



Ministry of Tourism
and Environment



Utility Regulatory
Authority

Report on Mechanism for URA to Verify Power Production Data

Consultancy Services to Conduct Energy
Supply and Demand Study 2018 – 2022

CBIT Maldives

Capacity Building for Improved Transparency
of Climate Change Mitigation and Adaptation
Actions in the Maldives



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CBIT MALDIVES

*Capacity Strengthening for Improved Transparency of
Climate Change Mitigation and Adaptation Actions in
the Maldives Project*



Prepared for:

Utility Regulatory Authority (URA), Maldives

Prepared under:

This report has been developed under the Capacity Strengthening for Improved Transparency of Climate Change Mitigation and Adaptation Actions in the Maldives (CBIT Maldives) Project. The project is executed by the Ministry of Tourism and Environment (MOTE), with financial support from the Global Environment Facility (GEF) and implementation support from the United Nations Environment Programme (UNEP).



Ministry of Tourism and Environment

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Citation:

URA, (2025). Report on Mechanism for URA to Verify Power Production Data:
Utility Regulatory Authority, Maldives

March 2025

List Of Abbreviations

BESS	Battery Energy Storage System
EMS	Energy Management System
FENAKA	Fenaka Corporation Limited
FSM	Fuel Supply Maldives
GMR	Greater Male' Region
MACL	Maldives Airport Company Limited
MBS	Maldives Bureau of Statistics
MoU	Memorandum of Understanding
MWSC	Male' Water and Sewerage Company Limited
PV	Photo Voltaic
STELCO	State Electricity Company Limited
URA	Utility Regulatory Authority
IPP	Independent Power Producer
PV	Solar Photovoltaic

Executive Summary

The Maldives Energy Supply and Demand study identified the current procedures and practices used for the collection, reporting, and verification of electricity generation and consumption data. Improvements to these procedures and practices are proposed here, based on the weaknesses and gaps observed. This is done with the intension of strengthening the capacity of the Utility Regulatory Authority (URA) to validate electricity supply and demand data of the country. Availability of validated electricity generation data is essential to monitor the progress and achievements of Maldives in meeting the commitments made under the Paris Agreement, especially the Nationally Determined Contributions (NDCs). This report intends to discuss the generation of electricity using both petroleum and renewable sources by all types of generators including the electricity utilities, captive power plants, and resorts.

Diesel has become the main fuel used by the generators in Maldives. Electricity generation by the diesel power plants is typically recorded hourly by the powerhouse operators using the energy meters installed at the powerhouses/generator substations. The running hours of the generators are also recorded, which are not directly used for generation reporting purposes, but are used for scheduling of maintenance. However, diesel consumption by the generators is measured daily by the generator operators either using the flow meters installed between the storage tanks and the generators or by using dip-stick measurements taken from the storage tanks.

All data pertaining to solar PV generation is recorded by the operators of the solar PV systems for internal reporting purposes, except for net metered solar PV systems and solar Independent Power Producers (IPPs), where both the electricity utility and the operator keep records. However, actual generation by all solar PV systems are recorded in the solar inverters, providing a comprehensive account of the total solar PV generation. Even though these inverter recordings are not as accurate as revenue class energy meters, they can be retrieved to supplement the data available in the main energy meters.

Electricity consumption in inhabited islands is well recorded as all consumers are issued with monthly electricity bills, based on the readings taken from energy meters connected at consumer premises. Total electricity consumption in inhabited islands is categorized as domestic, commercial and governmental following the tariff categories currently in force. Further segregation of these consumer categories is required to identify, analyze and report electricity consumption by various types of industrial and commercial activities. On the other hand, consumption recording of electricity generated by captive power generators and in resorts is typically not done separately and accurately. Instead, electricity consumption is assumed to be the same as electricity generation, as significant network losses are not present in such systems.

To collect electricity generation data from the two electricity utilities and captive generators, a data collection form has been developed and shared by URA. Appendix 3 presents this format. While the electricity data collection form currently used by URA is sufficiently detailed, there are some data gaps that need to be covered by the data collection form to provide a comprehensive overview of electricity generation in the country. In lieu of the common data collection form currently used by URA, revised forms given in Appendix 4 and Appendix 5 are proposed to be adopted to collect electricity data from utilities and captive generators.

Reporting of electricity generation data of resorts occur as a regular activity only within the resort company or the group of companies. Regularizing the reporting process is essential to capture the overall energy profile of the country. For this, a Memorandum of Understanding has been signed between the Ministry of Tourism and Environment, Maldives Bureau of Statistics (MBS), and URA where required electricity data is captured by the MBS as part of its regular data collection process and transferred to the ministry and URA. Upon receiving the data, the URA shall verify the data following the same approach taken for captive generation.

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1. Introduction

1.1.1 Objectives

During the Maldives Energy Supply and Demand Study 2018-2022, currently followed procedures and practices of collection, reporting, and verification of electricity generation and consumption data were identified. Based on the weakness and gaps observed in these procedures and practices, improvements for the same are proposed here with a view to strengthening the capacity of the URA to validate electricity supply and demand data of the country. Availability of validated electricity generation data is essential to monitor the progress and achievements of Maldives in meeting the commitments made under the Paris Agreement, especially the Nationally Determined Contributions (NDCs).

The report intends to discuss the generation of electricity using both petroleum and renewable sources by all types of generators including the electricity utilities, captive power plants, and resorts.

1.1.2 Background

Maldives is the first South Asian country to achieve 100% electrification. With close to 200 islands inhabited by a population of little more than half a million, and about another 200 islands dedicated to tourism, industry and agriculture, the supply of electricity to all these islands is challenging. Since almost all the islands are detached from one-another, electricity must be generated, distributed, and consumed within each island. This has been achieved by using centralised diesel generators generating electricity and low and medium voltage electricity networks distributing the centrally generated electricity to the end users. In resorts and industries, the captive generators directly supply to the end use facilities without passing through a distribution network. With the construction of Male'-Hulhumale' Link Road, the three islands Male', Hulhule, and Hulhumale' are physically connected through a bridge, allowing the generation in each island to be shared across a 132 kV transmission cable. In all other islands, isolated grids operate to serve the electricity requirement within the island.

1.1.2.1 Electricity Generation

In most islands, the generation capacity required to meet the demand is less than 1 MW. For this scale of generation capacity, most convenient technology is the high-speed diesel engine-based generators using auto diesel as the primary fuel. Due to the lack of indigenous fossil fuel resources, large quantities of diesel have been imported to Maldives every year. However, due to recent improvements in solar photo voltaic (PV) technology and efficiency, substantial cost reduction of solar panels and inverters, and abundant availability of solar resource in the country, Maldives has started using solar PV systems to offset part of its diesel engine-based electricity generation.

In line with the global trend in shifting from fossil fuel generation to renewable energy and the country's own policies and targets set to increase the renewable energy contribution for economic and environmental reasons, solar PV generation is expected to become a dominant electricity generation option for Maldives. In line with this,

- The electricity utilities have installed their own solar PV systems in own and government owned buildings, which generate electricity to offset the generation by the diesel generators.
- Similarly, the electricity utilities have engaged private developers to build, own, and operate solar PV power plants and sell the solar PV generation at a fixed rate substantially below the cost of generating electricity using diesel generators.
- The third model used to increase the solar PV contribution in the generation portfolio is the net metering scheme where the electricity consumers are allowed to install solar PV systems on their rooftops and use that electricity generation to off-set part of the consumers' own consumption. At the end of the billing period, in case the exports by the rooftop solar PV system have exceeded the

electricity imported and consumed by the consumer, the net energy export is compensated at a tariff comparable with the consumer tariff.

Following types of entities are engaged in electricity generation Maldives.

1. Electricity Utilities
 - i. State Electric Company Limited (STELCO)
 - ii. Fenaka Corporation Limited (FENAKA)
2. Captive Generators
 - i. Maldives Airport Company Limited (MACL)
 - ii. Male Water and Sewerage Company Limited (MWSC)
3. Resorts

1.1.2.2 Electricity Generation by the Utilities

State Electric Company Limited. State Electric Company Limited (STELCO) is a state-owned enterprise established in 1949 and functioning under the Ministry of Finance. STELCO is engaged in generation, transmission, distribution and retailing of electricity in the atolls of Kaafu (including the greater Male' region (GMR)), Ari and Vaavu. In addition to electricity, which is its core business, STELCO owns and operates water and sewerage facilities. By 2022, STELCO was operating 35 power plants and 7 water desalination plants and 5 sewerage systems in different islands.

In addition to its own diesel generators and solar PV systems, STELCO's total electricity generation is supplemented by an IPP operating a 5.6 MWp solar PV system installed along the Malé-Hulhumalé Link Road, as well as net-metered rooftop solar PV systems owned and operated by certain electricity consumers.

