



Ministry of Tourism and Environment

Training Report on

Guidelines & Protocols for Data Collection and Reporting for GHG Inventories

Consultancy Services for a GHG Inventory Expert

February 2025

CBIT Maldives

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



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Ministry of Tourism and Environment
Republic of Maldives

Training Report on Guidelines & Protocols for Data Collection and Reporting for GHG Inventories

Consultancy Services for a GHG Inventory Expert

[This training report covers two (2) of the four (4) required workshops under Deliverable 1.2.5: Workshop Reports on GHG Inventory Compilation and Maintenance of the Database Management System, and one (1) of the three (3) required workshops under Deliverable 1.4.3: Training Workshop Reports on QA/QC Plans.]

CBIT MALDIVES

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





Ministry of Tourism and Environment

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



This document was developed under the project “Capacity Strengthening for Improved Transparency of Climate Change Mitigation and Adaptation Actions in the Maldives (CBIT Maldives)”, financed by the Global Environment Facility (GEF).

The project is executed by the Ministry of Tourism and Environment, with implementation support from the United Nations Environment Programme (UN Environment).

February 2025

Consultant:

Development Advisory Services Pvt Ltd

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Executive Summary

As part of a consultancy project to develop guidelines and protocols for Greenhouse gas emission inventory, a training workshop was held from 22nd January to 24th January 2025. The main objective was to provide training on the use of guidelines and protocol for GHG emission estimation for Energy -sub categories.

The workshop was facilitated by GHG Inventory Expert, Mr. Zammath Khaleel. A total of 17 (9 male, 8 female) participants from the Climate Change Department of the Ministry and the President's Office took part in the training, which aimed to strengthen technical capacities for GHG inventory compilation and reporting.

Over the three days, the workshop focused on the following topics:

- Day 1: Emission compilation and calculation,
- Day 2: GHG reporting,
- Day 3: Quality Assurance (QA) and Quality Control (QC) processes.

The workshop was conducted in an interactive manner with presentations and example calculations followed by question and answers session. The sessions were designed capacitate the audience to use the guidelines and protocols and clarify any issues in GHG inventory compilation. The sessions also served as focus group feedback sessions to allow the consultant to include additional information or to simplify the concepts introduced in the guidelines and protocols.

This training workshop collectively fulfills the following project deliverables of the project;

- Deliverable 1.2.5: Four (4) workshop reports on GHG inventory compilation and maintenance of the database management system.
 - The workshop covered two of the four required workshops on GHG inventory compilation and reporting during Days 1 and 2.
- Deliverable 1.4.3: Three (3) training workshop reports on QA/QC plans
 - The last day of the workshop addressed one of the three required QA/QC workshops.

The remaining workshops are planned for Q2 2025, one for the energy sector and one for the non-energy sector—both of which will include the required QA/QC training (*Deliverable 1.4.3*)

1. Introduction

The Capacity Building Initiative for Transparency (CBIT) project of Maldives is aimed to strengthening institutional capacity for tracking mitigation and adaptation actions and establishing climate finance tracking system in the Maldives. It aims to establish and enhance the Maldives' transparency system, in line with Enhanced Transparency Framework (ETF) of Paris Agreement.

As part of the Maldives CBIT project, Development Advisory Services Pvt Ltd was recruited as consultants to Develop Guidelines and Protocols for Preparation of GHG inventory for Maldives. The main objective of the assignment is to develop nationally appropriate guidelines and toolkits to report GHG emissions in line with the Enhanced Transparency Framework (ETF) of the Paris Agreement.

The workshop was held from 22nd January to 24th January, 2025 to training of Climate Change Department staff on the use of guidelines and protocol to estimate GHG emissions. This training covers the data collection, emission calculation and compilation and reporting together with Quality Assurance and Quality control process. The training was distributed over three days to ensure that the audience has ample to time to understand, absorb and apply the highly technical knowledge included in the guideline.

The workshop began with opening remarks from Mr. Ahmed Waheed, Director, Climate Change Department of MCCEE. After the opening remarks of the workshop on presentations were given by the consultants followed by review sessions after break. The day 1 of the training was focused Introduction of Guideline covering aspects of emission calculation and compilation. Day 2 of the training focused on GHG reporting. Day 3 of the training focused QA/QC aspects of GHG inventory

This report is aimed to archive training material given on the workshop and record the feedback from the stakeholders. This report outlines as the following;

- **Objectives of the workshop:** the section includes the objectives of inception workshop will be described.
- **Training sessions:** this section describes the training method and materials provided during the training period..
- **Engagement and Feedback:** this section captures the main discussions and recommendations made by the participants on the training sessions and materials

2. Objectives

The main objective of the training was to capacitate Climate Change Department of Ministry of Climate Change Environment and Energy. The department is currently responsible for to inventory planning and compilation as such would be the main user of guidelines and protocol develop under the project.

This training sessions also serves as focus group feedback session for the training materials and overall guidance provided in the guidelines and protocol for data collection and emission estimation.

3. Training Sessions

As described above the training was stretched over 3 days to ensure that the audience has ample to time to understand, absorb and apply the technical knowledge included in the guideline. Each day focused on a specific topic on guideline

3.1 Day 1 – Emission calculation and compilation

Day 1 was focused on introducing the guideline with a focus on emission calculation and compilation. The presentation given introduced GHG emissions and the importance of compiling national GHG inventory. The session introduced key concepts of GHG inventory including IPCC definitions of various emissions, main IPCC sectors, Global Warming Potentials (GWPs) and TACCC principles. Furthermore, the presentation goes over step by step on inventory process of GHG inventory compilation introducing key processes like Key Category Analysis, data collection best practices. The presentation is included in the annex.

3.1 Day 2 – GHG inventory reporting

Day 2 was focused on using the guideline and protocols for reporting on GHG inventory. The presentation covers introduction to sub categories to be reported under Enhanced Transparency Framework, including the relevance of categories to the national context of Maldives. The training includes key definitions, and emission sources, step-by step guidance on preparation of emissions inventory for reporting with a particular focus on reporting requirements under the Paris Agreement. More guidance was provided on potential data sources including proxy data, and appropriating available data for use in emission calculation to improve completeness of the GHG inventory. Furthermore, training covers guidance on where to report different emission sources in accordance with the IPCC definitions. The step by step example was provided to illustrate the emission calculation and reporting for ease of understanding.

3.1 Day 3 – Quality Assurance (QA) and Quality Control (QC) processes.

Day 3 was focused on using the guideline and protocols for quality control and quality assurance steps to be undertaken during and after the GHG compilation process. The training material recaps day 2 lessons which includes key definitions of fuels, GWP etc , guidance on estimating emissions using sectoral approach. Followed by detail guidance on data quality control for each sub category and method and guidance on where to report different emission sources in accordance with the IPCC definitions. Training focused on differences in QC processes in different sectors and a need to have expert group for each main category for QC. The presentation included an example of applying QC process for a dummy dataset. The QA checklist was further elaborated on day 3 with further explanations on how it helps implement the TACCC principles for GHG inventory calculations and compilations.

4. Participant Engagement & Feedback

The participants were enthusiastically engaged with the information provided and clarified their understanding on the IPCC subcategories and definitions which differs from national definitions. The participants appreciated the local examples of data sources and step by step calculations with actual data as it allowed them to practically apply the guideline in actual GHG estimation. The key feedback on improvement future improvement of the training includes, further simplifying the concept descriptions, and including more examples of GHG calculation using local data and more guidance on use of IPCC software and ETF tool.

Annex 1: Agenda

22 January 2025 (Wednesday)	
Session 1: Training Workshop on Guidelines and Protocols for Data Collection and Reporting for GHG Inventories – Emission Calculation and Compilation	09:00 – 12:00
Break	12:00 – 14:00
Question and Answers session	14:00 – 16:00
23 January 2025 (Thursday)	
Session 2: Training Workshop on Guidelines and Protocols for Data Collection and Reporting for GHG Inventories – GHG inventory reporting	09:00 – 12:00
Break	12:00 – 14:00
Exercise and Review session	14:00 – 16:00
24 January 2025 (Friday)	
Session 3: Training Workshop on Guidelines and Protocols for Data Collection and Reporting for GHG Inventories – Quality Assurance (QA) and Quality Control (QC) processes.	09:00 – 12:00
Break	12:00 – 14:00
Exercise and Review session	14:00 – 16:00

Annex 2: Participant List



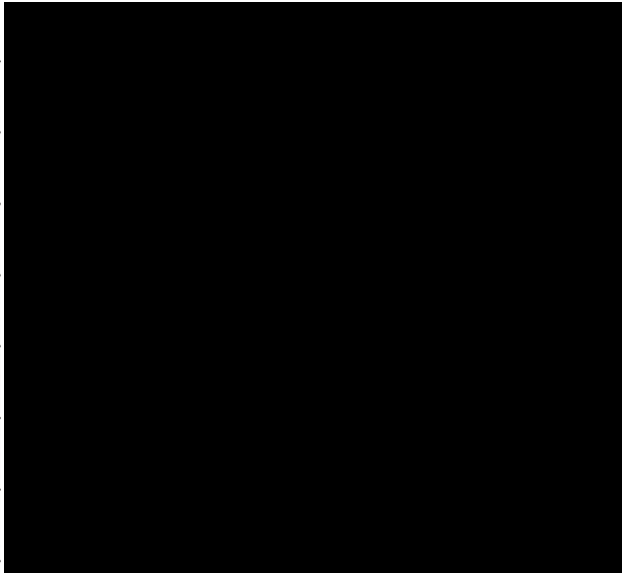
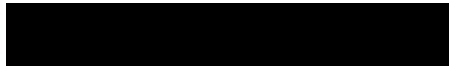


دائرة التغير المناخي، البيئة والطاقة
Ministry of Climate Change, Environment and Energy

Training workshop on Guidelines and Protocols for data collection and reporting required for GHG Inventories

Attendance Sheet

Date: 22-01-2025 Time: 10:00 AM Venue: Unimaa Room Section: Climate Change Department - CBIT PMU

	Name	Designation	Organisation	Contact no	Email Address	Signature
1	Amjad Abdulla	Director General	MCCEE			
2	Ahmed Waheed	Director	MCCEE			
3	Thibyan Ibrahim	Director	MCCEE			
4	Fathimath Nashwa	Assistant Director	MCCEE			
5	Ali Shareef	Special Envoy for Climate Change	President's Office			
6	Zammath Khaleel	Consultant - DAS	DAS			
7	Mohamed Inaz	Project Technical Coordinator	CBIT PMU			
8	Fathimath Raufa Moosa	Project Technical Coordinator	BTR PMU			
9	Ahmed Masoon	Programme Officer	MCCEE			
10	Juruath Abdulla Nafiz	Programme Officer	MCCEE			

