



Male' Water and Sewerage Company Pvt Ltd
Republic of Maldives

Technical Requirements & Scope of Works

For

**Design, Build, Own, Operate and Transfer / Power Purchase Agreement
for Warehouse, Solar PV, Battery Energy Storage System and Hybrid Control System for
R. Dhuvaafaru – Contractor Financed Basis**

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Document structure

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Definitions and abbreviations

Term	Meaning
BESS	Battery Energy Storage System.
BOOT	Build, Own, Operate and Transfer.
BOS	Balance of system; all supporting equipment and materials needed for safe operation.
COD	Commercial Operation Date.
EMS	Energy Management System.
MV	Medium Voltage.
PPA	Power Purchase Agreement.
PCS	Power Conversion System / bidirectional converter.
SCADA	Supervisory Control and Data Acquisition system.

1. BACKGROUND

1.1 Introduction

Male' Water and Sewerage Company Pvt Ltd operates essential utility infrastructure at R. Dhuvaafaru. The island power system is currently dependent on diesel generator operation to supply operational, domestic, institutional and utility loads.

MWSC intends to implement a Solar PV and Battery Energy Storage System hybrid solution at R. Dhuvaafaru to reduce diesel consumption, reduce carbon emission, improve generator operating efficiency, increase renewable energy contribution and improve overall power system resilience.

MWSC has received approximately 6,000 m² of land for this project. The land is intended to be developed with a warehouse that also functions as the Solar PV support structure. The warehouse shall be designed to provide practical operational use while enabling safe rooftop PV installation and maintenance.

MWSC shall provide the conceptual warehouse requirements and any available site information. The Supplier shall be responsible for concept validation, detailed design, engineering, supply, civil works, construction, installation, testing, commissioning, operation and maintenance of the complete project under the agreed PPA / BOOT structure.

MWSC approval at any stage shall not relieve the Supplier of its responsibility for design adequacy, safety, construction quality, system performance, statutory compliance, operation, maintenance and transfer obligations.

1.2 Existing power generation system

The existing R. Dhuvaafaru power system is primarily supplied by diesel generator sets. The hybrid system shall operate in coordination with the existing diesel generation system without causing generator under-loading, reverse power, voltage instability, frequency instability, nuisance tripping or unsafe operating conditions.

Generator	Approximate capacity	Remarks
CAT 3	1.5 MW	Existing diesel generator
CAT 8	1.3 MW	Existing diesel generator
C18	500 kW	Existing diesel generator
C32	800 kW	Existing diesel generator

The Supplier shall verify actual generator ratings, alternator ratings, controller details, protection settings, minimum loading requirements, fuel consumption curves, synchronization arrangement, neutral/earthing arrangement and operational constraints during the site assessment.

1.3 Existing generator operating philosophy

Time period	Indicative generator operation
08:00 - 11:00	CAT 3 + C18
11:00 - 17:00	CAT 3 + CAT 8
17:00 - 00:00	C18 + CAT 8
00:00 - 08:00	CAT 3

The Supplier shall review the current operating philosophy and propose a hybrid operating strategy considering PV generation, BESS dispatch, generator loading, spinning reserve and system stability.

1.4 Indicative load pattern

The following load pattern is indicative and shall be verified by the Supplier using additional historical data, site measurement and operating information before final sizing. The design shall be based on actual load demand, solar generation profile, generator minimum loading constraints, spinning reserve requirement and stability requirements.