Fenaka Corporation Limited. Established in 2012 by a presidential decree, Fenaka Corporation Limited (Fenaka) is a state-owned utility company operating under the Ministry of Finance. It provides electricity, water, and sewerage services to the outer island communities of the Maldives. Fenaka manages 149 powerhouses, supplying electricity to 155 inhabited islands across 16 atolls. Similar to STELCO, in addition to its own generation, several solar PV-based IPPs contribute to Fenaka's overall electricity generation.

To collect electricity generation data from the two electricity utilities STELCO and FENAKA, and captive power generators, the data collection form given in Appendix 1 was developed and used by the study team of the Energy Supply and Demand Study 2018-2022.

Despite supplying the total electricity requirement and more than 80% of the overall energy requirement of the country between them, due to the absence of any compelling regulations, electricity production data are not published by any of the electricity generating entities. Various reporting arrangements are proposed to be adopted by the different types of generators to ensure accurate data is available for verification by URA. It is possible to verify the electricity generation data provided by the two electricity utilities through two separate means.

- 1) Compare the total generation with the total electricity consumption of the island for the same period, collected through the same electricity data collection form, leaving provisions for network losses.
- 2) Estimate the total electricity generation based on the fuel consumption data provided through the electricity data collection form, assuming a fuel consumption rate (FCR) applicable for the powerhouse.

1.1.2.3 Electricity Generation by Captive Generators

Male' Water and Sewerage Company. Male' Water and Sewerage Company (MWSC) was established in 1995 and is engaged in water production and wastewater management systems in the GMR. MWSC is a state-owned enterprise with 80% ownership by the government and the balance 20% held by Hitachi Limited. It is

generating electricity in the GMR including in Male', Villingili, Hulhumale', Maafushi, Thilafushi, Kulhudhuffushi, Gulhi Falhu, and Dhuvaafaru to meet the electricity requirements of its desalination plants and the water distribution systems. In R.Dhuvaafaru, in addition to meeting its own electricity requirements, MWSC generates additional electricity and supplies to consumers, adopting an integrated utility model.

Maldives Airport Company Limited. Maldives Airport Company Limited (MACL) operates the Male'-Velana International Airport located on Hulhule Island in the North Male Atoll, near the capital island Male'. MACL operates its own diesel generating units and sources almost the entire electricity requirement of the airport through these generators. For standby power requirements, an electricity connection is provided to the airport by STELCO through the main grid connecting Male' and Hulhumale', which is used only when the MACL generators are not available due to maintenance requirements or when the airport electricity demand is higher than the capacity of the captive generators.

Other Captive Generators. Some of the industries, agricultural islands and some businesses generate electricity for their own consumption in lieu of grid electricity. However, generation data recorded by these captive generators is also not available for review. Since a comprehensive list of entities generating electricity for their own use is not available, capturing this information is challenging.

Captive generation and the use of electricity by MWSC are well recorded. However, in some of the islands, significant difference exists between generation and consumption, implying the consumption records are relating to only part of the facility operation. Therefore, it is recommended to capture all electricity uses comprehensively such that verification of electricity generation data with supplied water quantities can be carried out. On the other hand, generation data recorded by MACL is not available for review. While it is likely for the generation data to be recorded for internal monitoring purposes, the exact nature of recorded data is not known.

Verification of electricity production data provided by MWSC can be done by using established norms such as electricity consumption per unit quantity of water supplied. Since generation data is not reported by MACL, based on the fuel consumption records, it is possible to estimate the electricity production. Upon commencement of generation data by MACL through URA's electricity data collection form for captive generators (Appendix 5), verification of the same can be done based on fuel consumption data. Verification of electricity generation data pertaining to diesel generation by other captive generators shall be through the FCR approach proposed for other similar generations. However, if any solar PV installations are present, direct access to the invertors shall be obtained to validate the electricity generation by solar PV systems prior to inhouse consumption by the facility. To facilitate these verification measures, a comprehensive account of the available generators and solar PV systems are needed. Therefore, it is recommended for independent supervisors of the two utilities to be engaged to witness the commissioning parameters.

1.1.2.4 Electricity Generation in Resorts

The electricity networks or the power houses of the two state owned electricity utilities STELCO and FENAKA do not extend to the resort islands functioning independently in Maldives. Generally, each resort island comprises one island one resort concept, which self generates electricity using diesel generators, though some have started supplementing the diesel generation with roof mounted solar PV systems. This captive generation is considered a separate category of generation and consumption due to the uniqueness of these resorts in meeting their electricity needs.

1.1.2.5 Electricity Consumption

In the inhabited islands, the electricity is supplied by the electricity utilities to the end users based on a uniform national tariff approved by the URA. The tariff identifies several consumer categories including households, commercial, and government institutions. Water purification and distribution is another major electricity consuming activity, though a separate tariff category has not been identified as the water supply service is

integrated and provided by the same utilities. In the resorts, electricity generation and consumption occur within the same facility and all activities using electricity including desalination of water, cooking, heating, air conditioning and lighting are lumped together as separate end uses cannot be identified. Several industrial uses such as fish canning and cold storages are consuming electricity, but separate identification of these industrial activities is not possible due to such activities billed simply as a commercial activity.

1.1.2.6 *Distribution and Storage Losses*

Total generation of electricity is not available for consumption as part of the generation is lost in the process of distribution. In addition, with the advent of solar PV as a significant generating source, the need to store electricity generated by solar PV systems during the daytime to be used during the night makes electricity storage an essential element of electricity supply. When batteries are used to store electricity generated by solar PV systems, 5%–10% is lost in the charging, retaining and discharging process. Therefore, in recording, reporting and verifying electricity generation and consumption data, due recognition of distribution and storage losses need to be made to improve the accuracy of the process.

2. Current Mechanism for Data Collection and Reporting

2.1 Collection of Electricity Data

2.1.1 Electricity Generation Data

The key data pertaining to electricity generation are the amount of fuel consumed by the generators (in the case of thermal power generation) and the amount of electricity produced during the recorded period.

With the use of heavy fuel oil suspended due to environmental issues created by the fuel, Diesel has become the main fuel used by the thermal power generators in Maldives. Typically, Diesel use is measured daily by the generator operators either using the flow meters installed between the storage tanks and the generators or by using dip-stick measurements taken from the storage tanks. These daily records are reconciled with bulk quantities delivered to the powerhouse. As the measurement of fuel use is volume based, which depends on the ambient temperature, and the accuracy of flow meters and dip-stick measurements are low, overall accuracy of the fuel data recorded by the generators can be low. Strict regulation on fuel use and pilferage is also not observed in majority of powerhouses, resulting in differences between the delivered quantities and the actual use for electricity generation. Apart from the primary fuel, the use of lubrication oil and other materials and consumables are also recorded for operational purposes, but not reported along with energy production.

Electricity generation data is typically recorded hourly by the powerhouse operators using the energy meters installed at the powerhouses/generator substations. The accuracy of the energy meters is relatively high, with the overall error in recorded data expected to be less than 0.5%. The running hours of the generators are also recorded, which are not directly used for generation reporting purposes, but are used for scheduling of maintenance. The maximum power generation during each day is also recorded to monitor the adequacy of installed generator and network capacity to meet the demand.

Apart from net-metered solar PV systems and solar IPPs—where both the owner and the utility maintain records—all data recording is carried out by the operators of the generating systems solely for internal reporting purposes. One challenge with the generation data recorded by electricity utilities for net-metered systems is that the energy meters used only capture generation net of consumption. In contrast, the actual generation of all solar PV systems is recorded by the solar inverters, providing a more comprehensive overview of total solar PV output. Although inverter recordings are not as precise as revenue-class energy meters, they can still be retrieved to supplement the data available from energy meters.

2.1.2 Fuel Consumption Data

Fuel consumption by the thermal power plants are as important as electricity generation due to the significance of fuel cost in thermal power generation. Therefore, fuel consumption data corresponding to electricity production is recorded and reported in almost all thermal power plants. Since fuel consumption in diesel generators typically lie within a narrow range (typically between 0.23 l/kWh – 0.28 l/kWh), the fuel consumption data can be used to validate the electricity production data recorded for thermal power plants.

Most powerhouses operating in inhabited island are delivered fuel directly by Fuel Supply Maldives (FSM), and the fuel delivery records obtained from FSM can be used to validate the fuel consumption data recorded and reported by the powerhouses. However, fuel supply to resorts is done by various suppliers and specific quantities used for electricity generation is not available through the suppliers. Therefore, fuel consumption data of powerhouses in resorts is not available through FSM or any other fuel supplier.

2.1.3 Electricity Consumption Data

Electricity consumption in inhabited islands is well recorded as all consumers are issued with monthly electricity bills, based on the readings taken from energy meters connected at consumer premises. In the absence of smart meters and a practice by consumers to record energy meter readings on a regular interval, the consumption data is available only at the interval electricity bills are issued, which is monthly. Since different types of consumers pay for electricity consumption at different rates (tariffs), it is possible to segregate the total electricity consumption in an island to domestic, commercial and governmental categories following the tariff categories currently in force. Further segregation of these consumer categories is required to identify, analyse and report electricity consumption by various types of industrial and commercial activities. For this, identifying each consumer under Level 1 categorisation of International Standard Industrial Classification (ISIC) or similar standard at the time of providing the electricity connection by the electricity utility is recommended.

