ESTIMATING ENERGY EMISSIONS – STATIONARY

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Ministry of Tourism and Environment
Republic of Maldives

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

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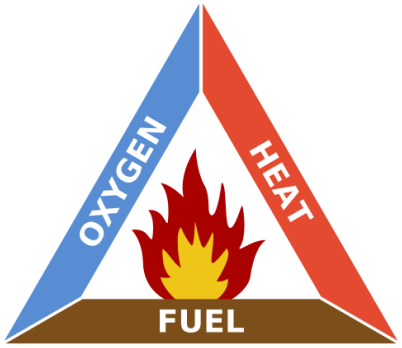
INTRODUCTION



Energy sector comprises of **emissions resulting from activities by fuel combustion and as fugitive emissions** i.e. escape without combustions.

What is fuel combustion?

"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"

What is fugitive emissions?

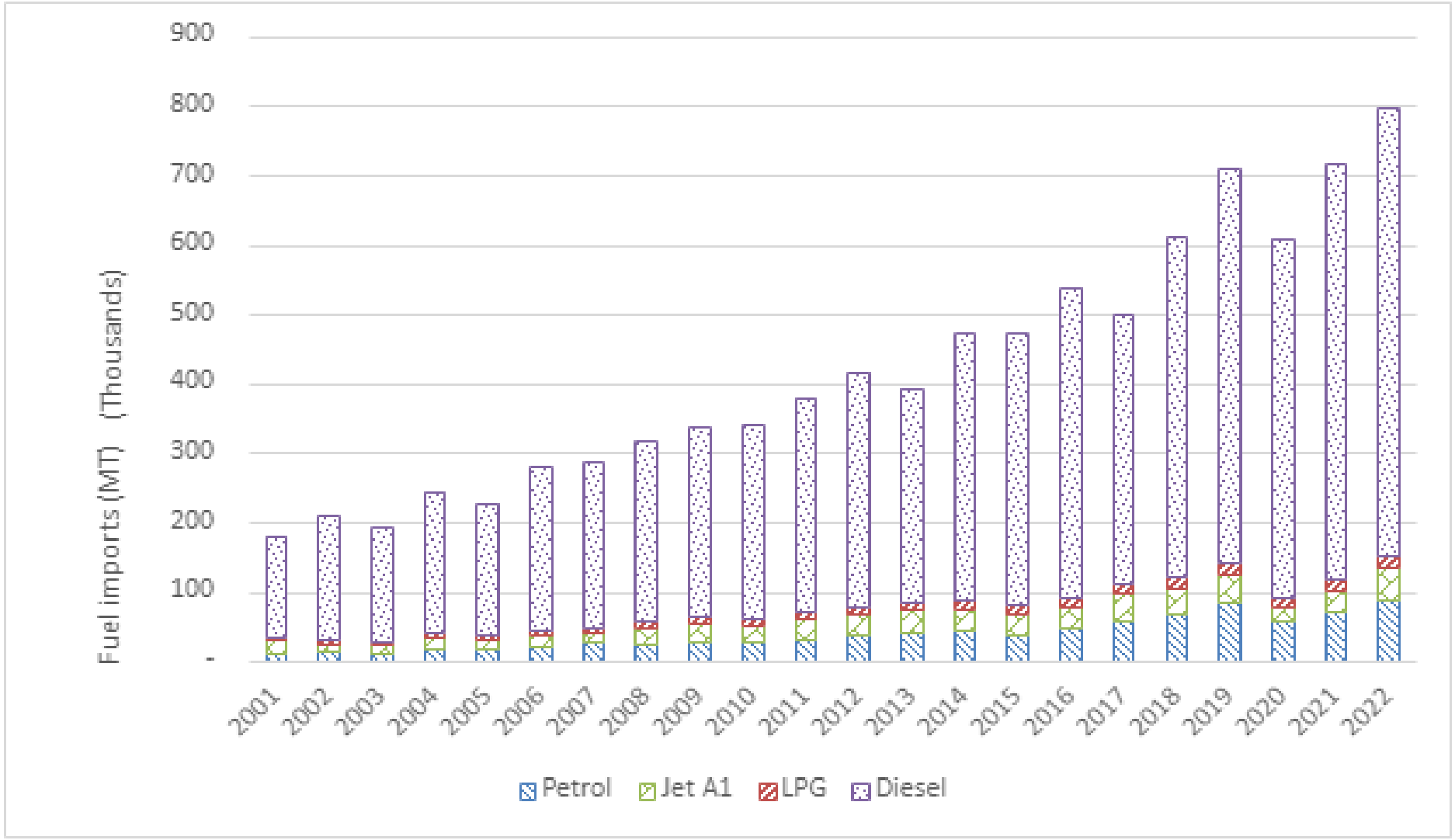
Fugitive emissions in the energy sector arise from extraction, transformation and transportation of primary energy carriers.

