53'17.33" N 73°06'47.11" E	78.7	65.6	64.5
2.Hanimaadhoo	28/08/2021 4:20 pm	6°45'51.70" N 73°10'46.80" E	69.8	65.8	59
3.Milandhoo	02/11/2021 3:30 pm	6°17'12.95" N 73°14'49.34" E	88.1	72.7	45
4.Manadhoo	28/11/2021 12:55 pm	5°46'03.99" N 73°24'58.21" E	86.0	73.7	49.8
5.Holhudhoo	03/02/2022 4:10 pm	5°45'23.14" N 73°15'43.98" E	78.8	70.7	61
6.Velidhoo	04/02/2022 10:45 am	5°39'57.41" N 73°16'32.85" E	74.2	70.3	64.8
7.Alifushi	02/11/2021 3:35 pm	5°57'50.55" N 72°57'16.54" E	82.9	66.0	63
8.Hulhudhuffaar	02/11/2021 3:35 pm	5°45'55.73" N 73°00'47.92" E	76.9	72.5	61
9.Thulhaadhoo	09/09/2021 5:45 pm	5°01'14.43" N 72°50'22.89" E	81.5	68.7	46
10.Dharavandhoo	06/09/2021 3:45 pm	5°09'24.86" N 73°08'09.26" E	83	72	54
11.Mulah	12/09/2021 9:45 am	2°56'41.22" N 73°35'07.82" E	99.8	64.6	55.9
12.Muli	10/09/2021 1:45 pm	2°55'02.31" N 73°34'49.34" E	80.1	67.2	50.1
13.Raiymandhoo	14/09/2021 2:05 pm	3°05'21.44" N 73°38'19.83" E	91.0	64.5	52
14.Veyvah	14/09/2021 3:25 pm	2°57'29.20" N 73°36'05.59" E	74	63	44
15.Nilandhoo	15/09/2021 3:30 pm	3°03'33.25" N 72°53'19.95" E	72.9	66.9	61
16.Guraidhoo	27/01/2022 3:15 pm	2°19'28.72" N 73°18'56.97" E	-	73.3	44.3
17.Thimarafushi	27/01/2022 6:15 pm	2°12'10.41" N 73°08'30.42" E	79.4	72.3	50.1
18.Maamendhoo	24/10/2021 12:20 pm	0°42'43.22" N 73°26'18.37" E	77.9	65.8	43.8
19.Faresmaathodaa		No data available	-	-	-
20.Gadhdhoo		No data available	-	-	-
21.Thoddoo		No data available	-	-	-

Island/Location	Sampling Date and Time	Coordinates of Powerhouse	Monitored Noise Level dB(A)		
			Inside Powerhouse	Outside Powerhouse	Residential/Open Area
22.Komandoo		No data available	-	-	-
Guidelines (WBG EHS Guidelines)			85* over 8 hours	70 1-hr LAeq	55 day 1-hr LAeq

= no data available

\*OHS standard, if exceeded ear defenders must be worn

Source: Noise level monitoring during field visits (consultant team, 2022)

154. It can be seen from Table 22 that the noise levels inside the powerhouses were in the range of 72-99 dB(A) requiring ear defenders for OHS in several circumstances whereas outside powerhouse the noise levels are in the range of 63–73 dB(A). At residential areas the noise levels are in the range of 44–64 dB(A) which in some cases is higher than the WHO guideline value of 55 dBA 1-hour LAeq for daytime when the measurements were taken. This shows higher noise levels are observed in and around the powerhouse locations in all the islands due to diesel generator operations.

155. **Ground water quality.** There are very limited freshwater resources on the outer islands. Rainwater harvesting and water supplied by the island council (ground water after treatment) are the main sources of water on the islands. The groundwater is generally high in salinity on most of the islands.

156. The ground water quality data collected from various studies is shown presented in Table 23 along with details of the monitoring locations. Monitoring locations are also shown on the map of the individual islands and some are provided in Appendix 10. Data are collected by agencies/consultants certified by EPA to conduct EIA thus it is assumed that the methodologies they follow are as per EPA baseline requirements. Groundwater quality is compared to national drinking water standards (Chapter 2) in the absence of ambient groundwater standards.

157. Table 23 confirms that the ground water in all the islands has high salinity ranging from 0.21 ‰ at Gahdhoo island to as high as 2.81‰ at Holhudhoo island against the EPA range of 0–1 ‰ for fresh drinking water. The pH is ranging from 7.22. to 8.28 which is on the higher side but within the EPA permissible range of 6.5 to 8.5. Conductivity is also within EPA limit for most of the islands except Hanimaadhoo and Holhudhoo islands where it is higher than the EPA limit for drinking water of <1500 µS/cm. This indicates the high concentration of dissolved solid in water in these three islands. It can also be seen from Table 23 that these islands plus Dhidhdhoo, Milandhoo, and Dharavandhoo have higher concentration of total dissolved solids compared to the EPA limit of <500 mg/l.

**Table 23: Existing Ground Water Quality on the Project Islands**

Islands	Sampling date and time	Location	Coordinates	Water Quality Status						Data Source
				Physical Appearance	Temperature (°C)	Total Dissolved Solids (mg/l)	pH	Salinity (‰)	Conductivity (µS/cm)	
1.Dhidhdhoo	09/01/2021 11:00:00 AM	Existing powerhouse	6°53'16.57"N 73° 6'47.80"E	Clear with particles	22.2	735	7.77	0.72	1439	EPA (20210715_EIA for the proposed powerhouse relocation at Ha.Dhidhdhoo.pdf )
2.Hanimaadhoo	01/10/2021	Hanimaadhoo Office	6°45'54.57"N, 73°10'43.87"E	Clear with particles	24.7	33000	7.59	448.3 <sup>32</sup>	66100	EPA (20211027_EIA for the Proposed Establishing a regional laboratory at Hdh.Hanimaadhoo)
3.Milandhoo	08/2020	Island Center	6°17'12.95" N 73°14'49.34" E	Clear with particles	29.2	595	7.4	0.87	-	EPA (EIA for the Proposed Road Development in Sh.Milandhoo)
4.Manadhoo	10/03/2021 8:00:00 AM	Island Center	5°46'1.75"N, 73°24'43.79"E	Clear with particles	23.4	238	7.88	0.23	476	EPA (20210921_EIA For the Establishment of Water Network in 4 Islands - HA. Kelaa HA. Baarah Sh. Funadhoo N. Manadhoo)
5.Holhudhoo	04/09/2020 11:00:00 AM	Pump station 1	5°45'22.1"N 73°15'45.4"E	Clear with particles	21.7	2890	7.93	2.81	4360	Final EIA report for water supplying system in Noonu Holhudhoo - Ismail Giyaas
6.Velidhoo	01/2021	Island Center	5°39'38.48"N, 73°16'35.40"E	Clear with particles	29	497	7.6	0.5	996	EPA (20220127_Emp for the proposed Establishment of Island Waste and Resource Management Center (IWRMC) at N.Velidhoo)
7.Alifushi	06/2014	Island Center	5°58'4.87"N 72°57'8.40"E	Clear with particles	29	497	8	0.5	996	(EIA Report 2014) Construction and Setup of an Island Sewerage System in Alifushi Island, Raa Atoll, Maldives-1.pdf
8.Hulhudhuffaar u	26/02/2022 10:00:00 AM	Island Center	5°45'54.90"N 73° 0'44.30"E	Clear with particles	22.3	269	7.6	-	539	EPA (20220605_EIA for the Proposed Road Development project at R.Hulhudhuffaar u)
9.Thulhaadhoo		No data available		-	-	-	-	-	-	
10.Dharavandhoo	29/03/2021 3:01:00 AM	STP site	5° 9'24.54"N 73° 8'9.32"E	Clear with particles	23.5	696	7.69	0.7	.	EPA (20210629_EIA for the Proposed development of Sewerage Network at B.Dharavandhoo)

<sup>32</sup> Data excluded from analysis; it may not have been reported correctly since the optimal salinity of marine water is 32–42‰

Islands	Sampling date and time	Location	Coordinates	Water Quality Status						Data Source
				Physical Appearance	Temperature (°C)	Total Dissolved Solids (mg/l)	pH	Salinity (‰)	Conductivity (µS/cm)	
11.Mulah	05/09/2019	Island Center	2°56'57.27"N 73°34'54.39"E	Clear with particles	19.6	418	7.4	-	836	EPA (20220316_EIA for the proposed Road development at M.Mulah .pdf)
12.Muli	26/06/2021 12:00:00 PM	Island Center	2°55'16.71"N, 73°34'49.29"E	Clear with particles	23.1	223	7.61	0.41	840	EPA (20210627_EIA- Establishment of Water Network in 4 Islands - M. Kolhufushi M.Muli, F.Bilehdhoo and Dh.Meedhoo)
13.Raiymandhoo	21/09/2020 9:00:00 AM	Pump Station	3° 5'26.84"N 73°38'19.25"E	Clear with particles	22.6	260	7.67	-	520	EIA for the Proposed Water and Sewerage System in M Raiymandhoo - amir musthafa
14.Veyvah	13/11/2021 10:00:00 AM	Control Site	2°57'27.52"N, 73°35'59.00"E	Clear with particles	20.1	408	7.6	0.4	816	EPA (20220111_EIA for the proposed Water and Sewerage Project at M. Veyvah.pdf)
15.Nilandhoo	10/2018	Island Center	3° 3'23.46"N 72°53'21.66"E	Clear with particles	21	-	7.37	0.36	740	EIA for the Proposed Water Supply System in F Nilandhoo - Final draft.pdf
16.Guraidhoo	05/02/2021 3:00:00 AM	Island Center	N 02°19'31.81"; E 073°19'21.81"	Clear with particles	23.5	-	7.48	0.34	689	EPA (20210602_EMP- IWRMC at Th.Guraidhoo.pdf)
17.Thimarafushi	23/09/2020	School (Residential Area)	2°12'21.67"N 73° 8'35.24"E	Clear with particles	-	-	8.28	-	518	Thimarafushi Road Asphalting EIA 23.9.2020 (low res) - Hana Saeed
18.Maamendhoo	21/03/2021 11:30:00 AM	Island Center	0°42'57.12"N, 73°26'20.44"E	Clear with particles	23	276	7.57	0.27	552	EPA (20210901_EIA for the Proposed Establishment of Water Network in 4 Islands - GA. Dhaandhoo, GA. Gemanafushi, GA. Maamendhoo, GDh. Madaveli)
19.Faresmaathodaa	21/03/2021 2:00:00 AM	Pump Station	0°12'6.32"N 73°11'6.61"E	Clear with particles	24.5	483	7.11		967	EPA (20211010_EIA For the Proposed Establishment of Water and Sewerage Network in 2 Islands - GDh Faresmathoda GDh Hoadedhoo)
20.Gahdhoo	23/11/2021 10:00:00 AM	Existing powerhouse	0°17'14.83"N 73°27'16.87"E	Clear with particles	20.3	253	7.8	0.21	.	EPA (20220226_EIA for the proposed relocation of powerhouse at GDh.Gahdhoo)

Islands	Sampling date and time	Location	Coordinates	Water Quality Status						Data Source
				Physical Appearance	Temperature (°C)	Total Dissolved Solids (mg/l)	pH	Salinity (‰)	Conductivity (µS/cm)	
21.Thoddoo	08/10/2020 12:20:00 PM	Near powerhouse (Residential Area)	4°26'12.26"N 72°57'38.52"E	Clear with particles	23.1	283	7.36	-	567	EPA (20210211_EIA for the proposed construction and operation of powerhouse in AA.Thoddoo)
22.Komandoo	12/01/2021 8:00:00 AM	Existing powerhouse	6° 3'16.06"N 73° 3'15.40"E	Clear with particles	28.2	381	7.22	-	761	EPA (20220113_EIA for the proposed power house relocation at Sh.Komandoo.pdf)
Optimal Range (EPA)					n/a	<500	6.5-8.5	Fresh 0-1, Slightly Saline, 1-3	<1500	

Source: - = no data available. Data was taken from the EIA reports published by EPA for various projects in each island. These reports are available at [https://drive.google.com/drive/folders/1dgvjrMTIzxMzjreInE2D7aT\\_VZZjYnZM](https://drive.google.com/drive/folders/1dgvjrMTIzxMzjreInE2D7aT_VZZjYnZM) (Link to EPA, Maldives website.)

158. **Marine water quality.** A desk-top study was completed to obtain existing water and sediment quality data for each of the three islands where marine components are located for the different interventions within the overall ASSURE Project. The findings of the literature review are provided for each island in Table 24. None of the reports reviewed provided any information on how samples were collected in the field. However, based on the information available, it is assumed that a single surface water sample was taken at each site. Since data are collected by agencies/consultants certified by EPA to conduct EIA it is assumed that the methodologies they follow are as per EPA baseline requirements. Dates of marine water quality sampling are not mentioned in the EIA reports.

**Table 24: Water Quality Data for ASSURE Project Sites with Marine Components taken from Reviewed Literature**

Parameter	Island Name			Optimal Range (EPA)
	Komandoo <sup>1,2</sup>	Mulah <sup>3</sup>	Muli <sup>4</sup>	
Temperature (°C)	20.9–21.8	22.3–23.8	27.43 - 28.61	18-32 (<1 °C change)
Conductivity (µscm <sup>-1</sup> )	-	-	54290 - 54560	-
pH	8.1 – 8.2	8.14 - 8.15	8.39 – 8.86	8.0-8.3
Salinity (‰)	33.29 – 33.85	32.88 – 33.47	35.84 – 36.10	32-42
Total Suspended solids (mg l <sup>-1</sup> )	<5	<5	-	-
Total Dissolved Solids (mg l <sup>-1</sup> )	-	-	27.15 – 27.29	-
Turbidity (NTU)	<0.1 – 0.139	<0.1 – 0.191	<0.1 – 0.181	<3-5
Nitrate (mg l <sup>-1</sup> )	2.3 – 2.7	-	-	<5
Ammonia (mg l <sup>-1</sup> )	-	-	-	2-3 maximum
Phosphates (mg l <sup>-1</sup> )	0.3 – 0.48	-	-	0.005-0.02
Dissolved Oxygen (mg l <sup>-1</sup> )	-	-	1.23 – 1.68	-
Biological Oxygen Demand (mg l <sup>-1</sup> )	-	-	-	<2
Total coliforms (MPN/100 ml)	6 - 9	-	-	-
Fecal coliforms (MPN/100 ml)	-	-	-	-

- = Parameter Not Assessed During Analysis

<sup>1</sup>Data taken from MTCC (2022). Water quality samples collected for laboratory analysis at five locations in water depths of 1 m. The sample locations were near the options that have been considered for ocean pilot installation in this area.

<sup>2</sup>Data taken from Epoch Associates (2020). Water quality samples were taken at two locations at the reef edge to north and southeast of the island. Parameters analyzed only include total coliforms, nitrates, and phosphates.

<sup>3</sup>Data taken from CDE Consulting (2021). Water quality samples were collected for laboratory analysis at a total of three sites to the west, south and east of the island in nearshore shallow waters.

<sup>4</sup>Data taken from Land and Marine Environmental Resource Group (LaMer) (2014). In situ measurements were taken using a multi-parameter probe and samples for turbidity were sent for laboratory analysis. pH exceeds the optimal range and DO levels are low but due to the age of the data which may not be reflective of current conditions it is not possible to explain why this is the case.

159. The EPA “EIA Data Collection Guidelines” establish optimum water quality guidelines for the Maldives, which have been adopted from Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA) (GBRMPA, 2009) and other related references. The results of the sampling around the islands showed that at most sites parameter levels are within these optimum guidelines at the time of sampling. However, at Komandoo Island, phosphate levels were above the EPA optimum guideline value at sample locations to the north and southeast of the island. In addition to the EPA standards, another regional benchmark for comparisons of analytical results with regards to eco-toxicology and overall contamination of the marine environment are available within the WIO-Lab Project (UNEP and CSIR, 2009), which provides Environmental Quality Targets (EQTs) and Probable Effect Concentrations (PECs). EQTs represent target values for water and sediment quality parameters, which in turn, ensure that EQOs (Environmental Quality Objectives) are met. Comparison of data in Table 24 with the EQTs shows that the parameter



levels across most sites are lower. In addition, total coliform levels also suggest sewage pollution around Komandoo.

## B. Ecological Resources

### 1. Terrestrial Biodiversity—Vegetation, Forests, and Mangroves

160. The terrestrial biodiversity baseline is based on the secondary data collected through various sources<sup>33</sup> including government publications and research papers, and primary data collected through ecological surveys. Flora of Maldives is limited in diversity due to small size of the islands. Based on the database on the Maldives EPA, there are 14 terrestrial protected areas in Maldives for the conservation of flora diversity in the country. The EPA further listed that no threatened plant species are reported to be found, but as per the IUCN Red List for Maldives mangroves are still under evaluation.

161. The report on floral identification of Maldives (Adams, 1998) presents that the natural vegetation of the Maldives is tropical coastal forest. Indigenous vegetation includes a variety of root crops, fruit trees such as mangoes, breadfruit, and a variety of citrus, and native vegetables and grasses. Introduction of alien plant species and coconut and other human activities means the natural vegetation pattern of the islands have been altered over the years nationwide. According to Adams (1998) there are 583 vascular plant species, of which 323 are cultivated, 260 species are native and naturalized plants. These plants include 214 flowering plants and five ferns and over 300 species may be used in traditional medicine. Out of these native and naturalized plants fewer than 100 species can be called indigenous. The soil in the center of the islands is normally rich and the soil in the periphery is less fertile. The islands of Maldives are small, low lying and isolated with limited natural vegetation that is distributed relatively uniform following the pattern of salt tolerant bushes at the edge and larger trees and coconut palms further inland. In the settled areas of the atolls, much of the native vegetation has been cleared for coconut plantations, home gardens, villages, and commercial crops. A significant percentage of the country is now under coconut and *Panicum* grassland.

162. Native plants of the islands can be ecologically grouped into five categories of vegetation (Adams 1988 cited in P4SD, 2011). They are beach pioneers, littoral hedge, sub-littoral thicket, climax forest and mangrove and swamp forests (P4SD, 2011). Vegetation found on a natural beach is highly salt tolerant and around twenty species of plants are documented on natural beaches. The littoral hedge is the second category with roughly about ten or so common species. The most common of all are *Scaevola sericea* (magoo) and *Pemphis acidula* (kuredi). These plant species grow with numerous branches and are normally scrubby in character. The sublittoral thicket is the third category with a distinct community of small trees comprising of more salt sensitive species found behind the beaches. This area contains about twenty common species with the dominant trees being *Cordia subcordata* (kaani), *Guettarda* (uni) *Hibiscus tiliaceus* (diggaa) and *Premna obtusifolia*. The climax forest is the fourth category which comprises of mature trees. In addition to this, *Hernandia nymphaeifolia* (kandu) and *Terminalia catappa* (midhilli) are found in this area. This is the most common vegetation occurring in the islands. However, there are only a few uninhabited islands in the country with this pattern of vegetation. There are

<sup>33</sup> The sources of secondary information included EPA publications (<https://en.epa.gov.mv/publications>); Ministry of Environment, Climate Change and Technology, Republic of Maldives publications (<http://www.environment.gov.mv/v2/en/types/publications>); <https://www.maldivesbiodiversity.org/>; National Biodiversity Strategy and Action Plan 2016–2025, Maldives (MEE, 2015); Common Plant of Maldives (FAO Report, 2016); Maldives Country Report to the Convention of Biological Diversity; Valuing Biodiversity—The economic case for biodiversity conservation in the Maldives, (IUCN, 2009).

13 species of mangroves belonging to nine genera recognized by Untawale and Jagtap (1991). Associated with mangroves are six species of plants and 37 species of fungi.

163. In terms of terrestrial environment, the forest area of Maldives is 1000 ha<sup>34</sup>. The coral substance of the Maldivian islands and their salinity have resulted in the non-existence of dense forests. While thick growths of almond are restricted to larger islands; coconut palms, breadfruit, screwpines, banyan, and lesser vegetation are omnipresent. Mangroves thrive in brackish waters and inland depressions, and different species of grass and sedge grow along the shorelines. Fruits including bananas, papaya, watermelons, mangoes, pineapples, jujubes, custard apples, and lime; and vegetables like green chili, small onions, pumpkins, cucumber, tomatoes, brinjals, cabbages and gourds are cultivated. Cereals such as millet and maize; and roots and tubers like taro, yam, sweet potatoes, and cassava are also grown domestically. Tropical flowers are found in abundance, either in the wild or cultivated in gardens. *Hibiscus tiliaceus*, *Cordia subcordata*, *Thespesia populnea*, and *Calophyllum inophyllum* are among a large variety of local timber grown for domestic consumption. The casuarina (*Casuarina equisetifolia*), a large, fast-growing evergreen, is being promoted by the Ministry of Fisheries and Agriculture as good wind breakers to shelter weaker plants from the damaging effects of sea spray.

164. Mangroves are distributed in Gaafu Hithadhoo of Addu Atoll in Eedhigali Kulhi, Hoededhoo in Gaafu Dhaalu–South Huvadhoo Atoll, Baarah, Filladhoo, Nohlivaranfaru of Haa Alifu Atoll, Kulhudhiffushi of Haa Dhaalu–South Thiladhunmathee Atoll and Isdhoo, Dabedhoo and L. Hithadhoo in Laamu Atoll and Huraah in Maale Atoll. In Hoededhoo, the mangrove species *Bruguiera gymnorhiza* (Bodovaki), *Bruguiera cylindrica* (Kandoo) and *Lumnitzera racemosa* (Burevi) are distributed in an area of approximately 100 meters by 50 meters. In Hithadhoo at Seenu Atoll, the mangrove species *Lumnitzera racemosa* and *Barringtonia asiatica* occur in a dense patch along with good growth of new individuals. *Excoecaria agallocha*, *Bruguiera cylindrica* and *Ceriops tagal* are the mangrove species occurring in Baarah. In Filladhoo, *Bruguiera gymnorhiza* and *Bruguiera cylindrica* are found.

165. Three of the project islands i.e., Hanimaadhoo, Milandhoo, and Manadhoo have larger areas of mangrove vegetation. Hanimaadhoo island has mangrove area in the northern part of the island (not mapped) and Milandhoo island (Figure 35) has a wetland area (Sikundi Kulhi) which has mangrove plants species namely kandoo, randoo and thela. Manadhoo island (Figure 36) has mangrove and a Vevu (see physical cultural resources section) which are island protected areas (not in the EPA list). There are also mangrove areas for which ESA are designated on Mulah, Muli and Faresmaathodaa.

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<sup>34</sup> Estimated by Global Forest Resources Assessment of 2005. However, the Agricultural Development Master Plan (2006–2020) of the Maldives estimated the forest areas being 3716 ha.

**Figure 35: Mangrove and Wetland Area on Milandhoo Island**



Source: Ecological Survey Report (Water Solutions, January 2023)

**Figure 36: Mangrove and Vevu Area on Manadhoo Island**



Source: Ecological Survey Report (Water Solutions, January 2023)

## 2. Terrestrial Biodiversity–Fauna

166. Due to the small size of the island nation, there are limited terrestrial mammals, amphibians, and reptiles and most species are not unique to islands but are widely distributed throughout the atolls.

167. As per the latest IUCN Red List for Maldives (EPA February 2022) there are 5 species of marine reptiles (all are turtle species) and 39 species of Corals evaluated, of these 7 species of coral are vulnerable, green turtle and 5 species of coral are endangered, and hawksbill turtle and 23 species of coral are critically endangered. Maldives also reports two species of mammals and 24 fish species as being threatened.

168. There are endemic subspecies of mammals and birds and some terrestrial and marine invertebrates and marine fish that are unique to Maldives. Some birds and various marine species are migratory and/or congregatory.

169. **Mammals.** Terrestrial mammalian fauna of the Maldives is limited. There two endemic subspecies of fruit bat, a common and widespread sub-species of Indian flying fox (*Pteropus giganteus ariel*), and a sub-species of variable flying fox (*Pteropus hypomelanus maris*) with only one historic record from Addu Atoll, both these species are listed as least concern as per the IUCN Global Red List of Threatened Species, as well as endemic Maldivian garden shrews, which are locally known as hikandhi (Tupaia). With no further records since 1936 Anderson et al (2021) note that the variable flying fox could either be extinct, a vagrant or a mislabeled record. They had recorded one insectivorous vagrant bat long winged tomb bat (*Taphozous longimanus*) that travelled from India. Cats, rats, and mice have been introduced by humans, often invading the uninhabited areas of islands, and becoming pests, and it is strictly forbidden to bring domestic dogs to the Maldives.

170. **Reptiles and amphibians.** The Maldives features two species of geckos (*Hemidactylus* spp.) and two agamid lizards, including the common garden lizard or bloodsucker (*Calotes versicolor*) and the snake skin (*Lygosoma albopunctata*). Also found on the islands are the common wolf snake (*Lycodon aulicus*), a small harmless blind snake (*Ramphotyphlops braminus*), a short-headed frog (*Sphaerotheca rolandae*), and a bigger toad (*Bufo melanostictus*). All these species are listed as being of least concern as per the IUCN Global Red List of Threatened Species.

171. The Maldives is home to five of the world's seven species of sea turtles, two of which are regularly seen, namely the critically endangered (as per IUCN Global Red List) hawksbill turtle (*Eretmochelys imbricata*), and the endangered green turtle (*Chelonia mydas*). The Olive Ridley turtles (*Lepidochelys olivacea*) is globally vulnerable (nationally data deficient) are most often found in Maldivian waters after becoming trapped in drifting ghost fishing nets, while the two species more rarely spotted are the loggerhead (*Caretta caretta*) and the leatherback turtle (*Dermochelys coriacea*) which are listed as vulnerable as per the IUCN Global Red List of Threatened Species (nationally both are data deficient). The islands are important nesting sites for the green turtle, and there are conservation programs in place that protect these nesting sites and the hatchlings that emerge from them.

172. **Birds.** Due to the oceanic location of this Indian Ocean archipelago, the avifauna of the Maldives consists mainly of pelagic or seabirds. There are over 100 species of birds around the islands, 36 of which are seabirds, such as the seasonal frigate birds, and white terns. Other bird species that inhabit the marshes and island bushes include the grey heron, various species of

plovers, sandpipers, godwits, stints, and gulls, as well as swifts, doves, pigeons, sparrows, swallows, and shrikes. The national bird of the Maldives is the white-breasted waterhen (*Dhivehi kabili*) which is listed as vulnerable as per the IUCN Global Red List of Threatened Species. The near threatened bird species include Pallid Harrier, Flesh-footed Shearwater, Eurasian Curlew, Bar-tailed Godwit and Curlew Sandpiper. There are 73 bird species that are migratory birds recorded from the island country. There is one Important Bird Area, Haa Alifu Atoll, in Maldives designated for its colony of lesser noddy (a non-migratory globally least concern species) which is >1% of the global population, this species nests in mangroves on oceanic islands and forages in the surrounding atoll waters and potentially out to sea. Little Heron *Butorides striata* is a widespread species globally with numerous subspecies. In the Maldives two endemic subspecies have been identified.

173. **Invertebrates including arthropods.** Very little of the local terrestrial invertebrate fauna are documented. There are several species of land-based arthropods (an invertebrate animal with an exoskeleton (external skeleton), a segmented body, and paired jointed appendages) in the Maldives, namely centipedes, millipedes, scorpions, and spiders. There are several spider species, including the brown huntsman spider (*Heteropoda venatoria*), lynx spiders, and black widows, which are occasionally found on Hulhumalé island and Malé International Airport. No threatened species have been reported. Some of the terrestrial invertebrates are unique to Maldives.

174. **Fish.** Over 1,090 species of fish have been recorded in the Maldives, with the most diverse group of fishes being gobies (90 species), followed by wrasses and groupers with 70 and 40 species, respectively. Endangered fish species in the Maldives includes the Napoleon wrasse (*Cheilinus undulatus*), sky emperor (*Lethrinus mahsena*) and longfin mako (*Isurus paucus*). However, only the Napoleon wrasse and sky emperor are found in nearshore shallow water environments. Some endemic fish species have only ever been recorded in nearshore waters of the North Ari Atoll (*Helcogramma larvata*) and the North Malé Atoll (*Opistognathus crassus* and *Aseraggodes andersoni*). Freshwater fishes are limited in Maldives and only 7 freshwater fish species have been reported in the country.

### 3. Vegetation and Fauna on the Project Sites (Habitat Types)

175. The proposed sites for the terrestrial installations under the ASSURE project were reviewed for the presence of vegetation. Grid upgrade work will be carried out along the road/streets of the islands. Similarly, BESS and EMS will be installed within the premises of the existing power houses on government land. These locations are in already modified habitat. No vegetation/trees exist on these sites. Roof top solar photovoltaic installation will be done on individual buildings also avoiding vegetation/trees. There are two terrestrial sites where further ecological survey was required to determine habitat type and vegetation/trees present – the wind turbine site on Manadhoo Island and the site of the ground mounted solar photovoltaic in Thoddoo Island. The ecological baseline for the three potential islands for the ocean energy installation, as the only project-funded marine component, is discussed in Appendix 9.

176. **Wind turbine site on Manadhoo Island.** The site proposed for wind turbine installation on Manadhoo islands has vegetation and tree cover (Figure 8) and owned by the island council. During the site surveys an assessment of the presence of flora and fauna has been carried out by Water Solutions in December 2022. Discussion with local people and the island council has also been carried out to identify the presence of fauna on the project site. At these discussion meetings information about protected areas, ecologically sensitive areas, mangroves, wetlands,

forests, coastal fringe vegetation, and potentially threatened species occurrence was obtained by Water Solutions.

177. It can be seen from the photographs of the project site in Chapter III and below that the proposed site has vegetation and trees and from Figure 37 that three wind turbines (out of six) have dense vegetation cover. The vegetation seen on the site includes both coastal and inner vegetation plants which are commonly found in the islands of the Maldives. The trees on the site include beach plum (*Scaevola taccada*), coconut palm (*Cocos nucifera*), Indian tulip tree (*Thespesia populnea*), cordia (*Cordia subcordata*), sea hibiscus (*Hibiscus tiliaceus*), and black mangrove (*Lumnitzera racemose*). The site does not have any large or old trees that are protected under regulation. Based on the discussions with the Island Council most of the trees on this part of the site are planted by the island council under afforestation and tree planting programs. The Island Council has afforestation and tree planting programs planned, most of the trees that are being planted commonly occur. Besides these trees there are shrubs and local grasses. Table 25 presents the details of the trees that are present in and around the proposed sites for the wind turbine installations. In total there are about 24 trees over the entire area of 5900 sqm (shown as the blue and pink area) plus a black mangrove.

178. The project site is mostly modified habitat with some naturally grown vegetation along the coast. The coast where dense vegetation is present supports natural habitat, littoral hedge and sub-littoral thicket albeit disturbed. Water Solutions identified that the vegetation provides the island with protection against beach erosion. This part of the beach area has no coastal protection such as a revetment. Although there are few mangrove plants found near the coastline there are no mangrove habitats found in the turbine locations. Black mangroves in this area prevent beach erosion by stabilizing sediments with their tangled roots and should be protected. Further, under regulation section 4 clause 1 of Island Greenery and Protection of Vegetation (2022-R92) removal of coastal vegetation, notably a 20 m vegetation belt from the vegetation line of an island is prohibited.

**Table 25: Details of Trees on the Proposed Site for Wind Turbine on Manadhoo Island**

Common Name	Scientific Name/IUCN Conservation Status	Number	Approximate height*
Beach Plum	<i>Scaevola taccada</i> /not assessed	4	0.5 – 1 meter
Coconut Palm	<i>Cocos nucifera</i> /not assessed	2	3 – 5 meters
Indian Tulip Tree	<i>Thespesia populnea</i> /LC	10	3 – 5 meters
Cordia	<i>Cordia subcordata</i> /LC	6	3 – 5 meters
Sea Hibiscus	<i>Hibiscus tiliaceus</i> /LC	2	3 – 5 meters
Black Mangrove	<i>Lumnitzera racemose</i> /LC	-	1 – 3 meters

\*Technical consultants indicate that trees of this height can be retained and will not affect wind flow around the turbines and thus energy generation, trees will therefore be retained unless directly under the project footprint.

Source: Ecological survey (Dec. 2022)



**Figure 37: Photographs of Project Site for the Wind Energy Pilot**







Source: PMU and consultant field visit

179. Resident crows and one Grey Heron (*Ardea cinera*) were spotted at the project site area during the ecological survey. No other birds were encountered during the survey. Based on discussions with local communities they have not spotted nor recorded any endangered/critically endangered species in the area. However, some members from the community noted that migratory birds were seen, sometime in the past, around the proposed site. The following birds (Table 26) were seen in this area during the months previous and use it as a habitat, as reported during consultations by the local community to Water Solutions. However, there are no official records of these specific on the islands. Based on consultation with local ecologist fruit bat, the endemic subspecies of Indian flying fox (*Pteropus giganteus ariel*) is rarely reported on the island. No roosts have been reported, but the species can fly up to 150 km from its roost to forage at night on fruit trees. The terrestrial habitat is not critical habitat for any threatened species although there is potential that the beach habitat may support nesting turtles – marine and coastal habitat in the Maldives is determined to be critical habitat for green and hawksbill turtle (Appendix 6) thus the beach area must be avoided.

**Table 26: Details of Migratory Birds and Bats Reported on Manadhoo Island**

Dhivehi Name	Common Name	Scientific Name/IUCN Conservation Status
Raabon'di	Black-crowned Night Heron	<i>Nycticorax nycticorax</i> / LC
Rathafai	Ruddy Turnstone	<i>Arenaria interpres</i> / LC
Iruvaahudh	Cattle Egret	<i>Bubulcus ibis</i> / LC
Bulhithun'bi	Whimbrel	<i>Numenius phaeopus</i> / LC
Indian flying fox	Indian flying fox	<i>Pteropus giganteus ariel</i> / LC (endemic subspecies)

Source: Ecological survey (December 2022)



180. **Solar photovoltaic site on Thoddoo Island.** The site proposed for ground mounted solar photovoltaic on Thoddoo island is agriculture land (Figure 38) and so a modified habitat. There is no natural vegetation present on the site. It is farmland without any trees or shrubs on the selected plot. Currently the site contains grass and pumpkin vines (*Cucurbita* sp). The trees and shrubs seen in the photographs are on the boundary of the plot planted to separate the agriculture plots (and thus will not be disturbed) and are locally grown plant species. During the site visit no birds were spotted on the proposed site and consultations raised no ecological interest. Terrestrial habitat is not critical habitat for any threatened species.

**Figure 38: Site Location and Vegetation/Crops at Proposed Site for Ground Mounted Solar Photovoltaic on Thoddoo Island (Before and After Cropping Activities)**







Source: PMU and consultant field visit

181. **Ecosystem services.** For Maldives, the natural resource base and the biological diversity of the ecosystems form the basis of its economic prosperity. Terrestrial ecosystems provide products and services that underpin people's well-being, such as the role they play in the provision of food security, livelihoods, and health. These contributions to human wellbeing are made both directly through the products (provisioning services such as through forest produces, tourism, medicine, and fuel etc.) provided by terrestrial ecosystems, as well as indirectly through the variety of life support and production support functions they generate (regulating and supporting services such as forestry etc.), and their intrinsic worth (or existence value) to people (cultural, spiritual, aesthetic services). Forest and mangrove resources such as wood, fruits and other extractables from parts of plants have been harvested for centuries in the Maldives. The terrestrial ecosystem services are very limited in the project islands.

### C. Marine Biodiversity

182. Detailed baseline of the marine biodiversity of the marine project sites is presented in Appendix 9.

183. The seascape of the Maldives is home to a rich diversity of marine biodiversity. Habitats of conservation note include coral reefs, seagrass beds and mangroves in bays and on the fringes of islands. These habitats in turn are home to a wide array of marine fauna. The outer edges of reef systems form reef slopes that are dominated by corals. Inshore of these reef slopes lie the reef flats where there is a mosaic of habitats, including patches of live coral, sand, rubble, and in numerous places, seagrass meadows. The local habitat mixes in these reef flat areas vary across islands and atolls. Mangrove habitat is more spatially limited in extent across the seascape. Coral reef systems form the dominant marine habitat in nearshore shallow waters in the Maldives. Significant declines in live coral reef are recorded in the Maldives with the 2015–2016 el niño event resulting in widespread bleaching.