Recording of electricity consumption by captive power generators such as desalination plants and resorts is typically not done separately and accurately. In the absence of sub-metering at these facilities, and due to generation occurring in the same premises as the consumption, electricity consumption is assumed to be same as electricity generation.

2.1.4 Electricity Distribution and Storage Data

In most island distribution networks, energy meters are present only at the powerhouse and at consumer premises. Thus, the network loss can only be estimated by subtracting the aggregate consumption by all the consumers from the total electricity generation. However, accuracy of this method is low, as indicated by the typical distribution loss levels (exceeding 15%) observed in most islands. Since the distribution line lengths are small, such high distribution losses are unrealistic and unacceptable. Installation of energy meters at key distribution nodes and distribution substations (transformers) would allow the network losses to be calculated more accurately.

Energy losses occurring in battery energy storage systems (BESS) can be calculated more accurately as charging and discharging cycles are recorded by the energy management systems (EMS) installed with the BESS. However, these recorded data are currently not analysed for loss estimation, and therefore, records are not maintained on storage losses. In the event the need for assessing storage losses occur, either using existing EMS or by installing bi-directional energy meters at the supply point of the BESS, the storage losses can be measured.

Under the URA Act (Law No. 26/2020), URA has the right to obtain electricity production and consumption data, and accordingly, URA collects data as and when a requirement arises, according to the nature of the data requirement.

2.2 Data Collection Formats

2.2.1 Data Collection Form used by the Energy Supply and Demand Study 2018–2022

To collect electricity generation data from the two electricity utilities and captive power generators, the data collection form given in Appendix 1 was developed and used by the study team of the Energy Supply and Demand Study 2018–2022.

The two electricity utilities: STELCO and FENAKA and some of the captive power generators submitted data for the study through the form, enabling the study to collect all relevant electricity generation data from these entities.

2.2.2 Data Collection Form Proposed to be Used by MBS for Resort Electricity Data

To collect electricity data from resorts, a MoU has been signed between the Ministry of Tourism and Environment, MBS, and URA, making provisions to update Chapter 4 Section A. Electricity Generation/Consumption used by MBS to collect data from resorts. Appendix 2 shows the section of the data collection form currently being used by MBS to collect electricity data from resorts.

2.2.3 Data Collection Form Currently used by the URA for Electricity Utilities and Captive Generators

To collect electricity generation data from the two electricity utilities and captive generators, a data collection form has been developed and shared by URA. Appendix 3 presents this format. Following main sections are included in the data collection form.

This comprehensive data collection form enables the capture of all electricity-related data for an island over a one-year period. It includes the following details:

1. **Island Information**
2. **Powerhouse Details**
3. **Generator Capacity:**
 - a. Diesel-based generation
 - b. Renewable-based generation
4. **Fuel Storage Facility Details**
5. **Generation and Distribution System Details**
6. **Historical Generation Data:**
 - a. Peak generation
 - b. Energy generation
 - c. Fuel consumption
 - d. Maintenance activities undertaken
7. **Electricity Consumption Data**
8. **Forecast Electricity Demand**

2.2.4 Proposed Improvements to the Data Collection Form Used by URA

While the electricity data collection form currently used by URA is quite detailed, there are some data gaps that needs to be covered by the data collection form to provide a comprehensive overview of electricity generation in the country. Table 2.1 lists the additional data that required and the purpose of having them.

Table 2.1: Required Modifications to the Electricity Data Collection Form

Section		Additional Data Requirement	Purpose
3.1.1	Powerhouse	Available capacity of each generator (kW)	Actual capacity available after derating is required
		Year of commissioning of each generator	To identify the age and possible replacement requirements
		Running hours of each generator	To identify the maintenance requirements and the verify the generation data provided

3.1.2	Private and other generators	Whether facilities are available to connect to the grid	To identify the possibility of adding these generators to the grid in case of a shortage of generation capacity in the grid.
3.2.1.3	Total PV installed capacity (kW)	Both kWp and kW of solar PV installations	The capacity of solar PV modules installed, and the installed capacity of solar PV system (electrical) are different and verification of generation data need clarity on capacity rating.
3.2.1.4	Total BESS installed capacity (kWh)	Both kW and kWh ratings of the BESS installations	The capacity of BESS is denoted by the combination of kW and kWh ratings.
3.2.1.6	Sizes of PV installations (kW)	Both kWp and kW of solar PV installations	The capacity of solar PV modules installed, and the installed capacity of solar PV system (electrical) are different and verification of generation data need clarity on capacity rating.
	Commissioning date of Solar PV Installations	Commissioning date of solar PV modules	To estimate the degradation of the solar system to make an accurate estimate of generation, the age of the modules is needed.
3.2.2.3	Total PV installed capacity (kW)	Both kWp and kW of solar PV installations	The capacity of solar PV modules installed, and the installed capacity of solar PV system (electrical) are different and verification of generation data need clarity on capacity rating.
3.2.2.4	Total BESS installed capacity (kWh)	Both kW and kWh ratings of the BESS installations	The capacity of BESS is denoted by the combination of kW and kWh ratings.
3.2.2.5	Sizes of Installation (kW)	Revise as 'Sizes of solar PV installations (kWp/kW)'	Need to collect both kWp and kW ratings of the solar installations
	Commissioning year of Solar PV Installations	Commissioning date of solar PV modules	To estimate the degradation of the solar system in order to make an accurate estimate of generation, the age of the modules is needed.
3.2.2.6	Battery storage capacity (kWh)	kW and kWh ratings of the BESS installations	The capacity of BESS is denoted by the combination of kW and kWh ratings.
	Commissioning year of BESS	Installation date and battery health status as recorded in the EMS	To assess the available battery capacity, the age and condition of batteries are needed.
4	Fuel (Diesel) Storage Capacity	Presence of flow meters	To gauge the accuracy of fuel consumption verification, whether the fuel consumption is measured

			using flow meters or dipstick need to be known.
6.3	Diesel consumption	Diesel delivered	For verification of fuel consumption, tallying the diesel deliveries with data provided by fuel supplier can be used.
6.4	Maintenance	Type of overhaul	The status of the generator depends on the type of overhaul done, which will be useful in the verification process.
7.1	Number of consumers	Water supply	Presence of water purification and supply system in the island
7.2	Consumption	Electricity consumption and quantity of water supplied	Electricity consumption for water purification and delivery is necessary to be collected separately. The quantity of water purified and delivered shall be collected for verification purposes.

Despite the adequacy of the data collection form discussed in Section 2.2.1 and presented as Appendix 1 for the purpose of preparing the national energy balance, considering the comprehensiveness of the data collection form currently in use (Appendix 1), and the familiarity of URA and the data providers of the form, URA may decide not to change the form in its entirety and instead, carry out changes while retaining the overall appearance and main feature of the form. Accordingly, the revised electricity data collection forms given in Appendix 4 and Appendix 5 can be adopted by URA for utilities and captive generators.

2.3 Reporting of Electricity Data

Despite meeting the country's total electricity demand and supplying over 80% of its overall energy needs, the electricity-generating entities mentioned in Section 1.2.1—including the two state-owned utilities—do not publish electricity production data due to the absence of regulatory requirements.

Several factors may contribute to the lack of compliance URA data reporting requests:

- Unavailability of some or most of the requested data
- Challenges in data collection and reporting due to the level of detail required
- Difficulty in interpreting certain data requirements
- Concerns over data confidentiality
- Limited willingness to cooperate in the reporting process

Identifying the reasons behind the non-submission of requested data is crucial for URA to enhance data collection and verification efforts. Given the absence of energy data from resorts, particular attention has been given to energy reporting within this sector. In 2022, a total of 11 resorts submitted electricity data, with some providing records spanning from 2019 to 2022. The submitted data is of acceptable quality and accuracy. However, the reluctance of most resorts to share their data suggests potential challenges in meeting reporting requirements.

3. Proposed Data Verification Mechanism

The electricity data collection form currently used by URA (Appendix 3), along with the revisions proposed in Section 2.2.3, is well-suited for gathering all necessary data from the electricity sector. However, the effectiveness of the current data collection process remains low, highlighting the need for refinement.

Unlike conventional data collection methods, energy supply and usage data—including of electricity, which plays a dominant role—must be fully captured to enable the preparation of a national energy balance. Without comprehensive data, conducting a regular and systematic energy demand and supply study, as done in other countries, is not feasible. Therefore, it is essential to refine and streamline the entire process of data recording, reporting, and verification.