11	Naufal Mohamed	Country specialist	CCD - NDC Partnership		
12	Raniya Husnu Al Suood	Programme Officer	MCCEE		
13	Naahy Mohamed Rasheed	Assistant Director	President's Office		
14	Aishath Reesha Suhail	Programme Officer	MCCEE		
15	Fathimath Zaina Shareef	Programme Officer	MCCEE		
16	Fathmath Maishan	Programme Analyst	CBIT PMU		
17	Izman Suhail	Climate Adaptation Analyst	Commonwealth		
18	Jauza Khaleel	Senior Climate Change Adaptation Consultant	IISD		
19	Jauza Khaleel	Senior Climate Change Adaptation Consultant	IISD		
20	Moosa Zameer	Consultant			



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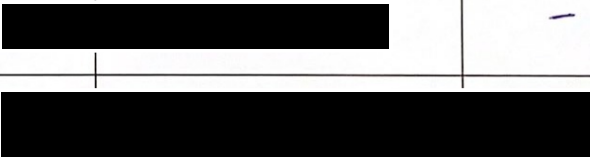
Ministry of Climate Change, Environment and Energy

Training workshop on Guidelines and Protocols for data collection and reporting required for GHG Inventories

Attendance Sheet

Date: 23-01-2025	Time: 10:00AM	Venue: Unimaa Room	Section: Climate Change Department - CBIT PMU
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	Name	Designation	Organisation	Contact no	Email Address	Signature
1	Amjad Abdulla	Director General	MCCEE			
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8	Fathimath Raufa Moosa	Project Technical Coordinator	BTR PMU			
9	Ahmed Masoon	Programme Officer	MCCEE			
10	Juruath Abdulla Nafiz	Programme Officer	MCCEE			

11	Naufal Mohamed	Country specialist	CCD - NDC Partnership	
12	Raniya Husnu Al Suood	Programme Officer	MCCEE	
13	Naahy Mohamed Rasheed	Assistant Director	President's Office	
14	Aishath Reesha Suhail	Programme Officer	MCCEE	
15	Fathimath Zaina Shareef	Programme Officer	MCCEE	
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Ministry of Climate Change, Environment and Energy

Training workshop on Guidelines and Protocols for data collection and reporting required for GHG Inventories

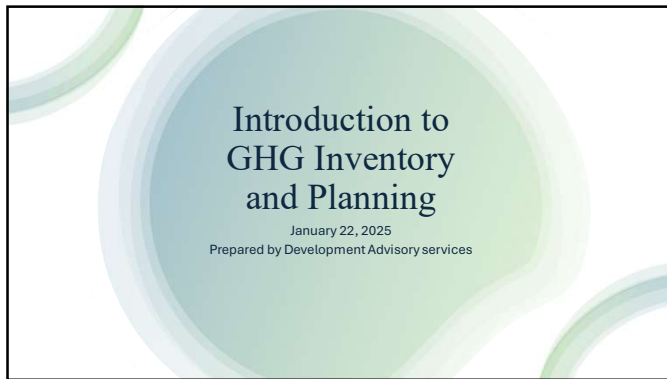
Attendance Sheet

Date: 24-01-2025	Time: 10:00 AM	Venue: Unimaa Room	Section: Climate Change Department - CBIT PMU
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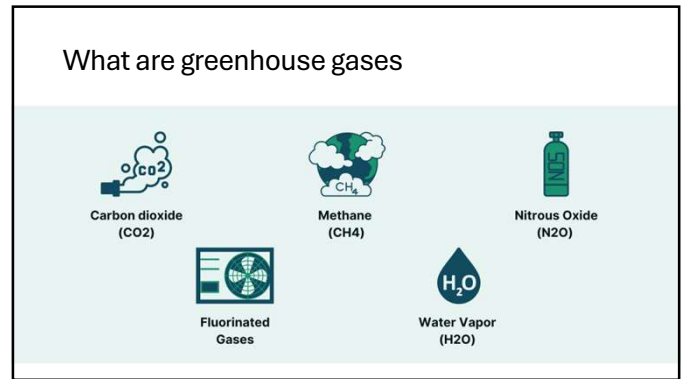
	Name	Designation	Organisation	Contact no	Email Address	Signature
1	Amjad Abdulla	Director General	MCCEE			
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10	Juruath Abdulla Nafiz	Programme Officer	MCCEE			

11	Naufal Mohamed	Country specialist	CCD - NDC Partnership	[REDACTED]	
12	Raniya Husnu Al Suood	Programme Officer	MCCEE	[REDACTED]	
13	Naahy Mohamed Rasheed	Assistant Director	President's Office		
14	Aishath Reesha Suhail	Programme Officer	MCCEE		
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17	Izman Suhail	Climate Adaptation Analyst	Commonwealth		
18	Jauza Khaleel	Senior Climate Change Adaptation Consultant	IISD	[REDACTED]	
19	Jauza Khaleel	Senior Climate Change Adaptation Consultant	IISD		
20	Moosa Zameer	Consultant		[REDACTED]	

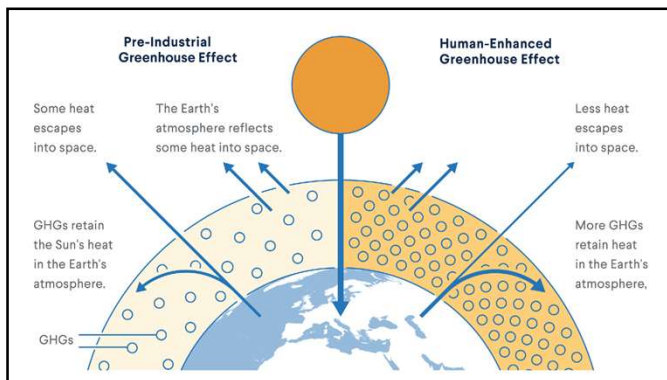
Annex 3: Presentation Materials



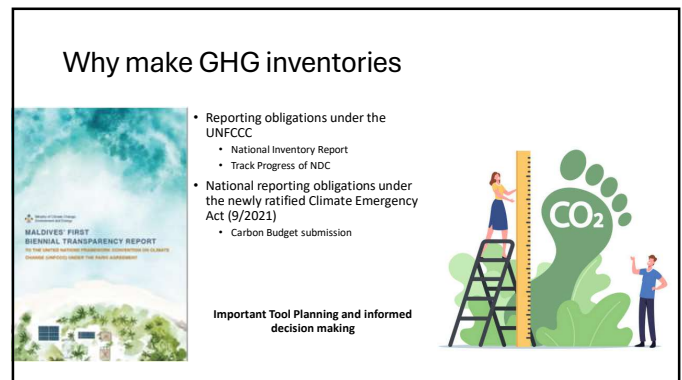
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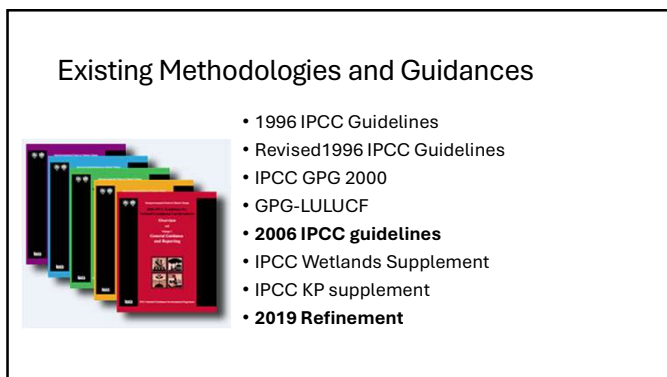
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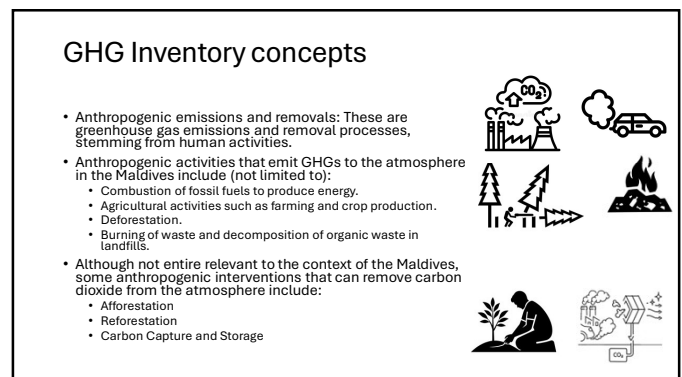
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GHG Inventory concepts

- **Greenhouse Gases:** The greenhouse gases covered depend on the national context and key category analysis. Based on previous inventories and assessments, the following three gases are the most relevant to the Maldives:
 - Carbon dioxide (CO₂)
 - Methane (CH₄)
 - Nitrous oxide (N₂O)
 - F-Gases
- **Sectors and Categories:** Greenhouse gas emission and removal estimates are categorized into primary sectors, each encompassing related processes, sources, and sinks [1]. These sectors are:
 - Energy
 - Industrial Processes and Product Use (IPPU)
 - Agriculture, Forestry, and Other Land Use (AFOLU)
 - Waste
 - Other (e.g., indirect emissions from nitrogen deposition originating from non-agricultural sources)

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GHG Inventory concepts

- **Global Warming Potential (GWPs):** GWP is a metric that compares the radiative forcing of a metric ton of a particular greenhouse gas over a specified time-period (e.g., 100 years) to the radiative forcing of a metric ton of CO₂ over the same period [1].

Global Warming Potential (GWP ₁₀₀)		
CO ₂	CH ₄	N ₂ O
1	28	265

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TACCC principles

- **Transparency:** Assumptions and methodologies should be clearly explained and documented
- **Accuracy:** Emission and removal estimates should be neither over nor under the true values
- **Consistency:** Inventories should be internally consistent with previous years' inventories
- **Completeness:** Inventories should be complete
- **Comparability:** Inventories should be comparable

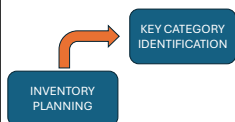
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INVENTORY PROCESS

INVENTORY
PLANNING

10

INVENTORY PROCESS



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Key Categories

- Most significant emission sources and sinks to prioritize resources
- For a new inventory, make rough estimates based on previous knowledge of activities, emission sources, and experience with similar inventories.
- For continuing inventory use the last national inventory to carry out Key category analysis



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Key category analysis

Level assessment

- Key categories are the ones that, when added together in descending order of magnitude, account for 95 percent of the total level of emissions and removals.