STATIONARY COMBUSTION

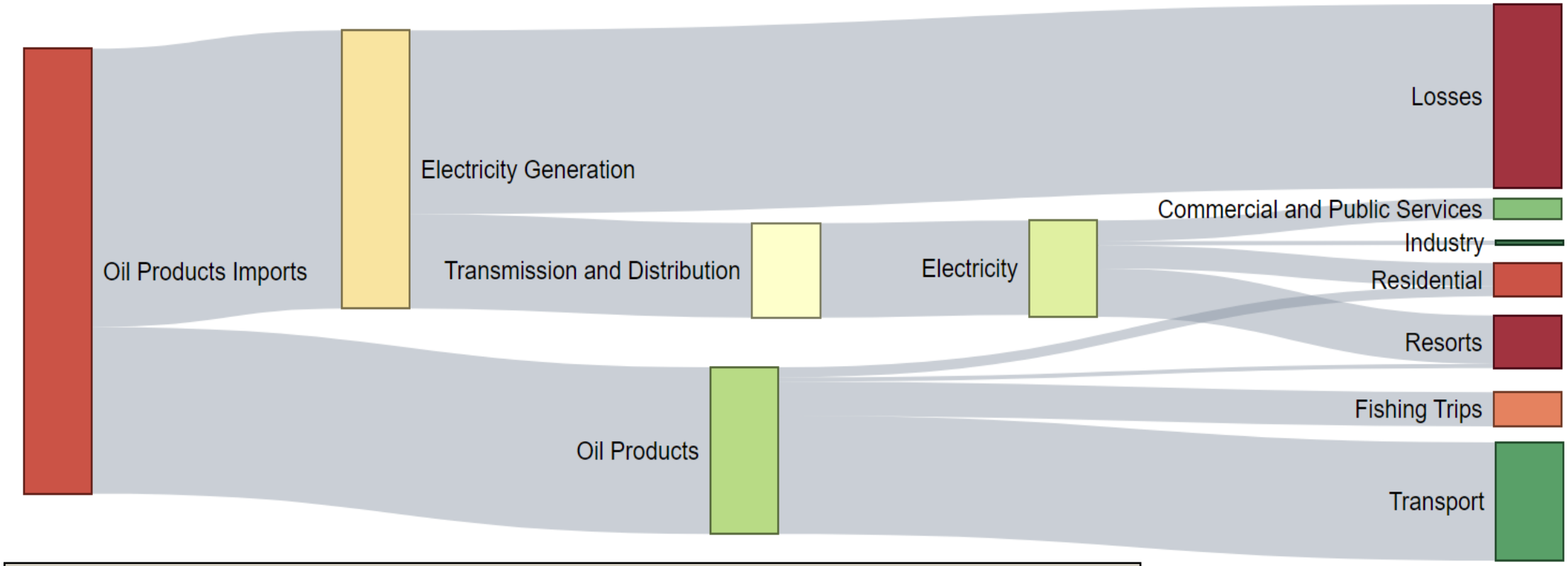
- Most of the emissions in an inventory occurs due to stationary combustion
- Stationary combustions is comprised of the following according to the IPCC 2006 guidelines:
  - Energy industries
  - Manufacturing Industries and Construction
  - Other Sectors
- These slides provide a guidance for calculating emissions from stationary combustion (eg: energy generation)

MALDIVES
ENERGY CONTEXT

NATIONAL CONTEXT – ENERGY USE



NATIONAL CONTEXT – ENERGY



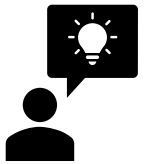
Sankey diagram. How the flow of oil products and electricity from import through generation, transmission, and distribution.
Transport is the most significant energy consumer overall, while within the electricity pathway, residential users and resorts appear to be the primary consumers

INTRODUCTION

SOURCE CATEGORIES

- In estimating emission, it is **important to clearly identify the main source categories that is relevant to Maldives** national circumstances.
- Maldives imports refined fossil fuel products to meet its energy needs and thus does not have any emission sources resulting from exploration and exploitation of primary energy sources (a.k.a. Oil and gas fields, coal mines etc.) and conversion of primary energy sources into secondary fuels in refineries and power plants.
- Maldives does not have any industry that utilizes hydrocarbons for any industrial production

FUEL DEFINITIONS



As a first step, terminologies used for the fuels in the Maldives must be identified and matched with the relevant IPCC terms

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 ^{o}C and 215 ^{o}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 distils between 180 ^{o}C and 380 ^{o}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 distil between 380 ^{o}C and 540 ^{o}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 ^{o}C and 300 ^{o}C but not generally above 250 ^{o}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	Liquified 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_3H_8) and butane (C_4H_{10}) or a combination of the two. They are normally liquified under pressure for transportation and storage.
Propane, Liquified		
Butanes, Liquified		

CONVERSIONS

- The activity data or the fuel information provided by the users are mostly available either in volume (litres) or in mass units (metric tonnes)
- The **volume or mass units need to be converted to energy units based on either Gross Calorific Value (GCV) or Net Calorific Value (NCV)**
- The energy **units used are the SI units (e.g. J – Joules) or multiples of SI units (e.g. TJ).**

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
Liquified Petroleum Gases	47.3	17.2	0.54

EMISSION CONVERSIONS

- Emissions will **need to be reported in common units of Carbon dioxide equivalent or CO_2eq.**
- According to the ETF MPGs, the Global Warming Potential (GWP_{100}) from the IPCC 5th Assessment Report has to be used for conversion.