To ensure accurate data collection, URA must capture and verify electricity generation and consumption across the following categories:

1. **Electricity generated and supplied by STELCO and FENAKA** in the Greater Malé Region (GMR) and in other inhabited islands using:
 - a. Diesel generators
 - b. Utility-owned solar PV systems
 - c. IPP-operated solar PV systems
 - d. Net-metered solar PV systems
2. **Electricity generated on resort islands** using:
 - a. Diesel generators
 - b. Solar PV systems
3. **Electricity generated by captive power producers**, such as:
 - a. MACL using diesel generators
 - b. MWSC using diesel generators

By improving the data collection framework and ensuring comprehensive reporting, URA can facilitate more accurate energy assessments and enhance the long-term sustainability of the sector.

3.1 Electricity Generated and Supplied by the Electricity Utilities

The two electricity utilities; STELCO and FENAKA sources the electricity required to serve its customer base from various sources such as diesel generators owned and operated by the utility itself, solar PV systems installed and operated by the utility, IPP solar PV systems, and consumer owned solar PV generation procured through the net metering scheme. Diesel generators are the main source of electricity for the two utilities. Almost in all the islands served by the two utilities, a powerhouse is maintained as the primary source of electricity. Solar PV generation is used to supplement the diesel generation, and in most islands, the two utilities are installing own solar PV systems. In addition, the ongoing net metering scheme allows consumers to meet at least part of their electricity requirement by installing rooftop solar PV systems and export any excess to the grid or import the shortfall from the grid. In a few islands, IPPs are operating solar PV power plants and supply electricity to the grid. As the operator of the island power system, the utility manages electricity data of the various sources and tally that with the data of electricity sales done by the utility.

3.1.1 Data Recording

Diesel Generators: Among the different generation sources, data related to diesel generation, including the details of the generators and the powerhouses, their operation and maintenance activities, fuel consumption, loading, and generation data are recorded in operating ledgers by the powerhouse staff of the utility and shares with the utility office in the island. As the current data procedure followed in recording data at powerhouses is satisfactory, no changes are recommended, apart from capturing all the data required in the URA electricity data form (Appendix 3) subject to the revisions proposed in Section 2.2.3. However, to improve the accuracy of fuel consumption data recorded, it is advisable to install and use fuel flow meters to measure the fuel consumption at each of the powerhouse.

Solar PV Systems of STELCO/FENAKA: Total electricity generation by these systems, typically installed on rooftops of own/governmental buildings, is measured using energy meters and recorded on a regular interval. However, since no commercial transactions are involved, recording of these data is done only for performance assessment.

IPP Solar PV Systems: According to the power purchase agreements between the utility and the IPP, total generation and supply of electricity by the solar PV power plant is measured using revenue class meters and paid for at the agreed tariff. Therefore, the generation data recorded is highly accurate.

Solar PV Net Metering Scheme: Despite the solar inverters are capable of recording generation data, this record is not captured and reported. Only the net export/import to the grid is recorded as the commercial agreement is in relation to net quantity of export/import. Recording of the total generation of net metered systems preferably through revenue class energy meters and for smaller installations (less than 20 kW), through their inverters, is recommended. Since remote access of inverter data is possible, it is recommended to obtain authorisation for access of inverter data of net metered solar PV systems and report the same along with the corresponding consumption by the net metered consumer.

3.1.2 Data Reporting

While the internal data reporting arrangements currently in place are satisfactory, dissemination of data by the utilities is not at a satisfactory level. Compared with electricity utilities in other countries, STELCO and FENAKA do not publish any operational data, apart from some electricity data made available in the annual reports. Apart from the compulsory reporting to URA, it is desirable for STELCO and FENAKA to publish electricity generation and sales data in regular intervals, such that energy sector stakeholders can access, analyse, and use latest electricity data before URA publishes the countrywide data upon processing data reported by all parties, which can be a time-consuming exercise. Appendix 6 provides a sample data reporting format that can be used by the two electricity utilities for online publication of electricity generation and sales data.

Electricity data reporting by STELCO and FENAKA to URA shall be by filling up the data collection form (either the simplified form presented as Appendix 1, which is adequate for the preparation of the energy balance, or the comprehensive form presented as Appendix 4 with revisions proposed in section 2.2.4) for each island/isolated power grid, annually, as an electronic submission (i.e. the file shared through email to designated email address of URA). As depicted in Figure 3.1, electricity data centrally collected by STELCO and FENAKA from all the islands shall be processed and published by the utility itself, while the data requested by URA through the data collection form shall be furnished for review, processing, and publication by URA as part of the national energy balance.

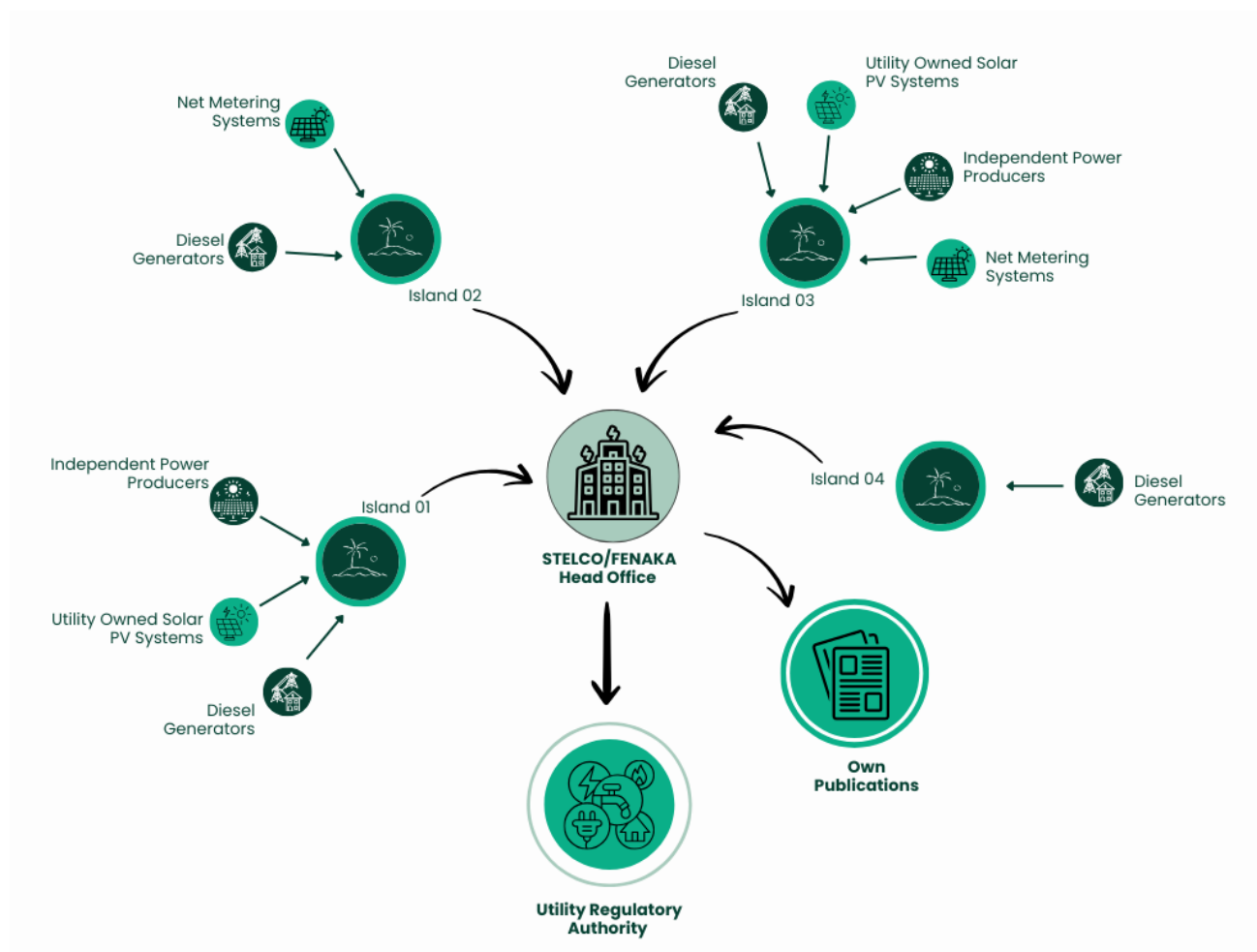


Figure 3.1: Proposed Data Reporting Arrangement for STELCO and FENAKA

3.1.3 Data Verification

It is possible to verify the electricity generation data provided by the two electricity utilities through two separate means.

- Compare the total generation with the total electricity consumption of the island for the same period, collected through the same electricity data collection form, leaving provisions for network losses. Since the loss of the distribution network does not vary significantly year-on-year, a reasonable estimate can be made on the network loss corresponding to the generation and consumption reported and verify whether the reported data are tallying with each other.
- Estimate the total electricity generation based on the fuel consumption data provided through the electricity data collection form, assuming a fuel consumption rate (FCR) applicable for the powerhouse. This assumption can be based on historic data or typical FCR values of similar types of generators. A comparison can be made between the reported electricity generation and the generation estimated using fuel consumption data. By collecting fuel delivery data from Fuel Supply Maldives (FSM), the fuel supplier to Fenaka and STELCO, the reported fuel consumption data can also be validated.