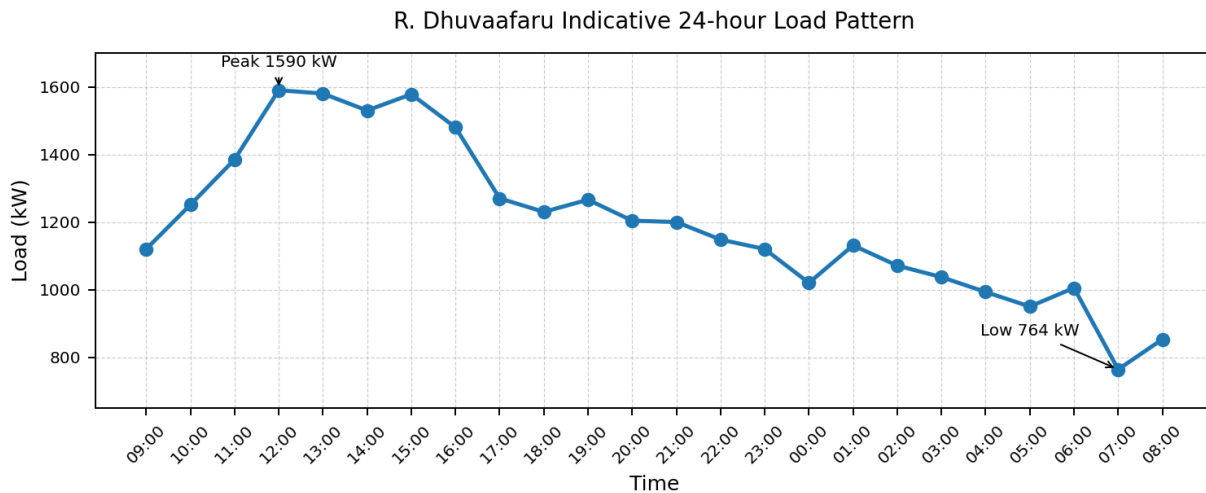


Figure 1: Indicative R. Dhuvaafaru 24-hour load pattern.

Time	kW	Time	kW
09:00	1120	10:00	1251
11:00	1385	12:00	1590
13:00	1580	14:00	1530
15:00	1578	16:00	1480
17:00	1270	18:00	1230
19:00	1266	20:00	1204
21:00	1200	22:00	1148
23:00	1120	00:00	1020
01:00	1131	02:00	1071
03:00	1037	04:00	993
05:00	950	06:00	1005
07:00	764	08:00	853

2. OBJECTIVES

1. Reduce diesel fuel consumption at R. Dhuvaafaru through the integration of Solar PV and BESS.
2. Utilize the allocated 6,000 m² land area by developing a warehouse suitable for rooftop Solar PV installation.
3. Implement the project under a PPA / BOOT structure where the Supplier undertakes detailed design, construction, ownership, operation, maintenance and transfer obligations.
4. Improve generator operating efficiency by maintaining safe generator loading and preventing reverse power or under-loading conditions.
5. Improve power system stability through BESS support for PV smoothing, frequency support, voltage support, ramp-rate control and peak support.
6. Obtain a complete and commercially transparent proposal covering tariff, concession period, risk allocation, ownership structure, buy-back options, performance guarantees and end-of-term transfer.
7. Set a maximum acceptable PPA tariff ceiling of USD 0.12/kWh for metered renewable energy delivered and accepted by MWSC.

3. SCOPE OF WORK

3.1 Site assessment and data validation

- Review the allocated 6,000 m2 land area and confirm usable area for warehouse, PV, BESS, PCS, EMS, transformer, RMU and maintenance access.
- Review access for construction, material delivery, lifting, equipment movement and future maintenance.
- Review existing powerhouse, generators, electrical distribution, MV interface, protection system, SCADA system and cable routes.
- Review environmental exposure including salt, humidity, wind, corrosion, drainage, flooding and fire safety separation requirements.
- Identify interfaces with MWSC operations, permitting requirements and future expansion requirements.

3.2 Concept design and approval process

- The Supplier shall develop the overall project concept and submit it to MWSC for approval before detailed design, procurement and construction.
- The concept shall include warehouse layout, PV/BESS sizing, system architecture, single line diagram, control philosophy, metering arrangement, interconnection point and expected fuel saving.
- After MWSC approval of the concept, the Supplier shall proceed with detailed design, supply, civil works, installation, testing and commissioning.