Trend assessment

- Key categories are those whose trend most significantly diverges from the overall trend

IPCC code	Category	Greenhouse gas	2011 Level	2022 Level	2022 Trend
1.A.4	Other Sectors - Liquid Fuels	CO ₂	X	X	X
1.A.1	Energy Industries - Liquid Fuels	CO ₂	X	X	X
1.A.3.d	Water-borne Navigation - Liquid Fuels	CO ₂	X	X	X
1.A.3.b	Road Transportation - Liquid Fuels	CO ₂	X	X	X
1.A.3.a	Civil Aviation - Liquid Fuels	CO ₂	X	X	X
1.A.3.e	Other Transportation - Liquid Fuels	CO ₂	-	-	X
4.C	Incineration and Open Burning of Waste	CH ₄	X	X	X

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INVENTORY PROCESS

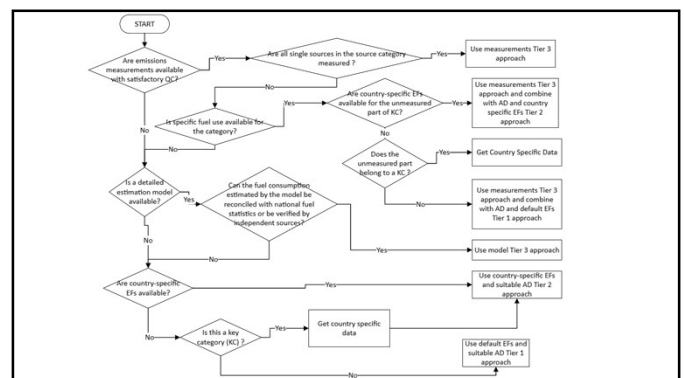


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Choosing Methodologies

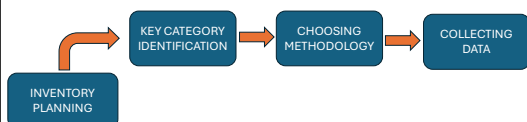
	Estimation Method	Example of Data collection required
Tier 1 - Basic	Default Emission factor x National Activity data (aggregated)	Total Fuel combusted for electricity generation
Tier 2 - Intermediate	Country Specific emission factor x Specific activity data	Fuels combusted for electricity generation together with the average combustion rates of the technology used
Tier 3 - Advanced	Emission measurements or models to estimate emissions accurately	Stack emissions for all the power houses

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INVENTORY PROCESS



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Best Practices in Data collection

- Prioritize collecting data that enhances estimates for the most significant key categories, considering their contribution, potential for change, and uncertainty.
- Choose data collection methods that progressively enhance inventory quality, aligning with data quality goals.
- Establish data collection practices (such as resource allocation, planning, documentation) that continuously enhance the inventory data.
- Gather data at an appropriate level of detail based on the chosen method.
- Regularly review data collection activities and methodological requirements to drive ongoing and efficient inventory improvement.
- Establish agreements with data providers to ensure consistent and continuous information flow.



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Collecting data

Recommended existing data source prioritization

- National Statistical Agencies – Maldives Bureau of Statistics, MCS
- Sectoral Experts/Government Agencies – URA, MOT, MPL . . .
- Other National Experts –consultants
- IPCC EFDB
- International Organizations – World Bank, FAO
- Historical references – FNC, SNC, BUR, Carbon Audit 2009
- Academia – MNU
- Inventory Reports of other similar countries

Source	Type of Activity Data
Maldives Customs Services	Fuel Import/Export data
State Trading Organization (STO)	Fuel Import/Export/stock data
Fuel Supply Maldives	Fuel Import/Export/stock data
Maldivian Gas	Fuel Import/Export/stock data
Villa Hukatha	Fuel Import/Export/stock data
Villa Gas	Fuel Import/Export/stock data
Hawks Pet Ltd	Fuel Import/Export/stock data
Maldivian Services	Fuel Import/Export/stock data
Asian Gas and Oil and Coastal Works	Fuel Import/Export/stock data
Hakatha One	Fuel Import/Export/stock data
Fuel Express Maldives	Fuel Import/Export/stock data
Maldivian Airports Company Limited	Fuel stock/consumption data
Regional Airports	Fuel stock/consumption data
ETELCO	Fuel Consumption Data
FENASA	Fuel Consumption Data
MNVSC	Fuel Consumption Data
Utility Regulatory Authority (Previously MEA)	Fuel Consumption data
Resorts	Fuel Consumption data and bed-nights or occupancy data
MRFCO	Fuel Consumption Data
MPL Including Regional Ports	Fuel Consumption Data
MIND/MPS	Fuel Consumption Data
Marine Fisheries	Fuel Consumption data
Ministry of Transport/ Transport Authority	Vehicle/vessel registry data
Ministry of Fisheries	Data on fishing trips/vessels
Ministry of Tourism	Bed nights/occupancy rates
Maldives Bureau of Statistics	Demography and socio-economic data/indices

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Collecting data

- Define the data set including the disaggregation, time series, details about sectors and sub-sectors, national coverage, requirements for uncertainty data, emission factors, and units of activity data
- Define the format (e.g., spreadsheet) and the structure of the data set
- Description of the assumptions made in the data sets
- Specify how often the data set is updated and which elements are updated
- Documentation and QA/QC Procedures
- Contact Information



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Generating new data

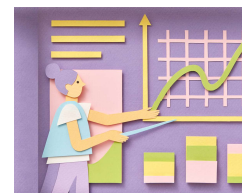
- May become necessary when representative emission factors, activity data, or other estimation parameters are unavailable
- Whenever possible, to generate the required data as an extension of existing programs rather than initiating entirely new ones
 - Example rather than have an independent survey incorporate new question into existing surveys like HIES, Census, Waste Accounting etc



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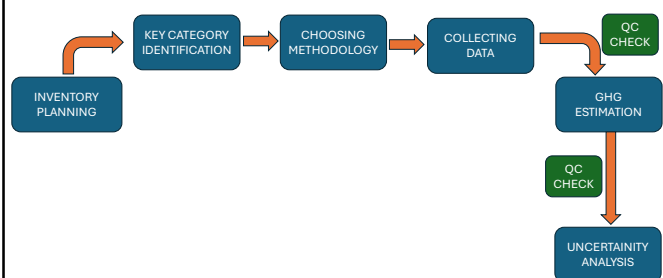
Adapting data for Estimation

- Filling Gaps in Periodic Data – When data collection intervals not aligning with annual inventory cycle (example waste audit data)
- Time Series Revision – when the data provider revises their historical data (example: data reconciliation process leading historical value revisions)
- Incorporating Improved Data - When new and improve data is available allowing higher tier estimated
- Incomplete Coverage: When data do not fully represent the entire country. Proxy data can be used to extrapolate (example use of bednights to estimate fuel use in resorts)



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INVENTORY PROCESS



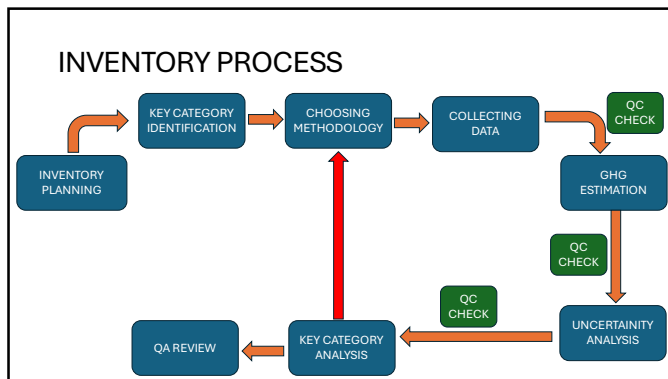
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GHG Estimation

$$\text{Emissions} = \text{Activity Data (AD)} \times \text{Emission Factors (EF)}$$



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QA Review– Completeness check (Notation Keys)

Notation Key	Definition
NO	(Not occurring) for activities or processes in a particular source or sink that do not occur within a country
NE	(Not estimated) for existing emissions by sources and removals by sinks of greenhouse gases which have not been estimated.
NA	(Not applicable) for activities in a given source/sink category that do not result in emissions or removals of a specific gas.
IE	(Included elsewhere) or emissions by sources and removals by sinks of greenhouse gases estimated but included elsewhere in the inventory instead of the expected source/sink category. Where "IE" is used in an inventory, the country should indicate, using the CRF completeness table (CRT 9?) where in the inventory the emissions or removals from the displaced source/sink category have been included and explain why they have placed these emissions or removals in a different category.
C	(Confidential) for emissions by sources and removals by sinks of GHGs where the reporting would involve the disclosure of confidential information
FX	(Flexibility) for cells where data are not available or reported because of a flexibility provision applied by a country that needed flexibility in the light of its capacity.

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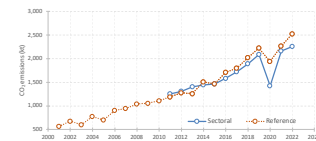
QA Review– Completeness check – (Units)

- Consistency of Units: Emissions and removals should be expressed in mass units consistently within each sector.
- Preferred Unit: Gigagram (Gg): Generally, emissions in summary and sectoral tables are expressed in gigagrams (Gg), but other SI mass units may be used for increased transparency.
- Appropriate Significant Digits: The number of significant digits in reported values should be appropriate to their magnitude. A precision of 0.1 percent of the national total is considered adequate for each gas.
- CO2 Equivalents: For certain gases specified in individual sector tables, emissions and removals should be reported in terms of carbon dioxide equivalents (CO₂e), which accounts for their global warming potential.
- Transparency in Conversion Factors: All conversion factors used to convert data from original units to the chosen reporting units should be documented transparently.

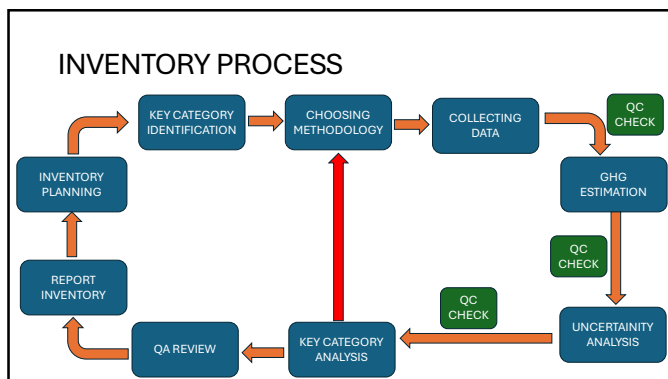
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QA review– Completeness check – (time series)

- It is considered good practice to ensure that all reporting tables are complete for each year including:
 - Summary table,
 - Sectoral table, and
 - cross-sectoral tables
- Create trend tables/graphs that summarize aggregated inventory data from different years.



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GHG Inventory Reporting – CRT Tables



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GHG Inventory Reporting – Archiving

- **Use of IPCC Inventory Software:** The inventory is established using the IPCC inventory software, which ensures standardized and consistent calculations. This software also includes data backup features, contributing to data security.
- **Excel Sheets for Data Storage:** sector-specific data, raw and processed data are stored in Excel sheets.
- **Documentation and Comments:** the commenting feature in the IPCC software is utilized to input remarks in relevant fields. These comments serve as a valuable resource for maintaining continuity and improving the inventory in the future.
- **Centralized Data Storage:** all datasets used for inventory preparation are centrally archived at the Ministry
- **Cloud Storage for Redundancy:** This ensures data integrity and minimizes the risk of data loss.



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ESTIMATING ENERGY EMISSIONS – STATIONARY

JANUARY 23, 2025
PREPARED BY: DEVELOPMENT ADVISORY SERVICES

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INTRODUCTION

Comprises of emission resulting from activities by fuel combustion and as fugitive emissions i.e. escape without combustions.