3.2 Captive Electricity Generation

3.2.1 Data Recording

MWSC: Captive generation by MWSC is well recorded in all the islands where MWSC maintains own generators to power the desalination and water purification plants as well as the distribution/sewerage pumps. Both electricity and water production data are available. However, a key weakness in the recorded data is the unavailability of consumption data between water purification and other purposes, which prevents verification of generation data. In some of the islands, significant difference exists between generation and consumption, implying the consumption records are relating to only part of the facility operation. Therefore, it is recommended to capture all electricity uses comprehensively such that verification of electricity generation data with supplied water quantities can be carried out.

MACL: Generation data recorded by MACL is not available for review. While it is likely for the generation data to be recorded for internal monitoring purposes, exact nature of recorded data is not known.

Other Captive Generators: Some of the industries, agricultural islands and some businesses generate electricity for own consumption in lieu of grid electricity. However, generation data recorded by these captive generators is also not available for review. Since a comprehensive list of entities generating electricity for own use is not available, capturing this information is not possible.

3.2.2 Data Reporting

None of the captive generators provide generation data on regular basis. On Request, MWSC has provided the requested data, while MACL is yet to respond. Due to the absence of information on other captive generators, URA has not initiated data collection from such entities.

To prepare a comprehensive database on electricity supply and use, collection of captive generation data is essential. MACL shall submit its electricity generation data by perfecting the electricity data collection form of URA. URA shall be collecting information on captive generation occurring in the country, likely in industrial and agricultural islands and large businesses where diesel generators and solar PV may be combined with BESS to supply electricity independent to the grid. As shown in Figure 3.2, these data need to be furnished directly by the captive generators to URA for processing, verification and publication by URA.

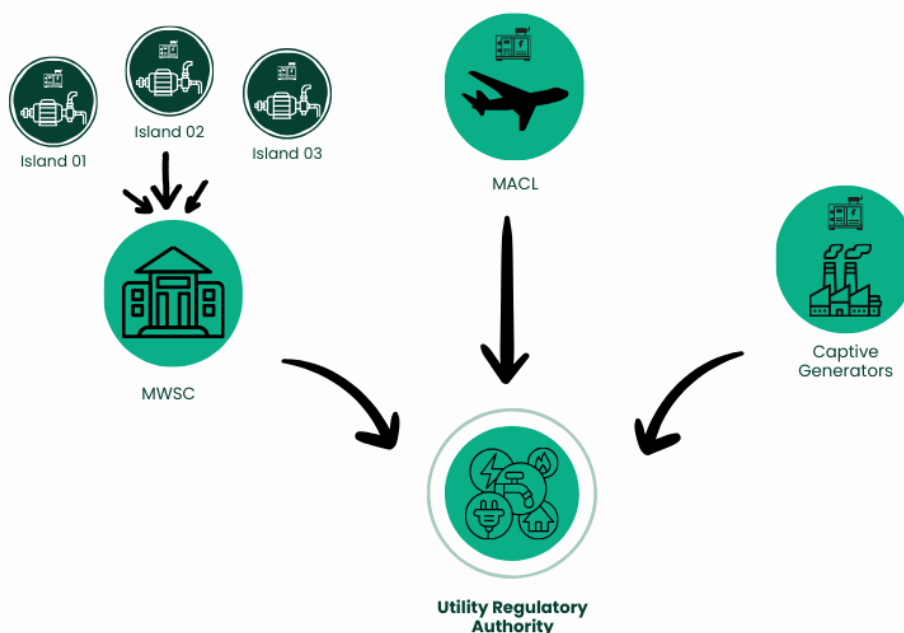


Figure 3.2: Proposed Data Reporting Arrangement for Captive Generation

3.2.3 Data Verification

MWSC: Verification of electricity production data provided by MWSC can be done similar to verification of resort data, by using established norms such as electricity consumption per unit quantity of water supplied. Similar to the treatment of different resort islands, different water treatment facilities of MWSC may have different consumption rates, and once the specific electricity consumption rate is established, future data can be verified against the water quantities supplied. In addition, using the specific fuel consumption rate of the diesel generators, a secondary validation can be done, if diesel supplied to the water purification plants can be collected through FSM.

MACL: While the generation data is not reported by MACL, based on the fuel consumption records, it is possible to estimate the electricity production. However, due to unavailability of data on fuel use for different purposes including electricity generation and transportation, this indirect approach may not be suitable for verification, unless the exact fuel consumption is reported by MACL. Therefore, verification of electricity generation by MACL need to be based on generation and fuel consumption data provided by MACL through URA's electricity data collection form.

Other Captive Generators: Verification of electricity generation data pertaining diesel generation shall be through the FCR approach proposed for other similar generation. However, if any solar PV installations are present, direct access to the invertors shall be obtained to validate the electricity generation by solar PV systems prior to inhouse consumption by the facility. To facilitate these verification measures, a comprehensive account of the available generators and solar PV systems are needed. Therefore, it is recommended for independent supervisors of the two utilities to be engaged to witness the commissioning parameters.

3.3 Electricity Generated in Resort Islands

3.3.1 Data Recording

Due to the importance of reliability of the electricity supply, all resort islands operate diesel generators of capacities exceeding the maximum demand of the resort. All operational data are recorded to ensure the performance and condition of the generators are well monitored allowing timely action in case an operational issue arises with the generators. Furthermore, the fuel delivery records are maintained for financial reporting purposes. In addition to diesel generators, some resorts have installed rooftop solar PV systems both to reduce costs and to reduce the carbon footprint of the resort.

Since no commercial significance is attached to the electricity production records, accuracy of the generation data recorded by the resorts may not be high. Therefore, it is recommended to get all resorts to install energy meters to record the electricity generation by diesel generators and solar PV systems. Since generation and consumption of electricity happens within the same premises, where a distribution network is not required, it can be assumed that the entire generation is consumed by the resort. However, the exact uses of electricity, such as for lighting, air conditioning, cooking, etc. are not separately monitored and recorded, due to absence of sub metering in the distribution panels of most resorts.

While electricity generation is the primary use of fuel in resort islands, other diesel uses such as to run the boilers for water heating and steam production, refuelling vessels and any land vehicles could exist at a small scale. Therefore, it is recommended to record fuel consumption by the diesel generators using fuel flow meters.

3.3.2 Data Reporting

Reporting of electricity generation data of resorts occur as a regular activity only within the resort company or the group of companies. As mentioned in Section 2.2, some of the resorts have shared electricity data with URA upon being requested, but majority of the resorts have not complied with the data request. Previously, Maldives Energy Authority, the predecessor of URA, has published the 'Island Electricity Databook' on several occasions, containing electricity generation data of a few of the resorts. However, overall data reporting of resorts has been poor and regularising the process is essential to capture the overall energy profile of the country. For this, the data collection approach agreed in the MoU between the Ministry of Tourism and Environment, Maldives Bureau of Statistics (MBS), and URA shall be made use. Accordingly, as shown in Figure 3.3, electricity data of each independent resort shall be collected by the MBS either directly or through the group office and then shared with URA.