3.3 Warehouse structure, civil works and construction

- MWSC shall provide only the conceptual warehouse requirements and available site information.
- The Supplier shall undertake detailed architectural, structural and civil design of the warehouse, including foundations, steel structure, roof system, drainage, access, walkways and maintenance provisions.
- The warehouse roof shall be designed for PV module layout, PV mounting loads, wind loads, corrosion protection, cable routes, earthing, lightning protection and safe maintenance access.
- The Supplier shall supply all warehouse materials and execute civil works, foundations, erection, roofing and all associated construction works.
- The Supplier shall submit structural calculations, drawings, shop drawings, material certificates, coating specifications, inspection records and as-built drawings.

3.4 Solar PV system

- The Supplier shall design, supply, install, test and commission a complete Solar PV system suitable for installation on the warehouse roof.
- The PV system shall include PV modules, inverters, mounting system, DC protection, AC protection, PV monitoring, PV cables, MC4 connectors, cable containment, earthing, labels and all required accessories.
- The Supplier shall state PV capacity in kWp, module brand/model, inverter brand/model, DC/AC ratio, expected daily and annual generation, degradation rate, warranties and expansion capability.

3.5 Battery Energy Storage System and PCS

- The Supplier shall design, supply, install, test and commission a complete BESS and PCS suitable for R. Dhuvaafaru hybrid power operation.
- The BESS scope shall include battery modules/racks/cabinets/container, BMS, PCS, DC/AC protection, battery combiner cabinets, fire detection and suppression, HVAC/cooling, emergency stop, local monitoring and EMS communication.
- The Supplier shall state total capacity, usable capacity, PCS rating, chemistry, depth of discharge, C-rate, round-trip efficiency, cycle life, degradation profile, end-of-life capacity, fire safety standard, warranty and replacement responsibility.

3.6 EMS, control, SCADA and data access

- The EMS shall coordinate PV generation, BESS charge/discharge, generator loading, PV curtailment, SOC management, ramp-rate control, voltage/frequency support, alarms, data logging and SCADA communication.
- The system shall prevent generator reverse power, generator under-loading, unsafe back-feed, voltage/frequency instability, uncontrolled PV export, nuisance tripping and poor load sharing.
- The Supplier shall identify EMS components including PLC, IPC, HMI, gateways, meters, CTs/VTs, communication hardware and protocols.
- The Supplier shall provide MWSC with real-time read access to generation, BESS status, availability, alarms, meter data and curtailment information throughout the concession period.
- At transfer, default or agreed trigger events, the Supplier shall provide PLC programs, controller logic, passwords, software access, licences, configuration backups and full system documentation.

3.7 Generator integration

- The Supplier shall review the existing generator operation and propose a suitable hybrid dispatch strategy.
- The strategy shall define minimum generator loading, spinning reserve, PV curtailment, BESS dispatch, evening peak support, cloud transient support, manual/automatic modes and emergency operation.
- BESS charging from generators shall not be implemented unless technically justified and approved by MWSC.

3.8 MV grid integration

- The Supplier shall design, supply, install, test and commission the complete MV grid integration works required to connect the PV+BESS system to the island power distribution network at the approved point of interconnection.
- The MV scope shall include, where applicable, transformer sizing and connection, RMU/MV switchgear, MV protection, metering, MV cables, terminations, interlocking, control interface, communication interface and all required accessories.
- The Supplier shall confirm interconnection voltage, fault level, protection settings, earthing/neutral interface, operating limits and interface requirements with the diesel generator system and distribution network.
- The Supplier shall provide MV single line diagram, protection coordination study, short-circuit calculation, cable sizing calculation, earthing interface details, metering arrangement, relay setting proposal and commissioning procedure.

3.9 Electrical distribution and balance of system

- The Supplier shall provide all electrical distribution and balance-of-system components required for complete and safe operation.
- BOS shall include, where applicable, LV switchgear, AC/DC cables, communication cables, cable trays/ladders, ducts/conduits, glands, lugs, ferrules, earthing, lightning protection, surge protection, fire protection, HVAC, spare parts, tools and labels.
- Any item not clearly identified as included shall be treated as excluded for evaluation purposes.