"the intentional oxidation of materials within an apparatus that is designed to provide heat or mechanical work to a process, or for use away from the apparatus"

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FUEL DEFINITIONS

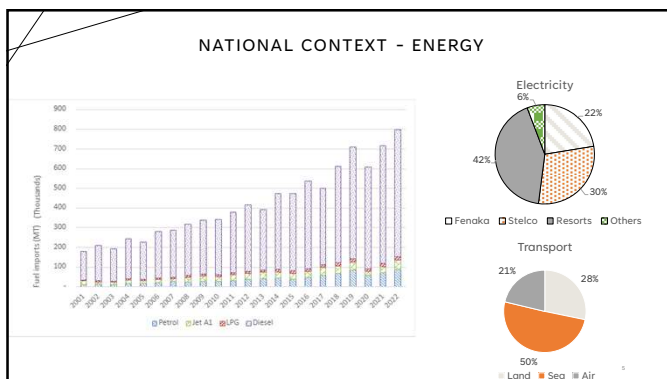
Fuel (Imported Maldives)	IPCC convention	Explanation
Petrol	Motor Gasoline	This is light hydrocarbon oil for use in internal combustion engines such as motor vehicles, excluding aircraft. Motor gasoline is distilled between 35 °C and 215 °C and is used as a fuel for land based spark ignition engines.
Marine Gas Oil	Gas/Diesel Oil	Gas/diesel oil includes heavy gas oils. Gas oils are obtained from the lowest fraction from atmospheric distillation of crude oil, while heavy gas oils are obtained by vacuum redistillation of the residual from atmospheric distillation. Gas/diesel oil distills between 180 °C and 380 °C. Several grades are available depending on uses; diesel oil for diesel compression ignition (cars, trucks, marine, etc.), light heating oil for industrial and commercial uses, and other gas oil including heavy gas oils which distill between 380 °C and 540 °C and are used as petrochemical feedstocks.
Diesel		
Kerosene Oil	Jet Kerosene	This is medium distillate used for aviation turbine power units. It has the same distillation characteristics and flash point as kerosene (between 150 °C and 300 °C but not generally above 250 °C). In addition, it has particular specifications (such as freezing point) which are established by the International Air Transport Association (IATA). Note that other forms of kerosene in Maldives, is also considered under Jet kerosene.
Jet A1		
Cooking Gas/LPG Propane, Liquefied	Liquefied Petroleum Gases	These are the light hydrocarbons fraction of the paraffin series, derived from refinery processes, crude oil stabilisation plants and natural gas processing plants comprising propane (C ₃ H ₈) and butane (C ₄ H ₁₀) or a combination of the two. They are normally liquefied under pressure for transportation and storage.
Butanes, Liquefied		

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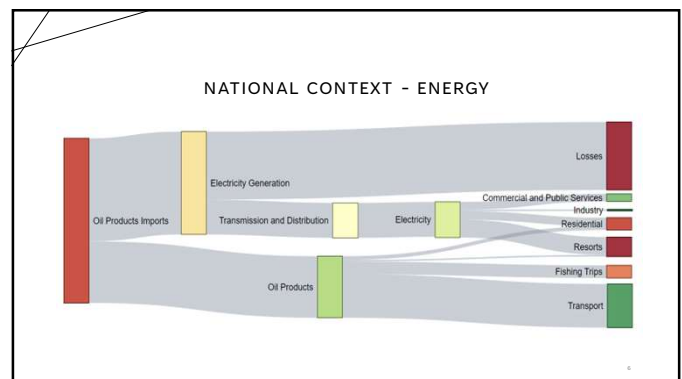
CONVERSIONS

Fuel - IPCC convention	Net Calorific Value, NCV (TJ/Giga grams)	Carbon content (tC/TJ)	Density (kg/L) or (T/m ³)
Motor Gasoline	44.3	18.9	0.75
Gas/Diesel Oil	43	20.2	0.84
Jet Kerosene	44.1	19.5	0.8
Liquefied Petroleum Gases	47.3	17.2	0.54

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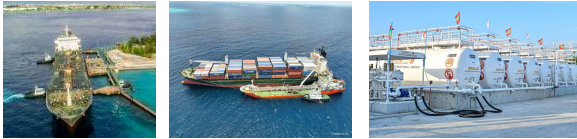


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REFERENCE APPROACH

$$\text{Apparent consumption} = \text{Total Import} - \text{Total Export} - \text{International bunkering} - \text{stock}$$

MCS, MCS, STO, MACL STO, MACL



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DATA SOURCES FOR REFERENCE APPROACH

Data sources	Data			
	Import	Export	Stock	Fuels Covered
Maldives Customs Services	X	X		Diesel, Petrol, Kerosene, Jet A1, LPG
State Trading Organization	X	X	X	Diesel, Petrol, Kerosene, Jet A1
Fuel Supply Maldives	X	X	X	Diesel, Petrol, Kerosene, Jet A1
Maldivian Gas	X	X	X	LPG
Villa Hakatha	X	X	X	Diesel, Petrol, Kerosene, Jet A1
Villa Gas	X	X	X	LPG
Hawks Pvt Ltd	X	X	X	Diesel, Petrol
Meridiam Services	X	X	X	Diesel, Petrol
Asian Gas and Oil and Coastal Blocks	X	X	X	Diesel, Petrol
Hakatha one	X	X	X	Diesel, Petrol
Fuel Express Maldives	X	X	X	Diesel, Petrol
Maldives Airports Company Limited			X	Diesel, Petrol, Kerosene, Jet A1
Regional Airports			X	Diesel, Petrol, Kerosene, Jet A1

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ESTIMATION METHOD

$$CO_2 \text{ emissions} = \sum_{\text{all fuels}} [(\text{Apparent consumption} \times \text{Conv factor} \times \text{Carbon content}) \times 10^{-3} - \text{Excluded carbon}] \times \text{Carbon oxidation factor} \times 44/12$$

$$\text{Apparent consumption} = \text{Total Import} - \text{Total Export} - \text{International bunkering} - \text{stock}$$

$$\text{Conv factor} = \text{NCV value from the table for the respective fuel type}$$

$$\text{Carbon content} = \text{Carbon content value from the table for the respective fuel type}$$

$$\text{Carbon oxidation factor} = 1, (\text{assuming all are fuel are combusting at } 100\%)$$

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STEP BY STEP OF REFERENCE APPROACH

• Obtain data from stakeholders

Obtain the data (import, export, international bunkering and stock change data) from stakeholders. Check if this is in liters, or metric tons

• Convert data to mass units (Giga grams)

Use the density conversion factors to calculate the mass in gigagrams (Gg).

TOTAL IMPORTS OF SELECTED ITEMS IN 2011

Description	Quantity(MT)
Marine Gas Oil (Diesel) Total	304,172.80
Aviation Gas	30,707.60
Propane, Liquefied	11,566.15
Petrol	31,121.57
Grand Total	377,893.79

RE-EXPORT OF FUEL IN 2011

DESCRIPTION	QUANTITY (in MT)
Marine Gas Oil (Diesel)	26273.78
Aviation Gas	94,399.88

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STEP BY STEP OF REFERENCE APPROACH

• Obtain data from stakeholders

Obtain the data (import, export, international bunkering and stock change data) from stakeholders. Check if this is in liters, or metric tons

• Convert data to mass units (Giga grams)

Use the density conversion factors to calculate the mass in gigagrams (Gg).

TOTAL IMPORTS OF SELECTED ITEMS IN 2011

Description	Quantity(MT)	Quantity (Gg)
Marine Gas Oil (Diesel)	304,172.80	304.17
Total	30,707.60	30.71
Aviation Gas	11,566.15	11.57
Propane, Liquefied	31,121.57	31.12
Petrol		

RE-EXPORT OF FUEL IN 2011

DESCRIPTION	QUANTITY (in MT)	QUANTITY (Gg)
Marine Gas Oil (Diesel)	26,273.78	26.27
Aviation Gas	94,399.88	94.40

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STEP BY STEP OF REFERENCE APPROACH

• Estimate Apparent Fuel Consumption in Gg

$$\text{Apparent consumption} = \text{Total Import} - \text{Total Export} - \text{International bunkering} - \text{stock}$$

TOTAL IMPORTS OF SELECTED ITEMS IN 2011

Description	Quantity (Gg)
Marine Gas Oil (Diesel)	304.17
Aviation Gas	30.71
Propane, Liquefied	11.57
Petrol	31.12
Grand Total	

Fuel	Import	Export	Bunkering	Stock	Apparent Consumption
Marine Gas Oil (Diesel)	304.17		26.27		277.9
Aviation Gas	30.71		94.40		?
Propane, Liquefied	11.57				11.57
Petrol	31.12				31.12

RE-EXPORT OF FUEL IN 2011

DESCRIPTION	QUANTITY (Gg)
Marine Gas Oil (Diesel)	26.27
Aviation Gas	94.40

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STEP BY STEP OF REFERENCE APPROACH

- Estimate Apparent Fuel Consumption in Gg

$Apparent\ consumption = Total\ Import - Total\ Export - International\ bunkering - stock$

Fuel	Import	Export	Bunkering	Stock	Apparent Consumption
Marine Gas Oil (Diesel)	304.17		26.27		277.9
Aviation Gas	125.11		94.40		30.71
Propane, Liquefied	11.57				11.57
Petrol	31.12				31.12

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STEP BY STEP OF REFERENCE APPROACH

- Convert Apparent Consumption to common Energy Unit (TJ)

$Apparent\ consumption\ (TJ) = Conv\ factor * Apparent\ consumption\ (Gg)$

Fuel	Apparent Consumption in Gg	NCV TJ/Gg	Apparent Consumption in TJ
Marine Gas Oil (Diesel)	277.9	43	
Aviation Gas	30.71	44.1	
Propane, Liquefied	11.57	47.3	
Petrol	31.12	43	

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STEP BY STEP OF REFERENCE APPROACH

- Convert Apparent Consumption to common Energy Unit (TJ)

$Apparent\ consumption\ (TJ) = Conv\ factor * Apparent\ consumption\ (Gg)$

Fuel	Apparent Consumption in Gg	NCV TJ/Gg	Apparent Consumption in TJ
Marine Gas Oil (Diesel)	277.9	43	11,949.7
Aviation Gas	30.71	44.1	1354.31
Propane, Liquefied	11.57	47.3	547.26
Petrol	31.12	43	1338.16

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STEP BY STEP OF REFERENCE APPROACH

- Estimate total carbon content (Gg of Carbon)

$Total\ Carbon\ content\ (Gg\ C) = Apparent\ consumption\ TJ * carbon\ content / 1000$

- Estimate net carbon emissions

$Net\ carbon\ (Gg) = Total\ Carbon\ content - Excluded\ carbon$

Fuel	Apparent Consumption in TJ	Carbon Content tC/TJ	Total Carbon content in Gg C
Marine Gas Oil (Diesel)	11,949.7	20.2	241.38
Aviation Gas	1354.31	19.5	26.41
Propane, Liquefied	547.26	17.2	9.41
Petrol	1338.16	18.9	25.29