184. Within the reef systems of the Maldives, the CBD (2017) reported that in the Maldives there are 258 species of hermatypic corals and 36 species of sponges. In some places, the Endangered coral reef species *Acropora rudis* has been recorded although the distribution of this species across the Maldives is unknown. Altogether there are 285 species of algae, 400 species of molluscs and 350 species of crustaceans and 80 species of echinoderms in these systems (CBD, 2017) (including the Endangered Prickly redfish (*Thelenota ananas*), Golden sandfish (*Holothuria lessoni*) and Black teatfish (*Holothuria nobilis*)). Corals reefs provide food for the Critically Endangered (and migratory/ congregatory) hawksbill turtle (*Eretmochelys imbricata*). Coral reefs also provide important habitat for Endangered species, including the ornate eagle ray (*Aetomylaeus vespertilio*) and Napoleon wrasse (*Cheilinus undulatus*). The reef areas also provide habitat for other migratory and congregatory species, including four species of sea turtles, whale shark and reef manta ray.

### D. Critical Habitats–Terrestrial and Marine Ecosystems

185. The presence of critically endangered, endangered, and vulnerable species in 50 km of each island has been screened using Integrated Biodiversity Assessment Tool (IBAT) tool. A summary of the IBAT screening results for each island is presented in Table 27. IBAT data lists approximately 1500 species in the project area, which includes 100 species listed in the globally threatened categories of Critically Endangered; Endangered; Vulnerable and about 1400 species of near threatened, least concern and data deficient (or non-threatened species). Informed by IBAT critical habitat assessment for the terrestrial ecosystems on all 21 islands with terrestrial components has been carried out for the project area as detailed in Appendix 6. Separately a

critical habitat assessment for the marine ecosystems has been carried out as detailed in Appendix 6 with the addition of a critical habitat screening for Komandoo Island (ocean energy) in Appendix 9 for the project-funded components.

186. Key findings are that all the islands support marine critical habitat with the Area of Analysis at seascape level, for the project funded components this is only of to the ocean energy component as discussed further in Appendix 9. In respect of coastal habitat, marine mangrove and hawksbill turtle (*Eretmochelys imbricata*) trigger critical habitat, this may be affected by the wind and ocean energy components. For the former, encroachment on the beach habitat will be prohibited, whilst the latter is discussed further in Appendix 9. Inland mangrove and wetland habitat is also determined to be terrestrial critical habitat trigger with the Area of Analysis at island level, this is present in at least six islands (Hanomaadhoo, Milandhoo, Manadhoo, Mulah, Muli, and Faresmaathoda) and must be protected from development, but the project footprint does not encroach it.

187. Northern/Southern Maldivian Little Heron (*Butorides striata didii/albidula*) also trigger terrestrial critical habitat with the Area of Analysis being at atoll level. At atoll level Haa Alif (Dhidhdhoo) and Meemuu (Mulah, Muli, Raiymandhoo, and Veyvah) could potentially support critical habitat for Northern Maldivian Little Heron being in atolls where the species has been recorded. Similarly, Gaffu (Maamedhoo, Faresmaathoda, and Gahdhoo) could support critical habitat for Southern Maldivian Little Heron being an atoll where the species was recorded. Since the Northern Maldivian Little Heron shows a preference for forested water margins which are not present on Dhidhdhoo or coastal habitat, so any critical habitat that is present at this atoll level will not be impacted. On the seven Meemuu and Gaffu atoll project islands forested water margins associated with mangroves and wetland areas plus coastal habitat will be avoided by project funded components with works being located in existing powerhouses and underground cabling following existing roads. At atoll level Haa Alif (Dhidhdhoo) also supports critical habitat for lesser noddy (a non-migratory globally least concern species) with the important bird areas (IBA) supporting >1% of the global population. This species nests in mangroves on oceanic islands and forages in the surrounding atoll waters and potentially out to sea, as no mangrove is present on Dhidhdhoo at island level there will be no impact on the critical habitat.

**Table 27: Potential List of Threatened Species from Integrated Biodiversity Assessment Tool Analysis of Each Island**

Site Name	CR	EN	VU	NT or LR/nt	LC or LR/lc	DD	Total Potential Species	Potential terrestrial critical habitat at island level	Potential marine critical habitat at seascape level	Overlap of critical habitat with project footprint*
Dhidhdhoo	4	19	61	90	1235	51	1460	Lesser Noddy NMLH	Yes	No
Hanimaadhoo	4	19	61	90	1235	50	1459	Mangrove	Yes	No
Milandhoo	4	19	61	90	1245	50	1469	Mangrove	Yes	No
Manadhoo	4	19	61	90	1245	50	1469	Mangrove	Yes	No
Holhudhoo	4	19	61	90	1246	50	1470	No	Yes	No
Velidhoo	4	19	61	90	1246	50	1470	No	Yes	No
Alifushi	4	19	61	90	1246	51	1471	No	Yes	No
Hulhudhuffaar	4	19	61	90	1245	51	1470	No	Yes	No
Thulhaadhoo	4	20	62	88	1241	55	1470	No	Yes	No
Dharavandhoo	4	19	61	89	1245	54	1472	No	Yes	No
Mulah Island	4	19	61	88	1229	51	1452	Mangrove NMLH	Yes	Yes, marine

Site Name	CR	EN	VU	NT or LR/nt	LC or LR/lc	DD	Total Potential Species	Potential terrestrial critical habitat at island level	Potential marine critical habitat at seascape level	Overlap of critical habitat with project footprint*
										(Ocean Energy Pilot, Appendix 9)
Muli	4	19	61	88	1227	51	1450	Mangrove MNLM	Yes	Yes, marine (Ocean Energy Pilot, Appendix 9)
Raiymandhoo	4	19	61	88	1230	51	1453	NMLH	Yes	No
Veyvah	4	19	61	88	1228	51	1451	NMLH	Yes	No
Nilandhoo	4	19	61	88	1227	52	1451	No	Yes	No
Guraidhoo	4	19	62	88	1239	54	1466	No	Yes	No
Thimarafushi	4	19	61	88	1228	52	1452	No	Yes	No
Maamendhoo	4	17	64	88	1215	50	1438	SMLH	Yes	No
Faresmaathoda	4	17	63	88	1204	50	1426	Mangrove SMLH	Yes	No
Gahdhoo	4	17	63	88	1203	50	1425	SMLH	Yes	No
Thoddoo	4	19	62	88	1238	57	1468	No	Yes	No
Komandoo	4	19	61	90	1246	51	1471	No	Yes	Yes, marine (Ocean Energy Pilot, Appendix 9)
Key to Threatened Status: CR - Critically Endangered; EN - Endangered; VU - Vulnerable; NT/nt - Near Threatened; LC/lc - Least Concern; DD - Data Deficient. LR – Low Risk; NMLH/SMLH Northern/Southern Maldivian Little Heron.										
*Avoidance of critical habitat is to be ensured through the EMP implementation and reconfirmed prior to approval of detailed design										

## E. Protected Areas

188. Maldives' protected area network consists of terrestrial and marine protected areas. As per EPA list (2022) the country has declared 79 protected areas<sup>35</sup> covering a total area of 54314.67 hectares, which represents less than 2% of terrestrial cover. 65 of the protected areas are marine protected areas and 14 are terrestrial protected areas. Besides these the country also has about 188 locally designated environmentally sensitive areas (EPA 2022 data) which are defined as requiring development to be restricted, regulated, and controlled. Figure 39 show the map of the protected areas of Maldives and ASSURE project islands overlayed on this map. Maps of individual islands and environmentally sensitive areas are provided in Appendix 3. It can be seen from Table 28 that none of the project islands has any protected area or key biodiversity areas/important bird areas—the nearest is to Guraidhoo at 800m distance. Some islands have locally designated environmentally sensitive areas. However, project sites are not located in them.

189. The project components have been screened for protected areas and key biodiversity areas/important bird areas using the IBAT tool. The buffer area analyzed included 1 km and 15 km. The results also show (Table 28) that none of the project islands overlap with any protected areas and key biodiversity areas/important bird areas. However, there are 24 sites (22 protected areas and two key biodiversity areas [KBA]) overlapped by a 15 km buffer for project sites. Details are provided in Table 29.

<sup>35</sup> EPA of Maldives (<https://www.environment.gov.mv/v2/en/download/11475>).



190. During site visits and consultations with local communities, it was further confirmed that the project sites are free from any designated protected areas, KBA/IBA, and areas locally protected by the island councils.

**Figure 39: Locations of Protected Area and Project Areas**



Source: Consultant work on Google earth image, <https://en.epa.gov.mv/publications>

**Table 28: Overlap Data of the Project Island with Protected Areas and Key Biodiversity Areas and/or Important Bird Areas of Maldives (1 km and 15 km buffer)**

Site/Islands Name	Protected Areas		KBA/IBA	
	1 km	15 km	1 km	15 km
Dhidhdhoo	0	3	0	1
Hanimaadhoo	0	2	0	1
Milandhoo	0	1	0	0
Manadhoo	0	0	0	0
Holhudhoo	0	2	0	0
Velidhoo	0	1	0	0
Alifushi	0	0	0	0
Hulhudhuffaar	0	0	0	0
Thulhaadhoo	0	3	0	0
Dharavandhoo	0	4	0	0
Mulah	0	1	0	0
Muli	0	1	0	0
Raiymandhoo	0	0	0	0
Veyvah	0	1	0	0
Nilandhoo	0	1	0	0
Guraidhoo	1 (800m)	1	0	0
Thimarafushi	0	0	0	0
Maamendhoo	0	0	0	0
Faresmaathoda	0	1	0	0
Gahdhoo	0	0	0	0
Thoddoo	0	0	0	0
Komandoo	0	2	0	0

Source: IBAT Screening Data

**Table 29: Details of with Protected Areas and Key Biodiversity Areas and/or Important Bird within 15 Kilometers Radius of Project Site**

Island/Project Site	PA or KBA/IBA	Habitat Type	Designated	IUCN Category
<b>Protected Areas</b>				
Dhidhdhoo	Baarah Wetland	Coastal	Mangrove, Wetland and Reef areas	VI
	Kelaa Kandoofaa	Coastal	Mangrove, Wetland and Reef areas	VI
	Gallandhoo Region	Marine	Island, Reef, and Lagoon areas	Ia
Hanimaadhoo	Baarah Wetland	Coastal	Mangrove, Wetland and Reef areas	VI
	Finey Thila Region	Marine	Dive site	VI
Milandhoo	Farukolhu	Marine	Island (Mangrove, Wetland, Reef, and lagoon) areas	VI
Holhudhoo	Orimas Thila Region	Marine	Dive site	VI
	Fohdhipparu Region	Marine	Sandbank and Lagoon areas	VI

Island/Project Site	PA or KBA/IBA	Habitat Type	Designated	IUCN Category
Velidhoo	Fohdhipparu Region	Marine	Sandbank and Lagoon areas	VI
Thulhaadhoo	Baa Atoll	Marine	UNESCO-MAB Biosphere Reserve	Not Applicable
	Olhugiri	Marine	Island, Reef, and Lagoon areas	Not Reported
	Maahuruvalhi	Marine	Reef areas protected	Not Reported
Dharavandhoo	Dhigali Haa	Marine	Reef and Giri areas protected	Not Reported
	Anga Faru	Marine	Reef, Lagoon and Sand bank areas protected	Not Reported
	Mendhoo Region	Marine	Island and Reef areas protected	Not Reported
	Hanifaru	Marine	Island, Reef, and Lagoon areas	Not Reported
Mulah	Lazikuraadi	Marine	Reef areas protected	Not Reported
Muli	Lazikuraadi	Marine	Reef areas protected	Not Reported
Veyvah	Lazikuraadi	Marine	Reef areas protected	Not Reported
Nilandhoo	Fushi Kanduu	Marine	Reef areas protected	Not Reported
Guraidhoo	Guraidhoo Kanduu	Marine	Marine Protected Area	Not Reported
Faresmaathoda	Dhigulaabadhoo	Marine	Island (Mangrove, Wetland, Reef and lagoon) areas	VI
Komandoo	Naalaa Huraa Region	Marine	Sandbank and Lagoon areas	VI
	Bollissafaru Region	Marine	Island, Reef, and Lagoon areas	VI
<b>KBA/IBA</b>				
Dhidhdhoo	Haa Alifu Atoll	Marine and Coastal	Congregations >1% global population; Lesser Noddy (least concern species)	Not Applicable
Hanimaadhoo	Haa Alifu Atoll	Marine and Coastal	Congregations >1% global population; Lesser Noddy (least concern species)	Not Applicable

## F. Socio-economic Environment

### 1. Land Use

191. There are about 1,190 islands in Maldives, of which 33 islands are small islands less than 1 sq.km. The usage is different in each island, 118 islands are utilized for residence of people, 109 islands are utilized as resort, 128 islands are for industry (agriculture, fishery, factory, airport, etc.) and others are uninhabited. 23.3% of the land area is agricultural land, forest is 3.0%, and other usages (residential, tourist and industrial areas) are 73.7% (Ministry of Fisheries and Agriculture, 2018).

192. The interventions proposed under ASSURE Project are located on 22 outer islands from 12 Atolls of Maldives. The land use in all project islands is residential followed by agriculture and fisheries. The land use of the proposed sites of the project components is mostly residential and open land with some vegetation.

193. Island wise details are provided in section 4 of this chapter and detailed land use maps of each island are provided in Appendix 8.

### 2. Demography

194. In the Maldives, where only less than 1% of the total area is land suitable for human habitation, population growth has far serious consequences than many other countries. Population of Maldives grows about 1.65% per annum and had alarmingly increased inward migration to the capital city for better livelihood causing major environmental implications. The Maldives population reached 515,000 by 2020 in which 56% is comprised of children and youth. One third of the population lives in the capital, Malé, which has an area of less than 2 sq km. The rest of the population is scattered over approximately 185 islands. The average population size



of these islands is 900 and the average household size is 6.5. Maldives has a relatively young population with almost 41% under 15 years of age and around 3% over 65 years of age. With regard to human development trends, the country ranks high among the Asia-Pacific countries. Table 30 presents the demographic details of ASSURE project islands, data is from 2014 but this is the most recent available.

**Table 30: Demographic Features of the Project Islands**

#	Atoll	Name of the island	Total Land Area (km <sup>2</sup> )	Population (Registered as of 31 Dec, 2014)	Number of Households	Migrants
1	Haa Alifu (HA.)	Dhidhdhoo	0.60	3,974	617	241
2	Haa Dhaalu (HDh.)	Hanimaadhoo	3.11	1,260	166	335
3	Shaviyani (Sh.)	Milandhoo	0.20	794	120	20
4	Noonu (N.)	Manadhoo	1.1	1,871	110	102
5	Noonu (N.)	Holhudhoo	0.2	2,170	328	130
6	Noonu (N.)	Velidhoo	0.4	2,526	376	274
7	Raa (R.)	Alifushi	0.6	2,675	428	233
8	Raa (R.)	Hulhudhuffaar	0.6	728	291	52
9	Baa (B.)	Thulhaadhoo	0.25	2,867	375	94
10	Baa (B.)	Dharavandhoo	0.54	1,089	166	118
11	Meemu (M.)	Mulah	0.70	1,832	231	81
12	Meemu (M.)	Muli	0.40	990	170	85
13	Meemu (M.)	Raiymandhoo	0.30	232	24	1
14	Meemu (M.)	Veyvah	0.40	328	52	40
15	Faafu (F.)	Nilandhoo	0.60	2,016	244	115
16	Thaa (Th.)	Guraidhoo	0.3	2,060	310	69
17	Thaa (Th.)	Thimarafushi	0.2	2,589	212	89
18	Gaafu Alifu (GA.)	Maamendhoo	0.50	1,537	244	84
19	Gaafu Dhaalu (GDh.)	Faresmaathodaa	0.40	1,796	238	80
20	Gaafu Dhaalu (GDh.)	Gadhdhoo	0.30	3,074	351	115
21	North Ari Atoll	Thoddoo	1.62	1,534	200	187
22	Lhaviyani Atoll	Komandoo	0.10	1081	293	57

Source: Island Councils, Statistical Yearbook of Maldives 2016 and Maldives Energy Outlook for Inhabited Islands 2013, Ministry of Environment and Energy, Maldives, Maldives Population and Housing Census 2014; and <http://www.atollsofmaldives.gov.mv>

195. The total population enumerated in Census 2014 is 407,660. Maldives is dominated by male population with 57% population of males and 43% of females<sup>36</sup>. Of this total, the Resident Population is 402,071, which consists of 338,434 as Resident Maldivians and 63,637 foreigners. Census 2014 captured 5,589 Maldivians as living abroad, and hence following the notion of previous censuses, the 'Total Maldivian Population' enumerated in Census 2014 was 344,023. The population is distributed within the country among administrative and non-administrative islands; administrative islands are those with Island Councils governing them. 96% of the population lives on administrative islands.

196. The age and sex composition of the Maldives in 2014 continued to resemble that of a developing country with a broad base, a relatively large proportion of people in the adult age categories (below 30 years of age), and relatively small proportion of people in the older age categories (above 60 years). There were a total of 93,478 children in the age group of under 15, with 45,154 female and 48,317 males. Over the past two decades, the growth in this age group has declined due to decreasing fertility. The total fertility rate declined from 6.4 to 2.2 children per

<sup>36</sup> Population and Housing Senses 2014, Republic of Maldives.

women. The population aged 15–64 years numbered 228,619 people and made-up 68% of the population at the time of the 2014 census. Persons aged 65 and above comprised 5% of the total population. There were a total of 16,337 people in this age group, with 8,631 males and 7,706 females.

197. In Household Income and Expenditure Survey (HIES) 2016, the working-age population (aged 15+) was 263,311, of which slightly more than one-half (53%) were women. The labour force participation rate was 58%. However, the rate for men was higher than that for women (75% for men and 42% for women). Employment totaled 142,422 people, with women accounting for 39%. More than one third of employment was in the informal sector (35%). More than 50% of the employed population had informal employment including about 4% informal employment jobs in formal sector enterprises and other non-informal production units. Among the employed persons 71% were employees, and 20% were either own-account or contributing family workers. Employment was heavily concentrated in the services sector (70%), particularly in public administration (15%) and trade (13%). Industry accounted for 18% of total employment and agriculture for 9%. Almost 65% of the employed population had secondary or tertiary educational attainment.

198. The overall unemployment rate was 6.1%, considerably higher among men (6.4%) than among women (5.6%). The youth (18–34 years) unemployment rate at 8% was higher than the national average. In total, 24,135 persons were classed under the potential labour force as available non-jobseekers or unavailable jobseekers. Out of this 97% of the population is available for work but not seeking a job (discouraged workers). The main reason for young people (15–17 years) was due to studying and for old age (65+ years) people was due to ill health. For those aged 18–64 years the main reason was household chores work. Table 31 provides labour force indicators of Maldives.

**Table 31: Labour Force Indicators**

Item	Total	Women	Men
Population (15+ years)	263311	139956	123354
Labour force	151706	59047	92659
Employment	142422	55721	86701
Branch of economic activity			
Agriculture	9	3	13
Industry	18	20	17
Manufacturing	11	18	6
Service	70	75	67
Public administration	15	13	16
Trade	13	13	13
Informal employment	35	40	31
Employment in informal sector	52	52	52

Source: Household Income and Expenditure Survey (HIES), Analytical Report III: Employment, 2016, Republic of Maldives

199. The Maldives is predominantly an Islamic country, and over 97% of the total population in the Maldives belong to Islam. Christianity consists of about 0.5 percentage of the total

population in the Maldives. Hindus constitute about 0.5 percentage of the total population of the Maldives. Dhivehi, an Indo-Iranian language related to Sinhalese is official language of Maldives. 98.6% of Maldivians speak a variety of Dhivehi. Linguistic minorities are small: Sinhalese (0.6%), Gujarati (0.1%), Malayalam (0.1%). English is commonly spoken at tourist sites. Literacy rate in Maldives is 97.7%.

200. The poverty headcount rate in the Maldives is 8.2% using the low poverty line (half the median of total expenditures) and 46.5% using the high poverty line (median total expenditures). This large difference in headcount rates indicates that over 38% of Maldivians are bunched between the 25<sup>th</sup> and 50<sup>th</sup> percentile of total expenditures. This indicates that a large part of the population lives within a relatively small range of total expenditures. About 8.2% of Maldivians consume less than 2,257 MVR per month (or MVR 74 per day) and almost half of all Maldivians (46.5%) consume less than 4,514 MVR per month (or MVR 148 per day).<sup>37</sup>

201. Approximately 64% of the population belongs to households where the head of household has below primary or only primary education. These households account for about 80 % of the poor (using the high and low poverty line), facing a poverty rate of 14% and 10% respectively using the low poverty line. While poverty does fall with increasing education of the head of household, households where heads have more than secondary education account for only 15% of the population. Finally, having an educated household head does not completely eliminate the risk of poverty, almost 2% of households living in households where the household head has above secondary education are poor (using the high poverty line). We also observe that not only the education level of the household head matters, Maldivians living in households with a higher share of highly educated household members tend to be less poor and poverty rates decrease to 2% for households where more than half of all household members have a secondary education or above.

202. Overall, 63.4% of the population belongs to households whose heads are employed and only 1.4% to households whose heads are unemployed. Poverty rates in households whose heads are unemployed are higher at 8.8% while poverty rates in households whose heads are employed are about 25% lower at 6.6%. Despite higher poverty rates, the large majority of the poor population belongs to households whose household head is employed, due to the large population share. Poverty rates are also relatively high at around 11% for households whose heads are inactive.

203. Maldivians living in households with heads who work in elementary occupations or skilled fisheries have the highest poverty rates of 14.4% and 11.6% respectively, accounting for about a quarter of the Maldivian population. On the other hand, poverty incidence is lowest among households whose household head works as manager (2%), technician (2%), or clerical support worker (2.1%).

204. About 39% of Maldivians households are female headed and poverty rates of female headed households are slightly higher than for male headed households. Households headed by females have poverty rates of 8.8% while those headed by males have poverty rates of 7.8%. These higher poverty rates are most likely associated with differences in labor market characteristics of females. About 71% of all women are employees compared to 75% of males. the largest proportion of females are professionals (almost one quarter of all females) but relatively fewer are managers, compared to their male counterparts. Females are also more likely to be employed as clerical support workers (16% compared to 9%) and craft and trade related

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<sup>37</sup> Household Income and Expenditure Survey 2016, Republic of Maldives.

occupations (17% compared to 9%). The type of industry that males and females are employed in also differs. A large majority of employed females is employed in the service sector (almost 80% compared to 69% of males) while fewer are employed in agriculture (2 compared to 14% of males).

205. In Maldives, there were 180,000 migrant workers in 2020, of which 63,000 are undocumented.<sup>38</sup> Currently, migrant workers are in large part a majority of the workforce and constitute one third of the population. They are mostly young men between 20 and 34 years old from Bangladesh, India, and Sri Lanka (one in four migrants). Most of the migrant workers at the lower skill levels are employed in the construction industry (and some waiters).<sup>39</sup> Employment Act 2/2008, its regulations, Immigration Act, and deportation Act no. 1/2007 provide protection for migrant workers. In August 2020, the government published a new migrant worker regulation, 2020/R-62, further cementing employers' responsibility for arranging migrants' arrival in the Maldives, in regard to accommodations, registration, and repatriation (cost secured).

206. In terms of health-related diseases registered in 2015, 47,095 children under the age of 5 years and 95,969 above the age of 5 years suffered acute respiratory infection. 33,199 children under the age of 5 years and 61,050 above the age of 5 years suffered viral fever in Republic of Maldives. 9,796 children under the age of 5 years and 21,723 above the age of 5 years suffered from diarrhea in 2015. Eight children under the age of 5 years and 2 above the age of 5 years suffered from measles in 2015. 18 children under the age of 5 years and 77 above the age of 5 years suffered from scrub typhus in 2015. 307 children under the age of 5 years and 1,572 above the age of 5 years suffered from dengue fever in 2015. 29 children under the age of 5 years and 160 above the age of 5 years suffered from typhoid in 2015. Maldives is free of malaria, but dengue fever is common with outbreaks in 2011, 2015, and 2016. There were a total of 311 COVID-19 deaths in Maldives to date and 186,000 cases but now only 1–2 new cases are being recorded.

### **3. Administrative Setup**

207. Based on its scattered geographic nature, the administrative system is divided into atolls, islands, and cities. The atolls are an administrative division are governed through Atoll Councils, headed by presidents elected by the population of the respective atoll. The atoll council is in-charge of the respective administrative divisions. Inhabited islands are administered through Island councils, headed by presidents elected by the population of the respective island. Cities are administered by city councils headed by mayors elected by the population of the respective city. Responsibilities of the Island council include preparation of island development plans in consultation with the community and submit the plan to the atoll council; and implement development projects planned and assigned by the government in line with the island development plans formulated by islands and submitted to the atoll councils.<sup>40</sup>

### **4. Economic Development**

208. The economy of Maldives is largely based on fishing and tourism; both sectors are fragile and vulnerable to external factors as well as natural disasters. Maldives' economic base is extremely narrow and dominated by tourism accounting over 27% of GDP in the recent years.

<sup>38</sup> Addressing the Socio-Economic Impact of COVID-19 on the Maldives, 2020, United Nations Report.

<sup>39</sup> Protecting Migrant Workers in Maldives, 2021, International Labour Organization.

<sup>40</sup>

<http://www.shareefweb.com/documents/LocalGovReforms/MaldivesDraftlaw&regulations/Draft%20Translation%20of%20decentralisation%20ActMaldives.pdf>

Following the tourism sector, fisheries, agriculture, construction, and commerce play a significant role in the Maldivian economy by contributing 5–10% of the gross domestic product (GDP) each. The Asian tsunami of 2004 and COVID-19 pandemic severely affected the Maldivian economy, causing major destruction of infrastructure and assets, especially those in the tourism and fisheries sector.

209. Maldives has attained upper middle-income status mainly through the successful development of high-end tourism. Tourism accounts for about a quarter of the country's GDP and more than 60% of the foreign exchange receipts. Fisheries is the second leading sector. Agriculture and manufacturing play a minor role in the economy, constrained by the limited availability of cultivable land, and low adoption of farming in outer islands due to lack of capacity and awareness on farming technologies, and insufficient power supply for cold storages. Most staple foods are imported. At the community level, Maldives' high exposure to natural hazards and extreme weather, together with vulnerabilities to food security supply chain and dependency on food imports, presents significant challenges. The global pandemic resulting from the novel coronavirus disease (COVID-19) has exposed the vulnerability of Maldives' heavy reliance on tourism. The real toll of the pandemic, however, is much higher, with thousands of livelihoods affected due to the slump in tourism activity. Biodiversity based sectors contribute 71% of national employment, 49% of public revenue, 62% of foreign exchange, 98% of exports and 89% of GDP (Rf135 billion).<sup>41</sup>

210. All atoll communities are provided with vital facilities established in the atoll capital islands, such as Atoll Hospital, a branch of Bank of Maldives and atoll school. The selected 22 islands for the ASSURE project are from 12 atolls only, Haa Alifu, Haa Dhaalu, Shaviyani, Noonu, Raa, Baa, Meemu, Faafu, Thaa, Gaafu Alifu, and Gaafu Dhaalu. All of the 11 atolls have airports, except Meemu and Faafu, and chartered seaplanes are operated by resorts and privately run ferries for their socio-economic activities and mobilization. For Meemu, nearest airport is Ifuru and for Fafu nearest airport is Maamigili. As of December 2020, these atolls have 53 resorts and 109 guest houses in operation with the capacity of 11,456 and 1,249 beds respectively which have created employment opportunities for their youth and the communities in diverse areas of formal and informal sectors.

211. All selected 22 ASSURE islands have major socio-economic infrastructures on the islands, covering atoll and island council secretariats, island courts, health centers, schools, agency post offices, BML agency shops and mosques. These infrastructures are equipped with communication facilities, such as telephone, fax and internet. Harbours and jetties exist in all 22 ASSURE islands, except Raiymandhoo. Whilst Raiymandhoo has no operational jetty or harbor vessels can go up to shoreline and from there equipment and materials can be transferred to local boats to bring them onto the island. The government has announced a jetty to be built although the timescale for this is not known. Since this island also has no guest house rooms in a local house will need to be rented. Table 32 gives some of the additional socio-economic infrastructures available on these islands.

**Table 32: Available Socio-Economic Infrastructures on 22 ASSURE Islands**

#	Name of the island	Guest house	Social Centre	Shops	Café /Restaurants	Workshops /Carpentry	Fish Processing
1	HA. Dhidhdhoo	1	1	80	3	4	0

<sup>41</sup> The Economic Value of Marine and Coastal Biodiversity to the Maldives Economy ([https://tamug-ir.tdl.org/bitstream/handle/1969.3/29202/policy\\_briefs\\_the\\_economic\\_value\\_of\\_marine\\_and\\_coastal.pdf?sequence=1&isAllowed=y](https://tamug-ir.tdl.org/bitstream/handle/1969.3/29202/policy_briefs_the_economic_value_of_marine_and_coastal.pdf?sequence=1&isAllowed=y))

#	Name of the island	Guest house	Social Centre	Shops	Café /Restaurants	Workshops /Carpentry	Fish Processing
2	HDh. Hanimaadhoo	4	1	37	7	4	0
3	Sh. Milandhoo	2	0	34	3	7	0
4	N. Manadhoo	2	0	53	3	4	0
5	N. Holhudhoo	1	1	43	4	5	0
6	N. Velidhoo	3	1	53	7	1	0
7	R. Alifushi	2	1	11	3	2	0
8	R. Hulhudhuffaar	1	1	10	3	1	0
9	B. Thulhaadhoo	1	0	27	5	3	2
10	B. Dharavandhoo	10	0	25	5	4	0
11	M. Mulah	1	0	11	3	3	1
12	M. Muli	1	1	23	1	3	2
13	M. Raiymandhoo	0 <sup>42</sup>	0	3	1	0	0
14	M. Veyvah	1	0	3	2	1	7
15	F. Nilandhoo	3	1	34	6	3	0
16	Th. Guraidhoo	1	1	29	4	11	15
17	Th. Thimarafushi	2	1	28	5	0	0
18	GA. Maamendhoo	5	0	22	6	4	0
19	GDh. Faresmaathodaa	1	0	20	2	1	1
20	GDh. Gadhdhoo	1	0	25	5	8	0
21	Thoddoo	56	0	11	12	3	0
22	Komandoo	1	1	46	3	2	6

Source: Island Councils.

## 5. Livelihood Activities

212. The major income generation avenues and employment opportunities on the 22 project islands are government employment, building construction, agriculture, fishing, boat building, and thatch weaving. It has been observed that the youth of most of these islands are engaged in tourism, fisheries, and construction. It has also been noticed that almost all households are engaged in thatch weaving, especially elderly people on most of the islands. Remittances from family members in resort jobs and other off island jobs also bring economic input to the households and islands. As is the case in other atolls, many households of these islands also supplement needs with locally cultivated crops or from home garden crops. It has been noticed that households in some of these islands have kept livestock as household based economic activities.

213. Many households of these 22 ASSURE project islands also have two or three sources of income. The income of a moderately well-off household typically could include a salary, government allowances and pensions, earnings from home based agriculture and fisheries related income generation activities and remittances from off island jobs.

214. The few skilled occupations available in these islands are mostly in the health, education and power generation sectors. However, as there is a lack of trained locals in the area of health and education many expatriates are employed in both areas. The power generation sector on these islands is identified as an area only occupied by locals.

<sup>42</sup> No guest houses are available so rooms will need to be rented in private houses for contractor staff based on the islands.

215. It is noticed that many foreign labour are employed or engaged in the few areas available for these island communities as avenues for income generation, such as farming, building construction, fishing, and shopkeepers.

216. As in the other atolls, the majority of salaried jobs undertaken by locals in these 22 islands are administrative, construction or resort jobs. The informants from island councils and other stakeholders from these island communities identified scarcity of jobs as a key concern on these islands. They noted that there is very limited employment available on the islands for school leavers and university graduates.

217. It has also been observed that most households of these islands own non-land assets such as coconut palms, screw pine, breadfruit, and mango trees. As a practice on the islands, a tree may be owned by an individual citizen or household separately to the land upon which it grows. This has been noticed as a very common practice in the atolls. Therefore, clearance of a plot may have an adverse impact on the livelihood of these households who are very much dependent on these trees.

218. Thoddoo island is known for its fertile soil and is the largest producer of watermelons in the country. In addition to watermelons, chili peppers and pumpkins, papaya and melons, mangoes and bananas, passion fruit, as well as a number of other fruits and vegetables are cultivated here. Cultivation of betel nut is also popular on the island, the leaves of which have medicinal properties and can be used as spices. Agriculture and fishing have long been the main activities of the local population. However, the actively developing tourism industry in recent years has confidently taken one of the leading places in the basis of the island's economy. Today, the island has dozens of hotels and guesthouses, restaurants and cafes, speedboats, a school and a medical facility, shops where both groceries and common household items can be bought.

219. The economy of the Maldives is also dependent on ecosystem services which include marine resources such as fisheries and tourism sector.

## 6. Social Infrastructure

220. **Health services.** Health services on all 22 ASSURE islands, except atoll capitals, are provided through health centers which have permanent buildings dedicated for the services. The health centers on the islands are mainly staffed composing of a doctor, nurse, community health worker or family health worker, manager or officer in charge and administrative officers. Health centers provide basic health care services and sometimes preventive services to the respective island community. Basic laboratory services are also provided to the community in most of these health centers.

221. The government has established a pharmacy on every island of these atolls through State Trading Organisation, a public owned company. The pharmacy is staffed with at least two pharmacists, if trained, or two assistant pharmacists, if trained personals are not available on the island.

222. The capital islands amongst these 22 ASSURE islands, HA. Dhidhdhoo, M. Muli and F. Nilandhoo, have Atoll Hospitals. The Atoll Hospital has secondary medical care capabilities, including x-ray and scan facilities, operating theatres, outpatient care and limited specialized staff.

223. The health centers and Atoll Hospitals experience electricity problems in those islands where they experience problems due to low voltage and voltage fluctuations in electricity supply. According to the health officials in those islands, electronic equipment is often damaged and could not be operated for the given life span of the equipment due to electrical problems with the poorly supplied electricity. Therefore, there is a need for an improved, reliable, and efficient electricity supply to improve the health care services on these islands.

224. Fully medically equipped air ambulances service is available all over Maldives for domestic medical flights and patient transfers. Depending on the patient's condition, intensive care transport in a Learjet or patient transfer by helicopter can be organized. In addition, ground transport to the nearest airport using a suitable ambulance to reduce the journey time as much as possible can be arranged locally.

225. **Education services.** Pre-primary to high secondary level education is available in nine of the 22 project islands, Dhidhdhoo, Milandhoo, Holhudhoo, Alifushi, Hulhudhuffaar, Dharavandhoo, Muli, Nilandhoo and Guraidhoo. Pre-primary to lower secondary level education is available on 9 islands, Hanimaadhoo, Manadhoo, Velidhoo, Thulhaadhoo, Thimarafushi, Mulah, Maamendhoo, Faresmaathodaa and Gadhdhoo. Pre-primary to primary level education is available on two islands, Raiymandhoo and Veyvah. Students who finish secondary education on the islands where they have education up to secondary level go elsewhere seeking further education, especially to Malé. It has been noticed that some secondary graduates who cannot afford to go elsewhere either join on or off island jobs or stay idle on the islands, unemployed.

226. The schools on the islands are facilitated with water storage tanks to provide safe drinking water to the students. The schools also have other vital facilities, such as toilets for both teachers and students, libraries with limited books and recreational facilities.

227. The schools are connected to FENAKA-supplied electricity in all 22 ASSURE islands. The informants from some of these islands pointed out that improvement of electricity will be a great support to improve school facilities, hence, the quality of education will be improved on the islands.

228. **Water and sanitation.** The population of Maldives has traditionally been dependent on well-water and rainwater for drinking, cooking, washing, bathing, and irrigation. As the freshwater lens is contaminated in almost all islands, mainly through percolation of human waste, as almost all houses have modern toilets which are connected to septic tanks with unlined floors that discharge sewage and human waste into the ground, the Government of Maldives has high priority to provide fresh and clean water and sewage systems to the households in all islands. Water and sanitation systems are available in many project islands and the systems are under construction in others; during project implementation it will need to be confirmed if the water supply on each island is fit to drink (or if water must be imported for workers) and that sanitation facilities to be used are connected to a treatment system. It is found that most of the public roofs on the islands are either reserved for rainwater harvesting to be connected to reverse osmosis systems or already connected.