3.10 Construction, installation, testing and commissioning

- The Supplier shall be responsible for all civil works, construction, physical installation, testing and commissioning required for a complete operational project.
- The Supplier shall submit construction method statements, lifting plans, HSE plan, QA/QC plan, installation schedule, inspection and test plans, commissioning procedure and trial operation plan.
- Testing shall include FAT, SAT, insulation resistance, continuity, earthing resistance, polarity, PV string testing, inverter configuration, BESS/PCS configuration, EMS programming, SCADA integration, generator interface, protection verification, functional tests and performance verification.
- The project shall not achieve COD until MWSC accepts the commissioning report and the agreed performance tests are completed.

3.11 Operation, maintenance and emergency response

- The Supplier shall operate and maintain the complete system during the concession period, including PV, BESS, PCS, EMS, warehouse-related PV interfaces, MV/LV electrical systems, fire safety systems and monitoring systems.
- The Supplier shall provide preventive maintenance plans, corrective maintenance procedures, spare parts strategy, remote monitoring, response times, reporting templates and escalation procedures.
- The Supplier shall prepare an emergency response and business continuity plan covering fire events, BESS alarms, inverter trips, communication loss, MV faults, severe weather, blackout recovery support and safe shutdown.

3.12 Training, documentation and technical transfer

- The Supplier shall train MWSC personnel on system overview, PV operation, BESS/PCS operation, EMS operation, generator integration, SCADA view, alarms, troubleshooting, emergency shutdown, and preventive maintenance and safety precautions.
- The Supplier shall provide O&M manuals, as-built drawings, test reports, warranty certificates, spare parts list, commissioning report, training records and all documentation needed for future transfer.
- The Supplier shall develop a structured technical transfer plan during the concession period to reduce long-term dependency on the Supplier.

4. PPA / BOOT COMMERCIAL REQUIREMENTS

4.1 Preferred commercial structure

The project shall be submitted under a PPA / BOOT structure. The Supplier shall design, build, finance, own, operate and maintain the project assets during the agreed concession period and transfer ownership to MWSC at the end of the term, subject to the approved commercial structure. A simple outright purchase proposal is not required as the primary offer; however, capital cost information shall be provided for tariff evaluation and residual value assessment.

Model	Description	Required submission
Full BOOT	Supplier owns 100% during the concession period and transfers ownership to MWSC at the end.	Tariff, concession period, transfer conditions and end-of-term asset condition.
BOOT with purchase options	Supplier owns the assets during the concession period, while MWSC has the right to purchase the system at defined years.	Buy-back price or residual value schedule by year and purchase methodology.
Gradual buyout	MWSC ownership share increases at predefined milestones during the concession period.	Ownership transfer schedule, tariff impact and governance rights.
Joint ownership / SPV option	Supplier may propose a project SPV or local operating company structure with MWSC participation or observer rights.	Legal structure, governance rights, funding requirement and tariff impact.

4.2 Tariff, payment basis and curtailment

- The maximum acceptable PPA tariff for the base proposal shall be USD 0.12/kWh for metered renewable energy delivered and accepted by MWSC at the agreed metering point.
- The Supplier shall provide the tariff in both USD/kWh and MVR/kWh and shall state whether the tariff is fixed or indexed.
- If escalation is proposed, the Supplier shall separately identify the opex-linked component and the capex/debt-service component.

- MWSC shall pay only for net energy that is metered, delivered and accepted by MWSC. No payment shall be made for curtailed energy, deemed generation, unavailable capacity, exported energy not accepted by MWSC, or energy restricted due to MWSC system stability requirements unless specifically agreed in writing.
- Curtailment required due to low load, generator minimum loading limits, BESS SOC limits, protection requirements, voltage/frequency stability, planned shutdowns, emergency operation, maintenance, or MWSC operating instructions shall not create payment obligation to the Supplier unless specifically agreed in writing.
- Any take-or-pay, minimum energy commitment or deemed generation mechanism shall be clearly stated and justified. MWSC reserves the right to reject such conditions.