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STEP BY STEP OF REFERENCE APPROACH

- Estimate total carbon content (Gg of Carbon)

$Total\ Carbon\ content\ (Gg\ C) = Apparent\ consumption\ TJ * carbon\ content / 1000$

- Estimate net carbon emissions

$Net\ carbon\ (Gg) = Total\ Carbon\ content - Excluded\ carbon$

Fuel	Apparent Consumption in TJ	Carbon Content tC/TJ	Total Carbon content in Gg C
Marine Gas Oil (Diesel)	11,949.7	20.2	
Aviation Gas	1354.31	19.5	
Propane, Liquefied	547.26	17.2	
Petrol	1338.16	18.9	

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STEP BY STEP OF REFERENCE APPROACH

- Estimate actual carbon emissions under reference approach

$Actual\ carbon\ emissions\ Gg = Net\ carbon * Carbon\ oxidation\ factor * 44 / 12$

Fuel	Apparent Consumption in TJ	Carbon Content tC/TJ	Total Carbon content in Gg C	Actual carbon emissions Gg
Marine Gas Oil (Diesel)	11,949.7	20.2	241.38	885.06
Aviation Gas	1354.31	19.5	26.41	96.84
Propane, Liquefied	547.26	17.2	9.41	34.50
Petrol	1338.16	18.9	25.29	92.73

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STEP BY STEP OF REFERENCE APPROACH

- Estimate actual carbon emissions under reference approach
 $Actual\ carbon\ emissions\ Gg = Net\ carbon * Carbon\ oxidation\ factor * 44/12$

Fuel	Apparent Consumption in TJ	Carbon Content tC/TJ	Total Carbon content in Gg C	Actual carbon emissions Gg
Marine Gas Oil (Diesel)	11,949.7	20.2	241.38	
Aviation Gas	1354.31	19.5	26.41	
Propane, Liquefied	547.26	17.2	9.41	
Petrol	1338.16	18.9	25.29	

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SECTORAL APPROACH

- Estimates made based on energy use in individual sectors
- The emissions factors catered to sector specific and technology specific activities
- More segregated data required from sectoral agencies



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CATEGORIES OF STATIONARY EMISSION FOR SECTORAL APPROACH

Category Code	Category	Relevance to Maldives Context
1A	Fuel Combustion Activities	Refer to subcategories for relevance
1A.1	Energy Industries	Refer to subcategories for relevance
1A.1.a	Electricity and Heat Production	Refer to subcategories for relevance
1A.1.a.i	Electricity Generation	This category should cover all electricity generation from public utilities. The activity data should cover data on electricity generated to be sold as well as own on-site use. There is no operational Combined Heat and Power Generation in Maldives
1A.1.a.ii	Combined Heat and Power Generation (CHP)	There is no operational Combined Heat and Power Generation in Maldives
1A.1.a.iii	Heat Plants	There is no heat production plants that generates heat to sold to retailers or customers in Maldives
1A.1.b	Petroleum Refining	This activity does not occur in Maldives
1A.1.c	Manufacture of Solid Fuels and Other Energy Industries	This activity does not occur in Maldives

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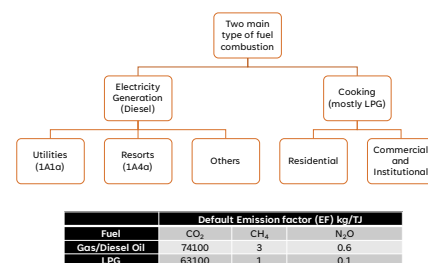
Category Code	Category	Relevance to Maldives Context
1A.2	Fuel Combustion Activities	Refer to subcategories for relevance
1A.2.a	Manufacturing Industries and Construction	Some activities under this category does occur in Maldives. Details given below
1A.2.a.i	Iron and Steel	This activity does not occur in Maldives
1A.2.a.ii	Non-Ferrous Metals	This activity does not occur in Maldives
1A.2.a.iii	Chemicals	This activity does not occur in Maldives
1A.2.a.iv	Pulp, Paper and Print	This activity does occur however printing press does not have stand-alone power generation and draws power from the utility producers
1A.2.e	Food Processing, Beverages and Tobacco	This activity does occur and would cover all food processing fuel combustion with the exception of fish processing plants. This would entail bottling activities done by MAWC, MWSC, island beverages etc that uses own fuel combustions to operate.
1A.2.f	Non-Metallic Minerals	This activity does occur and should cover on site power generation for cement factories operated by Villa and STO
1A.2.g	Transport Equipment	This activity does occur and should cover on site power generation at boat building, boat yards and shipways operating across Maldives
1A.2.h	Machinery	This activity does occur however does not have standalone power generation and draws power from the utility producers and therefore included in 1A.1a.i
1A.2.i	Mining (excluding fuels) and Quarrying	Sand mining activity for dredging, harbour and reclamation projects
1A.2.j	Wood and Wood Products	This activity does occur however does not have stand-alone power generation or on-site fuel combustion
1A.2.k	Construction	This activity does occur however does not have stand-alone power generation and draws power from the utility producers
1A.2.l	Textile and Leather	This activity does occur however does not have standalone power generation and draws power from the utility producers
1A.2.m	Non-specified Industry	Any GHG emitting activity via fuel combustion from any manufacturing industrial activity not listed above. Note that emissions from fisheries industry is covered under 1A.4c and therefore this sub-category for Maldives is assumed to be Not Occurring

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Category Code	Category	Relevance to Maldives Context
1A.4	Other Sectors	Refer to subcategories for relevance
1A.4.a	Commercial / Institutional	This occurs in Maldives and covers onsite fuel combustion activities in all commercial and institutional buildings. This covers fuel combustion for cooking, heating at restaurants, hotels, resorts and any other commercial buildings. In Maldivian context it covers mostly LPG use for cooking in commercial context. The fuel use for electricity generation in industries such as resorts should be included under this sub-category
1A.4.b	Residential	This occurs in Maldives and covers all onsite fuel combustion activities in residential dwellings. Mostly covers LPG use of for cooking
1A.4.c	Agriculture/Forestry/Fishing/Fish farms	Refer to subcategories for relevance
1A.4.c.i	Stationary	This occurs in Maldives and covers onsite fuel combustion activities (including power generation) in fish processing plants and agricultural islands
1A.4.c.ii	off-road vehicles and other machineries	This occurs in Maldives and covers all mobile fuel combustion in agricultural islands including off road transport, land tilling. However the information is likely going to be scattered to very small quantities and needs a survey to collect
1A.5	Non-Specified	Refer to subcategories for relevance
1A.5.a	Stationary	This occurs in Maldives and covers stationary fuel combustion onsite at military facilities/training facilities (eg. Girifushi etc) including cooking, power production.

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DATA FOR SECTORAL APPROACH



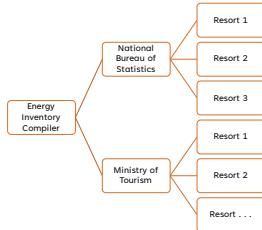
Fuel	Default Emission factor (EF) kg/TJ		
	CO ₂	CH ₄	N ₂ O
Gas/Diesel Oil	74100	3	0.6
LPG	63100	1	0.1

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ACTIVITY DATA FROM RESORTS

The information required for the estimation of emission and QA/QC process includes;

1. Fuel usage for electricity in litres
2. Electricity production in kWh from different sources including Renewable energy sources
3. Fuel used for cooking in litres or kg
4. Fuel used for waste incineration if any in litres by fuel types
5. average occupancy for the resort - % or bednights



ACTIVITY DATA FROM OTHERS

- Other Electricity generation: Annual Fuel used for electricity generation

Sector	Information source
1A2e – Food and Beverages	MAWC, MWSC (water bottling operation only) and Island Beverage
1A2f – Non-ferrous	Villa and STO cement operations and other concrete pre-casting operations
1A2g – Transport	Slipways and other boat building operations (eg. Al-Shaali and Gulfcraft)
1A4a – Commercial and institutional	MPL, MACL and other ports and airports power generation
1A4c1	Power generation and heating/cooking fuel use from fish processing factories and plants like MIFCO, Horizon and ENSIS.
Fisheries/Agriculture	