229. **Solid waste disposal.** Lack of proper waste management systems on the project islands is a major concern of the local communities. However, all islands have established designated waste sites and waste is managed by the councils in some of the islands. Most of the waste—the majority plastic—generated daily in the Maldives is burned out in the open, as landfills are not possible in a nation that is 99% water. There are no



designated facilities for hazardous/e-waste management in Maldives. Based on discussion with EPA, the government is still in the process of establishing these facilities. There is only one solid waste management facility in Maldives in Thilafushi island although it is not currently well managed. A Waste to Energy facility is currently being constructed at Thilafushi with support from ADB to also improve the landfill's management.

230. **Recreation and sports infrastructure.** All 22 ASSURE islands have limited recreational facilities such as football grounds, volleyball, bashi, and netball courts. As it has been informed by Councils that most of the islands will soon have new sports and recreational facilities such as sport arenas and futsal as a government pledge under its manifesto. It has been observed on many of these islands the sports arenas are under construction.

231. **Housing.** In general, most households in the Maldives, especially the atoll population, share living quarters with extended families. This makes quantification of housing conditions difficult. In the islands, houses are mainly built with cement bricks, most have cemented floors in living areas, and house compounds are generally large. The average household size is about six persons.

232. **Roads and communications.** Except for a few roads on Dhidhdhoo and Manadhoo no roads are paved on the ASSURE islands but are generally sandy and even.

233. ASSURE islands are accessible by air via domestic and international airports and seaplanes chartered/operated by resorts in the atolls. The islands are also accessible through inter atolls ferries and privately operated speed boats and ferry dhonies to and from Malé and islands within the atolls. There are no seasonal restrictions on travel although bad weather can delay sailing. Communication facilities are basically good, including telephone, fax, and internet access. Mobile phone services are available from both suppliers, Dhiraagu and Ooredoo on all ASSURE islands. It has been observed that there would hardly be any household without a mobile on any of these islands. Radio and TV channels are receivable to all households. In addition, almost all households are connected to Cable TVs, and some may have satellite TVs.

234. **Electrification and energy use.** Maldives has about 290 megawatts (MW) diesel generators, and more than 22 MW in renewable energy installations in 186 inhabited islands, and about another 144 MW diesel generators in resort islands. All the 22 project islands have access to the power supplied by the State Electric Company (STELCO) and FENAKA Corporation Limited (FENAKA). Main usage of power supplied by state companies is mostly for domestic use and for industrial purposes. STELCO and FENAKA are operating since long time and based on the consultations with FENAKA and local communities there are no major incidents related occupational health and safety (OHS) and/or community health and safety reported in the project islands although no health and safety records are maintained to confirm this.

## 7. Physical Cultural Resources

235. The proposed project sites and the surrounding areas are a mix of educational, commercial, and residential. There are no important historical or cultural sites in and around the project sites. Manadhoo island has a Vevu area of historic and cultural significance. This area has a traditional communal bath, a well, runs of old buildings and some tombstones. However, this area is very far from the project sites. Maldives also has Unique Coral Stone Mosques which are historically and culturally significant. There are six such mosques in Maldives but none of these are in project islands.

236. The other physical cultural resources present in the islands are graveyards, cemeteries, and mosques. There are mosques on all project islands. None of the project sites are directly supporting any physical cultural resources, although this will need to be confirmed in respect of the ocean energy component.

## **G. Environment and Socio-economic Profile of Project Islands**

237. The environmental and social-economic set up of the 22 ASSURE project islands is compiled based on the published data, field visits and consultations with stakeholders from each island. The details are presented in the following sections.

### **1. HA. Dhidhdhoo**

Location:	6° 53' 13" N 73° 6' 48" E
Registered Population (Census 2014):	3974
Number of households:	617
Original land area:	0.6 km <sup>2</sup>
Current land area	0.9 km <sup>2</sup>
Distance from Malé	305 km
Nearest airport	Huvarafushi (17.6 km)
Island description	The original island is long and narrow with about 1.5km lengthwise and 0.4km wide. Due to lack of space for housing reclamation has been done on the north side expanding to the west. The width of the island on the reclaimed side is now about 1.1 km.
Reclamation	There is a 50% increase in the island size from reclamation. About 0.3 km <sup>2</sup> of land has been reclaimed.
Location and year of establishment of powerhouse	6°53'17.42"N, 73°6'47.00"E 1994
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	The island has almost no natural vegetation. There is some shrubs and grassy land on the northeastern side
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	Residential houses at 10m and mosque at 1m.
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### **2. HDh. Hanimadhoo**

Location:	3° 7' 5" N; 72° 59' 3" E
Registered Population (Census 2014):	1260
Number of households:	166
Original Land area:	3.11 km <sup>2</sup>

Current land area	-
Distance from Malé	288 km
Nearest airport	Airport island (0 km)
Island description	Long island approximately 6.7km long and 0.8km on the widest part. The average width is around 0.5km and the narrowest parts are about 0.1km. Half of the island is an international airport.
Reclamation	None
Location and year of establishment of powerhouse	6°45'51.62"N, 73°10'46.19"E 1993
Protected areas	None
Ecologically significant area recognized by EPA	Hanimaadhoo mangrove area Special features of the area: mangrove and marshy areas and birds.
Mangrove/waterbody on island	Mangrove and marshy areas
Natural vegetation	The central western part of the island has residential areas. Large part of island on the eastern side supports vegetation
Agricultural land	The agricultural center is on the island. Some plots of land for agriculture are allocated on the central eastern side of the island.
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Marine habitat in project footprint	No
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	100m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 3. Sh. Milandhoo

Location:	3° 4' 42" N 72° 57' 50" E
Registered Population (Census 2014):	794
Number of households:	120
Original Land area:	1.3 km <sup>2</sup>
Current land area	As above
Distance from Malé	137 km
Nearest airport	Funadhoo (16 km)
Island description	Long island approximately 6.7km long and 0.8km on the widest part. The average width is around 0.5km and the narrowest parts are about 0.1km. Half of the island is an international airport.
Reclamation	None
Location and year of establishment of powerhouse	6°17'12.78"N, 73°14'49.45"E 2000
Protected areas	None
Ecologically significant area recognized by EPA	Milandhoo wetland area (Sikundi Kulhi) Special features of the area: mangrove plants kandoo, randoo and thela.
Mangrove/waterbody on island	Milandhoo wetland area and mangrove area
Natural vegetation	The island maintains about 54% of its natural vegetation, especially on the northern side of the island where a wetland area is. The built area is mainly on the central and southern parts of the island.
Agricultural land	Agriculture is important in the community and plots for agricultural purposes are allocated on the southern side of the island.

Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	100m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

#### 4. N. Manadhoo

Location:	5° 45' 56" N 73° 24' 38" E
Registered Population (Census 2014):	1871
Number of households:	110
Original Land area:	1.1 km <sup>2</sup>
Current land area	As above
Distance from Malé	176 km
Nearest airport	Maafaru (9.74 km)
Island description	The island is pear shaped with a length of about 1.6km in the longest diagonal. The island is 0.3 km wide in the narrowest part and 1 km wide in the widest part.
Reclamation	None
Location and year of establishment of powerhouse	5°46'4.24"N, 73°24'58.25"E 2009
Protected areas	None
Ecologically significant area recognized by EPA	Manadhoo wetland area about 6.5km southwest of Maafaru island. The area is mainly known for its kandoo forest. The island also has the Vevu area of historic and cultural significance. This area has a traditional communal bath, a well, ruins of old buildings and some tombstones. The area along with the surrounding forest is being developed as a Community Conserved Area by a local NGO, Manadhoo Zuvaanunge Gulhun.
Mangrove/waterbody on island	Manadhoo wetland area
Natural vegetation	The island maintains about 55% of its natural vegetation, with the built area being mainly on the central and eastern parts of the island.
Agricultural land	Some agricultural plots are given on the southern side of the island adjacent to the residential area.
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	Yes. Vegetation clearance will be required for wind turbine sites.
Number of trees supported by project footprint	About 24 trees on wind turbine site.
Marine habitat in project footprint	None.
Land use and ownership in project footprint	Residential area for grid work Vegetated area for wind turbines / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	130m to nearest residential property from wind turbine, FENAKA buildings are closer
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques and a Vevu area of historic and cultural significance
PCR on project footprint	None

### 5. N. Holhudhoo

Location:	5° 45' 17" N 73° 15' 46" E
Registered Population (Census 2014):	2170
Number of households:	328
Original Land area:	0.2 km <sup>2</sup>
Current land area	As above
Distance from Malé	178 km
Nearest airport	Maafaru (25 km)
Island description	The island is oval shaped with a length of about 0.7km a width of about 0.4 km.
Reclamation	None
Location and year of establishment of powerhouse	5°45'23.11"N, 73°15'44.11"E 2004
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Almost no natural vegetation. It is a highly urbanized island with no large forest/woody areas.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	40m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 6. N. Velidhoo

Location:	5° 39' 50" N 73° 16' 27" E
Registered Population (Census 2014):	2526
Number of households:	376
Original Land area:	0.4 km <sup>2</sup>
Current land area	0.6 km <sup>2</sup>
Distance from Malé	167 km
Nearest airport	Maafaru (28 km)
Island description	The island is long with a length of about 1.2km a width of about 0.6 km.
Reclamation	Yes The northwestern side of the island has been reclaimed.
Location and year of establishment of powerhouse	5°39'57.06"N, 73°16'32.97"E 1997
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Almost no natural vegetation. It is a highly urbanized island with no large forest/woody areas.

Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	30m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 7. R. Alifushi

Location:	5° 58' 2" N 72° 57' 12" E
Registered Population (Census 2014):	2675
Number of households:	428
Original Land area:	0.6 km <sup>2</sup>
Current land area	As above
Distance from Malé	206 km
Nearest airport	l'furu (30 km)
Island description	The island is circular/triangular with a width of 0.8-1km on either side.
Reclamation	No
Location and age of powerhouse	5°57'51.24"N, 72°57'17.08"E 1994
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Less than 25% of the natural vegetation remains with built up area in the center of the island. The natural vegetation remaining is on the periphery of the island on all sides.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	90m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 8. Hulhudhuffaar

Location:	5° 45' 43" N 73° 0' 44" E
Registered Population (Census 2014):	728
Number of households:	291

Original Land area:	0.6 km <sup>2</sup>
Current land area	As above
Distance from Malé	185 km
Nearest airport	Ifuru (6 km)
Island description	The island is long with 1.7km length and a width of less than 0.1km on the northern side and 0.4-0.5km on the southern side which is wider.
Reclamation	No
Location and year of establishment of powerhouse	5°45'55.36"N, 73° 0'47.75"E 1994
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	About a third of the natural vegetation remains around the island with built area in the center.
Agricultural land	Few
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	30m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 9. B. Thulhaadhoo

Location:	5° 1' 23" N 73° 15' 46" E
Registered Population (Census 2014):	2,867
Number of households:	375
Original Land area:	0.25 km <sup>2</sup>
Current land area	0.45 km <sup>2</sup>
Distance from Malé	120 km
Nearest airport	Dharavandhoo (36 km)
Island description	The island is currently, long with a length of about 1.2km and width of about 0.45 km.
Reclamation	Yes. Over several reclamation projects the island is currently about 80% larger than its original size.
Location and year of establishment of powerhouse	5° 1'14.48"N, 72°50'22.90"E 2001
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Almost no natural vegetation. It's a highly urbanized island with no large forest/woody areas.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes

Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	30m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 10. B. Dharavandhoo

Location:	5° 9' 28" N 73° 7' 49" E
Registered Population (Census 2014):	1,089
Number of households:	166
Original Land area:	0.54 km <sup>2</sup>
Current land area	0.66 km <sup>2</sup>
Distance from Malé	112 km
Nearest airport	Dharavandhoo (0 km)
Island description	The island is long with a length of about 1.5km a width of about 0.5 km.
Reclamation	Some reclamation on the southern side was done to build the airport. There was no major change to the island and residential areas in terms of size and shape.
Location and year of establishment of powerhouse	5° 9'24.96"N, 73° 8'9.51"E 2010
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	About 10% of the island has natural vegetation which is mainly on the northeastern side.
Agricultural land	Some
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	60m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 11. M. Mulah (Mulak)

Location:	2° 56' 15" N 73° 34' 52" E
Registered Population (Census 2014):	1832
Number of households:	231
Original Land area:	0.7 km <sup>2</sup>
Current land area	As above



Distance from Malé	137 km
Nearest airport	Kudahuvadhoo (84 km)
Island description	The island 1.2km long and 0.5 – 0.6 km wide.
Reclamation	None
Location and year of establishment of powerhouse	2°56'41.29"N, 73°35'7.23"E 2008
Protected areas	None
Ecologically significant area recognized by EPA	A mangrove area in the south end of the island is identified by EPA as an ecologically sensitive area. (2° 56' 30" N; 73° 35' 15" E)
Mangrove/waterbody on island	A mangrove area in the south end of the island.
Natural vegetation	Almost 50% of the land area is natural vegetation and much of this is in the southern end of the island. Houses have home gardens containing large shady trees.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Lagoon / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	80m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

## 12. M. Muli

Location:	2° 55' 15" N 73° 34' 52" E
Registered Population (Census 2014):	990
Number of households:	170
Original Land area:	0.4 km <sup>2</sup>
Current land area	0.75 km <sup>2</sup>
Distance from Malé	140 km
Nearest airport	Kudahuvadhoo (84 km)
Island description	Originally the island was long and narrow with one side wider than the other. Currently, the island 1.7km long and 0.3 – 0.5 km wide.
Reclamation	Yes. The eastern side along the whole length of the island has been reclaimed to about double the original size of the island.
Location and year of establishment of powerhouse	2°55'2.17"N, 73°34'49.28"E 2013
Protected areas	None
Ecologically significant area recognized by EPA	A mangrove area in the northern end of the island is identified by EPA as an ecologically sensitive area. (2° 55' 25" N; 73° 34' 59" E). It is identified as an important site for tortoises and terrestrial flora.  The channel on the south of Muli and the lagoon on the leeward site was also identified as an important area for its presence of unique environmental features. However, this area is part of the reclaimed area.
Mangrove/waterbody on island	A mangrove area in the northern end of the island
Natural vegetation	Very little of the natural vegetation remains.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes

Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Lagoon / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	70m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 13. M. Raiymandhoo

Location:	3° 05' 22" N 73° 38' 22" E
Registered Population (Census 2014):	2170
Number of households:	328
Original Land area:	0.3 km <sup>2</sup>
Current land area	As above
Distance from Malé	121 km
Nearest airport	Kudahuvadhoo (96 km)
Island description	The island is triangular/oval shaped with 0.86km along the longest length and about 0.4km at the widest side. The narrowest width of the island is about 0.1 km.
Reclamation	None
Location and year of establishment of powerhouse	3° 5'21.81"N, 73°38'24.89"E 2022
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	The island maintains much of its natural vegetation with only about 20% of the land as built area
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	10m
Harbor /Jetty available	No
PCR on island	Yes, Mosques
PCR on project footprint	None

### 14. Veyvah

Location:	2° 55' 15" N 73° 34' 52" E
Registered Population (Census 2014):	328
Number of households:	52
Original Land area:	0.4 km <sup>2</sup>
Current land area	As above

Distance from Malé	137 km
Nearest airport	Kudahuvadhoo (86 km)
Island description	The island is rectangular shaped with a length of about 1.5km and a width of about 0.3 km.
Reclamation	None
Location and year of establishment of powerhouse	2°57'29.20"N, 73°36'5.51"E 1993
Protected areas	None
Ecologically significant area recognized by EPA	Veyvah faru, the reef area on the eastern side of the island is identified as an ecologically significant area. It is considered important due to the significant marine life in the area which includes sharks, eagle rays, turtles, mantas, barracudas, and whale sharks.
Mangrove/waterbody on island	None
Natural vegetation	The island maintains most of its natural vegetation. About 80% of the natural vegetation remains intact.
Agricultural land	Some agricultural land is on the eastern side of the island.
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	50m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 15. Nilandhoo

Location:	3° 3' 21" N 72° 53' 22" E
Registered Population (Census 2014):	2,016
Number of households:	244
Original Land area:	0.56 km <sup>2</sup>
Current land area	0.75 km <sup>2</sup>
Distance from Malé	144 km
Nearest airport	Maamigili (53 km)
Island description	The island is long with a length of 1.3km and a width of about 0.8km.
Reclamation	Yes. About 0.3 km <sup>2</sup> of land has been reclaimed on the northwestern side of the island.
Location and year of establishment of powerhouse	3° 3'32.93"N, 72°53'20.11"E 2019
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	About 60% of the island is residential areas and of the remaining half is agricultural land. Most of the natural vegetation is on the southern side of the island and on the eastern side periphery.
Agricultural land	Some
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None

Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	50m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 16. Guraidhoo

Location:	2° 19' 30" N 73° 19' 9" E
Registered Population (Census 2014):	2,060
Number of households:	310
Original Land area:	0.3 km <sup>2</sup>
Current land area	0.75 km <sup>2</sup>
Distance from Malé	209 km
Nearest airport	Thimarafushi (23 km)
Island description	The island is long with a length of 1.5km and a width of about 0.6km.
Reclamation	Yes. An area more than the size of the original island has been reclaimed on the eastern side and extending to the south of the island.
Location and year of establishment of powerhouse	2°19'28.78"N, 73°18'57.82"E 2007
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Very little natural vegetation remains on the northern side of the island
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	40m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 17. Th. Thimarafushi

Location:	2° 12' 20" N 73° 8' 34" E
Registered Population (Census 2014):	2589
Number of households:	212
Original Land area:	0.2 km <sup>2</sup>
Current land area	
Distance from Malé	224 km
Nearest airport	Thimarafushi (0 km)

Island description	The island is oval shaped with a length of about 0.7km a width of about 0.4 km.
Reclamation	Yes
Location and year of establishment of powerhouse	2°12'10.54"N, 73° 8'30.38"E 2008
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Almost no natural vegetation. It is a highly urbanized island with no large forest/woody areas.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	50m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 18. Maamendhoo

Location:	0° 42' 50" N 73° 26' 21" E
Registered Population (Census 2014):	1,537
Number of households:	244
Original Land area:	0.5 km <sup>2</sup>
Current land area	As above
Distance from Malé	385 km
Nearest airport	Koodoo (2.5 km)
Island description	The island is long and narrow with a length of 1.4km and a width of about 0.45km.
Reclamation	None
Location and year of establishment of powerhouse	0°42'44.41"N, 73°26'18.02"E 2000
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	About 60% of the island is residential areas and of the remaining half is agricultural land. Most of the natural vegetation is on the southern side of the island and on the eastern side periphery.
Agricultural land	Yes
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)

Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	60m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 19. Faresmaathodaa

Location:	0° 12' 04" N 73° 11' 16" E
Registered Population (Census 2014):	1796
Number of households:	238
Original Land area:	0.4 km <sup>2</sup>
Current land area	As above
Distance from Malé	444 km
Nearest airport	Kaadedhoo (39 km)
Island description	The island is rectangular shaped with a length of about 1.5km and a width of about 0.3 km.
Reclamation	None
Location and year of establishment of powerhouse	0°12'4.17"N, 73°11'15.56"E 2008
Protected areas	None
Ecologically significant area recognized by EPA	A mangrove area on the island is identified by EPA as an ecologically sensitive area. (0° 12' 04" N; 73° 11' 09" E)
Mangrove/waterbody on island	None
Natural vegetation	The island is highly urbanized with some of the natural vegetation remaining on the southeastern side of the island. Houses maintain home gardens and large shady trees which make the overall island green.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	70m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

### 20. Gadhoo

Location:	0° 17' 20" N 73° 27' 21" E
Registered Population (Census 2014):	3,074
Number of households:	351
Original Land area:	0.3 km <sup>2</sup>
Current land area	0.6 km <sup>2</sup>
Distance from Malé	433 km
Nearest airport	Maavarulu (8 km)
Island description	The island is long with 1.7km length and a width of less than 0.1km on the northern side and 0.4-0.5km on the southern side which is wider.

Reclamation	Yes. An area on the north and eastern side of the island has been reclaimed making the island almost double in size.
Location and year of establishment of powerhouse	0°17'15.09"N, 73°27'17.10"E 1995
Protected areas	None
Ecologically significant area recognized by EPA	Gadhdhoo kandu (0° 17' 11" N; 73° 26' 51" E) on the southwestern side of the island has been identified as an ecologically sensitive side due to marine fauna such as tiger sharks, grey reef, and other sharks in the area.
Mangrove/waterbody on island	None
Natural vegetation	Very little of the natural vegetation remains. The island is densely populated and hence the need for reclamation.
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: Yes Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Residential area / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	20m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

## 21. Thoddoo

Location:	4° 26' 20" N 72° 57' 31" E
Registered Population (Census 2014):	1,826
Number of households:	377
Original Land area:	1.73 km <sup>2</sup>
Current land area	As above
Distance from Malé	67.8 km
Nearest airport	Velana International Airport (68.24 km)
Island description	The island is circular/triangular with a width of 1.1-1.5km on either side.
Reclamation	None
Location and year of establishment of powerhouse	4°26'12"N, 72°57'38"E 2021
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Some of the natural vegetation around the periphery of the island and between the residential area and farmland still exists. Otherwise mainly farmland
Agricultural land	Yes, 431 farming plots. About 70% of the island is farmland
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	No
Land use and ownership in project footprint	Agriculture land / Island Council (Government)



Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	400 m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

## 22. Komandoo

Location:	6° 3' 14" N 73° 3' 15" E
Registered Population (Census 2014):	1081
Number of households:	293
Original Land area:	0.1 km <sup>2</sup>
Current land area	0.2 km <sup>2</sup>
Distance from Malé	213.4 km
Nearest airport	Ifuru (38.4 km)
Island description	The island is circular/triangular with a width of 0.5-0.6km on either side.
Reclamation	Yes, the lagoon around the island has been reclaimed up to the reef. Reclamation work is ongoing to connect Komandoo and Mathikomandoo (uninhabited island) via a causeway.
Location and year of establishment of powerhouse	5°29'37"N, 73°25'26"E 2022
Protected areas	None
Ecologically significant area recognized by EPA	None
Mangrove/waterbody on island	None
Natural vegetation	Almost none due to reclamation
Agricultural land	None
Critical habitat (terrestrial/marine)	Terrestrial: No Marine: Yes
Terrestrial vegetation on project footprint	None
Number of trees supported by project footprint	None
Marine habitat in project footprint	Yes.
Land use and ownership in project footprint	Lagoon / Island Council (Government)
Nearest distance to property from powerhouse or other project site (excluding cables that run along existing roads)	More than 500m
Harbor /Jetty available	Yes
PCR on island	Yes, Mosques
PCR on project footprint	None

## V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

### A. Methodology

238. The methodology used for assessing the environmental impacts from the ongoing ADB supported POISED project in Maldives which is reported to be in line with EPA requirements has been adopted for the ASSURE project. The impact assessment methodology involves the following steps which are further elaborated in subsequent sections.

- (i) Identifying the environmental components that may be impacted.
- (ii) Screening and scoping for identifying the type of impacts including those during planning and design, construction, operation, and decommissioning stages of the project.
- (iii) Identifying the project influence area where the impacts will be felt.
- (iv) Defining the criteria for assessing the significance of each type of impact.
- (v) Identifying the significance of impacts based on qualitative and quantitative (where possible) techniques to guide development of mitigation measures and ensure that there are no or few significant residual impacts.

239. Both direct and indirect impacts as well as positive and negative impacts of the project have been assessed. Impacts are examined separately for the planning and design, construction, and operation as well as decommissioning phases of the project components. Table 33 shows the potential impacts from the activities of the project components. A (+) indicates a positive impact, (-) a negative impact and (0) indicates no or negligible impact based on initial review of the proposed project components. The level of potential impact can be further determined as small, medium to large depending on the magnitude, duration and frequency of the impact. An assessment of cumulative and induced impacts has also been carried out. The significance of impacts is further evaluated using criteria; (i) sensitivity, (ii) recoverability, (iii) importance, and (iv) spatial distribution as given in Table 34. The scoring for each criterion is based on the values given in Table 34. During the assessment process expert opinion is used to give relevant scores for each impact. 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 will give 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. The significance scores are interpreted as follows:

- (i) Score < 0: A positive impact/benefit
- (ii) Score 1-5: A minor impact
- (iii) Score 6-9: A moderate impact
- (iv) Score 10-12: A major impact

240. For the potential mitigation approaches, the mitigation hierarchy as defined in the ADB's Safeguard Policy Statement (2009) has been used and applied for potential impacts. The mitigation hierarchy; avoid, minimize, mitigate and compensate/offset; has been used to guide the mitigation of environmental and social impacts from the project components. The proposed mitigation strategy focuses on minimizing the minor to moderate impacts of the project components.

Table 33. Impacts Matrix for the ASSURE Project Components

Environmental aspects	Physical Environment															Biological Environment										Social Environment including Physical Cultural Resources																												
	Air Quality	Climate	Noise level (including underwater)	Light levels (including glint and glare/shadow flicker)	Topography (soil erosion)	Drainage and waterlogging	Marine hydro morphological process	Soil quality	Use of natural resources	Generation of wastes	Surface water quality	Surface water quantity	Ground water quality	Groundwater quantity	Marine water quality	Mangrove, wetland, forest habitat	Beach and coastal fringe vegetation	Other terrestrial habitat (Vegetation)	Terrestrial fauna	Avifauna	Coral reefs and seagrass	Other marine habitat	Marine fauna	Protected areas and ESA	Protected or threatened species	Spread of invasive species	Agricultural land	Human settlement	Recreational land	Other land use	Employment	Community health safety	Conflict including SAEH (community)	Communicable diseases (community)	Occupational health and safety	Aesthetics	Cultural/religious values	Cultural/religious sites	Chance finds	Pressure on community resources/facilities	Public utilities	Access to property / business / facilities	Road users	Local economy	Knowledge and awareness	Fishing and navigation	Local tourism	Financial benefit to community	Airport safety (glint and glare, collision)					
Project components																																																						
I. Planning and Design Phase (Pre-construction)																																																						
Siting of wind turbines in project site <sup>43</sup>	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	0	0	0	0	0	0	0	0	0	0	0	0	0		
Selection of sites for ocean energy pilot	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	0	0	0	0	0	0	0	0	0	0	-	-	0	0	
Surveys for ocean energy	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	0	0	0	0	0	0	0	0	0	+	0	-	-	0	0
Selection of sites for rooftop photovoltaic 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	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-		
Surveys and studies for agriculture system	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0
Consultation and focus group meetings	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	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0
II. Construction Phase																																																						
Labor influx and presence of workers	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	0	0	0	0	0	+	0	0	0	0	0	0
Site establishment, set up areas 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	
Transport of materials and equipment	-	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	
Storage (including fuel, oil, chemicals)	-	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	0	0	0	0	0	0	
BESS, EMS, Grid Upgrade – works in powerhouse	-	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	0	0	0	0	+	0	0	0	0	0
Grid upgrade – cabling	-	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	0	
Clearing of trees and vegetation for wind energy and ground mounted photovoltaic	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	0	0	0	0	0	0	0	0	0	0	0	0		
Wind turbine installation	-	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	-	
Ocean energy installation	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		

<sup>43</sup> MOECCT has not flagged any requirement for a met mast during pre-construction or operation, the IEE does not consider the impacts of a met mast to measure wind speed and if one is required the IEE will need to be updated.

Environmental aspects	Physical Environment															Biological Environment										Social Environment including Physical Cultural Resources																										
	Air Quality	Climate	Noise level (including underwater)	Light levels (including glint and glare/shadow flicker)	Topography (soil erosion)	Drainage and waterlogging	Marine hydro morphological process	Soil quality	Use of natural resources	Generation of wastes	Surface water quality	Surface water quantity	Ground water quality	Groundwater quantity	Marine water quality	Mangrove, wetland, forest habitat	Beach and coastal fringe vegetation	Other terrestrial habitat (Vegetation)	Terrestrial fauna	Avifauna	Coral reefs and seagrass	Other marine habitat	Marine fauna	Protected areas and ESA	Protected or threatened species	Spread of invasive species	Agricultural land	Human settlement	Recreational land	Other land use	Employment	Community health safety	Conflict including SAEH (community)	Communicable diseases (community)	Occupational health and safety	Aesthetics	Cultural/religious values	Cultural/religious sites	Chance finds	Pressure on community resources/facilities	Public utilities	Access to property / business / facilities	Road users	Local economy	Knowledge and awareness	Fishing and navigation	Local tourism	Financial benefit to community	Airport safety (glint and glare, collision)			
Ground mounted photovoltaic installation	-	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		
Installment of rooftop photovoltaic	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	-	0	0	+	0	0	0	0	0	0		
Installation agricultural interventions	-	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	0	
Connection to the grid (wind, ground mounted solar)	-	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 construction wastes	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	0	0	0	0	0	0	0	0	0	0	0	
Restoration of construction sites	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	0	+	0	0	0	+	+	0	0	0	0	0	0	0	0	0		
III. Operational Phase*																																																				
O&M of BESS, EMS, Grid Upgrade	+	+	+	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	0	0	+	0	0	0	+	0	0	0	0	0	0		
Disposal of batteries	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	-	0	0	0	0	0	0	0	0	0	0	0	
Operation of wind turbines <sup>44</sup>	+	+	-	-	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	+	0	0	0	+	+	0	0	0	0	-
Piloting (operation) of ocean energy	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	0	0	0	0	+	-	-	0	0	
O&M including cleaning of solar photovoltaic (rooftop and ground mounted)	+	+	+	-	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	0	0	+	0	0	0	0	0	-	
Disposal of photovoltaic 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	-	0	0	0	0	0	0	0	0	0	0	0	
Operation of agricultural interventions	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	0	0	+	0	0	0	0	+	+	0	0	0	+	0	
IV. Decommissioning Phase*																																																				
Disposal of batteries	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	-	0	0	0	0	0	0	0	0	0	0	0	
Disposal of photovoltaic 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	-	0	0	0	0	0	0	0	0	0	0	0	

\*Physical impacts of large-scale maintenance works and decommissioning RE equipment would be similar in nature to construction impacts

<sup>44</sup> MOECCT has not flagged any requirement for a met mast during pre-construction or operation, the IEE does not consider the impacts of a met mast to measure wind speed and if one is required the IEE will need to be updated.

**Table 34. Criteria for Evaluating Significance of Impacts**

Criteria	Scale	Attribute
Sensitivity How sensitive the receptor is to the predicated magnitude of impact/risk	-1	Positive Effect
	0	Not sensitive
	1	Low
	2	Medium
	3	High
Recoverability How long it would take for the receptor to recover from the impact	1	Short
	2	Medium
	3	Non-recoverable
Importance The importance of the receptor to the environment or society	1	Low
	2	Medium
	3	High
Spatial Distribution Distribution of impact	1	Local scale (island)
	2	Regional scale (atoll)
	3	Global scale

241. The assessment of the impacts is based on pre-feasibility and technical studies of the project components and may be subject to change following detailed design in which case the IEE and EMP will be revisited. In particular, any change to the selected turbine type and layout, or the choice of a foundation other than gravity-type will influence the impacts of the wind energy component. The IEE and EMP will also need to be updated following the studies for the pilot ocean power generation and agriculture interventions since the locations and exact scope of those components are still to be studied.

#### **B. Impacts and Mitigation: Planning and Design Phase (Pre-Construction)**

242. Scoping identifies only a few potential negative impacts from the planning and design stage that will be undertaken pre-construction. Planning and design activities include visits to the project sites for technical, environmental and gender and social assessments and detailed design. For the most part the assessment work is already completed as part of this IEE, but further assessment is required for the ocean energy and agricultural system involving consultants travelling to carry out the necessary assessments and consultations with local communities. For the ocean energy pilot there will be some physical survey activities that may result in minor disturbance to marine habitats as discussed in Appendix 9. Positive impacts include financial benefits to small businesses (guesthouses, cafes, shops, etc.) and increased awareness of the community (during consultations) about the project components and renewable energy through consultations.

243. The planning and design phase is critical in the mitigation of negative impacts. Avoidance of negative impacts is the first step in the mitigation hierarchy followed by minimization. Careful planning can avoid unnecessary negative impacts from the project-funded components. Site selection during the planning phase has already considered avoiding the most significant negative environmental and social impacts but further design decisions for the wind and ocean energy components need to ensure potential impacts are considered, similarly in planning the agricultural interventions the sites for any cold storage or shade houses will need to be appropriately located. For other components open land without any ecological significance or requiring tree cutting has been chosen.

244. The pre-construction stage is also when consideration must be given by the contractor to environmental management planning, sensitive construction methods, health, and safety risk assessment and management planning etc. Good planning is super critical in the mitigation of potential negative impacts. All the project sites are accessible by existing roads and there is no need for construction of new roads or wharfs and jetties to facilitate access; existing island accommodation and water supplies will be used whilst there is no need for construction sites to be established with storage of materials and equipment mostly being in the powerhouses as discussed in Chapter III.

## 1. Physical Environment

245. Pre-construction impacts on the physical environment are mostly negligible but there will be some minor impacts related to the completion of survey work for the ocean energy system. BESS and EMS will be installed within the premises of the existing powerhouses having only a small footprint with grid upgrades along existing roads as discussed in Chapter III. Since transformers will be dry (cast resin) type (no oils) and package substations and/or ring main units will be air insulated (no SF6 a potent greenhouse gas) the only further considerations for minimizing impacts on the physical environment during detailed design relate to operational noise levels from equipment, and ensuring drainage is maintained around foundations. The project will use compact and preassembled systems to minimize the subsequent impacts of construction. The site selected for the wind turbines on Mamadhoo island is about 130m from the nearest residential property so careful attention to the selection of the turbines and their layout is required since it is necessary to ensure the detailed design enables operational noise and shadow flicker requirements from the IFC EHS Guidelines on Wind Energy to be met, as well as considering locational constraints on the transportation of materials and equipment, and keeping construction related impacts to a minimum. The contractor through the contract will be required to undertake a noise and shadow flicker assessment of the detailed design to confirm that the IFC EHS Guidelines on Wind Energy requirements can be met at non-FENAKA properties, and only once this is demonstrated will the PMU approve it, further the contractor will also undertake commissioning noise monitoring to confirm it is compliant. There is one building (green roof on aerial photograph) that is a temporary boat shed for construction of a boat, MOECCT are informed that this will be removed before construction, this will need to be ensured otherwise it will not be possible for the project to comply with the noise and shadow flicker requirements at non-FENAKA properties. For FENAKA buildings there is no restriction on shadow flicker occurrence, but its occurrence will need to be factored into the operational, occupational health and safety risk assessment. The contractor will also be required to confirm their foundation method and undertake a quantitative construction noise assessment to confirm noise levels can be met at the nearest residential property at 130m.<sup>45</sup> The pilot ocean energy system will be a floating devise to be installed at a site to be selected during project implementation, as part of site selection marine survey work will be conducted pre-construction the impacts of which are considered further in Appendix 9 with the design needing to ensure impacts on the marine environment are minimized. Rooftop solar photovoltaic panels will be installed on public buildings and have no or minimal impact on the physical environment, except for potential glint/glare on neighboring properties (including airports) that can be addressed through orientation etc. The proposed site for the ground mounted solar (in Thoddoo island) is kept away from the residential areas so impacts from glint and glare will be minor. For all solar panels only those that do not contain hazardous materials will be utilized to avoid future issues with their disposal. The ground mounted solar

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<sup>45</sup> If piling is required the noise and groundwater impacts will need to be quantitatively assessed, noise levels must be complied with following the adoption of mitigation measures and there must be no impact on the freshwater groundwater lens which is usually found at 2 m or below ground level because of opening a new pathway for pollution.

photovoltaic on Thoddoo island will be established on agricultural land of 1,500 sqm and the design will need to ensure drainage is maintained ideally with rainwater harvesting incorporated which can then be used to wash the solar photovoltaic panels. The irrigation system will be implemented on agriculture lands on Thoddoo island with the cooperation of the farmers who will benefit, but in determining the best approach potential impacts in relation to soil quality and water resources (savings) will need to be considered along with the locational impacts of any cold storage or shade houses proposed. If cold storage is included the refrigeration will need to comply with the Maldives HCFC reduction policies, and hence refrigerant such as R-22 (CHClF<sub>2</sub> with 0.047 ozone depleting potential) must not be used. The project should ensure refrigerants such as R-717<sup>46</sup> (ammonia, toxic and corrosive, can cause explosion/fire, but it is not ozone depleting) will also not be used with only normal cooling water discharged and no chemicals or other impurities will be let out through the drain. Designs will not involve PCBs or the use of asbestos; use of SF6 is also not to be permitted.