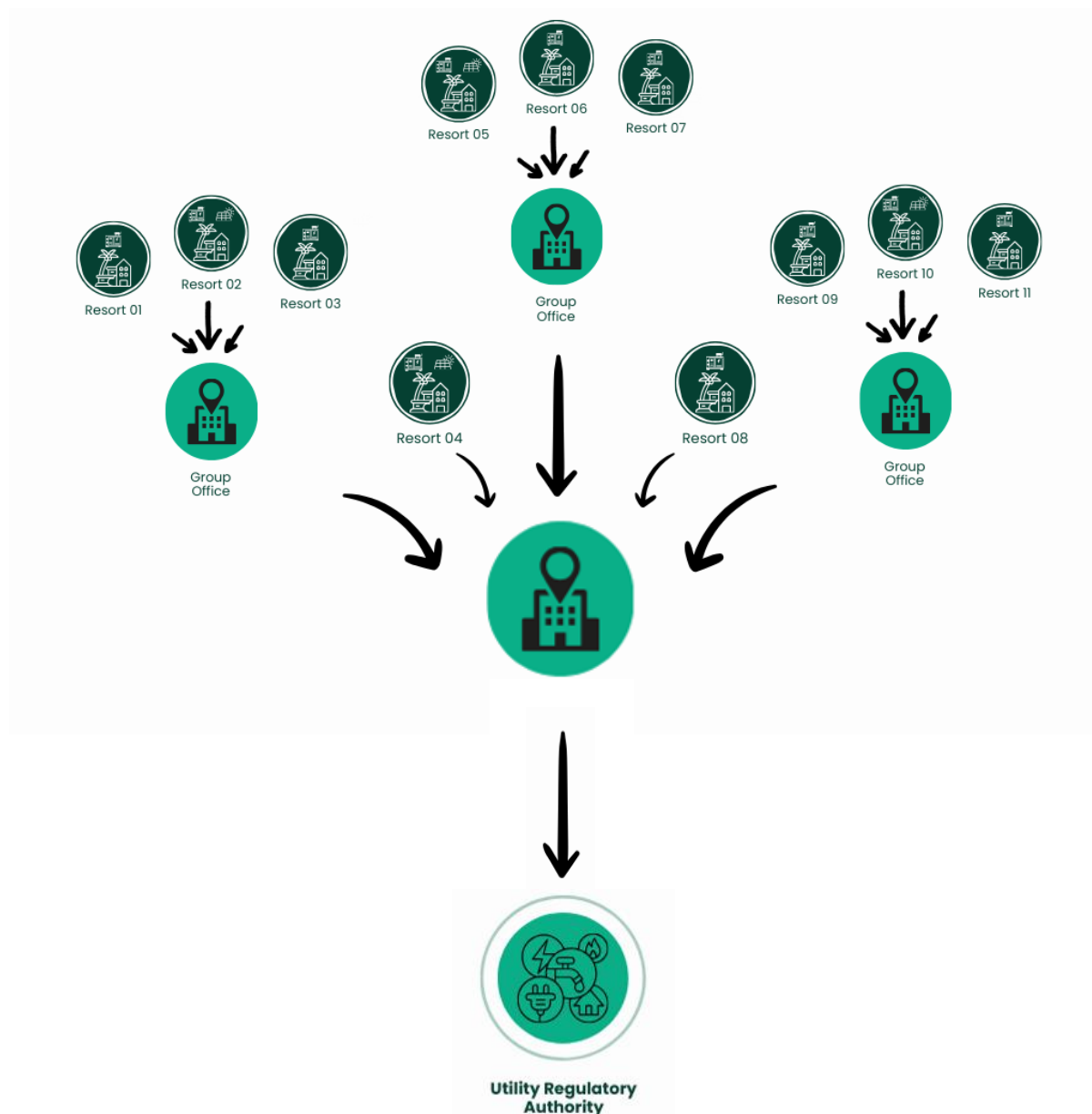


Figure 3.3: Proposed Data Reporting Arrangement for Resort Islands

3.3.3 Data Verification

At present, due to the absence of electricity generation and consumption data and the difference in consumption patterns of different resorts, verification of any electricity data provided to URA by the resorts can be done only at a broader level, comparing with established norms such as electricity consumption per guest night. Given the difference in such norms between different resorts, it is recommended to establish norms for each resort independently and use the same for future years, incorporating adjustments to reflect changes occurring to the resort year-on-year. Upon regularising electricity data collection from resorts through the MoU, URA shall verify the data following the methodologies followed for captive generation (Section 3.2.3).

APPENDIX 1 – Electricity Data Collection Form Used for the Energy Demand and Supply Study 2018–2022

Appendix 1: Electricity Data Collection Form Used for the Energy Demand and Supply Study 2018–2022

Electricity Supply Capacity

	Diesel Generators (kW)			Solar PV (kWp)			Battery Storage		Other	
	Installed Capacity	Available Capacity	Standby Capacity	Rooftop	Ground-mounted	Floating	Energy (kWh)	Power (kW)	Type	Capacity (kW)
2018										
2019										
2020										
2021										
2022										

Electricity Generation and Fuel Consumption

	Annual Generation (MWh)			Fuel Consumption for Electricity Generation	
	Diesel Generators	Solar PV	Other Renewables	Fuel Type	Consumption (l/yr)
2018					
2019					
2020					
2021					
2022					

Consumer Numbers and Demand

	Households	Commercial	Government	Industrial	Agricultural	Other		
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[illegible]

APPENDIX 2 – Electricity Data Collection Form Proposed to be Used in the Tourism Statistics Survey

Appendix 2: Electricity Data Collection Form Proposed to be Used in the Tourism Statistics Survey

Resort identifier	(as provided by MBS)
Location:	(Specify the region, e.g., North, North Central)
Bed Capacity	Bed capacity in a range (eg: <50,50-100,100-150,150-200,>200)
Resort ratings	3-star, 4-star, and 5-star

Type of Generation	Annual Generated amount in kWh	Fuel source
Please select Generated inhouse/ Outsourced)		Choose (Diesel, Solar, Others (specify)
Add row (Generated inhouse/ Outsourced selectable)		Choose (Diesel, Solar, Others (specify)

Fuel Bought

	Units (l, kg, MT)	Year (insert for which data is being collected)
Diesel		
Petrol		
LPG		
Others		

Inventory of fuel

	Units (l, kg, MT)	1 Jan of year	31 Dec of year
Diesel			
Petrol			
LPG			
Others			

Fuel Consumption by Use (Annual)

Year	Diesel	Petrol	LPG	Other (Specify)
	Units (l, kg, MT)	Units (l, kg, MT)	Units (l, kg, MT)	Units (l, kg, MT)
Electricity Generation				

Cooking				
Desalination				
Transport -Sea				
Transport -Land				
Others (specify)- fill in box				

Electricity Supply Capacity

Total Installed Diesel Generator Capacity (kW/MW)	
Power (kW)	Unit (kW /MW)

Solar PV	Unit (kWp)
Rooftop	
Ground-mounted	
Floating	
Total	

Other type of renewable energy	Unit (kWp)
Please specify	
Total	

Energy storage system is (if Available)

Battery Storage	
Power (kW)	Energy (kWh)
Other (Any other source used for Electricity Supply)	
Type	Capacity (kW)

Electric Power Generation

Month	Fuel Consumption (l)		Electricity Generation (kWh)					Electricity Demand (kW)	
	Diesel	Lub Oil	Diesel	Renewable - Solar	Renewable - Other	Total Electricity Generation (kWh)	Total Electricity Consumption (kWh) – to be provided if separate meter is available to be measured	Average Maximum	Average Minimum
January									
February									
March									
April									
May									
June									
July									
August									
September									
October									
November									
December									

Renewable Energy for Other Purposes

	Capacity (kW)
Solar water heating	
Waste heat recovery	
other	

APPENDIX 3 – Electricity Data Collection Form Currently Used by the Utility Regulatory Authority

Appendix 3: Electricity Data Collection Form Currently Used by the Utility Regulatory Authority

0 - Data Collection Year

--

1 - Island Information

1.1 Atoll

--

1.2 Island Name (Geographic)

--

1.3 Type of island/Resort Name

--

1.4 Population (registered)/Year Opened

--

1.5 No. of industrial installations/Beds

--

1.6 No. of Guest Houses (If applicable)/Bed Nights

--

2 - Powerhouse Information

2.1 Powerhouse Name

--

2.1 Powerhouse GPS Coordinates

--

2.2 24h electricity service start date

--

2.3 Islands covered by powerhouse (list)

--

2.4 Current Service provider

--

2.5 Previous Service Provider

--

2.6 Start date of Current Service Provider

--

2.7 Powerhouse Owner

--

2.8 Date of ownership transfer

--

2.9 Power System Registered Status

--

2.10 Power System Registered Date

--

2.11 Power System Registered Ref No.

--

3 - Generation Capacity

3.1 Diesel based generation - Powerhouse

3.1.1 Powerhouse

3.1.1.1 Total No. of generators

--

3.1.1.2 Total installed generator capacity (kW)

--

- 3.1.1.3 Generator capacities (kW)
- 3.1.1.4 Corresponding Generator Brand
- 3.1.1.5 Corresponding Generator Model
- 3.1.1.6 Corresponding Generator Operational Status
- 3.1.1.7 Comments

3.1.2 Private and other generators (standby) (If known by the utility)

- 3.1.2.1 No. of generators
- 3.1.2.2 Generator capacities (kW)
- 3.1.2.3 Total installed generator capacity
- 3.1.2.4 Comments

3.2 Renewable based generation

3.2.1 Utility/Gov Solar PV Projects (Large Scale)

- 3.2.1.1 Number of installations by location
- 3.2.1.2 Number of installations by Project
- 3.2.1.3 Total PV Installed Capacity (kW)
- 3.2.1.4 Total BESS Installed Capacity (kWh)

Breakdowns

- 3.2.1.5 Ownership of PV System
- 3.2.1.6 Sizes of PV Installation (kW)

Associated BESS

- 3.2.1.5 Sizes of Installation (kW)
- 3.2.1.6 Battery storage capacity (kWh)

3.2.2 Net-Metering (Solar PV)

- 3.2.2.1 Number of registered installations
- 3.2.2.2 Number of pending registrations
- 3.2.2.3 Total PV Installed Capacity (kW)
- 3.2.2.4 Total BESS Installed Capacity (kWh)

Breakdowns

- 3.2.2.5 Sizes of Installation (kW)
- 3.2.2.6 Battery storage capacity (kWh)