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EXAMPLE OF ACTIVITY DATA

Power House	Generated Units (kWh)			Consumed Units (kWh)			Demand (kW)			Consumers			Production %			Loss		
	By Diesel	By PV	Generated Total	Billed	FH Usage	Consumed Total	Total	Min	Max	Fuel	Lab Off	Connect	Diesel	Total	Diesel	Billed	FH Usage	Loss
Kashidhoo	105,120.00	-	105,120.00	97,856.00	3,982.00	101,838.00	110.00	215.00	30,430.00	53.00	0	0	450	100.00	0.00	92.85	3.76	3.36
Kashidhoo	101,320.00	-	101,320.00	96,560.00	3,716.00	100,276.00	110.00	198.00	26,360.00	162.00	1	1	450	100.00	0.00	95.34	3.67	0.91
Kashidhoo	116,850.00	-	116,850.00	108,842.00	4,548.00	113,390.00	119.00	230.00	33,362.00	128.00	3	3	450	100.00	0.00	93.15	3.72	0.87
Kashidhoo	120,630.00	-	120,630.00	111,524.00	4,548.00	116,072.00	96.00	266.00	34,480.00	130.00	0	0	450	100.00	0.00	92.12	3.60	0.72
Kashidhoo	123,036.00	-	123,036.00	114,987.00	4,835.00	119,822.00	112.00	219.00	34,422.00	102.00	2	2	450	100.00	0.00	93.46	3.76	0.22
Kashidhoo	105,650.00	1,364.00	107,014.00	102,644.00	4,216.00	106,860.00	96.00	209.00	30,040.00	97.00	2	1	453	106.71	1.29	95.90	3.54	0.16
Kashidhoo	111,140.00	6,537.00	117,677.00	108,968.00	4,184.00	113,152.00	96.00	211.00	32,241.00	165.00	0	0	453	104.44	1.56	93.45	3.56	0.00
Kashidhoo	115,810.00	6,183.00	121,993.00	115,947.00	3,857.00	119,804.00	100.00	248.00	33,686.00	113.00	1	0	454	104.96	0.04	94.36	3.24	0.01
Kashidhoo	106,800.00	5,780.00	112,580.00	106,370.00	4,006.00	110,376.00	90.00	248.00	30,496.00	135.00	0	0	454	104.03	0.97	93.85	3.53	0.18
Kashidhoo	109,870.00	6,328.00	116,198.00	110,572.00	3,715.00	114,287.00	96.00	209.00	31,437.00	139.00	4	1	457	104.54	1.46	94.89	3.20	0.00
Kashidhoo	103,910.00	5,728.00	109,638.00	104,186.00	3,837.00	108,023.00	100.00	248.00	30,572.00	115.00	2	0	456	104.78	0.22	95.03	3.30	0.04
Kashidhoo	102,470.00	5,367.00	107,837.00	100,966.00	3,710.00	104,676.00	88.00	191.00	28,760.00	169.00	1	0	462	105.02	1.98	93.86	3.44	0.10
Kashidhoo	1,322,446.00	36,377.00	1,358,823.00	1,278,821.00	48,449.00	1,327,270.00	88.00	290.00	379,496.00	1,508.00	18	0	462	107.21	5.37	93.99	3.56	0.55
Qaafaru	55,044.00	-	55,044.00	55,565.00	967.00	56,532.00	55.00	110.00	17,520.00	52.00	2	0	208	100.00	0.00	94.11	1.13	0.24
Qaafaru	55,150.00	-	55,150.00	52,888.00	716.00	53,604.00	52.00	109.00	18,340.00	41.70	2	0	207	100.00	0.00	95.23	1.46	0.06
Qaafaru	64,857.00	-	64,857.00	64,786.00	1,212.00	65,998.00	56.00	119.00	22,706.00	92.00	1	0	208	100.00	0.00	94.47	1.97	0.04
Qaafaru	66,337.00	-	66,337.00	65,565.00	540.00	66,105.00	44.00	137.00	22,560.00	79.00	1	0	209	100.00	0.00	93.88	1.36	0.24
Qaafaru	66,530.00	-	66,530.00	66,162.00	840.00	67,002.00	54.00	116.00	22,856.00	81.00	3	1	211	100.00	0.00	98.53	1.36	0.00
Qaafaru	67,322.00	-	67,322.00	65,847.00	765.00	66,612.00	42.00	113.00	20,486.00	42.00	1	0	212	100.00	0.00	95.16	1.33	0.00
Qaafaru	61,909.00	-	61,909.00	60,827.00	630.00	61,457.00	41.00	119.00	22,862.00	54.00	1	0	213	100.00	0.00	96.80	1.34	0.00
Qaafaru	66,815.00	-	66,815.00	64,646.00	885.00	65,531.00	57.00	126.00	24,866.00	103.00	0	0	213	100.00	0.00	94.22	1.20	0.00
Qaafaru	61,136.00	-	61,136.00	57,910.00	646.00	58,556.00	47.00	129.00	20,097.00	76.50	0	0	213	100.00	0.00	94.73	1.36	0.00
Qaafaru	63,955.00	-	63,955.00	59,213.00	838.00	60,051.00	50.00	122.00	25,432.00	76.00	3	0	216	100.00	0.00	93.91	1.33	0.00
Qaafaru	55,724.00	-	55,724.00	51,636.00	775.00	52,411.00	99.00	118.00	18,888.00	55.00	0	0	216	100.00	0.00	92.98	1.36	0.00
Qaafaru	63,597.00	-	63,597.00	59,508.00	775.00	60,283.00	56.00	121.00	19,836.00	54.00	4	0	220	100.00	0.00	94.01	1.20	0.00
Qaafaru	746,879.00	-	746,879.00	686,302.00	10,173.00	696,475.00	41.00	137.00	251,544.00	827.00	18	1	220	100.00	0.00	91.89	1.36	0.25

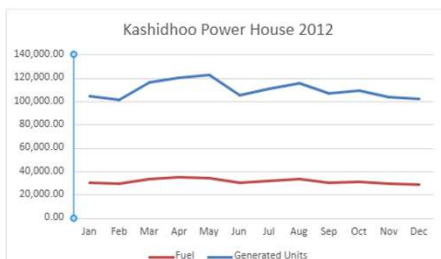
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QUALITY CHECKS

1. This data is obtained monthly for better quality assurance and consistency checks.
2. A basic check for any outliers on the total fuel use data and number of units produced.
3. Further this will need to be checked with the previous years for the same powerhouse to check for consistency before finalizing that the data could be safely used.
4. It is good practice to seek expert judgment and contact the stakeholder to see if any outliers observed is a true event in the dataset.
5. The next basic check is to check for number of units produced per litre (kWh/L).

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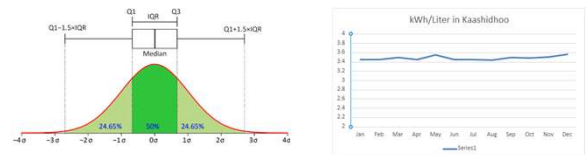
QUALITY CONTROL OF THE DATA – CONSISTENCY



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QUALITY CONTROL OF THE DATA – TECHNICAL CHECK

The datasets are quality controlled using a cutoff limit based on the following statistical analysis.



- Lower bound, $1.5 * IQR = Q1 - 1.5 * IQR = 2.157 \approx 2 \text{ kWh/L}$
- Upper bound, $1.5 * IQR = Q3 + 1.5 * IQR = 3.986 \approx 4 \text{ kWh/L}$

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ADAPTING DATA FOR INVENTORY

	2021 Diesel Consumption (liters)	Population (2014 Census)	% of Pop in Islands with data	Total Diesel Use in Liters
FENAKA + non-Utility	90,151,697.04	183,738.00	94%	?
STELCO	140,575,448		100%	140,575,448

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ADAPTING DATA FOR INVENTORY

	2021 Diesel Consumption (liters)	Population (2014 Census)	% of Pop in Islands with data	Total Diesel Use in Liters
FENAKA + non-Utility	90,151,697.04	183,738.00	94%	96,266,689
STELCO	140,575,448		100%	140,575,448

32

ADAPTING DATA FOR INVENTORY

- Convert fuel liters to mass units

$$\text{Total fuel use (Gg)} = \text{Total fuel}_{\text{Litres}} * \text{Density}_{\text{fuel}} / 1000,000$$

	Liters	Density	Mass (Gg)
A	96,266,689	0.84	
B	140,575,448	0.84	

33

ADAPTING DATA FOR INVENTORY

- Convert fuel liters to mass units

$$\text{Total fuel use (Gg)} = \text{Total fuel}_{\text{Litres}} * \text{Density}_{\text{fuel}} / 1000,000$$

	Liters	Density	Mass (Gg)
A	96,266,689	0.84	81
B	140,575,448	0.84	118

34

GHG ESTIMATION

- The following formula will give the apparent consumption in energy units (TJ)
 $\text{Consumption in (TJ)} = \text{Total fuel mass}_{\text{Gg}} * \text{NCV}_{\text{of the fuel}}$

The following formula can be used to calculate the emissions of the respective gas in terms of Gg.
 $\text{Emissions in (Gg)} = \text{Consumption}_{\text{TJ}} * \text{EF}_{\text{of the fuel}} / 1000,000$

Fuel	Net Calorific Value, NCV (TJ/Giga grams)	Default Emission factor (EF) kg/TJ		
		CO ₂	CH ₄	N ₂ O
Gas/Diesel Oil	43	74100	3	0.6

	Mass (Gg)	CO ₂ (Gg)	CH ₄ (Gg)	N ₂ O (Gg)
A	81	257.657	0.0104315	0.002086
B	118	376.2491	0.0152328	0.003047

35

GHG ESTIMATION

- The following formula will give the apparent consumption in energy units (TJ)
 $\text{Consumption in (TJ)} = \text{Total fuel mass}_{\text{Gg}} * \text{NCV}_{\text{of the fuel}}$

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Gas/Diesel Oil	43	74100	3	0.6

	Mass (Gg)	CO ₂ (Gg)	CH ₄ (Gg)	N ₂ O (Gg)
A	81			
B	118			

36

GHG AGGREGATION

	Mass (Gg)	CO ₂ (Gg)	CH ₄ (Gg)	N ₂ O (Gg)
A	81	257.657	0.0104315	0.002086
B	118	376.2491	0.0152328	0.003047

Global Warming Potential (GWP ₁₀₀)		
CO ₂	CH ₄	N ₂ O
1	28	265

	CO ₂ (Gg)	CH ₄ in CO ₂ eq (Gg)	N ₂ O in CO ₂ eq (Gg)	Total emissions Gg of CO ₂ eq
A	257.657	0.292080836	0.552867296	258.502
B	376.2491	0.045698267	0.001827931	376.2966
				634.7986

37

GHG AGGREGATION

	Mass (Gg)	CO ₂ (Gg)	CH ₄ (Gg)	N ₂ O (Gg)
A	81	257.657	0.0104315	0.002086
B	118	376.2491	0.0152328	0.003047

Global Warming Potential (GWP ₁₀₀)		
CO ₂	CH ₄	N ₂ O
1	28	265

	CO ₂ (Gg)	CH ₄ in CO ₂ eq (Gg)	N ₂ O in CO ₂ eq (Gg)	Total emissions Gg of CO ₂ eq
A	257.657			
B	376.2491			

38

ACTIVITY DATA FOR COOKING

- Segregated data from suppliers
 - Commercial reported under 1A4a
 - Residential reported under 1A4b

	Maldivian Gas		Villa	
	Domestic (kg)	Commercial (kg)	Domestic (kg)	Commercial (kg)
2011	2,790,926.00	2,898,958.00	2,938,133.00	2,938,133.00
2012	3,102,373.00	2,898,234.00	2,009,236.50	2,009,236.50
2013	3,436,636.00	3,097,717.00	2,900,828.50	2,900,828.50

$$\text{Emissions in (Gg)} = \text{Consumption}_{Tj} \cdot EF_{of \text{ the fuel }} / 1000,000$$

Fuel	Net Calorific Value, NCV (TJ/Gg)	Default Emission factor (EF) kg/TJ		
		CO ₂	CH ₄	N ₂ O
LPG	47.3	63100	1	0.1

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ACTIVITY DATA FOR COOKING

- Segregated data from suppliers
 - Commercial reported under 1A4a
 - Residential reported under 1A4b

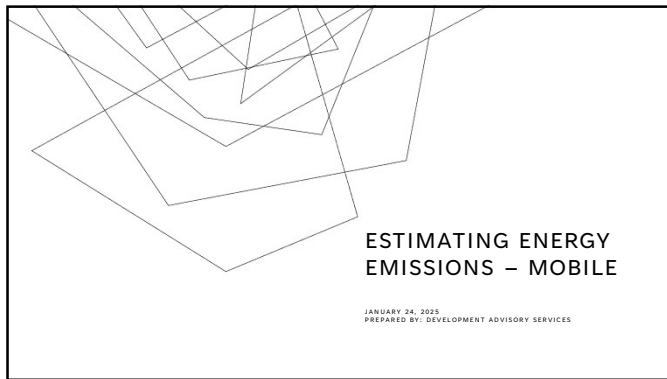
Fuel	Actual carbon emissions Gg in 2011 Reference approach
Propane, Liquefied	34.50

	Maldivian Gas		Villa	
	Domestic (kg)	Commercial (kg)	Domestic (kg)	Commercial (kg)
2011	2,790,926.00	2,898,958.00	2,938,133.00	2,938,133.00
2012	3,102,373.00	2,898,234.00	2,009,236.50	2,009,236.50
2013	3,436,636.00	3,097,717.00	2,900,828.50	2,900,828.50