246. To ensure that all the environmental measures to be considered during detailed design and pre-construction are implemented by the contractor, the EMP will be included in the bidding documents.

## 2. Biological Environment

247. Pre-construction impacts on the biological environment are mostly negligible but there will be some minor impacts related to the completion of survey work for the ocean energy system at the islands of Mulah, Muli and Komandoo. This will include marine ecology surveys to ensure the pilot is located away from coral and sea grass habitat. The pilot ocean energy system will be a floating device to be installed at a site to be selected during project implementation, as part of site selection marine survey work will be conducted pre-construction the impacts of which are considered further in Appendix 9 with the design needing to ensure impacts on the marine environment are minimized. The design will also need to ensure there are no impacts on terrestrial habitat (vegetation) by selecting a clear access point for installation, ideally installation will be undertaken from the existing wharf/jetty since the coastal strip of vegetation is not permitted to be cleared. Further no access across or storage on beach habitat will be permitted, these restrictions will need to be taken into account in the feasibility study when selecting the preferred ocean energy site.

248. The project facilities do not directly encroach on any protected areas, KBA and IBA or environmentally sensitive areas locally designated by EPA. Most of the terrestrial project sites are on modified habitat and not requiring any tree cutting or vegetation clearance although some agricultural crop will be lost to the ground mounted solar photovoltaic on agricultural land of 1500 sqm at Thoddoo island and potentially in the installation of other agricultural interventions. Grid upgrade work will be mostly done along the existing roads on the islands and routing can ensure damage to trees is avoided. However, attention is needed during detailed design to the wind energy component on Manadhoo island (Figure 37) since this site supports beach and coastal fringe vegetation as well as trees and inner vegetation plants which are commonly found in the islands of the Maldives. There are no threatened species of flora or fauna observed, and no old or large trees that would be protected under regulation. But there are about 24 trees over an area of 6,000 sqm and at least some of these will be lost to the turbine layout. The trees on the site include beach plum (*Scaevola taccada*), coconut palm (*Cocos nucifera*), Indian tulip tree (*Thespesia populnea*), cordia (*Cordia subcordata*), sea hibiscus (*Hibiscus tiliaceus*), and black

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<sup>46</sup> There are health hazards associated with the use of R-717 and skilled labour is required to operate and maintain R-717 refrigeration plants thus an alternative refrigerant is preferred.

mangrove (*Lumnitzera racemose*). In designing the turbine and related infrastructure layout, the contractor will need to ensure no trees or vegetation are lost from the 20 m vegetation belt from the coast, the littoral hedge and sub-littoral thicket are maintained, black mangroves that prevent beach erosion are maintained, and as few trees as possible are cut to facilitate the wind energy development with permission obtained from government, Island Council. Clear cutting the area of vegetation to facilitate construction will have an irreversible negative impact on the environment, thus the detailed design must seek to minimize tree loss whilst balancing wake effects and energy generation potential. Further no turbines will be permitted to be located on the beach itself. To ensure that all the environmental measures to be considered during detailed design and pre-construction are implemented by the contractor, the EMP will be included in the bidding documents.

### 3. Social Environment

249. Pre-construction impacts on the physical environment are mostly negligible but there will be some minor impacts related to ensuring community health and safety and interactions with fishing communities during the completion of survey work for the ocean energy system. Local boat drivers will likely be employed during these surveys whilst visits by the PMU and contractor for this and other components will benefit the local economy since accommodation and food will be required by them. During selection of the sites for ocean energy consultation will need to be undertaken to avoid conflict, especially with respect to fishing and navigation and water-based tourism activities.

250. A small footprint of land area is required for the project. The sites have been chosen to avoid relocation of residents and minimize loss of agricultural and recreational lands except for Thoddoo island where the project component will be of benefit to farmers. The sites selected for the project-funded facilities are free from any encroachments and no relocation is required. The site for the wind turbines is owned by the Island Council and will be transferred to the project. By retaining a buffer of 100 m to non-FENAKA properties community health and safety risks will be minimized. There is one building (green roof on aerial photograph) that is a boat shed for construction of a boat, MOECCT are informed that this will be removed before construction, this will need to be ensured otherwise it will not be possible for the project to meet the 100m set back requirement. FENAKA buildings can be closer, but the contractor will need to conduct a facilitated, operational occupational health and safety (OHS) risk assessment together with FENAKA to ensure that the risks are acceptable to them based on the extent the area within 100m is used by its personnel. Consultation is to be undertaken with the aviation authorities and nearest airport operator<sup>47</sup> to confirm they have no concern with the detailed design, on the islands with airports they should also be consulted for photovoltaic components due to potential for glint or glare. The site for the ground mounted photovoltaic on Thoddoo island is owned by the island council and whilst previously agricultural has already been cleared of crops. There are no sites of archaeological importance in and around the project facilities on selected project islands although as some mosques are adjacent to powerhouses' consideration will need to be given during pre-construction to minimizing noise disturbance during prayer times. The presence of no marine-based physical cultural resources beneath the footprint of the ocean energy pilot is to be reconfirmed in updating the IEE for the selected location.

251. Grid upgrade work will be mostly done along the existing roads on the islands; but routing can ensure damage to properties and public utilities is avoided. In all cases detailed design will

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<sup>47</sup> Nearest airport is Maafaru which is about 9.74 km from the island, though no significant impacts are anticipated the airport authority is to be consulted during detailed design.



need to ensure community health and safety risks are taken into account, and for wind turbines the aviation authorities are to be consulted regarding the need to light cranes and the turbines for the safety of aircraft.

252. To ensure that all these environmental measures to be considered during pre-construction are implemented by the contractor, the EMP will be included in the bidding documents.

### **C. Impacts and Mitigation: Construction Phase**

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

- (i) BESS, EMS, and upgrade of grid systems at powerhouses (equipment installation work),
- (ii) Upgrade of grid systems (cable work),
- (iii) Installation of rooftop photovoltaic panels and a ground mounted solar photovoltaic plant on Thoddoo island,
- (iv) Installation of wind turbines on Manadhoo island,
- (v) Installation of ocean energy pilot system, and
- (vi) Installation of agriculture interventions on Thoddoo island including drip irrigation system.

254. All 22 islands under the ASSURE project except for Komandoo (if chosen for the ocean energy system) will have some level of grid refurbishment (cable laying and associated control panel work) as well as a BESS system. The main anticipated impacts and risks relate to short-term (approximately 3-5 days for smaller works and 2-3 months for larger works i.e., wind turbine installation) disruption and disturbance during construction; pollution risks; and health and safety risks to workers and local communities, for example, island roads will be blocked, and noise and dust emissions will be created from the operation of construction machinery such as concrete mixers, bulldozers, dump trucks, cranes etc. Notable impacts of concern to the environment and local communities will arise from the civil works for cabling since this will be in the public domain and disrupt road users and the large-scale (in the context of Maldives) civil works for the installation of wind turbines on Manadhoo island.

255. Assessment of the impacts pre-mitigation using the significance criteria has been carried out for these activities and presented in Table 35 to Table 41 - Table 35 addresses the BESS which are to be installed at the powerhouses; two other small BESS will be in a cabinet/small building adjacent to the wind turbines/ground mounted solar system and impacts are considered under the relevant table for those project components. Impacts and mitigation measures are elaborated in subsequent sections. The ocean energy pilot will not have any civil work, but there will be disturbance to the marine environment from its installation as discussed in Appendix 9, which will need to be mitigated for.

**Table 35. Significance Analysis of Impacts of Battery Energy Storage System, EMS and Grid Upgrade (Works within Powerhouses) in ASSURE Project Islands**

Environment	Potential Impact		Impact	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	Small, short term, transient changes in ambient air quality due to dust and suspended particulate matter from construction of small buildings and traffic movements on unpaved access roads, as well as emissions from construction vehicles and machinery.	Yes(-)	0	1	1	1	3	Minor
	Climate	No impacts on climate due to BESS, EMS, or Grid Upgrade project activities.	No						
	Noise level (including underwater)	Medium, short term, transient changes in ambient noise due to mobilization of equipment and machinery, transport of materials, use of construction vehicles, and general construction activities in powerhouses (some powerhouses adjacent to residential areas but the powerhouses are already a source of high background noise levels).	Yes(-)	0	1	2	1	4	Minor
	Light levels (including glint/glare and shadow flicker)	No impacts on light levels due to BESS, EMS, or Grid Upgrade project activities, works during the daytime.	No						
	Topography (soil erosion)	Footprint of works is small within the existing powerhouses, the extent of any soil erosion because of rainfall inside the existing compound will be extremely limited, sandy soils are also well draining provided they are not compacted.	Minimal						
	Drainage and waterlogging	Footprint of works is small and within existing powerhouses but some potential for waterlogging due to the compaction of soils during site establishment, introduction of concrete foundations etc.	Yes(-)	0	1	1	1	3	Minor
	Marine hydrological processes	No impacts on marine hydrology due to BESS, EMS, or Grid Upgrade project activities as they are land based.	No						
	Soil quality	Medium, short-term risk of changes in soil quality within powerhouse from spills/leaks of fuel, oil, chemicals used in construction, soils are sandy and will absorb spills/leaks.	Yes(-)	1	1	1	1	4	Minor
	Use of natural resources	Sourcing of small volumes of cement, sand, and other building materials from off-island for the	Yes(-)	1	1	1	2	5	Minor

Environment	Potential Impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
		construction of foundations and small buildings for BESS installation							
	Waste generation	Impacts due to generation and inappropriate disposal of small volumes of inert spoil, solid and hazardous waste from construction like metal scraps and wooden packing material, polythene as well as municipal waste from construction labor at work sites. Disposal of defunct batteries for BESS needs particular attention as a hazardous waste material.	Yes(-)	1	1	2	2	6	Moderate
	Surface water quality	No impacts on surface water quality from BESS project activities as works confined to footprint of powerhouse with no surface water found nearby.	No						
	Surface water quantity	No impacts on surface water quantity from BESS, EMS, or Grid Upgrade project activities as surface water resources will not be used.	No						
	Ground water quality	Since groundwater is shallow and sandy soils highly permeable there is a medium but short-term pollution risk in the event of any leaks or spills due to use of fuel, oil, chemicals during construction works at the powerhouse.	Yes(-)	1	1	2	1	5	Minor
	Groundwater quantity	Existing island water sources will be utilized with permission of Island Council, volume required for construction water and water for the workers is limited.	Minimal						
	Marine water quality	Low risks to marine water quality from the transport of construction materials by boat and inappropriate disposal of wastes in the short term; especially any defunct batteries for BESS	Yes(-)	1	1	2	1	5	Minor
Ecological	Mangrove, wetland, forest habitat	No impacts due to BESS, EMS, or Grid Upgrade project activities as confined to footprint of powerhouses	No						
	Beach and coastal fringe vegetation	Project activities are confined to footprint of powerhouses, but some risk of disturbance on Raimandhoo as access will be via the beach (already disturbed existing boat landing areas are to be used for the transport of materials to minimize impacts)	Yes(-)	1	1	2	1	5	Minor
	Other terrestrial habitats (vegetation)	Footprint of BESS, EMS, or Grid Upgrade works is small within the existing powerhouses/no vegetation needs to be removed and there are no trees to be cut.	Minimal						

Environment	Potential Impact	Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance		
		Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level	
	Terrestrial fauna	No impacts due to BESS, EMS, or Grid Upgrade as project activities are confined to the footprint of powerhouses, fauna using forest and coastal habitat near powerhouses will be disturbed in short term, but no very noisy construction works so impact will be small.	Yes(-)	1	1	1	1	4	Minor
	Avifauna	No impacts due to BESS, EMS, or Grid Upgrade as project activities are confined to footprint of powerhouses, avifauna using forest and coastal habitat near powerhouses will be disturbed in short term, but no very noisy construction works so impact will be small.	Yes(-)	1	1	1	1	4	Minor
	Coral reefs and seagrass	No impacts due to BESS, EMS, or Grid Upgrade project activities as all activities are land based.	No						
	Other marine habitat	No impacts due to BESS, EMS, or Grid Upgrade project activities as all activities are land based.	No						
	Marine fauna	No impacts due to BESS, EMS, or Grid Upgrade as project activities are confined to footprint of powerhouses, but some risk of disturbance to marine fauna related to marine transport and the lack of usable wharf/jetty requiring a beach landing at Raimandhoo	Yes(-)	1	1	2	1	5	Minor
	Protected areas and ESA	No impacts due to BESS project activities as confined to footprint of powerhouses.	No						
	Protected or threatened species	No impacts due to BESS, EMS, or Grid Upgrade as project activities are confined to footprint of powerhouses, but some risk of disturbance to marine turtles related to marine transport and the lack of usable wharf/jetty requiring a beach landing at Raimandhoo	Yes(-)	1	1	2	1	5	Minor
	Invasive species spread	Limited risk of invasive species spread from the transport of materials as local boats will be used.	Minimal						
Social	Agricultural land	No impacts due to BESS, EMS, or Grid Upgrade project activities as confined to footprint of powerhouses.	No						
	Human settlement	No impacts due to BESS, EMS, or Grid Upgrade project activities as confined to footprint of powerhouses and all storage of materials will be within the compound itself.	No						
	Recreational land	No impacts due to BESS, EMS, or Grid Upgrade project activities as confined to footprint of powerhouses.	No						

Environment	Potential Impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
Environment	Other land use	Small footprint of land within the existing powerhouse will be required.	Yes(-)	0	1	1	1	3	Minor
	Employment	Small number of employment opportunities for labor during construction.	Yes(+)						
	Community health safety	No community access to powerhouse but medium, short term, transient disturbance due to noise as powerhouses are close to residential areas and introduction of some health and safety risks to community when materials and equipment transported to site on public roads and from inappropriate disposal of wastes like metal scraps, defunct batteries etc.	Yes(-)	1	2	2	1	6	Moderate
	Conflict including SAEH	Some risk of conflict as labor will in part come from off the island and may include migrant workers. Conflict may also arise because of social disturbances related to construction noise at the powerhouse, use of roads by construction vehicles and the inappropriate disposal of wastes like metal scraps, defunct batteries etc.	Yes(-)	1	1	2	1	5	Minor
	Communicable diseases	Low risk of communicable diseases such as COVID-19 introduced to community as labor will in part come from off the island, there is also a risk from vector borne diseases with ponded water due to poor drainage although the soils are sandy and thus should be well draining.	Yes(-)	1	1	2	1	5	Minor
	Occupational health and safety (OHS)	OHS risks to construction workers during the construction period, e.g., movement of vehicles, use of equipment and machineries, working conditions, etc. as well as hazards relating to working with electricity in connecting to the grid.	Yes(-)	2	2	2	1	7	Moderate
	Aesthetics	New buildings/containers installed in landscape but footprint of these is small and sited within the existing powerhouses all of which one are currently walled, storage of materials for the works will also be in the powerhouse.	Minimal						
	Cultural/religious values	Some powerhouses are in proximity to mosques resulting in disruption and disturbance during construction works	Yes(-)	1	1	2	1	5	Minor
	Cultural/religious sites	No impacts due to BESS, EMS and Grid Upgrade project activities as works confined to powerhouses.	No						
	Chance finds	Low risk as although there is excavation for foundations the footprint of BESS, EMS and Grid Upgrade works is small and within the grounds of	Yes(-)	0	1	1	1	3	Minor

Environment	Potential Impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
		the existing powerhouses which is already disturbed land.							
	Pressure on Community Resources	Small, short term, transient impacts as the existing accommodation and services will be used but only a small number of labors are required for the BESS, EMS and Grid Upgrade project activities, construction wastes will be taken off island to avoid Island Council having to take on responsibility for waste disposal.	Yes(-)	1	1	1	1	4	Minor
	Public utilities	Minimal impacts as BESS, EMS and Grid Upgrade requires connection to the existing island grid system but works are within the exiting powerhouse.	Minimal						
	Access to property / business / facilities	No impacts due to BESS, EMS and Grid Upgrade project activities as works confined to powerhouses.	No						
	Road users	Small, short term, transient impacts due to road user disruption as construction requires materials and equipment to be transported to site along public roads.	Yes(-)	1	1	1	1	4	Minor
	Local economy	Benefits from enhanced spending on food and lodging in local communities due to presence of small numbers of contractor's staff	Yes(+)						
	Knowledge and awareness	No impacts due to BESS, EMS and Grid Upgrade project activities although contractors will undertake awareness raising on electricity safety in the local communities.	No						
	Fishing and navigation	Small, short term, transient impacts as BESS system requires materials and equipment transported to site by boat using the existing wharfs/jetties which may conflict with access for other boat users	Yes(-)	1	1	1	1	4	Minor
	Local tourism	Small, short term, transient impacts as BESS system requires materials and equipment transported to site by boats and along public roads and although most activity is focused on the resort islands most inhabited islands have a degree of local tourism.	Yes(-)	1	1	1	1	4	Minor
	Financial benefit to community	No financial benefit will be accruing to the local community from the works	No						
	Airport safety	No risks to airport safety due to BESS, EMS, and Grid Upgrade project activities.	No						

**Table 36. Significance Analysis of Impacts of Grid Upgrade (Cabling) in ASSURE Project Islands**

Environment	Potential impact		Impact	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	Small, short term, transient changes in ambient air quality due to dust and suspended particulate matter from cable trenching in the public domain and traffic movements on unpaved access roads as well as emissions from use of construction vehicles and machinery.	Yes(-)	1	1	2	1	5	Minor
	Climate	No impacts on climate due to grid upgrade (cabling) works on islands.	No						
	Noise level (including underwater)	Medium, short-term, transient changes in ambient noise due to civil works (open trenching for underground cable installation) in public domain, mobilization of equipment and machinery, transport of materials, use of construction vehicles, and general construction activities near the residential properties.	Yes(-)	1	1	2	1	5	Minor
	Light levels (including glint/glare and shadow flicker)	No impacts on light levels due to grid upgrade (cabling) works on islands, works during the daytime.	No						
	Topography (soil erosion)	Footprint of works is small along exiting roads and as roads will be restored immediately the extent of any soil erosion because of rainfall will be extremely limited, sandy soils are also well draining provided they are not compacted.	Minimal						
	Drainage and waterlogging	Footprint of works is small along exiting roads and as roads will be restored immediately the extent of any waterlogging because of rainfall will be extremely limited, sandy soils are also well draining provided they are not compacted.	Minimal						
	Marine hydrological processes	No impacts on marine hydrological processes due to grid upgrade (cabling) works on islands.	No						
	Soil quality	Medium, short-term risk of changes in soil quality from spills/leaks of fuel, oil, chemicals used in construction, soils are sandy and will absorb spills/leaks.	Yes(-)	1	1	1	1	4	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
Environment	Use of natural resources	Sourcing of small volumes of sand and other materials for construction of cable trenches from off-island.	Yes(-)	1	1	1	2	5	Minor
	Waste generation	Impacts due to generation and inappropriate disposal of inert spoil, solid and hazardous waste from construction wastes like metal scraps and wooden packing material, polythene as well as municipal waste from construction labor at work sites.	Yes(-)	1	1	2	1	5	Minor
	Surface water quality	Minimal risk of impacts on surface water quality due to grid upgrade (cabling) works on islands as cabling works will be within the existing roads and potential for soil erosion is very limited.	Minimal						
	Surface water quantity	No impacts on surface water quantity due to grid upgrade (cabling) works on islands as the surface water resources will not be used.	No						
	Ground water quality	Since groundwater is shallow and sandy soils highly permeable there is a medium but short-term pollution risk in the event of any leaks or spills due to use of fuel, oil, chemicals during works.	Yes(-)	1	1	2	1	5	Minor
	Groundwater quantity	Existing island water sources will be utilized with permission of Island Council, volume required for construction water and water for the workers is limited.	Minimal						
	Marine water quality	Low risks to marine water quality from the transport of materials by boat and inappropriate disposal of wastes in the short term.	Yes(-)	1	1	2	1	5	Minor
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat due to grid upgrade (cabling) works on islands.	No						
	Beach and coastal fringe vegetation	Project activities are confined to footprint of existing roads, but some risk of disturbance on Raimandhoo as access will be via the beach (already disturbed existing boat landing areas are to be used for the transport of materials to minimize impacts on beaches)	Yes(-)	1	1	2	1	5	Minor
	Other terrestrial habitats (vegetation)	Footprint of the works is small along existing roads/no vegetation is to be cleared and no trees are to be cut.	Minimal						



Environment		Potential impact	Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Terrestrial fauna	Some potential disturbance to fauna using trees and vegetation along existing roads in short term/no vegetation is to be cleared or trees to be cut.	Yes(-)	1	1	1	1	4	Minor
	Avifauna	Some potential disturbance to fauna using trees and vegetation along existing roads in short term/ no vegetation is to be cleared or trees to be cut.	Yes(-)	1	1	1	1	4	Minor
	Coral reefs and seagrass	No impacts on coral reefs and seagrass due to grid upgrade (cabling) works on islands.	No						
	Other marine habitat	No impacts on marine habitats due to grid upgrade (cabling) works on islands.	No						
	Marine fauna	No impacts on marine fauna due to grid upgrade (cabling) works on islands, but some risk of disturbance to marine fauna related to marine transport and the lack of usable wharf/jetty requiring a beach landing at Raimandhoo	Yes(-)	1	1	2	1	5	Minor
	Protected areas and ESA	No impacts on protected areas and ESA due to grid upgrade (cabling) works on islands.	No						
	Protected or threatened species	No impacts on protected or threatened species due to grid upgrade (cabling) works on islands, but some risk of disturbance to marine turtles related to marine transport and the lack of usable wharf/jetty requiring a beach landing at Raimandhoo	Yes(-)	1	1	2	1	5	Minor
	Invasive species spread	Limited risk of invasive species spread from transport of materials as local boats will be used.	Minimal						
Social	Agricultural land	No impacts on agricultural land due to grid upgrade (cabling) works on islands as along existing roads.	No						
	Human settlement	Cabling works along existing roads in the built-up section of islands, storage of materials will be in the powerhouse, but the land use will be temporarily disrupted during cable trenching.	Yes(-)	1	1	2	1	5	Minor
	Recreational land	No impacts on recreational land due to grid upgrade (cabling) works on islands as along existing roads.	No						
	Other land use	Land within the powerhouse will be utilized for storage of construction materials and equipment.	Minimal						
	Employment	Small number of employment opportunities for labor during construction.	Yes(+)						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Community health safety	Health and safety risk to community especially vulnerable groups like children is present due to cabling works with open trenches in public domain, medium, short term, transient disturbance due to noise and from inappropriate disposal of wastes like metal scraps etc.	Yes(-)	2	2	2	1	7	Moderate
	Conflict including SAEH	Cabling work in public domain resulting in disruption and disturbance during construction, labor will in part come from off the island and may include some migrant workers. Social disturbances related to blocking of roads during works and inappropriate disposal of wastes like metal scraps etc.	Yes(-)	1	1	2	1	5	Minor
	Communicable diseases	Low risk of communicable diseases such as COVID-19 introduced to community as labor will in part come from off the island.	Yes(-)	1	1	2	1	5	Minor
	Occupational health and safety (OHS)	OHS risks to construction workers during the construction period, e.g., movement of vehicles, use of equipment and machineries, working conditions, etc. as well as hazards relating to working with electricity in connecting the underground cables to grid.	Yes(-)	2	2	2	1	7	Moderate
	Aesthetics	Temporary impact on aesthetics due to presence of open trenches and construction machinery in the public domain, storage of materials and equipment will be within the compounds of the existing powerhouses.	Yes(-)	1	1	1	1	4	Minor
	Cultural/religious values	Some cabling in proximity to mosques resulting in disruption and disturbance during construction works.	Yes(-)	1	1	2	1	5	Minor
	Cultural/religious sites	No impacts on cultural/religious sites due to grid upgrade (cabling) works on islands.	No						
	Chance finds	Low risk as there will be trenching but footprint small and along the existing roads which are already disturbed land.	Yes(-)	0	1	1	1	3	Minor
	Pressure on Community Resources	Small, short term, transient impacts as the existing accommodation and services will be used but only a small number of labors is required for the grid upgrade cabling work. Construction waste will be taken off the island	Yes(-)	1	1	1	1	4	Minor

Environment	Potential impact	Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
		Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	to avoid the Island Council having to take on the responsibility for waste disposal.							
Public utilities	Grid upgrade cabling requires connection to the grid system, there is also a risk other above and below ground public utilities are damaged during the cabling works.	Yes(-)	1	1	1	1	4	Minor
Access to property / business / facilities	Trenching for cabling works may temporarily restrict access to the properties for short time, it is maximum of one day for trench to remain open.	Yes(-)	1	1	2	1	5	Minor
Road users	Medium, short term, transient impacts as traffic and road users will be temporarily affected due to cabling (trenching) works on the existing roads.	Yes(-)	2	1	1	1	5	Minor
Local economy	Benefits from enhanced spending on food and lodging in local communities due to presence of limited numbers of contractor's staff	Yes(+)						
Knowledge and awareness	No impacts due to grid upgrade (cabling) works on islands although contractors will undertake awareness raising on electricity safety in the local communities.	No						
Fishing and navigation	Small, short term, transient impacts as grid upgrade requires materials and equipment transported to site by boat using the existing wharfs/jetties which may conflict with access for other boat users	Yes(-)	1	1	1	1	4	Minor
Local tourism	Small, short term, transient impacts as grid upgrades requires materials and equipment transported to site by boats and works along public roads; although most tourist activity is focused on the resort islands most inhabited islands have a degree of local tourism.	Yes(-)	1	1	1	1	4	Minor
Financial benefit to community	No financial benefit will be accruing to the local community from the works	No						
Airport safety	No impacts on airport safety due to grid upgrade works on Islands.	No						

**Table 37. Significance Analysis of Impacts of Solar Photovoltaic Installation (Rooftop)**

Environment	Potential impact		Impact	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	No impacts on air quality as no civil works involved in rooftop solar photovoltaic installations.	No						
	Climate	No impacts on climate from rooftop solar photovoltaic installations.	No						
	Noise level (including underwater)	Small, short term, transient changes in ambient noise levels due to installation work (e.g., frames for photovoltaic panels) with works on residential property in the public domain.	Yes(-)	1	1	2	1	5	Minor
	Light levels (including glint/glare and shadow flicker)	No impacts on light levels from rooftop solar photovoltaic installations during construction works, works in daytime.	No						
	Topography (soil erosion)	No impacts on topography as no civil works involved in rooftop solar photovoltaic installations.	No						
	Drainage and waterlogging	No impacts on drainage and waterlogging as the works involve installation on the rooftop of buildings.	No						
	Marine hydrological processes	No impacts on marine hydrological processes as works involve installation on rooftop of buildings.	No						
	Soil quality	Small, short-term risk of changes in soil quality in areas used for storage (e.g., existing powerhouses) from spills/leaks of fuel, oil, chemicals used in construction but no impact from the installation of the rooftop solar itself.	Yes(-)	1	1	1	1	4	Minor
	Use of natural resources	No cement or sand is required to be imported as no civil works are involved in rooftop solar photovoltaic installations.	Minimal						
	Waste generation	Impacts due to generation and inappropriate disposal of solid and hazardous waste from photovoltaic installation like metal scraps and wooden packing material, polythene as well as municipal waste from construction labor at work sites. Disposal of any defunct photovoltaic panels identified during installation needs particular attention.	Yes(-)	1	1	2	1	5	Minor
	Surface water quality	No impacts on water quality as no civil works involved in rooftop solar photovoltaic installations and storage will be at the existing powerhouse sites.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Surface water quantity	No impacts on water quantity as the surface water resources will not be used.	No						
	Ground water quality	Small, short-term risk of changes in groundwater quality within areas used for storage (e.g., existing powerhouses) from spills/leaks of fuel, oil, chemicals used in construction but no impact from the rooftop solar installation itself.	Yes(-)	1	1	2	1	5	Minor
	Groundwater quantity	Existing island water sources will be utilized with permission of Island Council, volume required for construction water and water for the workers is limited.	Minimal						
	Marine water quality	Low risks to marine water quality from the transport of materials by boat and inappropriate disposal of wastes in the short term.	Yes(-)	1	1	2	1	5	Minor
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat as works involved installation on rooftop of buildings.	No						
	Beach and coastal fringe vegetation	Project activities are confined to rooftops, but some risk of disturbance where an existing wharf/jetty is not available in which case already disturbed existing boat landing areas are to be used for the transport of materials to minimize impacts	Yes(-)	1	1	2	1	5	Minor
	Other terrestrial habitats (vegetation)	In most cases there will be no impact as installation is on residential rooftops but some small amount of trimming of tree branches from any surrounding trees may be required to avoid shade on the photovoltaic panels; no trees will be permitted to be cut.	Yes(-)	1	1	1	1	4	Minor
	Terrestrial fauna	Some risk of disturbance to fauna using trees and vegetation surrounding the buildings and along existing roads.	Yes(-)	1	1	1	1	4	Minor
	Avifauna	Some risk of disturbance to avifauna using trees and vegetation surrounding the buildings and along existing roads.	Yes(-)	1	1	2	1	5	Minor
	Coral reefs and seagrass	No impacts on coral reefs and seagrass as works involve installation on rooftop of buildings.	No						
	Other marine habitat	No impacts on marine habitat as works involve installation on rooftop of buildings.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Marine fauna	No impacts on marine fauna from works which involve installation on rooftop of buildings, but some risk of disturbance to marine fauna related to marine transport and where an existing wharf/jetty not available requiring beach landing.	Yes(-)	1	1	2	1	5	Minor
	Protected areas and ESA	No impacts on protected areas and ESA as works involve installation on rooftop of buildings.	No						
	Protected or threatened species	No impacts protected or threatened species from works which involve installation on rooftop of buildings, but some risk of disturbance to marine turtles related to marine transport and where an existing wharf/jetty not available requiring beach landing.	Yes(-)	1	1	2	1	5	Minor
	Invasive species spread	Limited risk of invasive species spread from transport of materials as local boats will be used.	Minimal						
Social	Agricultural land	No impacts on agricultural land as works involved installation on rooftop of residential buildings.	No						
	Human settlement	photovoltaic works on rooftops in the built-up section of islands at request of residents, storage of materials will be in the powerhouse but land use will be temporarily disrupted due to scaffolding for rooftop solar photovoltaic installation.	Yes(-)	0	1	2	1	4	Minor
	Recreational land	No impacts on recreational land as works involved installation on rooftop of residential buildings.	No						
	Other land use	Land within the powerhouse will be utilized for storage of construction materials and equipment.	Minimal						
	Employment	Small number of employment opportunities for labor during construction.	Yes(+)						
	Community health safety	Rooftop photovoltaic works in public domain will result in health and safety risks during installation work as well as from the movement of vehicles and from the inappropriate disposal of wastes like metal scraps etc. Disposal of defunct photovoltaic panels identified during installation will need particular attention.	Yes(-)	2	2	2	1	7	Moderate
	Conflict including SAEH	Rooftop photovoltaic work in public domain resulting in disruption and disturbance during installation but works at request of residents, labor will in part come from off the island and	Yes(-)	0	1	2	1	4	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
		may include some migrant workers. Social disturbances related to inappropriate disposal of wastes like metal scraps etc.							
	Communicable diseases	Low risk of communicable diseases such as COVID-19 introduced to community as labor will in part come from off the island.	Yes(-)	1	1	2	1	5	Minor
	Occupational health and safety (OHS)	OHS risks to construction workers during the construction period, e.g., movement of vehicles, use of equipment and machineries, working conditions, etc. as well as hazards relating to working with electricity as well as working at height on the rooftops with risk of fall increasing risk of fatality occurring.	Yes(-)	2	3	2	1	8	Moderate
	Aesthetics	Temporary impact on aesthetics due to presence of scaffolding in the public domain, storage of materials and equipment will be within the compounds of the existing powerhouses.	Yes(-)	1	1	1	1	4	Minor
	Cultural/religious values	No impacts on cultural/religious values as works involved installation on rooftop of residential buildings, no mosques etc.	No						
	Cultural/religious sites	No impacts on cultural/religious sites as works involve installation on rooftop of buildings.	No						
	Chance finds	No chance find issues as works involve installation on rooftop of residential buildings.	No						
	Pressure on Community Resources	Small, short term, transient impacts as the existing accommodation and services will be used but only a small number of labor is needed. Construction waste will be taken off the island to avoid the Island Council having to take on the responsibility for waste disposal.	Yes(-)	1	1	1	1	4	Minor
	Public utilities	No impacts on public utilities as works involve installation on rooftop of residential buildings and connection only to the household electric meter.	No						
	Access to property / business / facilities	During photovoltaic installation work scaffolding may temporarily restrict access to the properties for short time, but works are at the request of the residents.	Yes(-)	0	1	2	1	4	Minor
	Road users	Small, short term, transient impacts due to road user disruption as construction requires materials and equipment to be transported to	Yes(-)	1	1	1	1	4	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
		site along public roads and scaffolding may need to encroach onto the roads if no space.							
Local economy		Benefits from enhanced spending on food and lodging in local communities due to presence of limited numbers of contractor's staff	Yes(+)						
Knowledge and awareness		No impacts as works involve installation on the rooftops of buildings although contractors will undertake awareness raising on electricity safety in the local communities.	No						
Fishing and navigation		Small, short term, transient impacts as rooftop solar requires materials and equipment transported to site by boat using the existing wharfs/jetties which may conflict with access for other boat users	Yes(-)	1	1	1	1	4	Minor
Local tourism		Small, short term, transient impacts as rooftop solar requires materials and equipment transported to site by boats and public roads; although most tourist activity is focused on the resort islands most inhabited islands have a degree of local tourism.	Yes(-)	1	1	1	1	4	Minor
Financial benefit to community		No financial benefit will be accruing to the local community from the works	No						
Airport safety		No construction impacts on airport safety as works involved installation on the rooftop of buildings although during pre-construction airport authorities to be consulted for islands with airport.	No						

**Table 38. Significance Analysis of Impacts of Solar Photovoltaic Installation (Ground Mounted)**

Environment	Potential impact		Impact	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	Small, short term, transient changes in ambient air quality due to dust and suspended particulate matter from earthworks and traffic movements on unpaved access roads, as well as emissions from use of construction vehicles and machineries.	Yes(-)	1	1	2	1	5	Minor
	Climate	No impacts on climate due to ground mounted solar photovoltaic installations works on Thoddoo.	No						



Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
Environment	Noise level (including underwater)	Medium, short term, transient changes in ambient noise due to civil works (earthworks for foundation of solar photovoltaic frame) as well as mobilization of equipment and machinery, transport of materials, use of construction vehicles, and general construction activities. However, no residential or other sensitive receptors are in proximity of the proposed site.	Yes(-)	1	1	2	1	5	Minor
	Light levels (including glint/glare and shadow flicker)	No impacts on light levels due to ground mounted solar photovoltaic installations works on islands, works during the daytime.	No						
	Topography (soil erosion)	Footprint of works is small but some potential for soil erosion during site establishment, because of clearance of vegetation currently binding soil etc.	Yes(-)	1	1	1	1	4	Minor
	Drainage and waterlogging	Footprint of works is small but some potential for waterlogging due to the compaction of agricultural soils during site establishment, introduction of concrete foundations etc.	Yes(-)	1	1	1	1	4	Minor
	Marine hydrological processes	No impacts on marine hydrological processes due to ground mounted solar photovoltaic installations works on Thoddoo.	No						
	Soil quality	Medium, short-term risk of changes in soil quality from pollution due to spills/leaks of fuel, oil, chemicals used in construction, as an agricultural islands soils are more fertile and so more sensitive.	Yes(-)	1	1	2	1	5	Minor
	Use of natural resources	Sourcing of small volumes of cement, sand and other materials for construction from off-island for foundations.	Yes(-)	1	1	1	2	5	Minor
	Waste generation	Impacts due to generation and inappropriate disposal of small volumes of inert spoil, solid and hazardous waste from construction wastes like metal scraps and wooden packing material, polythene as well as municipal waste from construction labor at work sites. Disposal of defunct photovoltaic panels identified during installation will need particular attention	Yes(-)	1	1	2	1	5	Minor
	Surface water quality	No impacts on surface water quality due to ground mounted solar photovoltaic installations works as no surface water found nearby.	No						
	Surface water quantity	No impacts on surface water quantity due to ground mounted solar photovoltaic installations works as surface water resources will not be used.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Ground water quality	Since groundwater is shallow and sandy soils highly permeable there is a medium but short-term pollution risk in the event of any leaks or spills due to use of fuel, oil, chemicals during works.	Yes(-)	1	1	2	1	5	Minor
	Groundwater quantity	Existing island water sources will be utilized with permission of Island Council, volume required for construction water and water for the workers is limited.	Minimal						
	Marine water quality	Low risks to marine water quality from the transport of materials by boat and inappropriate disposal of wastes in the short term.	Yes(-)	1	1	2	1	5	Minor
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat due to ground mounted solar photovoltaic installations works.	No						
	Beach and coastal fringe vegetation	No impacts on beach and coastal fringe vegetation due to ground mounted solar photovoltaic installations works.	No						
	Other terrestrial habitats (vegetation)	Footprint of works is on agriculture land and vegetation will need to be cleared although it can be allowed to reestablish beneath the solar panel pergola post-construction, there are no trees to be cut.	Yes(-)	1	1	1	1	4	Minor
	Terrestrial fauna	The footprint of works is on agriculture land. No trees are to be cut but clearance of vegetation and earthworks for foundations will disturb the terrestrial fauna. Fauna using adjacent habitat will also be disturbed in short term, but no very noisy construction works so the impact will be small.	Yes(-)	1	1	1	1	4	Minor
	Avifauna	The footprint of works is on agriculture land. No trees are to be cut but clearance of vegetation and earthworks for foundations will disturb the avifauna. Avifauna using adjacent habitat will also be disturbed in short term, but no very noisy construction works so the impact will be small.	Yes(-)	1	1	1	1	4	Minor
	Coral reefs and seagrass	No impacts on coral reefs and seagrass due to ground mounted solar photovoltaic installations works.	No						
	Other marine habitat	No impacts on other marine habitat due to ground mounted solar photovoltaic installations works.	No						
	Marine fauna	No impacts on marine fauna due to ground mounted solar photovoltaic installations works,	Yes(-)	1	1	2	1	5	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
		but some risk of disturbance to marine fauna related to marine transport							
	Protected areas and ESA	No impacts on protected areas and ESA due to ground mounted solar photovoltaic installations works.	No						
	Protected or threatened species	No impacts on protected or threatened species due to ground mounted solar photovoltaic installations works, but some risk of disturbance to marine turtles related to marine transport	Yes(-)	1	1	2	1	5	Minor
	Invasive species spread	Limited risk of invasive species spread from construction vehicles due to vegetation clearance as no invasive species recorded, local boats will be used for transport of the materials.	Minimal						
Social	Agricultural land	The proposed site for solar photovoltaic installation in Thoddoo island is agriculture land. Loss of agricultural land beneath the solar photovoltaic system, although the site has already been handed over to the Island Council and cleared of crops	Yes(-)	1	1	2	1	5	Minor
	Human settlement	No impacts on human settlement due to ground mounted solar photovoltaic installations works on Thoddoo	No						
	Recreational land	No impacts on recreational land due to ground mounted solar photovoltaic installations works on Thoddoo	No						
	Other land use	No impacts on other land use due to ground mounted solar photovoltaic installations works on Thoddoo	No						
	Employment	Small number of employment opportunities for labor during construction.	Yes(+)						
	Community health safety	Health and safety risk is present due to photovoltaic installation in public domain, although away from built up area and most vulnerable receptors like children. Medium, short term, transient disturbance due to noise and from inappropriate disposal of wastes like metal scraps etc.	Yes(-)	1	2	2	1	6	Moderate
	Conflict including SAEH	Ground mounted photovoltaic works in public domain resulting in disruption and disturbance during construction, labor will in part come from off the island and may include some migrant workers. Social disturbances related inappropriate disposal of wastes like metal scraps, defunct photovoltaic solar panels etc.	Yes(-)	1	1	2	1	5	Minor

Environment	Potential impact	Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance		
		Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level	
	Communicable diseases	Low risk of communicable diseases such as COVID-19 introduced to community as labor will in part come from off the island, there is also a risk from vector borne diseases with ponded water.	Yes(-)	1	1	2	1	5	Minor
	Occupational health and safety	OHS risks to construction workers during the construction period, e.g., movement of vehicles, use of equipment and machineries, working conditions, etc. as well as hazards relating to working with electricity in connecting to the grid.	Yes(-)	2	2	2	1	7	Moderate
	Aesthetics	Temporary impact on aesthetics due to presence of earthworks and construction machinery in the public domain although proposed site is in agricultural setting and remote from residential and other sensitive receptors.	Yes(-)	1	1	1	1	4	Minor
	Cultural/religious values	No impacts on cultural/religious values due to ground mounted solar photovoltaic installations works on Thoddoo.	No						
	Cultural/religious sites	No impacts on cultural/religious sites due to ground mounted solar photovoltaic installations works on Thoddoo.	No						
	Chance finds	Some risk exists as the proposed site for the solar photovoltaic installation is an undisturbed land (although agriculture).	Yes(-)	1	1	1	1	4	Minor
	Pressure on Community Resources	Small, short term, transient impacts as the existing accommodation and services used but small number of labor.	Yes(-)	1	1	1	1	4	Minor
	Public utilities	Installation requires a new connection to the grid system involving cabling along the public road, risk other above and below ground public utilities damaged during cabling works to connect.	Yes(-)	1	1	1	1	4	Minor
	Access to property / business / facilities	Installation requires a new connection to the grid system; risk property access may be blocked for cabling works to connect although proposed site is in agricultural setting and remote from residential and other sensitive receptors.	Yes(-)	1	1	2	1	5	Minor
	Road users	Installation requires a new connection to the grid system, road access may be temporarily blocked for the cabling works needed for the connection.	Yes(-)	1	1	1	1	4	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
Local economy	Local economy	Benefits from enhanced spending on food and lodging in local communities due to presence of limited numbers of contractor's staff	Yes(+)						
	Knowledge and awareness	No impacts due to ground mounted solar photovoltaic installation works although contractors will undertake awareness raising on electricity safety in the local communities.	No						
	Fishing and navigation	Small, short term, transient impacts as works require materials and equipment transported to site by boat using the existing wharf/jetty which may conflict with access for other boat users	Yes(-)	1	1	1	1	4	Minor
	Local tourism	Small, short term, transient impacts as works require materials and equipment transported to site by boat and works along public roads for grid connection; although most tourist activity is focused on the resort islands Thoddoo island has a degree of local tourism.	Yes(-)	1	1	1	1	4	Minor
	Financial benefit to community	No financial benefit will be accruing to the local community from the works	No						
	Airport safety	No impacts on airport safety due to ground mounted solar photovoltaic installations works, there is no airport on Thoddoo island to be affected by glint/glare.	No						

**Table 39. Significance Analysis of Impacts of Wind Turbine Installation in Manadhoo Island**

Environment	Potential impact		Impact	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	Large, short term, transient changes in ambient air quality due to dust and suspended particulate matter from earthworks for foundations of six wind turbines and access track creation with occupied buildings of FENAKA and residential area in proximity and traffic movements on unpaved access roads as well as the emissions from use of construction vehicles and machinery.	Yes(-)	2	1	2	1	6	Moderate
	Climate	No impacts on climate due to wind turbine installation works on Manadhoo island.	No						
	Noise level	Large changes in ambient noise albeit short term during construction due to civil works including earthworks for foundations of wind turbines and access track creation, <sup>48</sup> mobilization of equipment and machinery, transport of materials, use of construction vehicles, and general construction activities as works in public domain. FENKEA powerhouse is already a source of high background noise. Nearest non-FENAKA receptor is 130m from the proposed wind turbine site on Manadhoo Island.	Yes(-)	2	1	2	1	6	Moderate
	Light levels (including glint/glare and shadow flicker)	No impacts on light levels due to wind turbine installation works on island, works during the daytime.	No						
	Topography (soil erosion)	Small change in topography as turbine installation will require earthworks for foundations and on-site access tracks; medium potential for soil erosion due to clearance of vegetation and trees exposing the bare soil to erosion etc.	Yes(-)	2	2	1	1	6	Moderate
	Drainage and waterlogging	Medium scale changes to drainage and potential for waterlogging are anticipated as	Yes(-)	2	2	1	1	6	Moderate

<sup>48</sup> For the purposes of assessment it is assumed gravity based foundation will be used, if piling is required the impact significance will increase due to louder construction noise.

Environment			Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Potential impact								
		the turbine installation will require foundation construction and short on-site access tracks.							
Marine hydrological processes		No impacts on marine hydrological processes due to wind turbine installation works on island, no turbines are to be installed on the beach.	No						
Soil quality		Medium, short-term risk of changes in soil quality from pollution due to spills/leaks of fuel, oil, chemicals used in construction.	Yes(-)	1	1	2	1	5	Minor
Use of natural resources		Impacts due to sourcing of medium volumes of cement, sand and other materials from off-island for construction of foundations, on-site access track etc.	Yes(-)	2	1	2	2	7	Moderate
Waste generation		Impacts due to generation and inappropriate disposal of medium volumes of inert excavated spoil, solid and hazardous waste from construction wastes like metal scraps and wooden packing material, polythene as well as municipal waste from construction labor at work sites.	Yes(-)	2	1	2	1	6	Moderate
Surface water quality		No impacts on surface water quality due to wind turbine installation works on island as no surface water found nearby.	No						
Surface water quantity		No impacts on surface water quantity due to wind turbine installation works on island as surface water resources will not be used.	No						
Ground water quality		Since groundwater is shallow and sandy soils highly permeable there is a medium but short-term pollution risk in the event of any leaks or spills due to use of fuel, oil, chemicals during works. <sup>49</sup> The risk is increased as excavations to 2.3m depth will be close to the level of the groundwater lens.	Yes(-)	2	1	2	1	6	Moderate
Groundwater quantity		Existing island water sources will be utilized with permission of Island Council, volume required for the construction water and water for the workers is small.	Yes(-)	1	1	2	1	5	Minor
Marine water quality		Low risks to marine water quality from the transport of materials by boat and inappropriate disposal of wastes in short	Yes(-)	2	1	2	1	6	Moderate

<sup>49</sup> For the purposes of assessment, it is assumed gravity based foundation will be used, if piling is required as this would definitely penetrate the groundwater lens this will increase the risk of pollution by creating a pathway from the surface to the freshwater.

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
		term, due to location of site the risks are increased as wind turbines are sited immediately adjacent to the marine environment and any loose spoil and wastes could be blown into the marine environment							
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat due to wind turbine installation works on Manadhoo island as the proposed work will not remove any mangrove, wetland, forest habitat from the site.	No						
	Beach and coastal fringe vegetation	A coastal vegetation strip of 20 m will not be permitted to be cleared, no work will be permitted on the beach but one turbine is located close to the beach, impact to be reconfirmed once final layout is available.	Yes(-)	3	2	2	1	8	Moderate
	Other terrestrial habitats (vegetation)	Impacts on other habitat as the proposed work will require removal of up to 24 trees from the proposed site to facilitate turbine construction and on-site access roads to two turbines	Yes(-)	2	2	2	1	7	Moderate
	Terrestrial fauna	Loss of vegetation and up to 24 trees will be lost which are a habitat for fauna. Fauna using remaining habitat will also be disturbed in short term due to noisy construction works.	Yes(-)	2	2	1	1	6	Moderate
	Avifauna	Removal of up to 24 trees from the proposed site will lead to loss of habitat for bird species which may also be using the trees to nest in. Avifauna using remaining habitat will also be disturbed due to noisy construction works in the short term.	Yes(-)	2	2	1	1	6	Moderate
	Coral reefs and seagrass	No impacts on coral reefs and seagrass due to wind turbine installation works on island.	No						
	Other marine habitat	No impacts on other marine habitat due to wind turbine installation works on island.	No						
	Marine fauna	No impacts on marine fauna due to wind turbine installation works, but some risk of disturbance to marine fauna related to marine transport	Yes(-)	1	1	2	1	5	Minor
	Protected areas and ESA	No impacts on protected areas and ESA due to wind turbine installation works on island.	No						



Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Protected or threatened species	No impacts on protected or threatened species due to wind turbine installation works on island, but turtles may nest on the adjacent beach and some risk of disturbance to marine turtles related to marine transport.	No	1	1	2	1	5	Minor
	Invasive species spread	Limited risk of invasive species spread from construction vehicles due to vegetation clearance as no invasive species recorded, local boats will be used for transport of the materials.	Minimal						
Social	Agricultural land	No impacts on agricultural land due to wind turbine installation works on island.	No						
	Human settlement	No impacts on human settlement due to wind turbine installation works on island.	No						
	Recreational land	No impacts on recreational land due to wind turbine installation works on island.	No						
	Other land use	Loss of vegetated land to the wind energy system, this land is already owned by the Island Council.	Yes(-)	1	1	2	1	5	Minor
	Employment	Some limited employment opportunities for local labor during project construction.	Yes(+)						
	Community health safety	Wind turbine works in public domain will need construction site to be securely fenced, this is a large-scale construction in context of Maldives and the island involving cranes etc. Health and safety risks when materials and equipment transported to site on public roads including abnormal loads and from inappropriate disposal of wastes like metal scraps etc.	Yes(-)	3	2	2	1	8	Moderate
	Conflict including SAEH	Wind turbine work in public domain resulting in disruption and disturbance during construction, labor will in part come from off the island and may include some migrant workers. Social disturbances related to use of roads by construction vehicles including abnormal loads for cranes/turbines and inappropriate disposal of wastes like metal scraps etc.	Yes(-)	1	1	2	1	5	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Communicable diseases	Low risk of communicable diseases such as COVID-19 introduced to community as labor will in part come from off the island, there is also a risk from vector borne diseases with ponded water	Yes(-)	1	1	2	1	5	Minor
	Occupational health and safety (OHS)	OHS risks to construction workers during the construction period, e.g., movement of vehicles, use of equipment and machineries, working conditions, etc. as well as hazards relating to working with electricity and working at height with risk of fall from significant height (23m) increasing risk of fatality – workers from Maldives and island will have no or limited experience of the heavy lifting and working at height that is involved increasing the risk.	Yes(-)	3	3	2	1	9	Moderate
	Aesthetics	Temporary adverse impacts on local aesthetics as the work will involve larger scale construction with tall cranes visible etc.	Yes(-)	2	1	1	1	6	Minor
	Cultural/religious values	No impacts on cultural/religious values due to wind turbine installation works on island.	No						
	Cultural/religious sites	No impacts on cultural/religious sites due to wind turbine installation works on island.	No						
	Chance finds	Some risk as the work will be carried out on undisturbed land.	Yes(-)	1	1	1	1	4	Minor
	Pressure on Community Resources	Small, short term, transient impacts as the existing accommodation and services used but small number of labor. Disposal of spoil to be agreed in consultation with Island Council. Construction waste will be taken off island to avoid the Island Council having to take on the responsibility for waste disposal.	Yes(-)	1	1	1	1	4	Minor
	Public utilities	Installation requires a new connection to the grid system but the powerhouse is adjacent, risk other public utilities need to be temporarily moved or are accidentally damaged in the movement of the abnormal loads for cranes/turbines on existing roads.	Yes(-)	1	1	1	1	4	Minor
	Access to property / business / facilities	Transport of cranes and turbines which are abnormal loads for the Maldives by the existing road may temporarily hinder access.	Yes(-)	1	1	2	1	5	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Road users	Transport of cranes and turbines which are abnormal loads for the Maldives by the existing roads may temporarily hinder road users.	Yes(-)	1	1	1	1	5	Minor
	Local economy	Benefits from enhanced spending on food and lodging in local communities due to presence of limited numbers of contractor's staff	Yes(+)						
	Knowledge and awareness	No impacts due to wind turbine installation works on island although contractors will undertake awareness raising on wind turbine and electricity safety in the local communities.	No						
	Fishing and navigation	Medium, short term, transient impacts as works require materials and equipment (abnormal loads) transported to site by boat using the existing wharf/jetty which may conflict with access for other boat users.	Yes(-)	2	1	1	1	5	Minor
	Local tourism	Medium, short term, transient impacts as works require materials and equipment (abnormal loads) transported to site by boat and works in the public domain; although most tourist activity is focused on the resort islands Manadhoo island has a degree of local tourism.	Yes(-)	2	1	1	1	5	Minor
	Financial benefit to community	No financial benefit will be accruing to the local community from the works	No						
	Airport safety	Airport safety may be affected due to presence of tall cranes for wind turbine installation works on island. <sup>50</sup>	Yes(-)	1	1	2	1	5	Minor

<sup>50</sup> Nearest airport is Maafaru which is about 9.74 km from the island, though no significant impacts are anticipated the airport authority is to be consulted to determine if cranes need to be lit (red light).

**Table 40. Significance Analysis of Impacts of Ocean Energy Pilot (see also Appendix 9)**

Environment	Potential impact		Impact	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	No impacts on air quality due to ocean energy pilot installation works.	No						
	Climate	No impacts on climate due to ocean energy pilot installation works.	No						
	Noise level (including underwater noise)	Underwater noise from anchoring on sea floor by 4-point mooring system	Yes(-)	1	1	2	1	5	Minor
	Light levels (including glint/glare and shadow flicker)	No impacts on light levels due to ocean energy pilot installation works, works to be during the daytime.	No						
	Topography (soil erosion)	No impacts on topography (soil erosion) due to ocean energy pilot installation works.	No						
	Drainage and waterlogging	No impacts on drainage and waterlogging due to ocean energy pilot installation works.	No						
	Marine hydrological processes	Limited impacts on marine hydrological processes due to scale of the ocean energy pilot installation works.	Minimal						
	Soil quality	Small, short-term risk of changes in soil quality in areas used for storage (e.g., existing powerhouses) from spills/leaks of fuel, oil, chemicals used in construction but no impact from the installation of the ocean energy pilot itself	Yes(-)	1	1	1	1	4	Minor
	Use of natural resources	No impacts on natural resources due to ocean energy pilot installation works.	No						
	Waste generation	Impacts due to generation and inappropriate disposal of solid and hazardous waste from construction like metal scraps and wooden packing material, polythene as well as	Yes(-)	1	1	2	1	5	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
Environment		municipal waste from construction labor at work sites.							
	Surface water quality	No impacts on surface water quality due to ocean energy pilot installation works.	No						
	Surface water quantity	No impacts on surface water quantity due to ocean energy pilot installation works.	No						
	Ground water quality	Small, short-term risk of changes in groundwater quality within areas used for storage (e.g., existing powerhouses) from spills/leaks of fuel, oil, chemicals used in construction but no impact from the installation of the ocean energy pilot itself	Yes(-)	1	1	2	1	5	Minor
	Groundwater quantity	No impacts on groundwater quantity due to ocean energy pilot installation works.	No						
	Marine water quality	Water quality impacts from anchoring on sea floor by 4-point mooring system, suspended sediment load etc. Pollution risk due to use of fuel, oil, chemicals in the construction works within the marine environment. Low risks to marine water quality from the transport of materials by boat and inappropriate disposal of wastes in the short term.	Yes(-)	1	1	2	1	5	Minor
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat due to ocean energy pilot installation works on islands.	No						
	Beach and costal fringe vegetation	Installation of ocean energy pilot will not affect beach and coastal fringe vegetation. In relation to access, all islands	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
		have a decent sized wharf/jetty that can be used so access via the beach is not needed, the access arrangements will need to be reconfirmed once the location is known.							
	Other terrestrial habitats (vegetation)	No impacts on other terrestrial habitats (vegetation) due to ocean energy pilot installation works.	No						
	Terrestrial fauna	No impact on terrestrial fauna due to the ocean energy pilot, in relation to access this will need to be reconfirmed once the location is known.	No						
	Avifauna	No impacts on avifauna due to ocean energy pilot installation works, in relation to access this will need to be reconfirmed once the location is known.	No						
	Coral reefs and seagrass	Installation of the ocean energy turbine will affect coral reefs and seagrass particularly from anchoring on sea floor by 4-point mooring system.	Yes(-)	3	3	2	1	9	Moderate
	Other marine habitat	Installation of ocean energy turbine will affect marine habitat (soft sediment) particularly from anchoring on sea floor by 4-point mooring system but this will quickly recover.	Yes(-)	1	1	2	1	5	Minor
	Marine fauna	Installation of ocean energy turbine will affect benthic fauna particularly from anchoring on sea floor by 4-point mooring system. Some additional risk of disturbance to marine fauna related to the marine transport	Yes(-)	1	1	2	1	5	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
	Protected areas and ESA	No impacts on protected areas and ESA due to ocean energy pilot installation works.	No						
	Protected or threatened species	Some risk of disturbance to marine turtles related to marine transport.	Yes(-)	1	1	2	1	5	Minor
	Invasive species spread	Risk of spread of invasive species due to ocean energy pilot installation works.	Yes(-)	1	1	1	1	4	Minor
Social	Agricultural land	No impacts on agricultural land due to ocean energy pilot installation works.	No						
	Human settlement	No impacts on human settlement due to ocean energy pilot installation works.	No						
	Recreational land	No impacts on recreational land due to ocean energy pilot installation works.	No						
	Other land use	No impacts on other land use due to ocean energy pilot installation works.	No						
	Employment	Small number of employment opportunities for labor during construction.	Yes(+)						
	Community health safety	Ocean energy installed in marine waters will present risks to community health and safety particularly for fishers and other boat users, health and safety risks from inappropriate disposal of wastes like metal scraps etc..	Yes(-)	2	2	2	1	7	Moderate
	Conflict including SAEH	Ocean energy installation in the public domain resulting in disruption and disturbance to fishers and navigation routes, labor will in part come from off the island and may include some migrant workers. Conflict may also arise due to inappropriate disposal of wastes like metal scraps, etc.	Yes(-)	1	1	2	1	5	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
	Communicable diseases	Low risk communicable diseases such as COVID-19 introduced to community as labor will in part come from off the island	Yes(-)	1	1	2	1	5	Minor
	Occupational health and safety (OHS)	OHS risks to construction workers during the construction period, e.g., use of equipment and machineries, working conditions, etc. as well as hazards relating to working with electricity and working over water.	Yes(-)	2	2	2	1	7	Moderate
	Aesthetics	Temporary impact on aesthetics due to presence of construction work in the marine environment, storage of materials will be within the powerhouse.	Yes(-)	1	1	1	1	4	Minor
	Cultural/religious values	No impacts on cultural/religious values due to ocean energy pilot installation works.	No						
	Cultural/religious sites	No impacts on cultural/religious sites due to ocean energy pilot installation works.	No						
	Chance finds	No chance finds issues anticipated due to ocean energy pilot installation works; although presence of marine physical cultural resources to be reconfirmed during feasibility study.	No						
	Pressure on Community Resources	Small, short term, transient impacts as the existing accommodation and services will be used but only a small number of labors is required for the ocean energy pilot. Construction waste will be	Yes(-)	1	1	1	1	4	Minor



Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
		taken off the island to avoid the Island Council having to take on the responsibility for waste disposal.							
	Public utilities	No impacts anticipated on public utilities due to ocean energy pilot installation works.	No						
	Access to property / business / facilities	No impacts anticipated on access to property / business due to ocean energy pilot installation works.	No						
	Road users	No impacts on road users anticipated due to ocean energy pilot installation works.	No						
	Local economy	Benefits from enhanced spending on food and lodging in local communities due to presence of limited numbers of contractor's staff	Yes(+)						
	Knowledge and awareness	No impacts due to ocean energy pilot installation works but contractors will undertake awareness raising on ocean energy safety for fishers and other boat users.	No						
	Fishing and navigation	Ocean energy installed in marine waters will cause disturbance to fishing and navigation during installation work.	Yes(-)	1	1	1	1	4	Minor
	Local tourism	Ocean energy installed in marine waters will cause disturbance to any water-based tourism during the installation work.	Yes(-)	1	1	1	1	4	Minor
	Financial benefit to community	No financial benefit will be accruing to the local community from the works	No						
	Airport safety	No impacts on airport safety due to ocean energy pilot installation works.	No						

**Table 41. Significance Analysis of Impacts of Agriculture Interventions on Thoddoo Island**

Environment	Potential impact		Impact	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	Small, short term, transient changes in ambient air quality due to dust and suspended particulate matter traffic movements on unpaved access roads, emissions from use of construction vehicles and machineries; to be reconfirmed once exact scope is known.	Yes(-)	1	1	2	1	5	Minor
	Climate	No impacts on climate due to agriculture interventions on Thoddoo island.	No						
	Noise level (including underwater)	Small, short term, transient changes in ambient noise due to mobilization of equipment and machinery, transport of materials, use of construction vehicles, and general construction activities in the agricultural landscape with low levels of existing noise; to be reconfirmed once the exact scope is known.	Yes(-)	1	1	2	1	5	Minor
	Light levels (including glint/glare and shadow flicker)	No impacts on light levels due to agriculture interventions on the island, installation will be done in the daytime.	No						
	Topography (soil erosion)	The footprint of irrigation pipelines although widely distributed is small, the shade houses and cold stores will likely also have small footprint thereby limiting the extent of any soil erosion, to be reconfirmed once the exact scope is known.	Minimal						
	Drainage and waterlogging	The footprint of works is small but some potential for waterlogging due to the compaction of soils during site establishment, and installation of the agricultural interventions e.g., any cold stores will need a concrete foundation.	Yes(-)	1	1	1	1	4	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
	Marine hydrological processes	No impacts on marine hydrological processes due to agriculture interventions on the island.	No						
	Soil quality	Medium, short-term risk of changes in soil quality from pollution due to spills/leaks of fuel, oil, chemicals affecting more sensitive agricultural soils over which irrigation pipelines will be installed.	Yes(-)	1	1	2	1	5	Minor
	Use of natural resources	Sourcing of small volumes of cement, sand and other materials from off-island for the installation of the agricultural interventions	Yes(-)	1	1	1	2	6	Minor
	Waste generation	Impacts due to generation and inappropriate disposal of small volumes of inert spoil, solid and hazardous waste from construction like metal scraps and wooden packing material, polythene as well as municipal waste from construction labor at work sites.	Yes(-)	1	1	2	1	5	Minor
	Surface water quality	No notable surface water bodies are present on Thoddoo island, so the surface water quality will not be impacted by construction work.	No						
	Surface water quantity	No impacts on surface water quantity due to agriculture interventions on the island as surface water resources will not be used.	No						
	Groundwater quality	Since groundwater is shallow and sandy soils highly permeable there is a medium but short-term pollution risk in the event of any leaks or spills due to use of fuel, oil, chemicals during works.	Yes(-)	1	1	2	1	5	Minor
	Groundwater quantity	Existing island water sources will be utilized with permission of Island Council, volume required for construction water and water for the workers is limited.	Minimal						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
	Marine water quality	Low and short-term risks to marine water quality from the transport of materials by boat and inappropriate disposal of wastes	Yes(-)	1	1	2	1	5	Minor
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat due to agriculture interventions on the island, to be reconfirmed once the scope is finalized.	No						
	Beach and costal fringe vegetation	No impacts on beach and costal fringe vegetation due to agriculture interventions on the island, to be reconfirmed once the scope is finalized.	No						
	Other terrestrial habitats (vegetation)	The proposed work will likely require clearing of some vegetation although no trees will be permitted to be cut and the footprint of works will be small on agricultural land, extent of any clearance to be reconfirmed once the scope and location are known during the feasibility stage.	Yes(-)	1	1	1	1	4	Minor
	Terrestrial fauna	The proposed work will likely require some clearing of vegetation on agricultural land which may affect fauna although footprint of works is small and no trees to be cut, to be reconfirmed once scope and location are known	Yes(-)	1	1	1	1	4	Minor
	Avifauna	The proposed work will likely require some clearing of vegetation on agricultural land which may affect avifauna although footprint of works is small and no trees to be cut, to be reconfirmed once scope and location are known	Yes(-)	1	1	1	1	4	Minor
	Coral reefs and seagrass	No impacts on coral reefs and seagrass due to agriculture interventions on the island.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
	Other marine habitat	No impacts on other marine habitat due to agriculture interventions on the island.	No						
	Marine fauna	No impacts on marine fauna due to agriculture interventions on the island, but some risk of disturbance to the marine fauna related to marine transport to the island.	Yes(-)	1	1	2	1	5	Minor
	Protected areas and ESA	No impacts on protected areas and ESA due to agriculture interventions on the island.	No						
	Protected or threatened species	No impacts on marine fauna due to agriculture interventions on the island, but some risk of disturbance to marine turtles related to marine transport to the island.	Yes(-)	1	1	2	1	5	Minor
	Invasive species spread	Limited risk of invasive species spread from transport of materials as local boats will be used.	Minimal						
Social	Agricultural land	Disturbance to agricultural land from the proposed interventions, but as this project component will benefit the farmers the impact is less significant.	Yes(-)	0	1	2	1	4	Minor
	Human settlement	No impacts on human settlement due to agriculture interventions on the island.	No						
	Recreational land	No impacts on recreational land due to agriculture interventions on the island.	No						
	Other land use	No impacts on other land use due to agriculture interventions on the island.	No						
	Employment	Some limited employment opportunities during construction.	Yes(+)						
	Community health safety	Work in public domain will present risks to community health and safety, health and safety risks from inappropriate disposal of wastes like metal scraps etc.	Yes(-)	2	2	2	1	7	Moderate

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
	Conflict including SAEH	Low risk of work in public domain resulting in disruption and disturbance to adjacent farmers since the works will benefit them, labor will in part come from off the island and may include some migrant workers. Social disturbances related to construction noise, use of roads by construction vehicles and inappropriate disposal of wastes like metal scraps etc.	Yes(-)	1	1	2	1	5	Minor
	Communicable diseases	Low risk communicable diseases such as COVID-19 introduced to community as labor will in part come from off the island, there is also a risk from vector borne diseases with ponded water.	Yes(-)	1	1	2	1	5	Minor
	Occupational health and safety	OHS risks to construction workers during the construction period, e.g., movement of vehicles, use of equipment and machineries, working conditions, etc.	Yes(-)	2	2	2	1	7	Moderate
	Aesthetics	The agricultural interventions will be carried out in the public domain, storage of materials in the landscape may temporarily impact on the landscape etc.	Yes(-)	1	1	1	1	4	Minor
	Cultural/religious values	No impacts on cultural/religious values due to agriculture interventions on the island.	No						
	Cultural/religious sites	No impacts on cultural/religious sites due to agriculture interventions on the island.	No						
	Chance finds	Undisturbed land may be involved which lead to low risk of making chance finds.	Yes(-)	1	1	1	1	4	Minor
	Pressure on Community Resources	Small, short term, transient impacts as the existing accommodation and services will be used but only a small	Yes(-)	1	1	1	1	4	Minor

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
		number of labors is required for the agricultural interventions.							
	Public utilities	There is also a risk other public utilities are damaged during the installation of the agricultural interventions especially irrigation pipelines as they are in the public domain.	Yes(-)	1	1	1	1	4	Minor
	Access to property / business / facilities	There may be restrictions on access to agricultural land during installation of the agricultural interventions but these will be done in close consultation with the community to avoid adverse impact and the works are to benefit the farmers of Thoddoo island so the significance will be less.	Yes(-)	1	1	1	1	4	Minor
	Road users	Small, short term, transient impacts as agricultural intervention requires materials and equipment transported to site along public roads.	Yes(-)	1	1	1	1	4	Minor
	Local economy	Benefits from enhanced spending on food and lodging in local communities due to presence of limited numbers of contractor's staff	Yes(+)						
	Knowledge and awareness	No impacts due to installation of agricultural interventions although contractors will undertake awareness raising on the agricultural interventions before handover to the island council for O&M.	No						
	Fishing and navigation	Small, short term, transient impacts as agricultural interventions require materials and equipment transported to site by boat using the existing wharf/jetty which may conflict with access for other boat uses	Yes(-)	1	1	1	1	4	Minor
	Local tourism	Small, short term, transient impacts as agricultural intervention requires	Yes(-)	1	1	1	1	4	Minor

Environment			Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	level
	Potential impact								
		materials and equipment transported to site along public roads; although most tourist activity is focused on the resort islands Thoddoo island has a degree of local tourism.							
	Financial benefit to community	No financial benefit will be accruing to the local community from the works	No						
	Airport safety	No impacts on airport safety due to agriculture interventions on the island.	No						



256. An analysis of the impacts of BESS, EMS, and grid upgrades in 20 ASSURE islands is presented in Table 35 and 36 respectively. Civil work is only required for laying of underground cables with trenching (0.5–1 meter deep and 45 cm wide) mostly along the side of the sandy roads and constructing concrete platform (maximum 15 sqm) for installation of packaged substations/power transformers and 14 m x 6 m (84 sqm.) for the BESS. The cabling work will be of short duration of about a week for each island and it is generally carried out manually by a team of 4–5 workers. BESS buildings will be constructed on open land (e.g., land which does not require vegetation clearance) within the premises of the existing powerhouse on each island. It will require 2–3 weeks' time to construct this small structure into which the pre-assembled BESS system will be supplied. There will also be impacts due to movement of construction traffic and access restrictions due to digging of trenches in front of buildings and residential houses. No heavy machinery will be operated. Trenches on roads will be filled back and regained to their previous status on the same day. As per the analysis there are minor to moderate negative impacts from the proposed works on the physical and social environment. Moderate impacts relate to waste generation and community and occupational health and safety. But all such impacts and risks can be easily mitigated by the contractors following national requirements and international good practice mitigation.

257. Analysis of the impacts of photovoltaic rooftop installations are minor except for community and occupational health and safety as can be seen from Table 37. For ground mounting on Thoddoo island (Table 38) there will be additional impacts since this is on agricultural land, but these are minor. All such impacts and risks can be easily mitigated by the contractors following national requirements and international good practice mitigation. The site preparation for ground mounting will involve only vegetation clearance and minor levelling and thus will not significantly change the drainage pattern.

258. For wind turbine installation in Manadhoo island, an analysis of the impacts is presented in Table 39. As per the analysis there are moderate levels of negative impact from the wind turbine installation activities. The site will be first cleared by removing vegetation and cutting down the trees. The civil works will require excavation of footing holes approximately 14.3m x 14.3m (204.5 sqm) at surface battered to base 2.3m below ground surface; anticipated to be just above the level of the ground water lens so as not requiring groundwater to be pumped, although this needs to be confirmed by ground investigation pre-construction. Total area to be cleared for six turbines is about 1227 sqm. The moderate adverse impacts are mainly on air (dusts) and noise, soil erosion, drainage, resource use, waste generation, groundwater quality, loss of habitats, disturbance of flora and fauna at the project site. The most significant impact on the physical environment relates to noise with the nearest non-FENAKA property at 130m. There will also be health and safety impacts to the community and workers during turbine assembly and installation (which involve heavy cranes and working on heights) and impacts due to movement of construction traffic including abnormal crane/turbine loads on narrow island roads, although these impacts will be minor and for a short time.

259. An analysis of the impacts of ocean energy system installation is presented in Table 40 with further details in Appendix 9. As per the analysis there are minor to moderate negative impacts from the proposed activity on marine ecology which will require anchoring of small scale hydrokinetic (system) floating devices on the sea floor either by 4-point mooring or gravity-based anchor. To manage the impacts on marine ecology a BAP is prepared. There will also be health and safety impacts to the community (notably fishers and other boats users) and workers which can be easily mitigated by the contractors following national requirements and international good practice mitigation.

260. For agriculture components on Thoddoo island, an analysis of the impacts is presented in Table 41. As per the analysis, except for health and safety which is a moderate risk, there are minor levels of negative impacts from the implementation of agriculture interventions although this is subject to confirmation once the actual interventions are confirmed. All such impacts and risks can be easily mitigated by the contractors following national requirements and international good practice mitigation.

## 1. Physical Environment

261. **Dust, noise, and vibration:** During the construction phase, construction activity will involve excavations for the BESS foundations, cable laying, photovoltaic array footings and foundations for wind turbines, as well as the movement of vehicles carrying the construction materials along the haul roads. Although all the sites are accessible, the movement of vehicles and excavation work would give rise to the emission of dust particles thereby affecting air quality marginally at the sites. The impact will be transitory in nature and therefore is assessed as being of minor significance except in the case of the wind turbines where impacts will be moderate due to the larger scale of excavations required. Covering stockpiles, minimizing double handling and drop loads as well as sprinkling of water during excavations will reduce the dust emission to a great extent. Existing roads and tracks will be used for construction and maintenance access to the sites and as these are not surfaced will either be covered or sprinkled with water during works to minimize the increase in airborne dust particles. Vehicles and machinery will undergo periodic checks and maintenance to ensure they are in good running condition and comply with air quality and emission regulations.