3.2.3 - Other Renewable Energy

3.2.3.1 Type of Renewable Energy

3.2.3.2 Ownership Types (per project)

3.2.3.3 Sizes of Installation (kW)

3.2.3.4 Total installed capacity (kW)

Associated BESS

3.2.3.5 Sizes of Installation (kW)

3.2.3.6 Battery storage capacity (kWh)

4 - Fuel (Diesel) Storage Capacity

4.1 No. of storage tanks

4.2 Total storage capacity (kilo Litres)

4.3 Estimated reserve (Days)

4.4 Storage capacities breakdown (kilo Litres)

5 - Generation & Distribution System

5.1 Generation Controls

5.1.1 Synchronising Panels

5.1.2 Automated Start/Stop

5.1.3 Generator Load Sharing/Control

5.1.4 SCADA system

5.1.5 Remote Control of Distributed RE plants

5.1.6 Energy Management Systems (EMS)

5.2 Generation & Transmission Voltages

5.2.1 400 V

5.2.2 11 kV

5.2.3 132 kV

5.2.3 Other (Specify):

5.3 LV network

5.3.1 Number of Distribution Boxes

5.3.2 Distribution Cables Installed Year

5.3.3 Last Upgraded Year

5.3.4 Existing Cable Sizes (mm²)

5.3.5 Corresponding Total Length of Cables (km)

5.3.6 Corresponding Upgraded Cable Length (km)

5.4 MV Network

5.4.1 Distribution Cables Installed Year

5.4.2 Last Upgraded Year

5.3.3 Last Upgraded Year

5.3.4 Existing Cable Sizes (mm²)

5.3.5 Corresponding Total Length of Cables (km)

5.3.6 Corresponding Upgraded Cable Length (km)

5.5 MV Transformers & Switchgear

5.5.1 No. of Step-up transformers

5.5.2 Power Ratings (kVA)

5.5.3 Breaker Ratings (A)

5.5.4 Transformer Types

5.5.5 No. of Step-down transformers

5.5.6 Power Ratings (kVA)

5.5.7 Breaker Ratings (A)

5.5.8 Transformer Types

6 - Generation History

6.1 - Peak Generation/Load

6.1.1 Diesel Plant load (max)

Max/Min	Jan	Feb	Mar	Apr

6.1.2 Diesel Plant load (max) time of day (hh:mm)

6.1.3 Diesel Plant load (min)

6.1.4 Diesel Plant load (min) time of day (hh:mm)

6.1.5 Solar Plant Peak generation est. (kW)

6.1.6 Solar Plant Peak generation est. time of day (hh:mm)

6.1.7 Battery Peak output (max)

6.1.8 Battery Peak output (max) time of day (hh:mm)

6.2 - Electricity Generated (kWh)

6.2.1 Diesel Based (Powerhouse)

*6.2.1 Powerhouse Self Consumption**

6.2.2 Solar PV (Govt/Utility large-scale projects)

6.2.3 Net-metering systems

6.2.4 Other Renewable energy

6.2.5 Solar PV (Private, large-scale projects)

6.2.6 Grand Total

TOTAL	Jan	Feb	Mar	Apr

6.3 - Diesel Consumption

6.3.1 Diesel Consumption (Litres) - Power Generation

6.3.2 Diesel Consumption (Litres) - Other

TOTAL	Jan	Feb	Mar	Apr

6.4 - Maintenance

6.3.1 Lube Oil Consumption (Litres)

6.3.2 Generator Overhauls (Nos.)

TOTAL	Jan	Feb	Mar	Apr

7 - Consumption Information (Annual)

7.1 - Consumption by Month - Number of Consumers

7.1.1 Domestic

7.1.2 Business

7.1.3 Government

7.1.4 Other (specify) *

7.1.5 Grand Total

TOTAL	Jan	Feb	Mar	Apr
-	-	-	-	-

7.2 -Consumption by Month - Totals (kWh)

7.2.1 Domestic

7.2.2 Business

7.2.3 Government

7.2.4 Other (specify) *

7.2.5 Grand Total

TOTAL	Jan	Feb	Mar	Apr
-	-	-	-	-

7.3 - Consumption by bands - No. of Consumers

7.3.1 Domestic

7.3.2 Business

7.3.3 Government

7.3.4 Other (specify) *

7.3.5 Grand Total

TOTAL	0-100	101-200	201-300	301-400
-	-	-	-	-

7.4 - Consumption by bands - Total (kWh) per band

7.4.1 Domestic

7.4.2 Business

7.4.3 Government

7.4.4 Other (specify) *

7.4.5 Grand Total

TOTAL	0-100	101-200	201-300	301-400
-	-	-	-	-

8 - Historic and Future Projected Demand Growth

	Historic				Future		
	Y - 3	Y - 2	Y - 1		Y + 1	Y + 2	Y + 3
8.1 Peak Demand (kW) - Diesel Only							
8.2 Peak Generation (kW) - Renewables							
8.3 Peak Demand (kW) - Total							
8.4 Total Electricity Consumption (kWh)							

APPENDIX 4 – Proposed Electricity Data Collection Form for Electricity Utilities

Appendix 4: Proposed Electricity Data Collection Form for Electricity Utilities

0 - Data Collection Year

--

1 - Island Information

1.1 Atoll

--

1.2 Island name

--

1.3 Type of island

--

1.4 Population (registered)

--

1.5 No. of industrial installations

--

1.6 No. of Guest Houses (If applicable)

--

2 - Powerhouse Information

2.1 Powerhouse Name

--

2.1 Powerhouse GPS Coordinates

--

2.2 24h electricity service start date

--

2.3 Islands covered by powerhouse (list)

--

2.4 Current Service provider

--

2.5 Previous Service Provider

--

2.6 Start date of Current Service Provider

--

2.7 Powerhouse Owner

--

2.8 Date of ownership transfer

--

2.9 Power System Registered Status

--

2.10 Power System Registered Date

--

2.11 Power System Registered Ref No.

--

3 - Generation Capacity

3.1 Diesel based generation - Powerhouse

3.1.1 Powerhouse

3.1.1.1 Total No. of generators

--

3.1.1.2 Total installed generator capacity (kW)

--

3.1.1.3 Individual generator capacity (kW)

3.1.1.4 Generator brand

3.1.1.5 Generator model

3.1.1.6 Generator installation year

3.1.1.7 Generator running hours

3.1.1.8 Generator operational status

3.1.1.9 Available capacity of generator (kW)

3.1.1.10 Comments

3.1.2 Private and other generators (standby) (If known by the utility)

3.1.2.1 No. of generators

3.1.2.2 Generator capacities (kW)

3.1.2.3 Total installed generator capacity

3.1.2.4 Possible to connect to grid (yes/no)

3.1.2.5 Comments

3.2 Renewable based generation

3.2.1 Utility/Gov Solar PV Projects (Large Scale)

3.2.1.1 Number of installations by location

3.2.1.2 Number of installations by Project

3.2.1.3 Total PV Installed Capacity (kWp)

3.2.1.4 Total PV Installed Capacity (kW)

3.2.1.5 Total BESS Installed Capacity (kW)

3.2.1.6 Total BESS Installed Capacity (kWh)

3.2.1.6 Total BESS Installed Capacity (kWh)

3.2.1.7 Year of commissioning

Breakdowns

3.2.1.5 Ownership of PV System

3.2.1.6 Sizes of PV Installation (kW)

Associated BESS

3.2.1.5 Sizes of Installation (kW)

3.2.1.6 Battery storage capacity (kWh)

3.2.2 Net-Metering (Solar PV)

- 3.2.2.1 Number of registered installations
- 3.2.2.2 Number of pending registrations
- 3.2.2.3 Total PV installed capacity (kWp)
- 3.2.2.4 Total PV installed capacity (kW)
- 3.2.2.5 Total BESS installed capacity (kW)
- 3.2.2.6 Total BESS installed capacity (kWh)

Breakdowns

- 3.2.2.7 Sizes of solar PV installations (kWp)
- 3.2.2.8 Sizes of solar PV installations (kW)
- 3.2.2.9 Year of commissioning
- 3.2.2.10 Battery storage capacity (kW)
- 3.2.2.11 Battery storage capacity (kWh)
- 3.2.2.12 Year of commissioning

3.2.3 - Other Renewable Energy

- 3.2.3.1 Type of renewable energy
- 3.2.3.2 Ownership types (per project)
- 3.2.3.3 Sizes of installation (kW)
- 3.2.3.4 Total installed capacity (kW)

Associated BESS

- 3.2.3.5 Sizes of installation (kW)
- 3.2.3.6 Battery storage capacity (kWh)

4 - Fuel (Diesel) Storage Capacity

- 4.1 No. of storage tanks
- 4.2 Total storage capacity (kilo Litres)
- 4.3 Estimated reserve (Days)
- 4.4 Flow meters available (yes/no)

- 4.5 Storage capacities breakdown (kilo Litres)

--	--	--

5 - Generation & Distribution System

5.1 Generation Controls

- 5.1.1 Synchronising Panels
- 5.1.2 Automated Start/Stop
- 5.1.3 Generator Load Sharing/Control
- 5.1.4 SCADA system
- 5.1.5 Remote Control of Distributed RE plants
- 5.1.6 Energy Management Systems (EMS)