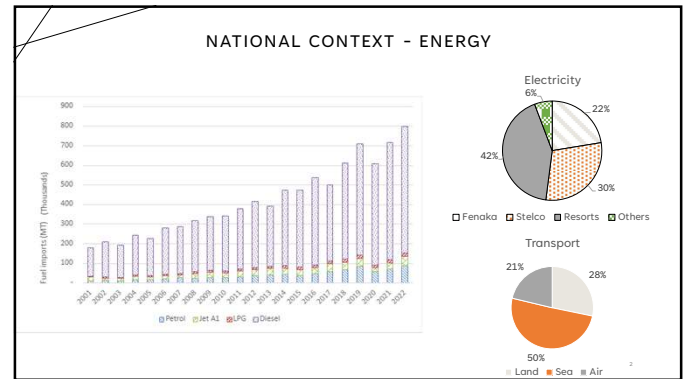
$$\text{Emissions in (Gg)} = \text{Consumption}_{Tj} \cdot EF_{of \text{ the fuel }} / 1000,000$$

Fuel	Net Calorific Value, NCV (TJ/Gg)	Default Emission factor (EF) kg/TJ		
		CO ₂	CH ₄	N ₂ O
LPG	47.3	63100	1	0.1

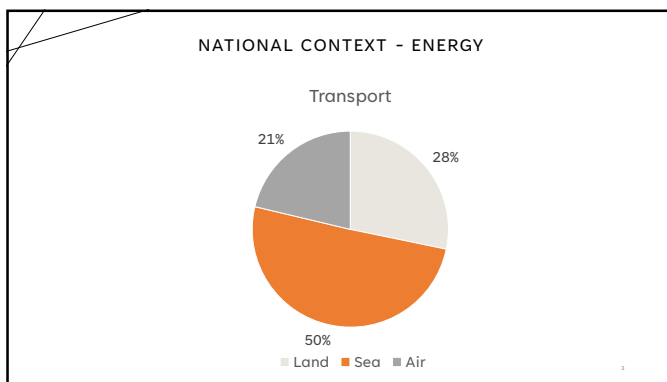
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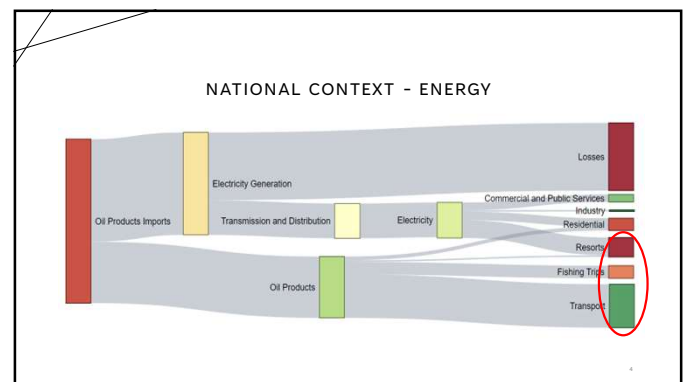
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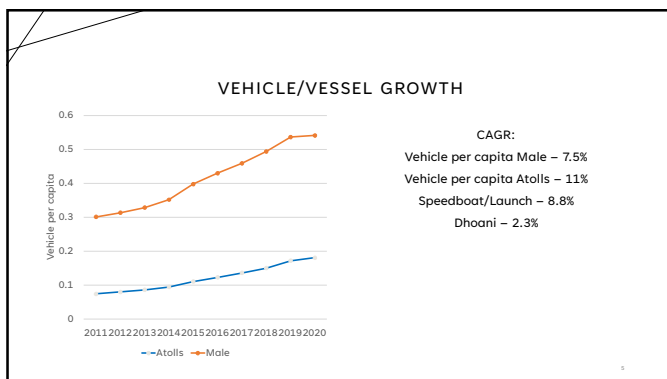
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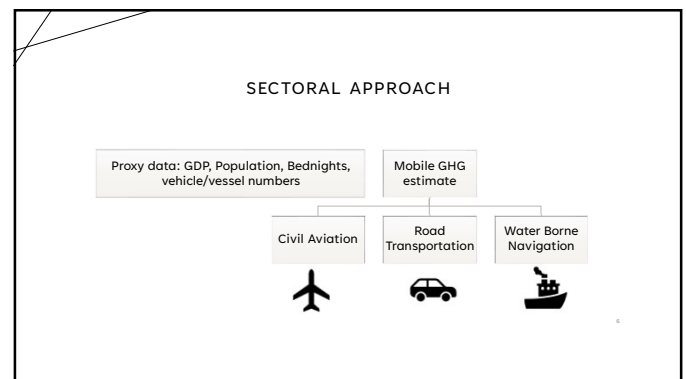
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6

RELEVANT IPCC CATEGORIES FOR MOBILE FUEL COMBUSTION

IPCC Category Code	CRT category code	Category	Relevance to Maldives Context
A		Fuel Combustion Activities	
A3	A3	Transport	
A3a		Civil aviation	
A3ai	memo item	International Aviation (International Bunkers)	This covers all international aviation. Data should be collected from all international airports in Maldives regarding the refueling. For tier 2 the method would require flight movements which would be available from the airports. Note only flights departing to or arriving from foreign airport should be considered in this calculation
A3aii	A3a	Domestic Aviation	This covers all domestic aviation including sea plane operations. Data should be collected from all airports in Maldives regarding the refueling. For tier 2 the method would require flight movements which would be available from the airports. Note no flights departing to or arriving from foreign airport should be considered in this calculation

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RELEVANT IPCC CATEGORIES FOR MOBILE FUEL COMBUSTION

IPCC Category Code	CRT category code	Category	Relevance to Maldives Context
A		Fuel Combustion Activities	
A3b	A3b	Road transport	
A3bi	A3bi	Cars	This covers all road transport through cars as defined by IPCC. This includes public and private cars fuel consumption
A3bii	A3bii	Light duty trucks	This covers all road transport through Light duty trucks as defined by IPCC. This includes public and private trucks and buses fuel consumption
A3biii	A3biii	Heavy duty trucks and buses	This covers all road transport through trucks and buses as defined by IPCC. This includes public and private trucks and buses fuel consumption
A3biv	A3biv	Motorcycles	This covers all road transport through Motorcycles as defined by IPCC. This includes public and private motorcycles fuel consumption
A3bv		Evaporative emissions from vehicles	This covers evaporative emissions from vehicles including lubricants evaporation
A3bvi		Urea-based catalysts	This is assumed to be not occurring in Maldives

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RELEVANT IPCC CATEGORIES FOR MOBILE FUEL COMBUSTION

IPCC Category Code	CRT category code	Category	Relevance to Maldives Context
A		Fuel Combustion Activities	
A3d		Water-borne Navigation	
A3di		International Water-borne Navigation (International Bunkering)	This covers all emissions related to international maritime vehicles that is either coming from or going to a foreign port. The reexport value for diesel is considered as data
A3dii	A3d	Domestic Water-borne Navigation	This covers all domestic transport excluding fishing. This means all passenger and cargo transport irrespective of economic sector.
A3e	A3e	Other	
A3ei	A3ei	Pipeline Transport	This does not occur in Maldives
A3eii		Off-road	This occurs in Maldives and covers all transport activity undertaken within all ports, harbours and off-road activities taking place at reclamation sites covering land and sea vehicles.

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RELEVANT IPCC CATEGORIES FOR MOBILE FUEL COMBUSTION

IPCC Category Code	CRT category code	Category	Relevance to Maldives Context
A		Fuel Combustion Activities	
A4	A4	Other Sectors	
A4a	A4a	Commercial/institutional	
A4aii		Off-road vehicles and other machinery	IPCC category 1A3eii commercial/institutional component is reported here.
A4aiv	A4aiv	Residential	
A4aivii	A4aivii	Off-road vehicles and other machinery	IPCC category 1A3eii residential component is reported here. In the Maldives there are no residential off road transport to be considered
A4c	A4c	Agriculture/Forestry/Fishing/Fish farms	
A4cii	A4cii	off-road vehicles and other machineries	This occurs in Maldives and covers all mobile fuel combustion in agricultural islands including off road transport, land tilling. However, the information is likely going to scattered to very small quantities and needs a survey to collect
A4ciii	A4ciii	Fishing (mobile combustion)	This occurs in Maldives and is key category. It covers all emissions from fishing vessels including for transport, cooking and other auxiliary purposes on the vessel.

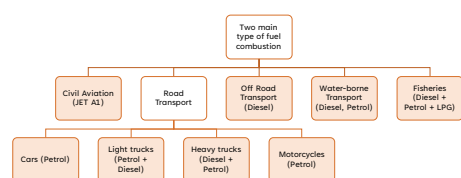
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RELEVANT IPCC CATEGORIES FOR MOBILE FUEL COMBUSTION

IPCC Category Code	CRT category code	Category	Relevance to Maldives Context
A		Fuel Combustion Activities	
A5	A5	Non-Specified	
A5b	A5b	Mobile	In the CRT all of the sub categories under this is reported together
A5bi		Mobile (aviation component)	This occurs in Maldives and covers aviation fuel combustion by MNDF military flights/drones and search and rescue operations
A5bii		Mobile (water-borne component)	This occurs in Maldives and covers water-borne fuel combustion by coastguard and Marine Police services and any other marine based fuel combustion carried out by military including search and rescue operations
A5biii		Mobile (other)	This could include refueling of vessels and air crafts for military operations by non-Maldivian military. This should not be included in the national total but reported as a memo-item.

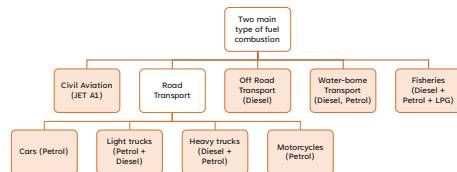
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DATA FOR SECTORAL APPROACH



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DATA FOR SECTORAL APPROACH



What data from which sources??