4.3 Ownership, transfer and purchase option

- MWSC shall retain the option to purchase the project assets during the concession period or receive the assets at the end of the concession period based on the approved commercial structure.
- The Supplier shall provide proposed concession period, end-of-term transfer condition, purchase option years, buy-back price schedule and residual value formula.
- The Supplier shall state how PPA payments already made by MWSC are treated in the buy-back value.
- Transfer shall include ownership title, software licences, passwords, access rights, O&M manuals, as-built drawings, commissioning records, spare parts and all technical documentation.
- The transfer condition shall include PV performance testing and BESS usable capacity testing, with clear treatment of battery degradation, remaining warranty and pending replacement obligations.

4.4 Governance and operational control

- The Supplier shall propose a governance arrangement that gives MWSC visibility and appropriate control during development, construction and operation.
- The proposal shall include a joint project steering team during design, construction and commissioning.
- MWSC shall have real-time read/write access to SCADA/EMS data, generation data, BESS status, alarms, availability, delivered energy and curtailment data.
- The Supplier shall submit monthly operational reports covering energy delivered, availability, curtailment, outages, fuel saving estimate, maintenance activities and safety incidents.
- MWSC may require an annual technical audit by MWSC or an independent engineer.

4.5 Risk allocation

Risk	Base allocation	Comment
Detailed design	Supplier	Supplier is responsible for detailed warehouse, PV, BESS, electrical and control system design.
Construction and installation	Supplier	Supplier is responsible for civil works, construction quality, installation, testing and commissioning.
Technology / performance	Supplier	Supplier is responsible for PV, BESS, PCS, EMS and system performance. Lower availability shall result in reduced payment or agreed remedies.
Operation and maintenance	Supplier	Supplier operates and maintains the complete system during the concession period.
Energy acceptance / offtake	MWSC, limited to accepted energy	MWSC pays only for energy delivered and accepted at the

Risk	Base allocation	Comment
		agreed metering point, subject to the agreement.
Curtailement	Supplier / no payment by MWSC unless agreed	Supplier shall design the system to handle curtailement safely. Curtailed or deemed energy is not payable unless specifically agreed.
Regulatory / permitting	Shared	Supplier provides technical submissions; MWSC supports land access and local regulatory coordination.
FX risk	To be proposed	Supplier shall state currency exposure and any proposed FX adjustment mechanism.
Change in law	To be proposed	Any change-in-law mechanism shall be clearly defined.
Force majeure	Shared	Each party shall take reasonable steps to mitigate impact.

5. PERFORMANCE, WARRANTY AND GUARANTEE REQUIREMENTS

- The Supplier shall provide performance guarantees for PV generation, BESS usable capacity, BESS/PCS response, EMS availability, system availability and power quality compliance.
- The Supplier shall state guaranteed availability and the reduction in payment or remedy if the system is unavailable or underperforming due to Supplier-responsible causes.
- The Supplier shall provide warranty details for PV modules, inverters, BESS, PCS, EMS, transformer, RMU, switchgear, cables, warehouse structure, corrosion protection, fire protection and HVAC.
- The Supplier shall state battery replacement responsibility, degradation assumptions, end-of-life capacity and replacement trigger during the concession period.
- The Supplier shall provide insurance details covering construction, equipment, operation, third-party liability, fire, natural hazards and other relevant risks.

6. DELIVERABLES

1. Site assessment report for the allocated 6,000 m2 project land at R. Dhuvaafaru.
2. Hybrid system concept design for MWSC approval, including PV/BESS sizing, system architecture, SLD, operating philosophy, metering concept and fuel saving estimate.
3. Warehouse detailed design package including architectural/civil/structural drawings, structural calculations, foundation design, roof design, corrosion protection, maintenance access and PV interface details.
4. Final IFC drawings and shop drawings for warehouse, PV, BESS, PCS, EMS, switchgear, transformer, RMU, cable routing, earthing and lightning protection.
5. Solar PV design report including PV capacity, layout, inverter sizing, generation estimate and expansion possibility.
6. BESS design report including capacity, usable capacity, PCS sizing, SOC strategy, fire safety, HVAC, degradation assumptions and replacement responsibility.
7. Hybrid control philosophy including PV dispatch, BESS dispatch, generator loading, PV curtailement, ramp-rate control and SCADA integration.
8. Electrical and MV grid integration design package including SLD, cable sizing, voltage drop, short-circuit, protection coordination, relay settings, earthing and lightning protection design.
9. Construction method statements, HSE plan, QA/QC plan, risk assessment and implementation schedule.