5.2 Generation & Transmission Voltages

- 5.2.1 400 V
- 5.2.2 11 kV
- 5.2.3 132 kV
- 5.2.3 Other (Specify):

5.3 LV network

- 5.3.1 Number of Distribution Boxes
- 5.3.2 Distribution Cables Installed Year
- 5.3.3 Last Upgraded Year
- 5.3.4 Existing Cable Sizes (mm2)
- 5.3.5 Corresponding Total Length of Cables (km)
- 5.3.6 Corresponding Upgraded Cable Length (km)

5.4 MV Network

- 5.4.1 Distribution Cables Installed Year
- 5.4.2 Last Upgraded Year
- 5.3.3 Last Upgraded Year
- 5.3.4 Existing Cable Sizes (mm2)
- 5.3.5 Corresponding Total Length of Cables (km)
- 5.3.6 Corresponding Upgraded Cable Length (km)

5.5 MV Transformers & Switchgear

5.5.1 No. of Step-up transformers

5.5.2 Power Ratings (kVA)

5.5.3 Breaker Ratings (A)

5.5.4 Transformer Types

5.5.5 No. of Step-down transformers

5.5.6 Power Ratings (kVA)

5.5.7 Breaker Ratings (A)

5.5.8 Transformer Types

6 - Generation History

6.1 - Peak Generation/Load

	Max/Min	Jan	Feb	Mar	Apr
6.1.1 Diesel Plant load (max)					
6.1.2 Diesel Plant load (max) time of day (hh:mm)					
6.1.3 Diesel Plant load (min)					
6.1.4 Diesel Plant load (min) time of day (hh:mm)					
6.1.5 Solar Plant Peak generation est. (kW)					
6.1.6 Solar Plant Peak generation est. time of day (hh:mm)					
6.1.7 Battery Peak output (max)					
6.1.8 Battery Peak output (max) time of day (hh:mm)					

6.2 - Electricity Generated (kWh)

	TOTAL	Jan	Feb	Mar	Apr
6.2.1 Diesel based (Powerhouse)					
6.2.1 Powerhouse Self Consumption*					
6.2.2 Solar PV (Govt/Utility large-scale projects)					
6.2.3 Net-metering systems					
6.2.4 Other renewable energy					
6.2.5 Solar PV (private, large-scale projects)					
6.2.6 Grand Total					

6.3 - Diesel Consumption

	TOTAL	Jan	Feb	Mar	Apr
6.3.1 Diesel delivered (Litres)					
6.3.1 Diesel consumption (Litres) - Power Generation					
6.3.2 Diesel consumption (Litres) - Other					

6.4 - Maintenance

	TOTAL	Jan	Feb	Mar	Apr
6.3.1 Lube oil consumption (Litres)					
6.3.2 Generator overhauls (Nos.)					
6.3.3 Type of overhauls					

7 - Consumption Information

7.1 - Consumption by Month - Number of Consumers

	TOTAL	Jan	Feb	Mar	Apr
7.1.1 Domestic					
7.1.2 Business					
7.1.3 Government					
7.1.4 Water supply					
7.1.5 Other (specify) *					
7.1.6 Grand Total	-	-	-	-	-

7.2 -Consumption by Month - Totals (kWh)

	TOTAL	Jan	Feb	Mar	Apr
7.2.1 Domestic					
7.2.2 Business					
7.2.3 Government					
7.2.4 Water supply					
7.2.5 Other (specify) *					

7.2.6 Grand Total

-	-	-	-	-
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7.3 - Consumption by bands - No. of Consumers

	TOTAL	0-100	101-200	201-300	301-400
7.3.1 Domestic					
7.3.2 Business					
7.3.3 Government					
7.3.4 Water supply					
7.3.5 Other (specify) *					
7.3.6 Grand Total	-	-	-	-	-

7.4 - Consumption by bands - Total (kWh) per band

	TOTAL	0-100	101-200	201-300	301-400
7.4.1 Domestic					
7.4.2 Business					
7.4.3 Government					
7.4.4 Water supply					
7.4.5 Other (specify) *					
7.4.6 Grand Total	-	-	-	-	-

8 - Historic and Future Projected Demand Growth

	Historic				Future		
	Y - 3	Y - 2	Y - 1	Y	Y + 1	Y + 2	Y + 3
8.1 Peak Demand (kW) - Diesel Only							
8.2 Peak Generation (kW) - Renewables							
8.3 Peak Demand (kW) - Total							
8.4 Total Electricity Consumption (kWh)							

APPENDIX 5 – Proposed Electricity Data Collection Form for Captive Generators

Appendix 5: Proposed Electricity Data Collection Form for Captive Generators

0 - Data Collection Year

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1 - Island Information

1.1 Atoll

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1.2 Island name (Geographic)

--

1.3 Type of island

--

1.4 Name of facility

--

2 - Powerhouse Information

2.1 Powerhouse GPS coordinates

--

2.2 Current service provider for the island

--

2.3 Power system registered status

--

2.4 Power system registered date

--

2.5 Power system registered ref no.

--

3 - Generation Capacity

3.1 Diesel based generation - Powerhouse

3.1.1 Powerhouse

3.1.1.1 Total no. of generators

--

3.1.1.2 Total installed generator capacity (kW)

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3.1.1.3 Individual generator capacity (kW)

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3.1.1.4 Generator brand

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3.1.1.5 Generator model

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3.1.1.6 Generator installation year

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3.1.1.7 Generator running hours

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3.1.1.8 Generator operational status

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3.1.1.9 Available capacity of generator (kW)

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3.1.1.10 Comments

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3.2 Renewable based generation

3.2.1 Solar PV

- 3.2.1.1 Total PV Installed Capacity (kWp)
- 3.2.1.2 Total PV Installed Capacity (kW)
- 3.2.1.3 Total BESS Installed Capacity (kW)
- 3.2.1.4 Total BESS Installed Capacity (kWh)
- 3.2.1.5 Year of commissioning

3.2.3 - Other Renewable Energy

- 3.2.3.1 Type of renewable energy
- 3.2.3.2 Sizes of installation (kW)
- 3.2.3.3 Total installed capacity (kW)

Associated BESS

- 3.2.3.5 Sizes of installation (kW)
- 3.2.3.6 Battery storage capacity (kWh)

4 - Fuel (Diesel) Storage Capacity

- 4.1 No. of storage tanks
- 4.2 Total storage capacity (kilo Litres)
- 4.3 Estimated reserve (days)
- 4.4 Flow meters available (yes/no)
- 4.5 Storage capacities breakdown (kilo Litres)

5 - Generation & Distribution System

5.1 Generation Controls

- 5.1.1 Synchronising panels
- 5.1.2 Automated start/stop
- 5.1.3 Generator load sharing/control
- 5.1.4 SCADA system
- 5.1.5 Remote control of distributed RE plants

5.1.6 Energy Management Systems (EMS)

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5.2 Power Distribution Network

5.2.1 Number of distribution boxes

--

5.2.2 Distribution cables installed year

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5.2.3 Last upgraded year

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5.2.4 Existing cable sizes (mm2)

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5.2.5 Corresponding total length of cables (km)

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5.2.6 Corresponding upgraded cable length (km)

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6 - Generation History

6.1 - Peak Generation/Load

6.1.1 Diesel plant load (max)

Max/Min	Jan	Feb	Mar	Apr

6.1.2 Diesel plant load (max) time of day (hh:mm)

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6.1.3 Diesel plant load (min)

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6.1.4 Diesel plant load (min) time of day (hh:mm)

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6.1.5 Solar plant peak generation est. (kW)

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6.1.6 Solar plant peak generation est. time of day (hh:mm)

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6.1.7 Battery peak output (max)

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6.1.8 Battery peak output (max) time of day (hh:mm)

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6.2 - Electricity Generated (kWh)

6.2.1 Diesel based (Powerhouse)

TOTAL	Jan	Feb	Mar	Apr

6.2.1 Powerhouse Self Consumption*

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6.2.2 Solar PV

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6.2.3 Net-metering systems

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6.2.4 Other renewable energy

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6.2.5 Grand Total

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6.3 - Diesel Consumption

	TOTAL	Jan	Feb	Mar	Apr
6.3.1 Diesel delivered (Litres)					
6.3.1 Diesel consumption (Litres) - power generation					
6.3.2 Diesel consumption (Litres) - other					

6.4 - Maintenance

	TOTAL	Jan	Feb	Mar	Apr
6.3.1 Lube oil consumption (Litres)					
6.3.2 Generator overhauls (Nos.)					
6.3.3 Type of overhauls					

APPENDIX 6 – Electricity Data Reporting Format for Online Publication by Electricity Utilities

Appendix 6: Electricity Data Reporting Format for Online Publication by Electricity Utilities

Electricity Generation

[illegible]

Electricity Sales

[illegible]