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CIVIL AVIATION

Fuel Consumption method

Data Required: Fuel use for aviation data segregated between international and domestic preferably in monthly intervals

Data Source: MACL, Regional Airports

Landing and Take off method

Data Required: landing and take off activity data including aircraft type and route

Data Source: MACL, Regional Airports, CAA

Emissions = LTO Emissions + Cruise emissions

Jet Fuel Sales January 2016		Liters
International		13,564,200
Domestic		3,454,166
MACL OWN CONSUMPTION		440
Total		17,018,806

AIRCRAFT		LTO emissions factors (kg/LTO) (1)						LTO Emissions Conversion factor (kg/LTO)
		CO ₂	CH ₄	N ₂ O	CO	NO ₂	SO ₂	
A300		5450	0.12	0.2	25.86	14.80	1.12	1.72
A310		4760	0.03	0.2	19.46	28.30	5.67	1.51
A320		230	0.06	0.01	8.30	2.07	0.58	0.07
A321		240	0.06	0.02	1.51	2.24	0.00	0.20
A321XLR		620	0.01	0.02	1.82	2.33	0.20	0.20

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QUALITY CHECKS

Compare the fuel use data (for both international and domestic with imports

Check the trends of multiple years or within the year for outliers and provide reasonable explanation for outliers

fuel usage data from the individual operators could also be obtained and compared with data provided by MACL

Jet Fuel Sales January 2016		Liters
International		13,564,200
Domestic		3,454,166
MACL OWN CONSUMPTION		440
Total		17,018,806

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ROAD TRANSPORT

Fuel Consumption method

Data Required: Fuel use for road transport segregated by fuel

Data Source: FSM, HAKATHA, VILLA HAKATHA etc

Vehicle Kilometer travelled method

Data Required: Total vehicles, distance travelled and vehicle fuel economy segregated by vehicle type

Data Sources: Ministry of Transport, NBS

Type of Vehicles	Registered							Major vehicles	Other vehicles	Not considered in 60 th percent
	2010	2011	2012	2013	2014	2015	2016			
Motor cycle	41,217	52,399	54,467	61,118	68,259	78,991	80,237	Motor cycle	Ambulance	Battery Scooter
Car	3,148	3,510	3,708	3,994	4,495	5,269	5,714	Car	Crane	Battery Car
Bus	19	128	110	140	151	160	178	Bus	Fork-Lift	Battery tricycle
Pick-Up	1,661	1,755	1,800	1,860	1,990	2,251	2,510	Pick-Up	Excavator	Electric bicycle
Lorry	750	756	768	772	783	802	820	Lorry	Dumper	
Van	886	1,038	1,077	1,154	1,246	1,371	1,485	Van	Tractor	
Jeep	391	474	484	491	506	552	574	Jeep	Loader	
Ambulance	18	20	21	22	23	25	26	Ambulance	Fuel tank truck	
Truck	32	34	36	38	40	42	45	Truck	Bouser	
Fork-Lift	224	221	227	247	257	287	313	Fork-Lift		
Excavator	104	313	340	360	415	462	544	Excavator		
Tractor	911	916	916	931	1,027	1,040	1,040	Tractor		

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IPCC DEFINITIONS OF VEHICLES

Cars	Emissions from automobiles so designated in the vehicle registering country primarily for transport of persons and normally having a capacity of 12 persons or fewer.
Light duty trucks	Emissions from vehicles so designated in the vehicle registering country primarily for transportation of light-weight cargo or which are equipped with special features such as four-wheel drive for off-road operation. The gross vehicle weight normally ranges up to 3500-3900 kg or less.
Heavy duty trucks and buses	Emissions from any vehicles so designated in the vehicle registering country. Normally the gross vehicle weight ranges from 3500-3900 kg or more for heavy duty trucks and the buses are rated to carry more than 12 persons.
Motorcycles	Emissions from any motor vehicle designed to travel with not more than three wheels in contact with the ground and weighing less than 680 kg.

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VEHICLE KILOMETER TRAVELED

Vehicle	Fuel	Fraction for type of gas	Km/day	Km/year	Km/Litre	Litre/km
Motor cycle	Petrol	1	13	4745	15	0.0667
Car ★	Petrol	1	22	8030	12	0.11
Taxis ★	Petrol	1	100	36500	5	0.11
Bus ♦	Petrol	0.977	40	14600	8	0.125
Pick-up Δ	Petrol	0.3208	20	7300	7	0.143
Lorry ♦	Diesel	0.678	20	7300	10	0.125
Van Δ	Petrol	0.021	40	14600	5	0.22
Jeep Δ	Diesel	0.979	40	14600	8	0.3
Truck ♦	Petrol	0.4819	40	14600	5	0.142
Other vehicles ♦	Diesel	0.5178	40	14600	8	0.125
	Petrol	0.2663	20	7300	10	0.125
	Diesel	0.0383	40	14600	5	0.22
	Petrol	0.9616	40	14600	8	0.3
	Diesel	1	5	1825	8	0.3

★ = Passenger cars with 3-way catalyst, Δ = Light duty trucks with 3-way catalyst, ♦ = Heavy duty trucks and buses

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ESTIMATION METHOD – ROAD TRANSPORT

$$\text{Total fuel use (Gg)} = \text{Total fuel}_{\text{Litres}} * \text{Density}_{\text{fuel}} / 1000,000$$

$$\text{Emissions in (Gg)} = \text{Total fuel mass}_{\text{Gg}} * \text{NCV}_{\text{of the fuel}} * \text{EF}_{\text{of the fuel}} / 1000,000$$

Emission Factor (EF) kg/TJ

Fuel	CO ₂	CH ₄	N ₂ O
Gas/Diesel Oil	74100	3.9	3.9
Petrol	69300	33	3.2

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QUALITY CHECKS

Cross check data and assumptions with similar estimates available from other national studies in transport sector

Vehicle	Fuel	Fraction for type of gas	Km/day	Km/year	Km/Litre	Litre/km
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Cross reference could also be made with other similar vehicle fleets elsewhere.

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OFF - ROAD TRANSPORT

Fuel Consumption method

Data Required: Fuel use for off road transport segregated by fuel

Data Source: MTCC, STO, MPL, MACL, Regional airports

$$\text{Total fuel use (Gg)} = \text{Total fuel}_{\text{Litres}} * \text{Density}_{\text{fuel}} / 1000,000$$

$$\text{Emissions in (Gg)} = \text{Total fuel mass}_{\text{Gg}} * \text{NCV}_{\text{of the fuel}} * \text{EF}_{\text{of the fuel}} / 1000,000$$

Fuel	NCV	Emission factor (EF) kg/TJ		
		CO ₂	CH ₄	N ₂ O
Gas/Diesel Oil	43	74100	4.15	28.6
Petrol – 4 stroke	44.3	69300	50	2
Petrol – 2 stroke	44.3	69300	130	0.2

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SAMPLE DATA SET FOR OFF ROAD TRANSPORTATION

Type of vehicle	Heavy/Light	Vehicle Name	Fuel type	Fueling (MCH)			Fueling (Shulhamale)			Fueling (Thalukushi)		
				2021 (L)	2022 (L)	2023 (L)	2021 (L)	2022 (L)	2023 (L)	2021 (L)	2022 (L)	2023 (L)
Reach Stacker	Heavy	R5003	Diesel	13,488	17787	581						
	Heavy	R5004	Diesel	23,948	5543							
	Heavy	R5005	Diesel	24,120	32879	20,190						
	Heavy	R5006	Diesel	50,783	70209	21,954						
	Heavy	R5007	Diesel	304			18050.9	44771.87	13918.26			
	Heavy	R5008	Diesel				20413.1	15230.94	17564.88			
	Heavy	R5009	Diesel	72,551	52132	15,605						
	Heavy	R5010	Diesel	46,427	51106							
	Heavy	R5011	Diesel			3,721						
	Heavy	R5012	Diesel			4,219						
Barge Handlers	Heavy	R5013	Diesel			4,423						
	Heavy	R5014	Diesel			680						
	Heavy	BH003	Diesel	13,497	32802	4,370	1058.13	319.02	913.41			
	Heavy	BH005	Diesel	1,354			13807.6	47081.05	14461.83			
	Heavy	BH006	Diesel	68,038	51816	7,243						
	Heavy	BH007	Diesel		40236	23,546						
	Heavy	RT001	Diesel	63,416	66700	19,301						
	Heavy	RT002	Diesel	57,720	65067	18,027						
	Heavy	TT003	Diesel									
	Heavy	TT004	Diesel	468	27	381.79	148.17					
RTS	Heavy	TT007	Diesel			1148	668	108.45				
	Heavy	TT012	Diesel									

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QUALITY CHECKS

Assess the data received by comparing the data with multiple years and see if there are any outliers or discrepancies.

Compare the information between comparative operations to see if there are significant differences.

Compare the fuel consumption rates with level or size of the operations from the data provider.

Consult the expert group to verify the validity of the data received and any outliers and discrepancies identified in previous steps.

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WATER BORNE NAVIGATION

Fuel Consumption method

Data Required: Fuel use for water borne transport segregated by fuel

Data Source: ???



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WATER BORNE NAVIGATION - TOURISM

A parameter for litres/bednight can be used to estimate the fuel consumption by the safaris in the tourism sector.

Fuel	Resorts (fuel liters/bednight)	Safaris (fuel liters/bednight)
Petrol	2.60	1.06
Diesel	2.78	15.87

Year	Registered Bed Capacity (end Year)	Bed Capacity in Operation (annual average)	Bed Night Capacity	Tourist Bed Nights ¹
2018	45,419	41,887	15,290,704	9,477,680
Resorts	32,137	29,400	10,721,344	8,000,049
Hotels	1,862	1,759	642,480	255,389
Guest Houses	8,563	8,000	2,921,048	944,521
Safari Vessels	2,857	2,728	995,832	277,720

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WATER BORNE NAVIGATION - GENERAL

Estimate fuel use based on potential run hours (similar to VKT)

	Vessel type	Fuel type	Fraction of active vessels	Fraction of operating vessels per year	Fuel consumption (l/hr)	Annual Hours of operation
Passenger	Dhoni ^a	Diesel	0.95	0.50	39.00	625.00
	Passenger ferry	Diesel	1.00	1.00	39.00	3650.00
	Speed boats	Petrol	0.19	0.70	65.00	1200.00
	Dhoni*	Diesel	0.95	0.60	39.00	871.20
Cargo	Baithelli	Diesel	0.92	0.50	27.00	871.20
	Barge	Diesel	0.93	0.50	57.00	580.80
	Oil barge	Diesel	1.00	0.50	32.00	580.80
	Oil tankers	Diesel	0.60	0.50	32.00	580.80
	Landing craft	Diesel	0.91	0.50	32.00	580.80

^a 20% of Dhoni should be applied as Passenger Dhoni

* 3% of Dhoni should be applied as cargo Dhoni

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ESTIMATION METHOD - WATER BORNE NAVIGATION

$$\text{Total fuel use (Gg)} = \text{Total fuel}_{\text{Litres}} * \text{Density}_{\text{fuel}} / 1000,000$$

$$\text{Emissions in (Gg)} = \text{Total fuel mass}_{\text{Gg}} * \text{NCV}_{\text{of the fuel}} * \text{EF}_{\text{of the fuel}} / 1000,000$$

Fuel	NCV	Emission factor (EF) kg/TJ		
		CO ₂	CH ₄	N ₂ O
Gas/Diesel Oil	43	74100	7	2
Petrol	44.3	69300	7	2

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QUALITY CHECKS

Cross checked with similar estimates available from other national studies in marine transport sector.
Cross reference with other similar marine transport in other small island developing countries.
Seek expert opinion or judgement when in doubt

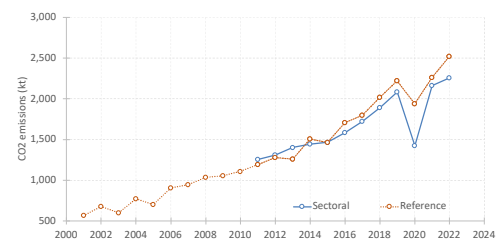
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REFERENCE APPROACH VS SECTORAL APPROACH



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REFERENCE APPROACH VS SECTORAL APPROACH



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Annex 4: Workshop Photos