262. During the construction phase, the major sources of noise pollution are wind turbine construction and movement of vehicles carrying the construction material and equipment to the sites. Noise pollution created during wind turbine construction operations can present a health hazard to site operatives and cause annoyance to neighbors; the level of noise generated will depend on the construction method. For site preparation including gravity-based foundations, depending on the type and age of equipment used by the contractor, noise levels from construction at 10m could range from 73-92 dB(A) per British Standard (BS) 5228 equating to noise levels of about 50-70dB(A) at 130m and potentially requiring a temporary acoustic noise barrier to be installed to reduce noise levels by a further 10dB(A) around construction activities and/or the site boundaries. If piling were to be used, Figure 40 shows the variation of noise level with distance. If piling is undertaken in absence of noise mitigation, given this can generate construction noise of up to 112dB(A) at 10m per BS5228 it will not be possible to meet the daytime noise limit of 55dB(A) applicable to the nearest adjacent property at 130m distance and 70dB(A) at the FENAKA buildings even with an acoustic noise barrier. Therefore, use of piling is to be avoided and a gravity-based foundation is the preferred, and technically feasible option for a 25kW wind turbine. If alternative foundation methods are required quiet piling methods must be adopted (e.g., drill piling to be used, as generating up to 90dB(A) at 10m distance per BS5228 it is a lot quieter than driven piles using diesel and air hammers, continuous noise is also less disturbing than impulsive hammer piling noise) with noise assessment conducted by the contractor to confirm noise limits can be met by the construction method.<sup>51</sup> Further the timing and

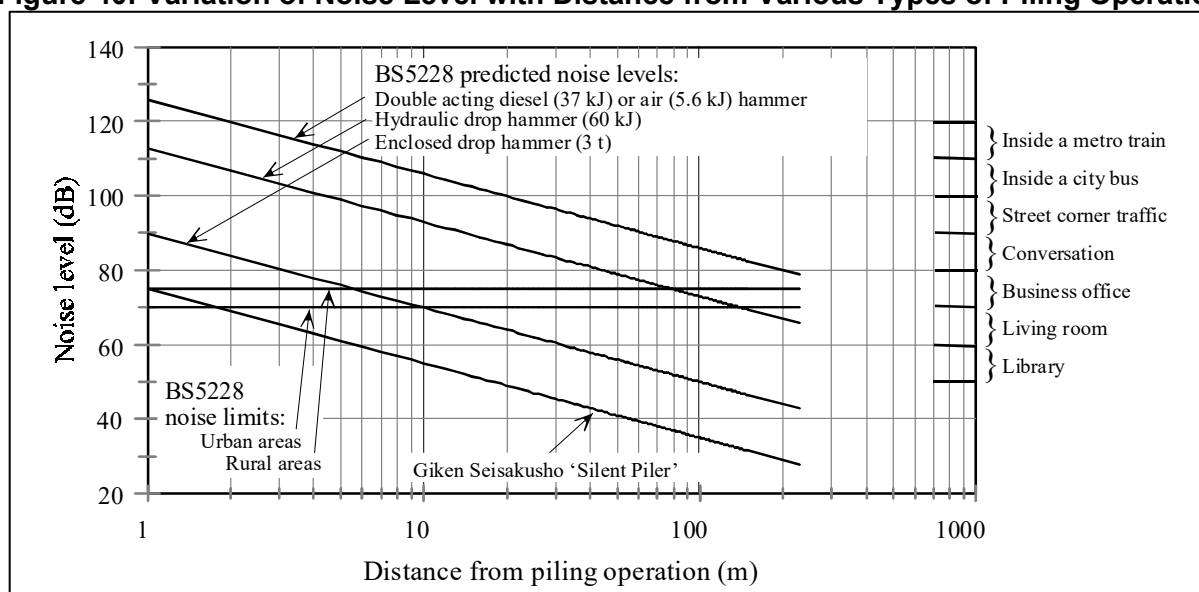
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<sup>51</sup> If following geotechnical investigations piling is required the contractor will quantitatively model the noise and vibration levels experienced at the adjacent properties based on their proposed construction method and mitigation measures to be adopted, the noise and vibration assessment will need to be submitted to PMU for review and approval alongside the detailed design. Contractor will develop a piling management sub-plan to the CEMP addressing both the noise and vibration impacts. Continuous noise monitoring to be undertaken at adjacent properties for the duration of all such work.

duration of piling activities can be reduced to minimize the duration of exposure of occupants of adjacent properties to high noise levels within a given hour and day but with L<sub>Amax</sub> to be 75dBA.

263. Piling work for construction of wind turbine foundations would also lead to vibration impact. Piling-induced ground vibrations can lead to human disturbance and structural damage. Table 42 provides guidelines of Eurocode 3 for acceptable human exposure to ground vibrations depending on the length of the construction period and structural damage thresholds. These range from a maximum peak particle velocity of 2 mm/s for buildings of architectural merit, to 15 mm/s for industrial buildings. Given the nearest residential property is 130m construction induced vibration is likely to be minimal although if piling is used the contractor will need to confirm vibration limits can be met.

**Figure 40: Variation of Noise Level with Distance from Various Types of Piling Operation**



Note: as per British Standard BS5228, in urban areas, equivalent should not exceed 75 dB at the outside of a noise sensitive building (i.e., a residential or office building), with a lower limit of 70 dB applying in rural areas which is less stringent than the noise levels applied to the project

Source: [http://www-civ.eng.cam.ac.uk/geotech\\_new/people/bolton/mdb\\_pub/117\\_DFC\\_2002\\_363\\_371.pdf](http://www-civ.eng.cam.ac.uk/geotech_new/people/bolton/mdb_pub/117_DFC_2002_363_371.pdf)

**Table 42: Minimum Separation Between Piling Operations and Sensitive Buildings**

Building type (vibration limit from Eurocode 3)	Press- in method	Impact hammer (stiff clay / medium dense sand; (C=0.75) (Eurocode 3)		Vibrator (Eurocode 3) kJ/cycle		
		5 kJ/blow	25 kJ/blow	2 kJ/cycle	10 kJ/cycle	50 kJ/cycle
Architectural merit (2 mm/s)	3.5 m	26.5 m	59 m	16 m	36 m	78 m
Residential area (4 mm/s)	1.75 m	13 m	30 m	8 m	18 m	39 m
Light commercial (10 mm/s)	0.7 m	5 m	12 m	3.1 m	7 m	16 m
Heavy Industrial (15 mm/s)	0.5 m	3.6 m	8 m	2.1 m	5 m	10 m

Source: [http://www-civ.eng.cam.ac.uk/geotech\\_new/people/bolton/mdb\\_pub/117\\_DFC\\_2002\\_363\\_371.pdf](http://www-civ.eng.cam.ac.uk/geotech_new/people/bolton/mdb_pub/117_DFC_2002_363_371.pdf)

264. Most of the access roads to the sites are motorable and project traffic would be limited. The major work of the construction is expected to be carried out during the daytime. Apart from vehicles bringing in materials to the sites and cranes for installation of wind turbines, construction works will not require heavy powered equipment. Noise produced during the construction period in most instances (except the wind turbines) will have only minor impacts on residents. While the impact of noise and vibration cannot be avoided altogether, impacts will be minimized by prohibiting all work between 22:00 hours and 06:00 hours. Additional measures such as selection of construction techniques and machinery seeking to minimize ground disturbance and noise vibrations; proper maintenance and operation of construction equipment; and operation of machinery generating high levels of noise during project facility installations being restricted to between 8:00 am and 5:00 pm in areas where there are nearby residences with exact timings of work being agreed in consultation with the Island Councils and residents will help to minimize the impact.

265. Considering the nature of the work, the impacts on topography due to the installations will be insignificant. No topographical changes are envisaged. The proposed sites are accessible by existing access roads and wharfs/jetties (except Raimandhoo) and these existing facilities will be used to transport materials and equipment. The nature of the construction works indicates that no toxic or hazardous materials will be used, apart from fuel oils for vehicles and the Li-on and flow batteries, which will need to be securely stored above high flood level. All the materials required for construction works will be sourced from existing licensed suppliers and sources to minimize the impacts of acquiring them. Construction waste will be sorted out by the contractors for recycling and removed off site from the island. Soil excavated from foundation footings will be used in landscaping or disposed of at designated places agreed with the Island Councils. No surface or groundwater will be tapped at the project sites. The water required for construction (concrete mixing) and consumption will be supplied by the island council. Impacts on water resources are mostly related to pollution from fuel, oil, or chemical spill and from poor waste management practices. The ocean energy component will cause temporary marine water quality impacts during the anchoring process whilst marine water quality will also be impacted by inappropriate waste disposal etc.

266. As stated above, except for wind turbine construction, the environmental disturbances during construction will be small and transient, such as dust, noise, incremental traffic loads on the roads, and gaseous emissions created by trucks and heavy construction equipment. Careful planning and design during pre-construction can ensure that the construction wind turbine impacts are minimized. Implementation of effective environmental supervision, monitoring and reporting system using checklists of all contractual environmental requirements will help ensure no significant residual impact.

## **2. Biological Environment**

267. The impacts on biological environment are of minor to moderate significance. The biological impacts of the ocean energy system are discussed in Appendix 9 which will lead to similar impacts as those discussed for the pre-construction activities already discussed above. The main biological impacts from the terrestrial project construction activities will be from clearing of vegetation for the Thoddoo ground mounted solar and clearing of about 1,227 sqm area for construction of foundations for six wind turbines in Manadhoo island. This will require the cutting of up to 24 trees on the project site. Loss of trees will have irreversible impact as these are native trees which will be completely removed. There is also displacement of local fauna due to loss of habitat. However, in terms of the land area in question in Manadhoo island (1.1 sq km), the area is limited in extent (<0.18% of total vegetation cover of the island which is about 0.66 sq km)

compared to the current vegetation cover on the island and has little use value to the community, the community benefits from the wind turbine will be more. Where cutting of trees is required it will be compensated by planting additional trees at 1:2 or 1:4 for coconut palms pre-construction. The necessary budget will be provided by MOECCT for planting trees. Cutting and planting of trees will be done in coordination with Island Council and EPA. Following mitigation measures will be implemented by the contractor,

- (i) Marking of trees to be removed prior to clearance, and strict control on all vegetation clearing activities under supervision of an ecologist to ensure minimal clearance and no disturbance to nesting birds etc.
- (ii) Contractor to ensure that there is no illegal or accidental clearing of vegetation, felling of trees or disturbance of fauna.
- (iii) Protect/preserve topsoil separately to subsoils and reinstate after construction completed.
- (iv) Once the ground mounted solar and wind turbines are built, any empty spaces can be vegetated and at Manadhoo planted with shrubs or smaller trees, which will not impact the wind turbine operation.
- (v) Transplantation or compensatory replanting of the removed trees in coordination with island council and EPA.
- (vi) Cut trees must not be burned, the leaves can be made to mulch and used for slower release of carbon stored in biomass and the woody parts can be reused for longer lasting objects and hence slow the release of carbon.

268. Careful planning and design during pre-construction can ensure that the construction ocean energy and wind turbine impacts are minimized. Implementation of the marine BAP for ocean energy and effective environmental supervision, monitoring and reporting system using checklists of all contractual environmental requirements will help ensure no significant residual impact.

### **3. Social Environment**

269. Temporary negative impacts on the appearance of the project areas are anticipated due to supply, storage and haulage of construction material and movement of equipment and machinery. The impacts will be minimized by the selection of suitable storage areas for materials with minimum visibility from residences and roads with screening where necessary – in most cases in the existing powerhouses. The transportation of construction materials and project equipment will require about ten truck trips per day during the working period of eight hours. It will mean there is more traffic, particularly heavy traffic, on the road than usual. The distance from the harbor/wharf/jetty to the proposed sites is generally short so few roads will be affected by this. The traffic level will return to normal after the construction work is completed. The construction will require not more than 30 workers at one time, who will reside in existing accommodation outside the project sites. The presence of workers will have impacts on local resources and may lead to conflict with local communities. For all project-funded components community and occupational health and safety risks must be managed. Following additional mitigation measures will be implemented to minimize impacts/risks and ensure health and safety of local communities and construction workers.

- (i) Conduct work after consultation with the Island Councils to choose a time that will cause minimal disturbances to the community.
- (ii) Construction activities are only undertaken during the daytime and local communities informed of the construction schedule.
- (iii) Operation of machinery generating high levels of noise during cabling work, solar panel installations and for the wind turbine construction will be restricted to

between 8:00 am and 5:00 pm in areas where there are nearby residences that could be disturbed.

- (iv) Construction workforce to use existing facilities which have the provision of proper sanitation, water supply and waste disposal facilities.
- (v) Contractor to conduct a health and safety risk assessment and prepare and implement a health and safety plan to minimize risks following the hierarchy of avoidance, minimization, and control in the first instance with the provision of PPE only as a last resort.
- (vi) Provide PPE and ensure its use by workers.
- (vii) Contractor to arrange for health and safety inductions and training sessions for all workers.

270. Since there are no physical cultural resources on the project sites, there will be no impacts on physical cultural resources through the implementation of various project components although mosque users may be disturbed when works adjacent in which case activities to be limited during prayer times. The EMP contains a 'chance find' provision in case such are encountered during excavation of the sites since some of the sites are located on undisturbed lands.

#### **D. Impacts and Mitigation: Operational Phase**

271. The activities within the scope of this IEE for the operational phase are:

- (i) operation and routine maintenance of the island grid system
- (ii) end of life disposal of batteries
- (iii) operation and routine maintenance of wind turbines
- (iv) operation and routine maintenance of solar photovoltaic systems
- (v) end of life disposal of photovoltaic panels
- (vi) operation of ocean energy pilot system
- (vii) operation of agriculture interventions

272. Following construction, in most cases, the project impacts will diminish to a negligible level although all the project components except the grid upgrades will be visible in the island landscape. Traffic to and from the existing powerhouses will reduce to present levels; although existing access routes will continue to be utilized during the operation and maintenance of the project facilities. Once construction is completed the project components will provide cleaner and less fossil fuel consuming electricity benefiting air quality and climate. Unlike diesel generation, the operation of the renewable energy power plants will not result in emissions to air or water during operation.

273. The solar components contribution to noise will be undetectable and any noise from the BESS and transformers will be insignificant compared to that of the adjacent diesel generators. There will be some minor noise generated from pumps for the agricultural intervention. The water to be used for washing the solar panels will be taken from rainwater or the island council supply and no new groundwater source will be tapped. By avoiding the use of detergent or chemicals in the wash water, impacts on soil and groundwater quality can be minimized. Some impacts on soil quality and ground water resources are anticipated as the irrigation system will use ground water to drip irrigate the agricultural land. However, use of efficient pumping system will have positive impacts on Thoddoo island water resources. Other than the handling and end life disposal of batteries and photovoltaic panels and health and safety risks operation of the grid system including BESS and transformers, solar photovoltaic systems, and irrigation systems, will have at

most minor adverse impacts. Therefore, detailed analysis of the impacts from operations of these project facilities has not been undertaken.

The key operation stage impacts are related to the ocean energy—marine habitats, coral, and seagrass etc. (discussed in Appendix 9); and the wind energy systems—visual and noise impacts, risk of bird and bat collision with wind turbines, health and safety risks to communities and residences from accidental blade throw. The pre-mitigation analysis of the impacts from operation of wind turbine facilities is presented in Table 43 and from operation of wind turbine facilities is presented in Table 44. As per the analysis (as shown in Table 43) from the operation of wind turbine there are moderate to minor level of negative impacts mainly from noise generated, on avifauna (birds) of the island, local aesthetics, and the health and safety of the workers and communities. The operational impacts from the ocean energy system are moderate to minor (as shown in Table 44) related to marine ecology impacts and health and safety especially of fishers and other boat users. Impacts of large-scale maintenance works for the wind turbine component will be similar in nature to construction activities and are not reassessed.

**Table 43. Significance analysis of Impacts from Operation of Wind Turbine installation in Manadhoo Island**

Environment	Potential impact		Impact	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	Since the wind turbines will be connected to the grid there will be an air quality benefit due to operation of wind turbines reducing the need for diesel generator set operation on Manadhoo island.	Yes(+)						
	Climate	Climate change benefits due to operation of wind turbines on the island.	Yes(+)						
	Noise level (including underwater noise)	There is a risk of increased noise levels from the operation of wind turbines. However, the detailed design will ensure that turbine noise will be maintained at <35dBA at the nearest residential property which is about 130 m away from the nearest wind turbine.	Yes(-)	1	1	2	1	5	Minor
	Light levels	There is chance of shadow flicker from the operation of the wind turbines. However, the detailed design will ensure shadow flicker levels will not exceed the IFC EHS guideline level.	Yes(-)	1	1	2	1	5	Minor
	Topography (soil erosion)	No impacts on topography (soil erosion) due to operation of wind turbines on the island.	No						
	Drainage and waterlogging	No impacts on drainage and waterlogging due to operation of wind turbines on the island, adequate drainage is to be incorporated into detailed design.	No						
	Marine hydrological processes	No impacts on marine hydrological processes due to operation of wind turbines on the island.	No						
	Soil quality	No impacts on soil quality due to operation of wind turbines on the island.	No						
	Use of natural resources	No impacts on natural resources due to operation of wind turbines on the island.	No						
	Waste generation	No waste generation due to operation of wind turbines on the island.	No						



Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
Environment	Surface water quality	No impacts on surface water quality due to operation of wind turbines on the island.	No						
	Surface water quantity	No impacts on surface water quantity due to operation of wind turbines on the island.	No						
	Ground water quality	No impacts on ground water quality due to operation of wind turbines on the island.	No						
	Groundwater quantity	No impacts on groundwater quantity due to operation of wind turbines on the island.	No						
	Marine water quality	No impacts on marine water quality due to operation of wind turbines on the island.	No						
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat due to operation of wind turbines on the island.	No						
	Beach and costal fringe vegetation	No impacts on beach and costal fringe vegetation due to operation of wind turbines on the island.	No						
	Other terrestrial habitats (vegetation)	No impacts on other terrestrial habitats (vegetation) due to operation of wind turbines on the island.	No						
	Terrestrial fauna	No impacts on terrestrial fauna due to operation of wind turbines on the island.	No						
	Avifauna	During operation of wind turbine there is risk of bird and bat collision with wind turbines; no threatened species have been identified by the ecology surveys.	Yes(-)	1	2	1	1	5	Minor
	Coral reefs and seagrass	No impacts on coral reefs and seagrass due to operation of wind turbines on the island.	No						
	Other marine habitat	No impacts on other marine habitat due to operation of wind turbines on the island.	No						
	Marine fauna	No impacts on marine fauna due to operation of wind turbines on the island.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Protected areas and ESA	No impacts on protected areas and ESA due to operation of wind turbines on the island.	No						
	Protected or threatened species	No impacts on protected or threatened species due to operation of wind turbines on the island.	No						
	Invasive species spread	No impacts on invasive species spread due to operation of wind turbines on the island.	No						
Social	Agricultural land	No impacts on agricultural land due to operation of wind turbines on the island.	No						
	Human settlement	No impacts on human settlement due to operation of wind turbines on the island.	No						
	Recreational land	No impacts on recreational land due to operation of wind turbines on the island.	No						
	Other land use	There will be restrictions on the use of land within the 100m setback distance that has to be maintained for community health and safety purposes and restrictions on FENAKA using land within 34.5m of the wind turbines as the minimum setback per IFC EHS guidelines.	No	1	1	2	1	5	Minor
	Employment	Some limited employment opportunities during project operation phase.	Yes(+)						
	Community health safety	Community health and safety due to wind turbine which is accessible by the community. Accidental damage of wind turbines during operation such as from lightning strikes will also lead to community health and safety risks. Since these are the first wind turbines on Manadhoo and FENAKA has no or limited experience of maintenance set back is 100m from community receptors to provide an additional safety buffer over and above the minimum 34.5m	Yes(-)	2	2	2	1	7	Moderate

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
		setback of 1.5 x total height per the IFC EHS Guidelines.							
	Conflict including SAEH	No conflict including SAEH due to operation of wind turbines on the island.	No						
	Communicable diseases	No risk of communicable diseases due to operation of wind turbines on the island.	No						
	Occupational health and safety	OHS risks to O&M workers including working with electricity and working at height – workers from Maldives and island will have no or limited experience of wind turbine maintenance increasing the risk.	Yes(-)	2	3	2	1	8	Moderate
	Aesthetics	Operation of six wind turbines on island which will be visible from distance will affect local aesthetics.	Yes(-)	2	1	1	1	6	Moderate
	Cultural/religious values	No impacts on cultural/religious values due to operation of wind turbines on the island.	No						
	Cultural/religious sites	No impacts on cultural/religious sites due to operation of wind turbines on the island.	No						
	Chance finds	No chance finds risks due to operation of wind turbines on the island.	No						
	Pressure on Community Resources	No pressure on community resources due to operation of wind turbines on the island.	No						
	Public utilities	The wind turbines will be connected to the grid thereby improving the energy supply for the island.	Yes(+)						
	Access to property / business	No risks of access to property / business due to operation of wind turbines on the island.	No						
	Road uses	No impacts on road uses due to operation of wind turbines on the island.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Local economy	Benefits from enhanced energy supply during operation period.	Yes(+)						
	Knowledge and awareness	As a pilot the wind turbines will increase FENAKA and island council's understanding of wind turbine operation.	Yes(+)						
	Fishing and navigation	No impacts on fishing and navigation due to operation of wind turbines on the island.	No						
	Local tourism	No impacts on local tourism due to operation of wind turbines on the island.	No						
	Financial benefit to community	No financial benefit will be accruing to the local community from the works	Yes(+)						
	Airport safety	Airport safety may be affected due to wind turbine installation works on island. <sup>52</sup>	Yes(-)	1	1	2	1	5	Minor

**Table 44. Significance Analysis of Impacts from Operation of Ocean Energy Pilot on Islands**

Environment	Potential impact		Impact	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	No impacts on air quality due to operation of ocean energy pilot as not connected to the grid.	No						
	Climate	No impacts on climate due to operation of ocean energy pilot as not connected to the grid.	No						
	Noise level (including underwater noise)	There is a risk of increased underwater noise levels from the operation of kinetic energy turbines.	Yes(-)	1	1	2	1	5	Minor
	Light levels	There will be marking of the ocean energy pilots with navigation lights to avoid navigation collision.	Yes(-)	1	1	1	1	4	Minor

<sup>52</sup> Nearest airport is Maafaru which is about 9.74 km from the island, though no significant impacts are anticipated the airport authority is to be consulted during detailed design.

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Topography (soil erosion)	No impacts on topography (soil erosion) due to operation of ocean energy pilot.	No						
	Drainage and waterlogging	No impacts on drainage and waterlogging due to operation of ocean energy pilot.	No						
	Marine hydrological processes	The ocean energy system will convert kinetic energy to electricity but given the scale of the pilot the impact on marine hydrological processes will be small and limited to the immediate area	Yes(-)	0	1	1	1	3	Minor
	Soil quality	No impacts on soil quality due to operation of ocean energy pilot.	No						
	Use of natural resources	No impacts on natural resources due to operation of ocean energy pilot	No						
	Waste generation	No waste generation due to operation of ocean energy pilot	No						
	Surface water quality	No impacts on surface water quality due to operation of ocean energy pilot.	No						
	Surface water quantity	No impacts on surface water quantity due to operation of ocean energy pilot.	No						
	Ground water quality	No impacts on ground water quality due to operation of ocean energy pilot.	No						
	Groundwater quantity	No impacts on groundwater quantity due to operation of ocean energy pilot.	No						
	Marine water quality	Impacts on marine water quality due to operation of ocean energy pilot.	Yes(-)	1	1	2	1	5	Minor
Ecological	Mangrove, wetland, forest habitat	No impacts on mangrove, wetland, forest habitat due to operation of ocean energy pilot.	No						
	Beach and costal fringe vegetation	No impacts on beach and costal fringe vegetation due to operation of ocean energy pilot.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
Environment	Other terrestrial habitats (vegetation)	No impacts on other terrestrial habitats (vegetation) due to operation of ocean energy pilot.	No						
	Terrestrial fauna	No impacts on terrestrial fauna due to operation of ocean energy pilot.	No						
	Avifauna	No impacts on avifauna due to operation of ocean energy pilot.	No						
	Coral reefs and seagrass	Coral reefs and seagrass may be affected from operation of underwater turbines due to footprint impacts and shading.	Yes(-)	3	3	2	1	9	Moderate
	Other marine habitat	Other marine habitat may be affected from operation of underwater turbines due to footprint impacts.	Yes(-)	3	3	2	1	9	Moderate
	Marine fauna	Marine fauna species may be affected from operation of underwater turbines – due to collision or entrapment with the former being the more significant risk.	Yes(-)	3	3	2	1	9	Moderate
	Protected areas and ESA	No impacts on protected areas and ESA due to operation of ocean energy pilot	No						
	Protected or threatened species	Marine protected or threatened species may be affected from the operation of underwater turbines – due to collision or entrapment with the former being the more significant risk.	Yes(-)	3	3	2	1	9	Moderate
	Invasive species spread	No impacts on invasive species spread due to operation of ocean energy pilot.	No						
Social	Agricultural land	No impacts on agricultural land due to operation of ocean energy pilot.	No						
	Human settlement	No impacts on human settlement due to operation of ocean energy pilot.	No						
	Recreational land	No impacts on recreational land due to operation of ocean energy pilot.	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
Environment	Other land use	No impacts on other land use due to operation of ocean energy pilot.	No						
	Employment	No impacts on employment due to operation of ocean energy pilot.	No						
	Community health safety	Community health and safety due to ocean energy being in marine environment which is accessible by community especially fishers – an exclusion zone will need to be established.	Yes(-)	1	2	2	1	6	Moderate
	Conflict including SAEH	No risk of conflicts due to operation of ocean energy pilot.	No						
	Communicable diseases	No risk of communicable diseases due to operation of ocean energy pilot.	No						
	Occupational health and safety	OHS risks to O&M workers including working with electricity and working over water	Yes(-)	2	2	2	1	7	Moderate
	Aesthetics	Operation of ocean energy pilot in waters which will be visible from distance will affect local aesthetics.	Yes(-)	1	1	1	1	4	Minor
	Cultural/religious values	No impacts on cultural/religious values due to operation of ocean energy pilot.	No						
	Cultural/religious sites	No impacts on cultural/religious sites due to operation of ocean energy pilot	No						
	Chance finds	No chance finds risk due to operation of ocean energy pilot	No						
	Pressure on Community Resources	No pressure on community resources due to operation of ocean energy pilot	No						
	Public utilities	No impacts on public utilities due to operation of ocean energy pilot as it will not be connected to the grid.	No						
	Access to property / business / facilities	No impacts anticipated on access to property / business due to ocean energy pilot	No						

Environment	Potential impact		Impact	Sensitivity	Recoverability	Importance	Spatial Distribution	Significance	
			Yes/No	-1,0,1,2,3	1,2,3	1,2,3	1,2,3	Score	Level
	Road users	No impacts on road users due to operation of ocean energy pilot	No						
	Local economy	No impacts on local economy due to operation of ocean energy pilot	No						
	Knowledge and awareness	As a pilot the ocean energy installation will increase FENAKA and island council's understanding of ocean energy operation.	Yes(+)						
	Fishing and navigation	Restriction on any fishing due to operation of ocean energy pilot, as a temporary exclusion zone will be required for health and safety. Impacts on ecosystem services that fishers are reliant on may occur. There are no important fisheries at the islands of Mulah and Muli, but Komandoo Island is known for its fisheries activities.	Yes(-)	1	1	1	1	4	Minor
	Local tourism	Restriction on any marine based tourism due to operation of ocean energy pilot, as a temporary exclusion zone will be required for health and safety.	Yes(-)	1	1	1	1	4	Minor
	Financial benefit to community	No financial benefit will be accruing to the local community from the works	No						
	Airport safety	No impacts on airport safety due to operation of ocean energy pilot	No						



## 1. Physical Environment

274. Only minor impacts are envisaged on the physical environment except for battery disposal which will have a moderate impact. During the operation phase batteries from the BESS as part of the grid upgrades and the BESS for the ground mounted photovoltaic plant and wind turbines will have to be replaced after 7–8 years (although Li-ion batteries may be able to serve up to 10 years given the advancement in technology and the flow batteries piloted on two islands will have a longer life). The batteries will need to be disposed of [recycled] as hazardous waste which there is no capacity in the Maldives to accept. In both cases at end of life the batteries will be exported from Maldives for reuse, recycling and/or disposal which will be assured through a battery disposal agreement that will be part of the contractual arrangements with the suppliers. Such a contractual agreement will reduce the need for storage by FENAKA as cells can be removed and replaced at the same time by the supplier. Only dry batteries will be transported to avoid possible leakages. The handling 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). FENAKA will have an emergency plan in place in case of the accidental bursting of the batteries.

275. Careful site selection at the planning stage eliminates impacts on sensitive areas and disturbances to residential areas from the wind energy pilot. Noise impacts from the operation of wind turbine could be an issue. However, the impacts will be minimized through detailed design of the wind turbine (to meet 35 dB(A) at the nearest residential area) and by placing them as far away as possible and at least 100m from the residential area. Regular maintenance of wind turbines by the contractors in the pilot stage and then FENAKA will keep noise levels within limits. In order to determine the impacts of operation of wind turbine at proposed site (Manadhoo island) an initial noise and shadow flicker analysis has been carried out by Michael L.S. Abundo (Ocean Pixel Pte. Ltd.) as part of site assessment and planning considerations for pilot wind project. Following are the results of the noise and shadow flicker analysis with the assessment of the final proposed layout (referred to as Scenario 5) included in Appendix 14:

- (i) Wind turbines to be used: 25 kW capacity
- (ii) Possible total capacity: 150 kW
- (iii) Noise at nearest residential receptors: <35dB at 10m/s wind speed as LA90
- (iv) Shadow Flicker at nearest residential receptor: <30 hours per year, <30 minutes per day on the worst affected day

276. Though the project components do not increase the use of any fuels, oils or chemical storage and handling of transformer oils, residual oil from separator and lubricating oil storage will be an issue for ongoing O&M of the powerhouses as the current practices are inadequate. As part of the grid upgrade 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 structures at the fuel storage tanks so that they will be protected from rain and will store spilt or leaked fuel for pump-out and environmentally safe and sound disposal; (ii) redesign of the existing oil-separators; and (iii) construction of bunded, impermeable concrete areas for the storage of empty lubricant oil drums. Additionally, work practices and site environmental management need to match this requirement to ensure that no fuel, oil or other lubricant is allowed to enter the external environment.

## 2. Biological Environment

277. Operation of the wind turbine will cause minor negative impacts on avifauna species such as birds, bats etc. Though the wind turbines are of small capacity there is a risk of resident or occasional migratory birds or fruit bats colliding with the wind turbines, but no threatened species are known to be supported by Manadhoo island per consultations with locals and island council. As a pilot, monitoring and adaptive management such as curtailment of wind turbine operations during migratory periods (birds) or low wind speeds (in respect of bats) will be implemented as required.

278. Operation of the ocean energy pilot will have minor to moderate impacts on marine ecology primarily due to footprint, shading, collision and entrapment impacts as discussed further in Appendix 9. Careful site selection and design of the ocean energy system at the planning stage can reduce impacts on coral and seagrass and marine fauna. As a pilot, monitoring and adaptive management will be implemented as required. If unanticipated marine ecological impacts were found to result from the ocean energy system it will be decommissioned, as is currently the plan with EPA approval required to make it into a permanent installation. The following measures are proposed to ensure that adverse impacts related to operation of the pilot are mitigated as far as possible:

- (i) As part of a precautionary avoidance approach consideration to be given to the potential to deploy the ocean energy pilot outside of the seasonal periods when whale sharks or reef manta ray be present around islands. Devices to be selected that have the slowest frequency of rotation to minimize the potential for injury that may ensue from any impact with blades. The potential for locating energy devices in deeper water is also preferred as they will minimize the percentage of the water column within the rotor swept area, but only if these areas are not of greater sensitivity for species that may be at risk from collision.
- (ii) To align with global good practice approaches, monitoring is to be completed to define the level of risk for collision and to record any interactions with marine wildlife. Ideally, the monitoring studies related to collision risk would seek to support improvement to the knowledge base and help to address the gaps identified by Sparling et al. (2020). For the development of monitoring approaches, references can be made to Hasselman et al. (2020). Some key aspects to be incorporated into the monitoring approach include:
  - (a) Nearfield video monitoring of interactions of marine species (including behavioral changes) and to record any incidence of collision.
  - (b) Ground truthing fish species presence prior to deployment and during operation using acoustic methods (e.g., echosounders).
  - (c) Measurement of stimuli to correlate with animal behavior, such as currents, underwater sound, water particle characteristics.
- (iii) The above could also be used to monitor the influence of underwater sound generated by the devices. During the pilot phase underwater sound measurements to also be taken following guidance set out by Polagye and Bassett (2021), including approaches that seek to differentiate sound produced by energy device and broader natural and anthropogenic sources.
- (iv) Monitoring to inform adaptive management approaches during operation. This may include alteration to blade rotation velocities and size, halting operations, changes to design or re-deployment in locations of lower sensitivity. The monitoring must also be capable of informing larger array scale deployment in the Maldives in the future.

- (v) The devices are to be designed to ensure containment of any harmful materials arising from leaks or machinery failure. All equipment used should be maintained regularly in accordance with the manufacturer's recommendations to help reduce the potential for accidental discharges. No harmful materials shall be released to the marine environment.

### **3. Social Environment**

279. During operation both the wind turbines and ocean energy which are in the public domain will pose a moderate risk to community health and safety as well as to workers health and safety. In respect of the wind turbines there are risks due to (i) community access to the base of the turbine which can be minimized by posting warning signage, installing fencing and providing awareness raising, and (ii) accidental breaking of the wind turbine blades which will be minimized by following international engineering standards during detailed design and construction and regularly maintaining the wind turbines. Maldivian islands are vulnerable to the tropical cyclones and hurricanes. The foundations of wind turbine will be designed to withstand powerful cyclones and hurricanes, which will limit the probability of generation unavailability as well as reducing any potential failure hazard of the wind turbine structure. Since these are the first wind turbines on Manadhoo and FENAKA has no or limited experience of maintenance, set back is 100 m from community receptors is required to provide an additional safety buffer over and above the minimum 34.5 m setback of 1.5 x total height per the IFC EHS Guidelines. FENAKA informed by a facilitated risk assessment undertaken with the contractor will develop and implement a maintenance plan, an occupational health and safety plan and emergency response plan to handle any emergency that may arise during the operation period, their workers will be trained to deal with the emergency situations. The ocean energy devices will require navigation lighting to avoid collision of the structure by other vessels. It is likely that a temporary exclusion zone will be required around the devices during their operation to avoid interference by fisheries and to avoid collision with other vessels in the waters around the islands. There are no important fisheries at Mulah and Muli Islands, but Komandoo is known for fisheries activities, and there are also marine tourism activities that could be disturbed. The overlap with such activities is not known but under a worst-case scenario only a small area may be excluded for a temporary period during the pilot phase. Other health and safety risks could come from photovoltaic panels being lifted and blown onto adjacent properties during tropical cyclones and hurricanes; therefore, the foundations and racking systems of photovoltaic panels will be designed to withstand such powerful cyclones and hurricanes.

280. Due to the setback requirement further use of the land area around the wind turbines for other development will be restricted, as the setback must be maintained on health and safety grounds. The other potential impact could be visual with the addition of the tall wind turbines on Manadhoo island having a moderate impact, and the possibility of some glint and glare from the photovoltaic panels to be installed on residential properties and from the ground mounted plant in Thoddoo island.

281. During the operation 10–15 additional staff in total who will be employed by FENAKA to operate all the project facilities alongside existing FENAKA colleagues; they will utilize the existing sanitation and welfare facilities at the powerhouses. Domestic waste generated by this small number of people can be readily handled by the island councils but as noted above any defunct batteries must not be given to the island councils as they do not have capacity to deal with them.

## **E. Impacts and Mitigation: Decommissioning Phase**

282. Decommissioning impacts are similar in nature to those of construction for the removal of the installation, mostly this will be done at end of life. The ocean energy pilot will be decommissioned at the end of 12 months and all infrastructure will be removed. Removal of the ground anchors may cause some localized disturbance like those identified during construction. However, removal of the anchors will enable natural restoration to pre-installation conditions. Rather than decommissioning the devices can be transferred elsewhere for reuse. If devices are not to be reused, they should be re-purposed as a priority to reduce the volume of waste produced. Dismantling (including disposal) of the pilot wind turbine will be done by the supplier only if the pilot for the wind energy is found to be not successful at the end of the pilot period otherwise it will be retained.