10. Testing and commissioning procedure including FAT, SAT, pre-commissioning checks, performance testing and trial operation.
11. Complete PPA / BOOT proposal including tariff, concession term, ownership structure, risk allocation, O&M responsibility, performance guarantee, buy-back/purchase option schedule and end-of-term transfer arrangement.
12. USD/kWp calculation for PV and USD/kWh calculation for BESS for evaluation reference.
13. Training plan, O&M manuals, as-built drawings, test reports, warranty certificates, commissioning report and transfer documentation.

7. DURATION, REPORTING AND REVIEW

7.1 Implementation schedule

- Site assessment and data review.
- Concept design submission and MWSC approval.
- Detailed engineering design and MWSC approval.
- Warehouse construction design and fabrication/procurement.
- PV, BESS, PCS, EMS and electrical equipment manufacturing/procurement.
- Factory testing and shipment.
- Delivery to Male and R. Dhuvaaafaru.
- Civil works and warehouse construction.
- PV, BESS, PCS, EMS, MV/LV and electrical installation.
- Testing, commissioning, training and Commercial Operation Date.

7.2 Reporting and review milestones

Report / milestone	Minimum content
Inception / kickoff report	Project understanding, information requirements, schedule and risk register.
Concept design submission	Warehouse concept validation, hybrid system concept, SLD, operating philosophy, metering and fuel saving estimate.
Detailed design submission	IFC drawings, calculations, equipment datasheets, protection settings and construction methodology.
Construction progress reports	Progress, HSE, QA/QC inspections, non-conformances and corrective actions.
Commissioning report	Test results, settings, performance data, alarms, communication verification and operator training record.
Monthly O&M report	Energy delivered, availability, curtailment, outages, fuel saving estimate and maintenance activities during concession.
Final transfer report	Asset condition, performance tests, BESS capacity test, documents, passwords, licences and spare parts at transfer/buy-back.

8. EXPERTISE REQUIRED

Key expert	Required experience / responsibility
Project Director / Manager	Renewable energy / hybrid power project development, PPA/BOOT implementation, construction management, stakeholder coordination and commercial operation.
Lead Electrical Engineer	Power distribution systems, hybrid power systems, PV, BESS, generator integration, protection coordination, SCADA integration and electrical system design.
Solar PV Design Engineer	PV layout, inverter sizing, DC/AC design, mounting selection, solar generation assessment, PV protection and rooftop PV installation.
BESS / PCS Specialist	Battery system design, PCS operation, BMS integration, SOC management, fire safety, HVAC, degradation and BESS commissioning.
EMS / SCADA Integration Specialist	PLC, IPC, HMI, Modbus TCP/IP, gateways, generator controller interface, remote monitoring and control system commissioning.
Protection and Power Quality Specialist	Short-circuit studies, relay coordination, reverse power protection, anti-islanding, harmonic analysis, grounding systems and island microgrid protection.
Structural / Civil Engineer	Warehouse detailed design, structural calculations, foundations, drainage, corrosion protection and PV roof interface requirements.
MV Grid Integration Specialist	MV switchgear, RMU, transformer integration, MV cabling, protection coordination, testing and safe energization.
Construction / HSE Engineer	Site execution, method statements, lifting plans, HSE plan, QA/QC inspection and construction supervision.
Testing and Commissioning Engineer	PV, BESS, PCS, EMS, generator integration, protection testing, SCADA communication and hybrid system trial operation.

9. ANNEX

Existing generator list, ratings, controller details.

Generator	Rating	Controller Details
CAT 08	1360	DSE8610MKII
CAT C32	640	DSE8610MKII
CAT C18	508	DSE8610MKII
CAT 03	1600	DSE8610MKII