283. The project will require the use of batteries (for BESS system, ground-mounted solar and wind turbines) which will need environmentally sound and safe disposal [recycling] after 7–8 years of operation. Maldives has no capacity to dispose of the batteries which will be classed as hazardous waste. To control possible future impacts, it is proposed that suppliers handle the disposal of the batteries. As part of procurement procedures, MOECCT will ensure that supplier has an environmentally safe and sound system in place for safe disposal [recycling] of used batteries. Similarly, the project's solar photovoltaic panels are expected to have an economic life of 25 years. Decommissioned solar photovoltaic panels can be sent for recycling based on the thin-film technologies and their update. Dismantling of the photovoltaic panels will be handled by suppliers that offer the best price to FENAKA for used photovoltaic panels in the future.

## **F. Cumulative and Induced Impacts of Project Components**

284. The project-funded installations proposed on the outer islands are located on government land and involve small scale installations having only minor to moderate adverse impacts. However, they will facilitate private sector renewable energy installations as discussed in the Due Diligence Report (Appendix 6) and are being constructed on islands where a range of adverse impacts have already occurred from a variety of sources, including vessel movements, land reclamation, sewage discharge etc. MOECCT will need to ensure its development follows the mitigation measures set out to address the adverse impacts arising from the construction, operation and decommissioning of the project-funded components and that the associated private sector development follows the frameworks for the preparation of environmental management plans, biodiversity action plans, and biodiversity offset management plans to avoid significant cumulative environmental effects from installing the project and associated facilities in the outer islands of Maldives.

285. Induced impacts may be beneficial due to renewable energy providing an increase in economic activities such as industrial development, tourism, and fisheries. However, such economic activities are also having adverse impacts and need to be managed by the government. The increase in penetration of renewable energy in islands will reduce dependency of islands on fossil fuel (mainly diesel) which will lead to reductions in greenhouse gas induced climate change risks and local air and noise pollution.

## VI. CONSULTATIONS AND INFORMATION DISCLOSURE

### A. Consultations

286. ADB's Safeguard Policy Statement (2009) requires projects to carry out meaningful consultation on an ongoing basis. Public consultation will: (i) begin early and carry on throughout the project cycle; (ii) provide timely disclosure of relevant information, understandable and accessible to people; (iii) ensure a free and un-intimidated atmosphere without coercion; (iv) ensure gender inclusiveness tailored to the needs of disadvantaged and vulnerable groups; and (v) enable the incorporation of all relevant views of affected people, and stakeholders into project decision making, mitigation measures, the sharing of development benefits and opportunities and implementation issues.

287. During preparation of the IEE consultations have taken place by the consultants on behalf of the energy department MOECCT with key stakeholders (including government officials at local and national level, community leaders, non-government organizations [NGOs]) as well as public consultations on project islands with project beneficiaries and members of the public likely to be affected by various aspects of the project.

#### 1. Consultation with Key Stakeholders

288. Key stakeholders consulted included MOECCT, FENAKA, EPA, URA, island councils, and NGOs in different phases starting from project identification to site selection and field surveys. The consultations were conducted through one-to-one fact to face meetings as well as through virtual means. The list of officials/people contacted along with points discussed is presented on Table 45.

**Table 45: List of Stakeholders Consulted and Issues Discussed**

Sl. No.	Agency/ Department and Date	Officials Met	Issues discussed
1.	MOECCT (several times including during ADB Fact Finding mission)	Mr. Ajwad Mustafa, Permanent Secretary Mr. Ahmed Ali, Director General Mr. Ali Majid, Deputy Minister	Project components, requirements of ADB Safeguard Policy Statement (2009). Scope of the IEE and documentation/reporting requirements as per Safeguard Policy Statement (2009) and national EIA regulations. Institutional setup and capacity.
2.	EPA (several times including during ADB Fact Finding mission and 2 <sup>nd</sup> week of January 2023 to discuss 2022 regulation on tree removal from islands)	Mr. Ibrahim Naeem, Director General Mr. Rifath Naeem, Senior Environmental Analyst	National regulatory and legal frameworks, project categorization, reporting and monitoring requirements, permitting requirements and timeframe, institutional setup and capacity, baseline data requirements. Project scope, approval process, opinion, or recommendation on where ADB IEE should focus, coordination with island EPA offices. National EIA requirements as per national regulations. Key biodiversity aspects of ADB Safeguard Policy Statement (2009) and the main components of biodiversity assessment, categorization requirements, protected areas and sensitive areas.
3.	FENAKA (several times including during field visits)	Mr. Nashith, Director Mr. Mohammed Irfan Managers and technicians from each island FENAKA branch	Project components and scope of the IEE. Role and responsibilities of FENAKA. Existing organizational setup and environmental management/pollution control system in place. Past experience in environmental management.

4.	Island Councils	Presidents, Vice President and Secretary General of all island councils on 22 islands	Project components and scope of the IEE. Site specific environmental and ecological issues. Role of island councils in environmental protection. Key environmental issues on the island.
5.	URA (during ADB Fact Finding mission)	Mr. Akram Waheed, Director	Roles and responsibilities of URA. Project activities and likely permitting/licensing requirements.
6.	NGOs (during field visits) (Name of NGO and Person Contacted): Milandhoo Youth Movement, Ahmed Sham Base Jamuiyya, Ismail Khaleel, Bafa Jamuiyya, Mohamed Razeen Alifushi Vadinge Ekuveri Jamuiyyaa, Ibrahim Zaheen Hulhudhuffaar Zuvaanunuge Roohu, Ibrahim Shifaz Dharavandhoo Unite, Ahmed Shifau Community Empowerment Linkage, Mohamed Latheef Veyvashu Ekuveringe Dhirun, Ibrahim Firag Nilandhoo Young Generation (NYG), Murushidh Abdurrazaq Yes Jamuiyya, Ahmed Rasheed Gadhdhoo New Generation (GANG), Muaviyath Jameel Thoddoo Sustainable Development Association, Ali Abdulla Thoddoo Sosun Club, Muaviyath Hassan		NGO practices and likely involvement in project activities. Key environmental and social issues on the islands and Maldives.

## 2. Public and/or Community Consultations

289. The public and/or community consultation sessions were conducted together with social and technical teams. The consultation process started to be conducted during the difficult period of COVID-19, hence, the mobility and meetings were restricted due to the travel and meeting restrictions. Many of the selected ASSURE islands were under monitoring several times. In fact, some visits were made under special permission. The visits to all 22 islands were made in different stretches (from August 2021 to June 2022, and December 2022) as the islands are from different atolls, 13 from north and 10 from south of Malé.

290. Due to the restrictions in place due to the COVID-19, the initial activities carried out in the field were limited to the meetings with councils and FENAKA branches. In most of the cases, the island council meetings were held as single sittings also attended by community stakeholders including representatives of Women Development Committees to avoid multiple contacts and control interactions. No formal meetings were held on the islands which were under monitoring.

291. The visits to all selected ASSURE islands were made during peak time of the COVID-19 when there were restrictions on travel and large gatherings. Follow-up meetings were also held

to some of the islands which could not be visited due to COVID-19. Some visits were made on special arrangements. However, utmost effort has been made to engage all key stakeholders in consultation meetings wherever possible. In total 264 participants covering 35% women (174 male and 90 female) participated in the consultation meetings. Consultations on islands selected for pilot wind and ocean energy projects and ground mounted photovoltaic plant (Thoddoo) were carried out as part of the site assessments. Table 46 gives the participants details with segregation of male and female participants.

292. A photographic record of the consultations is provided in Appendix 4.

**Table 46: Details of Consultation Meetings in Islands**

#	Name of the island	Date	Number of Participants	
			Male	Female
1	HA. Dhidhdhoo	29/08/2021	6	3
2	HDh. Hanimaadhoo	26/08/2021	4	6
3	Sh. Milandhoo	02/11/2021	4	4
4	N. Manadhoo	28/11/2021 & 30/5/2022	13	5
5	N. Holhudhoo	02/02/2022	5	1
6	N. Velidhoo	03/02/2022	7	2
7	R. Alifushi	02/11/2021	9	2
8	R. Hulhudhuffaaruu	02/11/2021	9	3
9	B. Thulhaadhoo	09/09/2021	8	1
10	B. Dharavandhoo	06/09/2021	14	5
11	M. Mulah	12/09/2021	8	6
12	M. Muli	09/09/2021	4	5
13	M. Raiymandhoo	12/09/2021	14	8
14	M. Veyvah	14/09/2021	7	4
15	F. Nilandhoo	16/09/2021	10	8
16	Th. Guraidhoo	27/01/2022 & 11-12/06/2022	6	2
17	Th. Thimarafushi	27/01/2022 & 12-13/06/2022	6	0*
18	GA. Maamendhoo	25/10/2021	7	3
19	GDh. Faresmaathodaa	26/10/2021	7	7
20	GDh. Gadhdhoo	27/10/2021	6	7
21	AA. Thoddoo	3-4/6/2022	17	6
22	Sh. Komandoo	31/5/2022	3	2
		<b>Total</b>	<b>174</b>	<b>90</b>

\*Women participants were also invited but did not attend.

## **B. Findings of the Consultation Meetings**

293. The local communities were briefed about the purpose of consultations, proposed project and scope of activities, likely sites of the project facilities using island maps, key environmental and social issues, and invited participants to raise issues/concerns. Table 47 summarizes some of the social, environment, and economic issues/concerns discussed during the consultation meetings and response/action taken by the project to address the same.

**Table 47: Summary of Issues Discussed<sup>53</sup> During Consultations**

<b>Issues Raised</b>	<b>Response/Action taken</b>
Few participants raised concerns whether in cases solar energy is not available there may be power failures	It was informed that there will be battery backup system as well as diesel generator system will continue to ensure uninterrupted power supply.
Will there be any disturbances during construction stage	There will be some minor short term disturbances during the construction stage. Adequate measures will be included in the EMP.
Some concerns were raised if there would be an increase in existing power bills due to project	It was clarified that the project will not affect their current power bills and investment cost will not be a liability to them.
Some concerns were raised on how project waste will be handled.	It was clarified that waste will be handled by contractor as per Island Council regulations. No waste will be left on the island.
There were queries and suggestions from communities on awareness and training to women on safety and maintenance of electrical appliances.	It was informed that awareness and training to women will be an integral part of the project. A separate gender action plan will be prepared to include these aspects.
Queries were raised if the project will cause air and noise pollution and how it will be controlled.	It was informed to the communities that the proposed project will be designed fulfilling all requirements of socio-environmental due diligences set by ADB and the country, hence, all measures will be taken to reduce and control noise and air emissions during and after the implementation of the project on these islands. International standards are set in the design for the procurement of all required materials and construction work for power systems.
Participants in some islands raised queries if the project will cause pollution including waste and how this will be dealt with.	It was informed to the communities the proposed renewable energy system will minimize environmental pollution to a great extent by reducing emissions, smoke and noise, hence reduce health issues, especially, those who are directly and closely exposed to the emissions on the islands. It was also informed to the communities that the standards also would be set for safe-handling, storage and disposal of oil and its residues and disposal of construction and installation wastes during and after the implementation of the project in all islands according to the Maldives waste disposal regulations as set by Environmental Protection Authority (EPA).
Some residents asked about how to raise complaint.	It was informed to the communities that a proper mechanism to address potential grievances of environmental and social issues will be in place so that people can bring the issues in right time and they can be redressed properly in a timely manner as needed. The GRM will be communicated to the people prior to the start of the project implementation.
On Dharvandhoo island communities and island council suggested to look for alternate site for the floating photovoltaic installation as the current site will be used for water sports and recreation facilities.	The site was replaced with ground mounted site.

294. Besides floating and land based solar photovoltaic installations (to be supported by private sector) and grid upgrades, questions were also asked about specific components such as wind

<sup>53</sup> Queries raised by people were answered to their satisfaction and it was assured that their concerns will be addressed in the process of project design.



turbine installation in Manadhoo islands, agriculture system in Thoodoo island and ocean installations on three islands.

295. On Manadhoo island local people informed that they are not aware of noise issues from wind turbine operation. They also have not raised any issue with the proposed site. When asked about the presence of birds on the island, they have not seen any specific birds in the area. On Thoddoo island people have not shown any issues with proposed site for agriculture intervention as the site is away from the residential areas. They mention that the improvement in the irrigation system will help them to grow more crops which will enhance their income. About ocean energy components, people are not aware of such technologies and do not raise any concerns.

296. Overall, the island communities are positive and welcomed the installation of the RE based interventions including solar photovoltaic, BESS, distribution grid improvement, and wind and ocean energy. Many members stated their wish to start the project as soon as possible. Some residents asked about how to raise a complaint. It was informed to the communities that a proper mechanism to address potential grievances of environmental and social issues will be in place as practiced in the ongoing projects so that people can bring the issues in right time and they can be redressed properly in a timely manner as needed.

### **C. Information Disclosure**

297. Information disclosure will follow the procedure for ADB environment category B projects. It is the policy of the ADB to have environmental assessment reports made available and/or accessible to the general public.

298. All environmental documents are subject to public disclosure, and therefore, will be made available to the public. This IEE will be disclosed on ADB's website upon receipt and also on the website of MOECCT. This IEE with the executive summary translated into local language will be made available for perusal at the MOECCT head office in Malé, at Island council offices, at powerhouses on the islands, and at other locations accessible to stakeholders (to be determined by MOECCT). If requested the entire IEE will be translated to local language free of charge by MOECCT.

### **D. Follow up Consultations**

299. MOECCT will ensure that meaningful public consultations are undertaken through the entire project cycle, the design, installation, and operation phases. Additional consultations will be required for pilot projects on wind and ocean energy during detailed design and also on the agriculture components in completing further studies.

300. **During feasibility study and detailed design.** During the detailed design stage public consultation through MOECCT with the support of FENAKA will be carried out for all project components before the contract award. Consultations should convey how community health and safety will be ensured during construction and opportunities to raise a grievance. Consultations for each component must ensure a representative percentage of the local community are consulted, as well as gender balance. Consultation suggestions/recommendations will be included in the updated IEE.

301. For the consultations, the dates, attendees, male/female split, topics covered, and views and opinions raised should be recorded along with details of how the project has responded to

them. Consultation meetings are to have at least 20% representation of women, if it is not possible at the public meeting/consultation a separate gender focus group must be held to ensure their concerns are heard. If public meetings are not possible to convene due to COVID-19 restrictions, then the same representation should be achieved through door-to-door consultations within communities.

302. **During project implementation.** Public consultation is an integral part of the project implementation. The process of public consultation and consultation with other concerned stakeholders will be continued during project implementation by MOECCT and their contractors and as necessary during the operation and maintenance stage. The public and other concerned stakeholders will be informed about the project at every stage of project execution through notices, pamphlets, information provided through community representatives, and face-to-face consultations etc.

303. During detailed design and pre-construction, contractors in coordination with FENAKA field officers will hold face-to-face consultations with all persons occupying properties in proximity of the project components to keep them fully informed of the nature of works and latest schedule, and to discuss any specific concerns these persons may have regarding environmental and social impact.

#### **E. Grievance Redress Mechanism**

304. 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) has been proposed. When and where the need arises, this mechanism will be used for addressing any complaints that may arise during the pre-construction, construction and operation of the project. The grievance mechanism is scaled to the risks and adverse impacts of the project. It will address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people at no costs and without retribution. It will be accessible to members of the community but also workers upon approval of the project by ADB. The mechanism is not impeding access to the Maldivian judicial or administrative remedies. MOECCT with the support of FENAKA and Island Councils will appropriately inform the affected people about the mechanism on approval of the project.

305. The following seven-step mechanism is proposed for grievance redress of environmental and social matters in installation and operation of various project components using existing island council administrative structures (affected persons/organizations/ community groups), any of which can be complainants.

306. The MOECCT project management unit (PMU) will be based at FENAKA headquarters in Malé and will have two supervisors (PIU) from FENAKA at island level who are based on site along with the contractors. The supervisors will be nominated as the site-level GRM focals for the project with the contractor also designating a site-level GRM focal. The PMU based in Malé will have a designated staff member to address all potential complaints from the workers and public for both the installation and operation phases of the project, they will liaise daily with the supervisors on the islands regarding any grievances received. Any complaint will be recorded and investigated by the PMU working with the contractors and operations managers of FENAKA (as appropriate) together with the Island Council. A complaints register will be maintained which will show the details and nature of the complaint, the complainant, the date and actions taken because of the investigation.

It will also cross-reference any noncompliance report and/or corrective action report or other relevant documentation.

307. When construction starts, a signboard will be erected at all sites providing the public with updated project information and summarizing the grievance redress mechanism process including contact person details at the site and PMU. All corrective actions and complaints responses carried out on site will be reported back to the PMU through the field level supervisors. The PMU will include the complaints register and corrective actions/responses in its progress and environmental monitoring reports to the ADB.

308. In the whole process, the Maldives national agencies (EPA for environment related grievances, Ministry of Housing and Infrastructure for social/resettlement related grievances, Ministry of Health or Ministry of Employment for labor related grievances) will be always available to receive public complaints and advise the PMU on resolution and their grievance redress performance.

309. On receipt of a complaint in any form (in person, telephone, written, minor/major, and even if informal) the nominated site complaints officer will log the details in a complaints register. They will forward the complaint to the contractor/construction manager/operations manager (as appropriate) within 12 hours. In case of a grievance relating to immediate risk to human life, or impending damage to structures, flora or fauna, or physical cultural resources, the contractor or supervising field staff will get in immediate contact with the PMU GRM Focal who shall have the power to halt works until required corrective action is taken. The contractor or managers will respond to the site-level supervisors within 1 week with advice on corrective actions taken or put in train. The supervisors will review and find a solution to the problem in consultation with the Island Council and, if necessary, the Atoll Council and other relevant agencies. Then the supervisors will report back to the Island Council and PMU and affected persons within one weeks' time. If the complainant is dissatisfied with the outcome or have received no advice in the allotted time, he or she can take grievance to PMU. The PMU GRM Focal will refer matter to the relevant internal committee (GRC) and if it remains unresolved at PMU level then refer it to the national agency (EPA, MOHI, MOH, MOE). The national agency will refer it to its existing internal grievance committee and report back to PMU and PMU will report back to site level supervisors/Island Council/affected persons about the outcome. If unresolved or at any time if a complainant is not satisfied, he or she can take the matter to the appropriate court. Both successfully addressed complaints, however minor they may have been, and non-responsive issues will be reported to the ADB by the PMU.

310. The affected person (complainant) at any time can access the national judicial system irrespective of the result of project-level grievance redress mechanism. An affected person can also use the ADB Accountability Mechanism through directly contacting (in writing) the Complaint Receiving Officer (CRO) at ADB headquarters or ADB's South Asia Energy Division. A complaint can be submitted in any of the official languages of ADB's DMCs. The ADB Accountability Mechanism information will be included in the signboard or notices as part of disclosing the GRM.

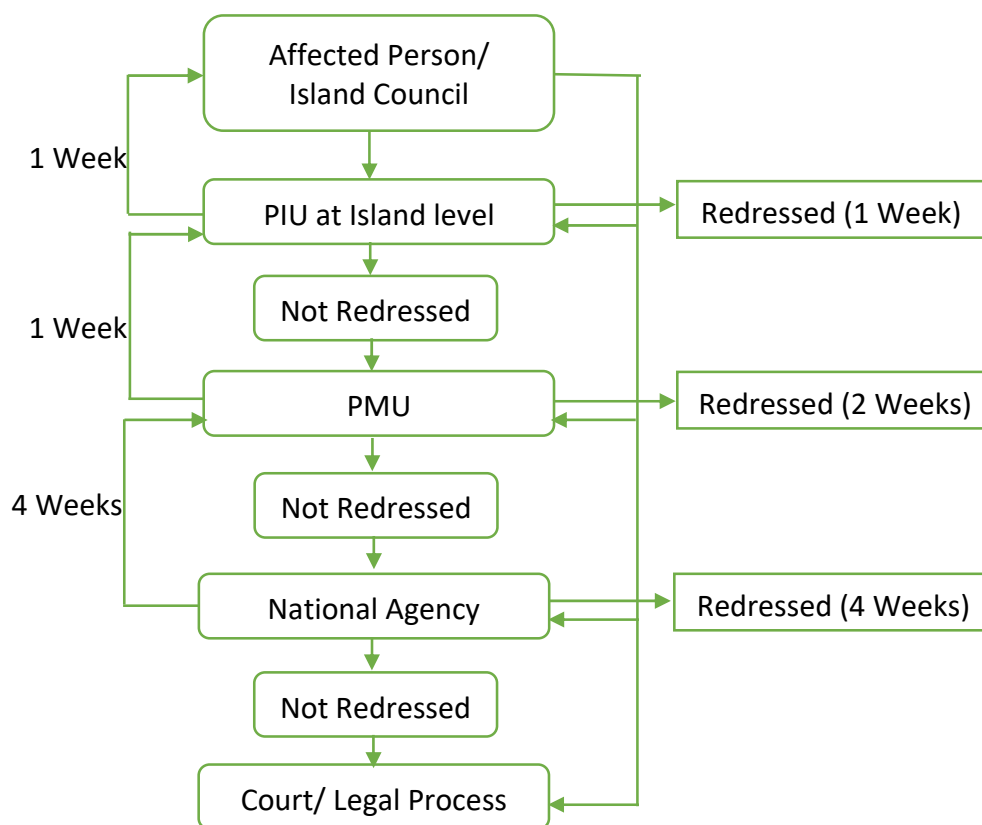
311. Table 48 presents the steps and corresponding time frame for proposed grievance redress mechanism.

312. Figure 41 shows the proposed Grievance Redress Mechanism.

**Table 48: Grievance Redress Process**

Stage	Process	Duration*
1	Affected Person (AP)/Island Council takes grievance to site supervisors (PIU)	Any time
2	Site supervisors (PIU) review and find solution to the problem in consultation with Island Council and, if necessary, the Atoll Council and other relevant agencies	1 week
3	PIU reports back to AP/Island Council and PMU GRM Focal	1 week
If unresolved		
4	AP/Island Council takes grievance to PMU GRM Focal	Within 2 weeks of receipt of decision in step 3
5	PMU refers matter to relevant internal committee (GRC) and if unresolved by PMU refers to national agency	2 weeks
6	National agency refers to its internal committee and conveys decision back to PMU	4 weeks
7	PMU reports back to PIU/AP/Island Council	1 week
If unresolved or at any stage if AP is not satisfied		
AP/Island Council can take the matter to appropriate court		As per judicial system

\*Grievance to be resolved in timescale stated but cannot be closed out until the agreed action is implemented in full.

**Figure 41: Proposed Grievance Redress Mechanism**

Source: Consultant Work

## VII. ENVIRONMENTAL MANAGEMENT PLAN

### A. Introduction

313. ADB's Safeguard Policy Statement (2009) requires that an environmental management plan (EMP) be prepared and implemented for a category B environment project. The EMP is the synthesis of all the mitigation measures to avoid, minimize, mitigate, or compensate/offset for the adverse environmental impacts and risks on the physical, biological, and socioeconomic environment that have been identified in the previous sections of the IEE as well as to enhance positive impacts. It aims to ensure compliance with (i) ADB's Safeguard Policy Statement 2009 requirements and international good practice as set out in the related International Finance Corporation (IFC) Environment, Health and Safety (EHS) general, Electric Power Transmission and Distribution and Wind Energy guidelines, and (ii) applicable environmental, health and safety requirements of the Government of Maldives, including the international agreements which it is a signatory too, as well as the sensitivity of local ecological and human receptors in the project area of influence.

314. The EMP outlines the mitigation measures to be implemented set to a timeframe, and the responsibilities for implementing them, whilst a monitoring plan elaborates on the monitoring requirements and responsibilities. To ensure these mitigation and monitoring plans are implemented, MOECCT and their Project Management Unit (PMU) supported by a Project Management Consultant (PMC) will need to undertake a program of environmental supervision and monitoring during project implementation. The institutional arrangements for this are also set out. The definitive version of the EMP cleared by ADB is the version disclosed on its website. The EMP is dynamic and can be updated as appropriate during the project implementation. However, any update to the EMP will first need to be cleared by ADB. In addition, any unanticipated impacts including changes to the project design and layouts as assessed in the IEE, or requirements for corrective action due to non-compliance identified during project implementation will be reported to ADB. In this case appropriate action will be agreed and taken by MOECCT and their contractors and FENAKA/Island Councils once operational to address them and bring the project implementation back on track.

315. The major components of the EMP are:

- (i) Corrective action plan for existing facilities (powerhouses) to be implemented by FENAKA pre-construction;
- (ii) Mitigation plan including performance standards to be followed by concerned parties during preconstruction, construction, operation and decommissioning of the project components;
- (iii) Monitoring plan including performance standards for quantitative monitoring to be undertaken; and
- (iv) Institutional arrangements, including organizational roles and responsibilities for mitigation, supervision, monitoring and reporting on EMP implementation, capacity development and training requirements for MOECCT, the PMU, their contractors, and FENAKA/Island Councils on various aspects of EMP implementation and, an indicative cost estimates/budget for its implementation.
- (v) Grievance redress mechanism (GRM)—Chapter F of the IEE report sets out the GRM for the project with roles and responsibilities for MOECCT, the PMU, their contractors, and FENAKA/Island Councils.

316. The EMP will form part of all bidding and contract documents and during planning and detailed design (pre-construction) and construction the contractors will be responsible for implementing all relevant measures under the supervision of the MOECCT. Any updates to it will be incorporated into the contract document. The contractors must always follow the definite version of the EMP which is the version that is disclosed on ADB's website. Contractors will cover the costs where corrective action is required due to non-compliance on behalf of the contractors, their subcontractors or third parties with the EMP.

317. There are five EPC contract packages to be awarded for the (i) lithium-ion BESS, (ii) flow BESS, (iii) ocean energy pilot, (iv) wind energy pilot, and (v) ground mounted solar on Thoddoo island. There are also two works contract packages for (i) grid upgrades and (ii) rooftop solar, under which there may be 3–4 lots each. For these the equipment will be separately procured under two goods contracts. Both the EPC and works contracts must append a full copy of the EMP including both the general and site-specific mitigation and monitoring plans relevant to the contract. For goods contracts MOECCT PMU will need to ensure relevant EMP measures including prohibitions on PCBs, asbestos containing materials, and SF6 are reflected in the equipment specifications.

## **B. Existing Facilities Corrective Action Plan**

318. Since the project involves existing facilities that have been subject to environmental audit it is necessary for corrective action to be undertaken. Appendix 7 contains the corrective action plan for existing facilities (powerhouses); unless otherwise indicated, all actions are to be completed by FENAKA or delegated to the contractors through the scope of the relevant contracts prior to the contractor being given access to the project sites.

319. MOECCT PMU will be responsible to submit a report on the status of the corrective actions undertaken by FENAKA or delegated to ADB for clearance prior to the contractor being given access to the powerhouses in question to undertake works including site establishment. Contractors will be responsible for implementing any corrective actions delegated to them, or otherwise outstanding on gaining access to the powerhouses in addition to the requirements of the mitigation plan.

## **C. Mitigation Plan**

320. The mitigation hierarchy; avoid, minimize, mitigate, offset/compensate; has been used to guide the mitigation of environmental and social impacts from the project components. Careful site selection and project design at the planning and detailed design stage can avoid significant impact. This is especially so since the ocean energy pilot is to be sited in the marine environment in a location that is still to be confirmed, and since the wind energy pilot can have noise, shadow flicker and safety impacts if it is not designed to meet performance standards in line with the IFC EHS Guidelines on Wind Energy. The environment, health and safety parameters to be followed for the ocean energy and wind energy pilots are set out in the mitigation plan and will need to be taken on board by the contractor, MOECCT PMU with the support of the PMC must ensure the performance standards are adhered to before approving any detailed design. The rest of the proposed mitigation strategy focuses on minimizing the minor to moderate impacts of the project components. In addition to the impacts of the ocean and wind energy systems mentioned above the main anticipated impacts and risks of the project-funded components relate to short-term (approximately 3-5 days for smaller works and up to two months for larger works i.e. wind turbine installation) disruption and disturbance during construction; pollution risks; and health and safety

risks to workers and local communities, for example, island roads will be blocked and noise and dust emissions will be created from the operation of construction machinery such as concrete mixers, bulldozers, dump trucks, cranes etc.

321. A general mitigation plan showing the stage-wise potential impacts and proposed mitigation measures and responsible party has been prepared in a matrix form and presented in Table 1, Appendix 16. Considering there are several project components which involve construction work, this common matrix will be applicable for all the components involving construction activities and will be attached to all EPC and works contracts. Operational phase mitigation measures are primarily for FENAKA, except for the ocean energy and wind energy pilots where the contractor will continue to be responsible for operation during and decommissioning at the end of the pilot, and the agricultural interventions which will be handed over to the Island Councils. All maintenance works during the operation phase, including by the contractors during their defect liability period and any operation and maintenance obligations will be undertaken following the construction measures. Separate matrices have been prepared for the individual components addressing component-specific impacts and mitigation of a particular component as follows:

- (i) General mitigation plan matrix for all construction work (Table 1, Appendix 16) including environmental codes of practice (Appendix 17),
- (ii) Mitigation plan matrix for BESS, EMS and Grid Upgrades (Table 2, Appendix 16),
- (iii) Mitigation plan matrix for solar photovoltaic plants (rooftop and ground mounted) (Table 3, Appendix 16),
- (iv) Mitigation plan matrix for Wind Energy Pilot (Table 4, Appendix 16),
- (v) Mitigation plan matrix for Ocean Energy Pilot (Table 5, Appendix 16) which is to be updated for ADB clearance following confirmation of the selected island, and
- (vi) Mitigation plan matrix for agricultural intervention (Table 6, Appendix 16) which is to be updated for ADB clearance following confirmation of the scope of physical interventions.

322. These mitigation plan matrixes for the ocean energy pilot and agricultural intervention will be updated as part of updating the IEE following the feasibility studies since the locations and exact scope are still be studied, the updated EMP will be cleared by ADB before the feasibility study is approved by MOECCT.

#### **D. Monitoring and Reporting**

The extent of monitoring and reporting must be commensurate with the project's impacts and risks. Throughout implementation of the project, MOECCT, and FENAKA/Island Councils during operation, will need to supervise and monitor EMP implementation progress and the impacts of the project in the field, the performance standard being all EMP mitigation and monitoring measures are implemented in full at the appropriate time. The environmental monitoring plan (EMOP) (Table 7, Appendix 16) sets out the minimum provisions for quantitative environmental monitoring and performance standards to be achieved—scope and periodicity is commensurate with the project's impacts and risks. Monitoring activities including any laboratory analysis for air quality, noise and water quality are to be carried out by a suitably qualified and experienced third-party monitoring organization that is approved by the EPA. Quantitative monitoring activities may be modified during project implementation, depending on the contractors' performance and analytical results obtained. If performance is worse than expected, corrective action will be identified, and environmental monitoring activities adjusted accordingly by MOECCT and their contractors if during pre-construction and construction and FENAKA/Island Councils once

operational, to help resolve any unsatisfactory performance. MOECCT will establish a system for supervision and monitoring and preparing semi-annual environmental monitoring reports for submission to ADB and local disclosure with inputs from FENAKA/Island Councils during operation.

## **E. Implementation Arrangement**

The main institutions that will be involved in environmental management activities are the Ministry of Finance as the executing agency (EA); and MOECCT as implementing agency (IA) of the project, project management consultant (PMC), EPC and works contractors, and line agencies including the Environment Protection Agency (EPA). The project management unit (PMU) will be established under MOECCT for implementing the project facilities. MOECCT will be responsible for implementation, supervision and monitoring of the project with the support of FENAKA and the Island Councils.

323. MOECCT PMU will coordinate with EPA to seek advice on regulatory requirements for the project. If required MOECCT with support from PMC environment experts will update this IEE and EMP to meet the EPA requirements to get necessary approvals as per national requirements.

324. Efficient project implementation related to the EPC, works and goods contracts will be provided by the PMC and will include preparation of bidding documents; assistance during the bidding process and evaluation; and supervision of the technical design, equipment supply, construction, and commissioning as well as piloting and decommissioning in respect of the ocean and wind energy.

325. The EA/IA have overall responsibility for all aspects of the project. The IA through the PMU with support of the PMC will be responsible for day-to-day management of technical aspects of the project. The PMU will be responsible for updating the IEE and EMP as well as approving contractors' feasibility studies, detailed designs, and construction related management plans, and to ensure on-ground implementation by the contractors of the EMP. The EA/IA will ensure the environmental management and monitoring budgets are available and utilized as necessary for timely implementation of the EMP and CAP for existing facilities by all government entities.

326. The existing capacity of MOECCT in managing project level environmental aspects needs strengthening to ensure compliance with ADB and government requirements. PMU will have an environment officer and social (community liaison) officer in the project organization structure who will be full-time and primarily responsible for ensuring that the EMP and CAP for existing facilities is properly implemented. PMC will provide training and capacity building to PMU staff on managing the environmental issues associated with project and be responsible for ensuring the quality of deliverables before submission to ADB. Costs for the appointment of PMU officers and for the PMC consultant support are included in the capacity building component of the Project.

327. The contractors will be informed of their responsibility to comply with the EMP and the requirements of ADB. There are specific responsibilities for EMP compliance during construction phase that will rest with the contractors who will be supervised and monitored by the safeguards team of PMU and PMC. The contractors will be required to have one staff with experience in environmental management and one staff with experience of health and safety to supervise and monitor day-to-day EMP implementation and be responsible for preparing plans such as the CEMP, CHSMP, etc.



## 1. Institutional Arrangement

328. MOECCT will have ultimate responsibility for implementing the provisions of the EMP with the main parties involved in environmental management and monitoring activities for this project being:

- (i) **Ministry of Finance** as the executing agency to provide guidance to MOECCT on all project related matters.
- (ii) **Ministry of Environment, Climate Change and Technology** as the implementing agency responsible for environmental, health and safety management and compliance with the government regulatory requirements, ADB's Safeguard Policy Statement 2009, the project's loan covenants and EMP requirements ultimately lies with the MOECCT management.
- (iii) **Project management unit.** Responsible for the overall day-to-day management of the technical, environmental, and social aspects of project implementation and thus compliance with the government regulatory requirements, ADB's Safeguard Policy Statement 2009, the project's loan covenants and EMP requirements. The PMU will include an Environmental Officer and Social (Community Liaison) Officer who will be responsible for advising the technical arm of the PMU on EMP implementation requirements, supervising and monitoring EMP implementation including on-site supervision, acting as a GRM Focal, and preparing the semi-annual EMRs for submission to ADB.
- (iv) **Project management consultants).** Consulting firm to support PMU in overseeing project implementation, including and international environment consultants and national environment and terrestrial/marine ecological consultants to support PMU with updating of the IEE, providing regular (monthly) on-site supervision during the construction period, and undertaking ecological field survey work.
- (v) **International marine ecology expert.** To provide environment safeguards capacity development support, this expert will be separately appointed under TA6603.
- (vi) **Contractors and their subcontractors (if any).** Through the contract, MOECCT will delegate responsibility for implementing all relevant EMP measures to their contractors. The contractors are to employ suitably qualified and experienced full-time environment and social officers and health and safety officers as their safeguards team with a dedicated EHS supervisor on each island and health and safety steward on each active construction site where there are multiple islands/sites involved. For the wind pilot and ocean pilot ecologists will also be employed.
- (vii) **Construction workers employed formally or informally by the contractors and their subcontractors.** These workers will need to abide, in their behavior and work, to directives issued by their employer with regards to environmental, health and safety management.
- (viii) **FENAKA.** Responsible for implementation of the CAP and operation of the BESS, grid upgrades, rooftop and ground mounted solar upon handover from the contractors.
- (ix) **Island councils.** Responsible for providing and enforcing island-levels permissions as well as operation of the agricultural intervention upon handover.
- (x) **Environment protection agency.** Responsible for providing and enforcing all national environmental clearances required.
- (xi) **Project financiers—ADB.**

329. Key roles and responsibilities with respect to EMP implementation, supervision, monitoring and reporting are discussed in more detail below with the implementation arrangements illustrated in Figure 42. Reporting, instructions, liaison/consultation, and advice/inspection channels are also shown.

## **2. Ministry of Environment, Climate Change and Technology and Project Management Consultants Roles and Responsibilities**

330. MOECCT will be the implementing agency and their management will establish a new PMU to be responsible for day-to-day management of project implementation including EMP implementation, supervision, and monitoring of their contractors' performance as well as establishment of the GRM and resolution of any grievances received. MOECCT will delegate relevant detailed design, pre-construction, and construction measures to its contractors through the contract. It will also put in place the institutional arrangements to ensure private sector developers will follow the Safeguard Policy Statement (2009) requirements (not just the government regulatory requirements) in developing associated facilities of the project. However, MOECCT will have ultimate responsibility for ensuring the provisions of the EMP are implemented by all parties concerned.

331. During project implementation, MOECCT/PMU is responsible for the following activities (not an exclusive list):

- (i) Ensuring adequate budget, institutional/management support, and staff resources are allocated to implement, supervise, and monitor the EMP throughout the project.
- (ii) Upon loan effectiveness appointing a suitably qualified and experienced, named environment officer and social (community liaison) officer and providing them with adequate resources and facilities to support MOECCT/PMU with EMP implementation.
- (iii) Providing with the support of PMC and the international marine ecology expert a suite of training activities for PMU staff, contractors, and EPA in relation awareness raising on Safeguard Policy Statement (2009) requirements and EMP implementation.
- (iv) Ensuring that all PMU staff support and attend all capacity development and training activities provided, and to facilitate the provision of the training venues etc.
- (v) Adopt a zero-tolerance approach to OHS on the project, enforce all PMU staff to comply with the OHS requirements of the EMP including the wearing of appropriate PPE on the construction site to set a good example to the contractor and their workers.
- (vi) Securing national environmental clearances before contract award and complying with any requirements set.
- (vii) Implementing the EMP and supervising and monitoring implementation by the contractor during all relevant stages of project implementation.
- (viii) Incorporating the EMP into the bidding and contract documents before issuing tenders and contract awards. The contract will explicitly require the contractors to provide an environment safeguards team to support EMP implementation, to report at least monthly to the PMU on their EMP implementation and immediately report any unanticipated impacts including health and safety incidents and chance finds.
- (ix) Reviewing bids to ensure they are in accordance with the EMP requirements prior to contract award.

- (x) Reviewing and approving in a timely manner contractors' detailed designs as well as any additional environmental safeguard assessments and their CEMP and CHSMP and sub-plans to ensure they incorporate and are in accordance with the EMP requirements.
- (xi) Updating the IEE/EMP as required in consultation with ADB prior to approval of the feasibility studies and detailed designs to reflect any changes from the scope and design assessed by the IEE and obtaining ADB's clearance for the update prior to commencement of any work, including site establishment. Once cleared, ADB will disclose the updated IEE on its website whilst PMU will locally disclose it.
- (xii) Preparing a community liaison/consultation plan and training plan to elaborate on EMP implementation.
- (xiii) Developing with the support of PMC international environment expert formal systems and templates for the PMU environment officer, the contractors, and national PMC consultants to supervise, monitor and report on day-to-day implementation of all aspects of EMP implementation, including the immediate reporting of non-compliances, unanticipated impacts, accidents, and chance finds etc.
- (xiv) Undertaking on-site supervision with all active construction sites (excluding rooftop solar sites) being physically visited by the PMU environment officer at least once per month to determine the status of EMP implementation by the contractors – FENAKA supervision staff will also assist PMU with day to day monitoring of EMP implementation.
- (xv) Keeping daily records and photo logs of site observations to inform preparation of the semi-annual EMRs.
- (xvi) With the support of PMC conduct monthly EHS meetings with each contractor's management including physical "spot check" site visits to at least one of their active construction sites (including rooftop solar sites) and the ocean and wind energy pilot projects during their first year of O&M to audit EMP implementation.
- (xvii) Identifying areas for improvement, unsafe acts, and any non-compliance with the EMP by the contractor and instructing corrective action to be taken by them to bring implementation back on track.
- (xviii) Ensuring that prior to handover from the contractors the project components as constructed will enable FENAKA and the Island Councils to comply with their O&M actions; undertaking site visits to check their EMP compliance during O&M stage.
- (xix) With the support of PMC developing O&M SOPs reflecting O&M-related environment, health and safety measures to be adopted and followed by FENAKA site operations management teams upon handover to them. For the powerhouses (grid upgrades) SOPs will include safe handling, storage, and disposal of diesel fuel, oil residues, and lubricating oil associated with existing diesel generators.
- (xx) Thoroughly investigating all unanticipated impacts, near-misses, accidents, and chance finds; preparing a detailed incident report where applicable, identifying and instructing corrective action particularly to avoid any repetition of near-misses and accidents.
- (xxi) Monitoring and reporting on EMP implementation including the submission of semi-annual EMRs to ADB from loan effectiveness and at least the first year of operation up until the ADB project completion report (usually 1-2 years after financial close) or longer period if required due to outstanding environmental issues.
- (xxii) Undertaking ongoing consultation with island councils and local communities to inform them of progress with project implementation including prior to finalization

of detailed designs, giving attention to consultations with women and other vulnerable groups. All ongoing consultation, such as, minutes of the meetings will be documented in the EMRs submitted to ADB.

- (xxiii) Upon loan effectiveness establishing and operationalizing the GRM for affected persons (construction workers and local community members) in line with provisions of the IEE report, including establishing a grievance redress committee for affected persons, recording and promptly addressing all environmental and social grievances received. Contact details for the GRM will be prominently displayed on notice boards at the project site. All ongoing grievance-related information will be documented in the EMRs submitted to ADB. Further details on the GRM are provided in Section 6.
- (xxiv) Locally disclosing the IEE and other environmental safeguards documentation. This will include MOECCT website publication and ensuring full copies of the IEE report and its executive summary translated into Dhivehi are available at the island council, powerhouse and construction site offices. Notices will also be placed on noticeboards at the project site and offices informing of the main findings of the IEE and the availability of the IEE report with notice given that help with translation into affected persons' languages or an explanation of their content will be extended free of charge on request.
- (xxv) Reporting any unanticipated impacts, incidents, and chance finds to ADB within 48 hours of them occurring along with a corrective action plan.
- (xxvi) Updating the IEE/EMP as necessary and locally disclosing any updates if unanticipated impacts (including project scope or design changes) occur during implementation; any such updates must be submitted to ADB for clearance and disclosed on the ADB website before any related works commence or are cleared to continue.
- (xxvii) Upon any decommissioning including of the ocean energy pilot and wind energy pilot if not successful, ensure construction-related measures in relation to the dismantling of equipment and restoration of the sites and other specific activities like transport and disposal of used batteries, photovoltaic panels, and electrical equipment are being followed.
- (xxviii) Developing and taking all requisite corrective action in case of any non-compliance with the EMP during pre-construction and construction, including repair of any property damage and financial compensation (insurance) for any health and safety incidents.

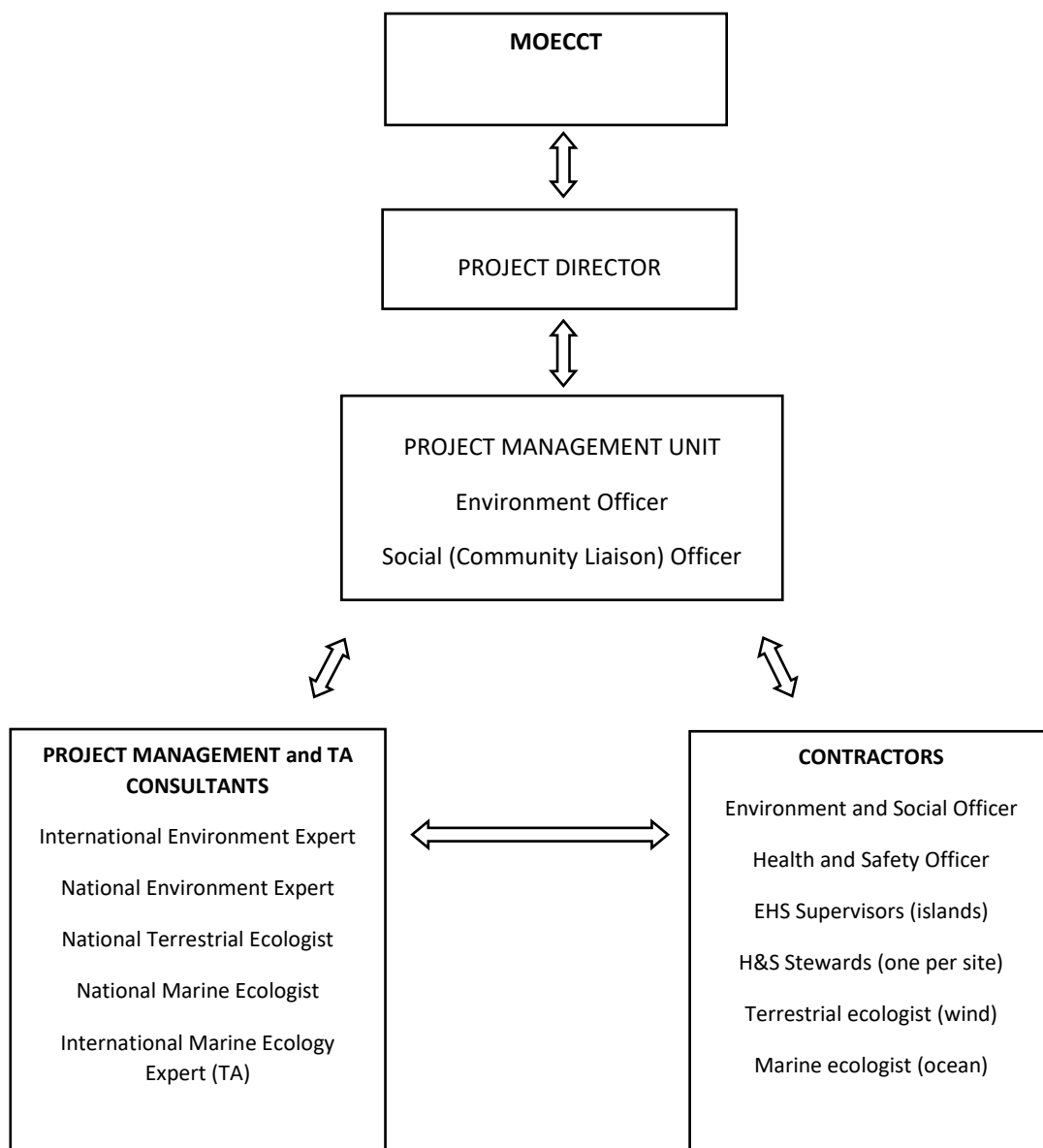
### **3. Project Management Consultant Roles and Responsibilities**

332. The PMC will be comprised of individuals or a firm including international and national environment consultants and national terrestrial and marine ecological consultants. There will be a separate international marine ecology consultant employed under ADB TA. These consultants will support MOECCT/PMU by undertaking the following activities (not an exclusive list):

- (i) Support delivery of safeguard training and capacity building activities and provide on-the-job guidance to PMU and contractors ensuring compliance with the EMP requirements.
- (ii) Supporting PMU to obtain national environmental clearances before contract award.
- (iii) Supporting PMU to incorporate the EMP into the bidding and contract documents before issuing tenders and contract awards.

- (iv) Supporting PMU in reviewing bids to ensure they are in accordance with the EMP requirements prior to contract award.
- (v) Supporting PMU in reviewing contractors' detailed designs as well as any additional environmental safeguard assessments and their CEMP and CHSMP and sub-plans.
- (vi) Leading on updating the IEE/EMP as required in consultation with ADB prior to approval of the feasibility studies and detailed designs to reflect any changes from the scope and design assessed by the IEE.
- (vii) Helping to prepare the community liaison/consultation plan and training plan to elaborate on EMP implementation.
- (viii) Developing the formal systems and templates for supervision and monitoring to ensure that contractors adhere to all the provisions in the EMP as well as their CEMPs, CHSMPs, and sub-plans as approved by the PMU.
- (ix) Organizing and conducting monthly EHS meetings with each contractor's management including physical "spot check" site visits to at least one of their active construction sites (including rooftop solar sites) to audit the EMP implementation.
- (x) Keeping records and photo logs of site observations to inform preparation of the semi-annual EMRs.
- (xi) Helping to develop O&M SOPs reflecting O&M-related environment, health and safety measures to be adopted and followed by FENAKA site operations management teams upon handover to them.
- (xii) Helping to prepare the EMRs for submission to ADB.
- (xiii) Reporting on any grievances or violations of the EMP and assisting in implementing solutions and remedial measures.
- (xiv) Supporting PMU to undertake ongoing meaningful consultation with affected communities to keep them informed of progress and local disclosure of the findings of the IEE reports and EMRs etc.
- (xv) Supporting implementation of the GRM and assisting PMU to resolve on-going issues related to environmental and social safeguards during pre-construction and construction.

**Figure 42: Institutional Arrangement for Environment Management Plan Implementation**



Source: PAM

#### 4. Contractor Roles and Responsibilities

333. The contractors will be required to comply with the EMP during all relevant phases, closely supervised and monitored by PMU supported by the PMC. The contractors will be delegated, through the contract, the requirement to undertake relevant mitigation and monitoring actions as set out in this EMP at the construction sites as well as at any overnight accommodation provided by them, and to assist with operation of the GRM. The contractors are required to ensure that the EMP requirements are cascaded down to all subcontractors undertaking works relating to the project, regardless they are formally or informally employed. The construction contractors will have a corporate EHS policy and environmental management certifications preferably such as ISO 14001 (or equivalent) and EHS certification such as ISO 45001 or equivalent.

334. The contractors are to employ the following suitably qualified and experienced officers as their safeguards team:

- (i) at least one dedicated environment and social officer with an environmental management bachelor's degree or similar qualification to be based full-time on-site for the duration of works under the contract package, to monitor and supervise the contractor's EMP implementation on a day-to-day basis reporting to their management and ensure quantitative monitoring as per the EMOP requirements,
- (ii) at least one dedicated health and safety officer with NEBOSH/IOSH certification or similar qualification to be based full-time on-site for the duration of works under the contract package, to monitor and supervise the health and safety aspects of the contractor's EMP implementation on a day-to-day basis reporting to their management and ensure quantitative monitoring as per the EMOP requirements.
- (iii) For the wind pilot and ocean pilot, a terrestrial or marine ecologist respectively to implement the EMP requirements and support the environment and social officer in undertaking ecological quantitative monitoring as per the EMOP requirements.

335. Further, each island and active construction site is to have adequate health and safety supervision to ensure the health and safety of all workers and local communities; the health and safety officer will be supported by full-time on-site EHS supervisors with at least one supervisor per island, and full-time on-site Health and Safety stewards with at least one steward at each active construction site.

336. The safeguards team of the contractors will be responsible for reporting environmental safeguards progress and performance at least monthly to the PMU including recording all data required by the EMOP and providing necessary inputs to the quarterly progress reports and semi-annual EMRs for the duration of their contract. The contractor's safeguards team will also act as the GRM Focals for each contract package/lot to keep affected persons informed of works and be available to receive and deal with any grievances from workers and the local community at the project site level.

337. During project implementation, the contractors are responsible for the following activities (not an exclusive list):

- (i) Implementing all actions and responsibilities allocated to the contractors under the EMP for the full duration of the contractor's involvement in the project.
- (ii) Ensuring adherence to all applicable national environment, health, safety, and labor laws and regulations in force at the time.
- (iii) Ensuring adherence to ADB's Safeguard Policy Statement (2009) and the related IFC Environment, Health and Safety (EHS) guidelines.

- (iv) Ensuring the feasibility studies and detailed designs reflect the EMP requirements; seeking to ensure the same or no worse impact than the design assessed in the IEE.
- (v) Supporting PMU to update (as required) the IEE in respect of the feasibility studies and detailed design by undertaking further assessment as required by the EMP and providing sufficient details to inform a revised project description and any subsequent reassessment of impacts.
- (vi) Ensuring adequate budget and staff resources are allocated to comply with and implement the contractor's responsibilities under the EMP and to supervise and monitor the active construction site to protect the environment and ensure the health and safety of all workers and affected communities.
- (vii) Ensuring a suitably qualified and experienced safeguards team has been appointed to undertake regular on-site supervision and monitoring activities before the commencement of works.
- (viii) Undertaking and documenting a facilitated health and safety risk assessment considering all stages of the project, not just those stages the contractor is responsible for, and including consideration of COVID-19 risks amongst others.
- (ix) Preparing a Construction Environment Management Plan (CEMP) and a Construction Health and Safety Management Plan (CHSMP) both with sub-plans as specified in the EMP for review and approval by PMU prior to the commencement of works.
- (x) Ensuring that all construction workers including all formal and informal employees and subcontractors understand their responsibilities to implement the EMP and mitigate environmental impacts associated with pre-construction and construction activities.
- (xi) Providing and ensuring attendance at EHS training to formal and informal construction workers and other personnel as required.
- (xii) Adopting a zero-tolerance approach to OHS on the project, enforce all workers to comply with the OHS requirements of the EMP including the wearing of appropriate PPE on the construction site.
- (xiii) Supporting PMU in undertaking ongoing public consultations and implementing the site-level GRM; in particular, the contractor's GRM focals shall thoroughly document details of complaints and make its best efforts to resolve the complaints at project site level; all this information is to be included in the contractor's monthly reports to MOECCT.
- (xiv) Undertaking environmental monitoring as set out in the EMOP (Table 7, Appendix 16) during pre-construction and construction (as well as the O&M stage for the wind and ocean pilot projects) and documenting qualitative and quantitative monitoring results.
- (xv) Submitting monthly environmental management reports to PMU (these reports will be included as part of the contractor's monthly progress reports), relating the work undertaken over the reporting period and documenting the environmental measures including monitoring activities that have been carried out, problems encountered, record data including near misses and incidents, grievances received, and follow-up actions that were taken (or will be taken) to correct the problems.
- (xvi) Informing PMU immediately in case of any approved detailed design changes or unanticipated environmental impacts occurring during the project implementation stage, and as required, provide any information needed to the PMU to enable them



to promptly update the IEE/EMP for clearance by ADB before any changes are implemented.

- (xvii) Informing PMU within 24 hours in case of chance find or incident on site and providing within 48 hours an incident report with corrective action detailing how reoccurrence will be prevented.
- (xviii) Informing PMU immediately in case of any non-compliance and help them to prepare as necessary a corrective action plan for clearance by ADB, the contractor is required to implement all necessary corrective action requested by PMU to ensure the project remains in compliance with national regulatory requirements, ADB's Safeguard Policy Statement (2009), the project's loan covenants and EMP requirements.

338. For the O&M and decommissioning phases, any contractors hired for major maintenance works or decommissioning will also be supervised and monitored by MOECCT or FENAKA with their EMP roles and responsibilities the same as those of the contractors for construction.

## **F. Monitoring and Reporting Arrangements**

339. An Environment Monitoring Report (EMR) (template included in Appendix 13) will be submitted to ADB on a semi-annual basis by the PMU with safeguards inputs provided to quarterly progress reports as per the PAM. Since no social safeguard impacts are anticipated, the environmental monitoring reporting will also reflect on any social impacts. Following loan effectiveness, semi-annual EMRs will be due for submission to ADB within 15 days of the month following period end, e.g., before mid-July and mid-January each year. The EMRs will describe project implementation progress, any scope or design changes, compliance against environment and social safeguard requirements that are covenanted in the legal agreements, progress with environment mitigation implementation, quantitative monitoring results in accordance with the EMOP, and details of grievances received. If any performance standards are breached or any of the safeguard requirements that are covenanted in the legal agreements are found not to be satisfactorily with complied by MOECCT or their contractors, an appropriate, time bound, budgeted, corrective action plan (CAP) will be developed and implemented as agreed upon with ADB to rectify unsatisfactory project performance or any safeguard noncompliance in a timely manner. EMRs, any CAP or updated IEE submitted to ADB during project implementation will first be reviewed by ADB for quality and acceptability and then once cleared by ADB disclosed locally (on the MOECCT website and in island council, powerhouse, and construction site offices) and on the ADB website upon receipt. PMU will carry out the following actions to supervise and monitor EMP implementation (not an exclusive list) and ensure intended environmental safeguard outcomes are being achieved by the ASSURE project:

- (i) Undertaking regular on-site supervision each month and keeping daily records and photo logs of site observations to inform preparation of the semi-annual EMRs—FENAKA supervision staff will also assist PMU with day-to-day monitoring of EMP implementation.
- (ii) Conducting monthly EHS meetings including “spot check” site visits to audit in more depth EMP implementation by the contractors and those responsible for O&M.
- (iii) Obtaining monthly reports from contractors and during O&M the FENAKA operational site management teams.
- (iv) Reviewing qualitative and quantitative monitoring results to identify any issues of concern.

- (v) Identifying areas for improvement, unsafe acts, and any non-compliances with the EMP and instructing corrective action to be taken by them to bring implementation back on track.
- (vi) Keeping records of all monthly reports, meetings, inspections and audits and time-bound corrective actions instructed.
- (vii) Supervising and monitoring the implementation of corrective actions alongside EMP implementation to ensure that these are implemented in a timely manner.

340. In addition to standard contract monitoring systems established by the PMU the PMC will develop formal systems and templates for monitoring and reporting on EMP implementation, with the following reporting lines. Those responsible shall ensure timely submissions of reports with an acceptable level of detail:

- (i) Contractors will establish their own internal systems for monitoring and reporting their EMP implementation.
- (ii) Contractors as the main executors of the EMP will formally submit monthly and quarterly environmental management reports per an agreed template to PMU who will share the report with the Environment Officer who in turn will share with PMC.
- (iii) Once works commence on site the PMU Environment Officer will keep written records and photo logs of their site observations reporting their findings at least weekly to the PMC who will prepare written monthly summaries of the EMP progress—these monthly summary reports will be attached to the EMRs submitted to ADB.
- (iv) Photographic records will be kept, covering all activities on site as well as key locations such as stores, sanitation and welfare facilities, overnight accommodation etc. Photographs for key areas will also be taken prior to beginning of construction activities, to provide the environmental baseline. Copies of all geo-referenced photographs will be retained centrally by the Environment Officer and PMC along with their site observation records and the written monthly summaries.
- (v) PMC to convene monthly EHS meetings to be attended by the PMU staff, PMC, and contractor's management and safeguard team to discuss EMP implementation progress; initially progress will be discussed in relation to detailed design actions and as the project progresses will move onto pre-construction and contraction actions etc.
- (vi) During the monthly EHS meetings areas for improvement, unsafe acts, and any non-compliances, time-bound corrective actions and responsibilities to address them will be discussed, agreed, and documented – minutes of monthly EHS meetings will be taken by the PMC and submitted to the Environment Officer to be attached to EMRs submitted to ADB.
- (vii) Environment Officer will be able to instruct other members of the PMU and be given delegated authority to instruct the contractors to take corrective action at any time in relation to EMP implementation.
- (viii) Environment Officer will maintain the time-bound corrective action plan, monitoring and reporting of corrective actions will be undertaken alongside monitoring and reporting of EMP implementation.

341. The Environment Officer will be responsible for obtaining and centrally maintaining documentation, and that document control is ensured through access by and distribution to relevant personnel. Documentation and records to be kept by all parties in hard copy as well as electronic format are as follows (not an exclusive list):

- (i) Definitive IEE and EMP (as disclosed on the ADB website)
- (ii) National environmental clearance documentation
- (iii) Tree felling permits, etc.
- (iv) Community liaison/consultation plan and records of all consultations undertaken
- (v) Training plan and training records
- (vi) Records of emergency preparedness and response drills
- (vii) Document review and approval records
- (viii) CEMP, CHSMP and their subplans
- (ix) Contractor's certifications and insurances
- (x) Completed site checklists and photographic records
- (xi) Corrective action instructions
- (xii) Contractor's records and incident reports
- (xiii) GRM records

342. MOECCT and those with O&M responsibilities will facilitate ADB—or any third party selected on behalf of ADB—to carry out the following monitoring actions to supervise project implementation:

- (i) Conduct periodic site visits during the project implementation to confirm compliance with ADB's Safeguard Policy Statement 2009, the project's loan covenants and EMP requirements.
- (ii) If required, conduct supervision missions with detailed review by ADB's safeguard specialists/officers or consultants.
- (iii) Review and comment on the periodic EMRs to ensure that adverse impacts and risks of the project are mitigated as was planned and agreed with ADB, that any corrective actions have been duly implemented, and that the GRM is fully functional.
- (iv) Work with MOECCT and those with O&M responsibilities to rectify to the extent possible any failures to comply with their safeguard commitments, as covenanted in the loan agreement, and exercise remedies to re-establish compliance as appropriate.
- (v) Prepare a project completion report that assesses whether the objective and desired outcomes of the EMP have been achieved, considering the baseline conditions, and monitoring results.

343. For this purpose, MOECCT, and their contractors, FENAKA and the Island Councils will provide ADB with access to the site and all requested information on the project. For any ADB supervision missions to ongoing construction works, MOECCT and the contractors will be required to provide all ADB staff with a project site health and safety induction and adequate PPE in accordance with Table 2.7.1 of the IFC EHS General Guidelines—Occupational Health and Safety Section.

## **G. Capacity Development**

344. Given a new PMU will be set up for the project with staff lack familiarity with EHS requirements especially international good practice those working on the project will need trainings on environmental safeguards in general and the specifics of management and monitoring requirements for the project. The contractors' staff would also need some training and awareness raising to ensure they fully understand the EMP requirements. Thus, a training program will be implemented per Table 50. These training modules will be delivered by the PMC and are not part of the contractor's cost (other than their staff attendance) but will be a part of the

project cost that includes institutional strengthening, capacity building and training for safeguards. Training modules can be changed during project implementation based on MOECCT requirements. Separate to the EMP training in Table 49 the international consultants will also deliver training to the MOECCT and EPA with respect to ESMS implementation and reviewing and approving the private sector components which are associated facilities of the project.

**Table 49: Training Programme**

<b>Item</b>	<b>Duration/Method</b>	<b>Attendees</b>	<b>Delivered by</b>	<b>Estimated Cost in \$</b>	<b>Budget Source</b>
Introduction to ADB's Safeguard Policy Statement (2009), IFC EHS Guidelines, National Requirements, and Project EMP	1 day face to face event	PMU Staff Contractors' Management and Environment Safeguards Teams	PMC National and International Environment Expert	2,000	PMC Contract
EMP Implementation for Pre-Construction including CEMP and CHSMP development	1 day face to face event	PMU Staff Contractors' Management, Site Engineers and Environment Safeguards Teams	PMC National and International Environment Expert	2,000	PMC Contract
EMP Implementation for Wind Energy	1 day face to face event	PMU Staff Contractors' Management, Detailed Design, and Environment Safeguards Teams	PMC National and International Environment Expert	2,000	PMC Contract
EMP Implementation for Ocean Energy	1 day face to face event	PMU Staff Contractors' Management, Detailed Design, and Environment Safeguards Teams	PMC National and International Environment Expert, together with International Marine Ecology Expert	3,000	PMC Contract TA 6603
GRM operation	1 day face to face event	GRM Focals PMU Staff FENAKA Supervision Staff Contractors' Management and Environment Safeguards Teams	PMC National and International Environment Expert	2,000	PMC Contract
Site supervision and monitoring including use of detailed monitoring framework (checklists) and preparing period Environmental Monitoring Reports	2-day face to face event	PMU Staff FENAKA Supervision Staff Contractors' Management and Environment Safeguards Teams	PMC National and International Environment Expert	4,000	PMC Contract
CAP implementation and safe handling, storage, and disposal of diesel fuel, oil residues, and lubricating oil associated with existing diesel generators	1 day face to face event	PMU Staff FENAKA management Powerhouse Staff	PMC National and International Environment Expert	2,000	PMC Contract

Item	Duration/Method	Attendees	Delivered by	Estimated Cost in \$	Budget Source
EMP Implementation for O&M handover including the SOPs	1 day face to face event	PMU Staff FENAKA management Powerhouse Staff	PMC National and International Environment Expert	2,000	PMC Contract
<b>Total</b>				<b>19,000</b>	

ADB = Asian Development Bank, EHS = Environmental, Health, and Safety, EMP = environmental management plan, GRC = Grievance Redress Committee, GRM = grievance redress mechanism, IFC = International Finance Corporation, PMC = Project Management Consultants, PMU = Project Management Unit

## H. Environmental Management Plan Implementation Schedule and Budget

345. The indicative implementation schedule is shown in Chapter III, Table 17. The contractors will submit a more detailed project implementation schedule. During the pre-construction period, a formal screening option will be obtained by PMU from the EPA under the EIA regulations and the requisite national environmental clearance will be obtained before any contracts are awarded except in the case of the pilot projects and agricultural intervention where the feasibility studies will need to be completed first. In these cases, the feasibility studies will not be approved until the environmental clearance has been obtained from EPA and the contractor will need to program this procedure into their program. Strictly no contracts will be awarded before the EMP has been incorporated into the contract documentation. Further, no site establishment or construction activity is to take place before the PMU has received and approved the detailed design and requisite contractor's CEMP and CHSMP including all sub-plans.

346. Necessary budgetary provisions must be made by MOECCT, and its contractors, to ensure financial resources are available for implementing the environmental measures of the project. For the EMP implementation a sum of about \$2–3 million is estimated to be required with \$0.25 million counterpart funds set aside for environmental and social mitigation cost covering items such as EPA application costs, compensatory plantation etc. This budget will also be used for non-resource person costs for conducting the training and supervision and monitoring throughout project implementation. For contract and consultancy related costs these are only an estimate, since these are subject to competitive bidding it will be for the contractor/consultants to reflect in their BOQ and ensure adequate budgeting is provided in their bids for the EMP implementation. The indicative costing breakdown for the ASSURE project is shown in Table 50.

**Table 50: Indicative Costing for Environmental Management Plan Implementation**

Mitigation Measures	Estimated Cost in \$	Budget Source
<b>PMU Consultant Support</b>		
PMU Environment Officer for the 5-year implementation period (@2000/month for 5 years)	120,000	PMU Consulting Services Budget
PMU Social (Community Liaison) Officer for the 5-year implementation period (@2000/month for 5 years)	120,000	
<b>PMC Consultant Support</b>		PMC Consulting Services Budget
International environmental specialist (1 for 6.5 PM intermittent @ 16,500/month)	107,250	
National environment specialist (1 for 12 PM intermittent @ 7,500/month)	90,000	
National terrestrial ecologist (1 for 3 PM intermittent @ 7,500/month)	22,500	
National marine ecologist (1 for 12 PM intermittent @ 7,500/month)	90,000	
EMP Training Cost - see training table for details of activities	18,000	
<b>TA 6603 Consultant Support</b>		ADB TA Budget
International marine ecology expert (1 x 4.5 PM intermittent @ 25,000/month)	112,500	
EMP Training Cost - see training table for details of activities	1,000	
<b>Contractor Staffing Costs</b>		Contract Cost
E&S Expert (@ 1,500/month for 36 months X up to 13 contract packages/lots)	702,000	
health and safety Expert with NEBOSH/IOSH (@ 1,500/month for 36 months X up to 13 contract packages/lots – additionally EHS officers and health and safety stewards are required for packages/lots having multiple islands/sites the numbers of which are unknown and will need to be determined by the contractors based on their scope of work)	702,000	
Terrestrial Ecology Expert – Wind Pilot (@ 1,500/month for 36 months)	54,000	
Marine Ecology Expert – Ocean Pilot (@ 1,500/month for 36 months)	54,000	
Implementation of Existing Facilities Corrective Action Plan @ \$5,000 per substation	100,000	FENAKA O&M Budget
Contractor's Mitigation Plan Cost including PPE provision @ 1% of \$51m contract cost for 13 contract packages/lots	510,000	Contract Cost
Contractor's Quantitative Environmental Monitoring - see EMOP (Appendix 16) for details of activities	127,500	Contract Cost
Compensatory Reforestation (LS)	25,000	E&S Mitigation Budget Counterpart Fund
EPA application cost, Ongoing Consultation, GRM Implementation, including COVID-19 Precautions for Consultation or GRC Meetings to cover ad hoc cost of printing leaflets, purchasing masks and hand sanitizers for consultees, hire of venue or food purchase etc. (LS)	25,000	E&S Mitigation Budget Counterpart Fund
<b>TOTAL</b>	<b>2,980,750</b>	

ADB = Asian Development Bank, EHS = Environmental, Health, and Safety, EMP = environmental management plan, EMOP = environmental monitoring plan, GRM = grievance redress mechanism, IOSH = institute of occupational safety and health, NEBOSH = National Examination Board in Occupational Safety and Health, PMC = Project Management Consultants, PPE = personal protective equipment.

## VIII. CONCLUSION AND RECOMMENDATIONS

347. The environmental risks and impacts associated with implementation of proposed ASSURE project components (BESS, distribution grid upgrading, wind turbines, ocean energy, rooftop solar photovoltaic panels, and agriculture system) in outer islands of Maldives have been assessed and described in the previous sections of this document.

348. The findings establish that the ocean energy pilot to be sited in the marine environment on one of the following islands: Mulah, Muli, or Komandhoo following a feasibility study by the contractor will impact both natural and critical marine habitat, but no significant impacts are anticipated given the scale of the pilot. Coral and seagrass will be avoided to ensure no net loss can be achieved without offset. The pilot wind power generation will be designed to achieve 35 dB at 10 m/s wind speed at 10 m height as LA90 at the nearest residential receiver, as well as shadow flicker and safety (including set-back in case of any blade or tower failure) requirements in line with the IFC EHS Guidelines on Wind Energy such that no significant impacts are anticipated.

349. In addition to the impacts of the ocean and wind energy systems mentioned above the main anticipated impacts and risks of the project-funded components relate to short-term (approximately 3–5 days for smaller works and up to two months for larger works i.e. wind turbine installation) disruption and disturbance during construction pollution risks, and health and safety risks to workers and local communities, for example, island roads will be blocked and noise and dust emissions will be created from the operation of construction machinery such as concrete mixers, bulldozers, dump trucks, cranes etc. Such impacts and risks can be easily mitigated by the contractors following national requirements and international good practice mitigation. All sites for all the terrestrial project facilities have been selected by MOECCT with due consideration to environmental and social aspects including habitats, legally protected areas, and physical cultural resources. BESS will be installed on 20 outer islands within the premises of existing powerhouses in a small building or container. Upgrading of the existing distribution grid on 20 outer islands will involve the installation of underground cables—23 km of 400 kV cable and 14.9 km of 11 kV cables—along existing island roads, control panels, distribution boxes, 29 package substations or ring main units, and 17 transformers in the existing powerhouses. There are no environmentally sensitive areas in and around these existing powerhouses which support modified habitat. Total capacity of the rooftop solar installations will be up to 2.5 MW peak—the solar home systems will be installed by FENAKA Corporation Limited on rooftops of the individual buildings or houses of the customers on consumer priority basis; based on existing rooftops this will have limited environmental impacts, but occupational and community health and safety risks and waste generation still need to be managed. However, outside of the existing powerhouses and rooftops there will need to be cutting and trimming of trees and vegetation from the project sites specifically from the proposed site for the wind turbine installation on Manadhoo Island where 24 trees including 2 coconut palms as well as a mangrove species are found. To ensure the Project is in accordance with the new (2022) national regulations, no trees or vegetation within 20m of the outermost coastal tree is permitted to be cleared and no coconut palms must be cut without EPA permission. Trees cut will be compensated on the island in question with the same species at a ratio of 1:2 or 1:4 for coconut palms before works commence to ensure the space for this compensation planting can be found since space is limited. There is a risk of resident or occasional migratory birds or fruit bats may collide with the wind turbines, but no threatened species are known to be supported by Manadhoo island, as a pilot monitoring will identify if adaptive management such as curtailment of operations is required. Similarly, if unanticipated

impacts resulted from the ocean energy system it will be decommissioned, as is currently the plan, with EPA national approval required to make it into a permanent installation.

350. An environmental management plan (EMP) has been prepared for the Project-funded components. Provided the EMP requirements are followed during detailed design and construction, and all the project-funded components are well maintained and operated by MOECCT and FENAKA Corporation Limited, the project-funded components will not have any significant long-term adverse environmental impacts; in fact, the project will create long-term environmental benefits by reducing CO<sub>2</sub> emissions as well as reducing emissions of SPM, SO<sub>x</sub> and NO<sub>x</sub> plus noise from existing diesel generators. This IEE is considered adequate to justify the environmental and social feasibility of installing the project components in the outer islands proposed under ADB's ASSURE project. However, the IEE and EMP will need to be updated following the detailed studies for the pilot ocean power generation and agriculture interventions since the locations and exact scope are still to be studied.