Global Warming Potential (GWP_{100})		
CO_2	CH_4	N_2O
1	28	265

METHODOLOGIES

- There are **two general methodologies** for estimating the CO_2 emissions from fuel combustion.
- **Method 1** is the **sectoral approach** where estimates are based on consumption data.
- **Method 2** is the **reference approach**, which is also known as the 'top-down' approach to estimate CO_2 emissions.

APPROACH 1: REFERENCE

REFERENCE APPROACH

- Reference approach calculates CO_2 emissions from fuel combustion activities.
- As Maldives does not produce any fossil fuels the apparent consumption is calculated only for secondary fuels.
- The main level of data required is high level fuel supply data (the total energy supply data without any disaggregation in specific energy-related activities).
- In addition, fuel export and storage or fuel stock statistics are also required for the estimation of the apparent consumption

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

MCS, MCS, STO, MACL STO, MACL

DATA SOURCES FOR REFERENCE APPROACH

Data sources	Data				
	Import	Export	Stock	International Bunkering	Fuels Covered
Maldives Customs Services	X	X		X	Diesel, Petrol, Kerosene, Jet A1, LPG
State Trading Organization	X	X	X	X	Diesel, Petrol, Kerosene, Jet A1
Fuel Supply Maldives	X	X	X		Diesel, Petrol, Kerosene, Jet A1
Maldive 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	X	Diesel, Petrol, Kerosene, Jet A1
Regional Airports			X	X	Diesel, Petrol, Kerosene, Jet A1

ESTIMATION METHOD

General Formula used to estimate CO_2 emissions under reference approach

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

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

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

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

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

STEP BY STEP GUIDE FOR REFERENCE APPROACH

(1) 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

(2) Convert data to mass units (Giga grams)
Use the density conversion factors to calculate the mass in gigagrams (Gg).

Example

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

Continued..

STEP BY STEP GUIDE FOR REFERENCE APPROACH

(3) Estimate Apparent Fuel Consumption in Gg

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

Example

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

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	

RE-EXPORT OF FUEL IN 2011

DESCRIPTION	
Marine Gas Oil (Diesel)	26.27
Aviation Gas	94.40

STEP BY STEP GUIDE FOR REFERENCE APPROACH

(3) Estimate Apparent Fuel Consumption in Gg

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

Example

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

STEP BY STEP GUIDE FOR REFERENCE APPROACH

(4) Convert Apparent Consumption to common Energy Unit (TJ)

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

Example

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	

STEP BY STEP GUIDE FOR REFERENCE APPROACH

(4) Convert Apparent Consumption to common Energy Unit (TJ)

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

Example

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

STEP BY STEP GUIDE FOR REFERENCE APPROACH

(5) Estimate total carbon content (Gg of Carbon)

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

(6) Estimate net carbon emissions

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

Example

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

STEP BY STEP GUIDE FOR REFERENCE APPROACH

(7) 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

APPROACH 2: SECTORAL

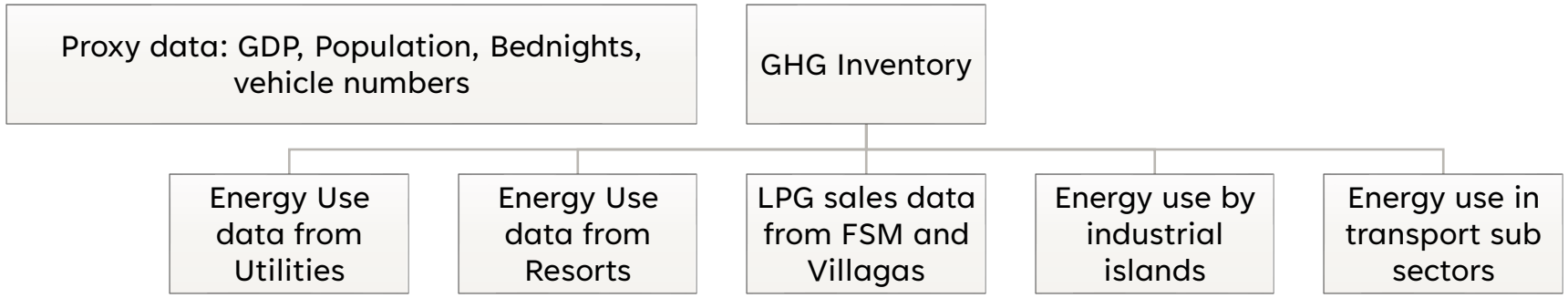
SECTORAL APPROACH

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

Example



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**
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

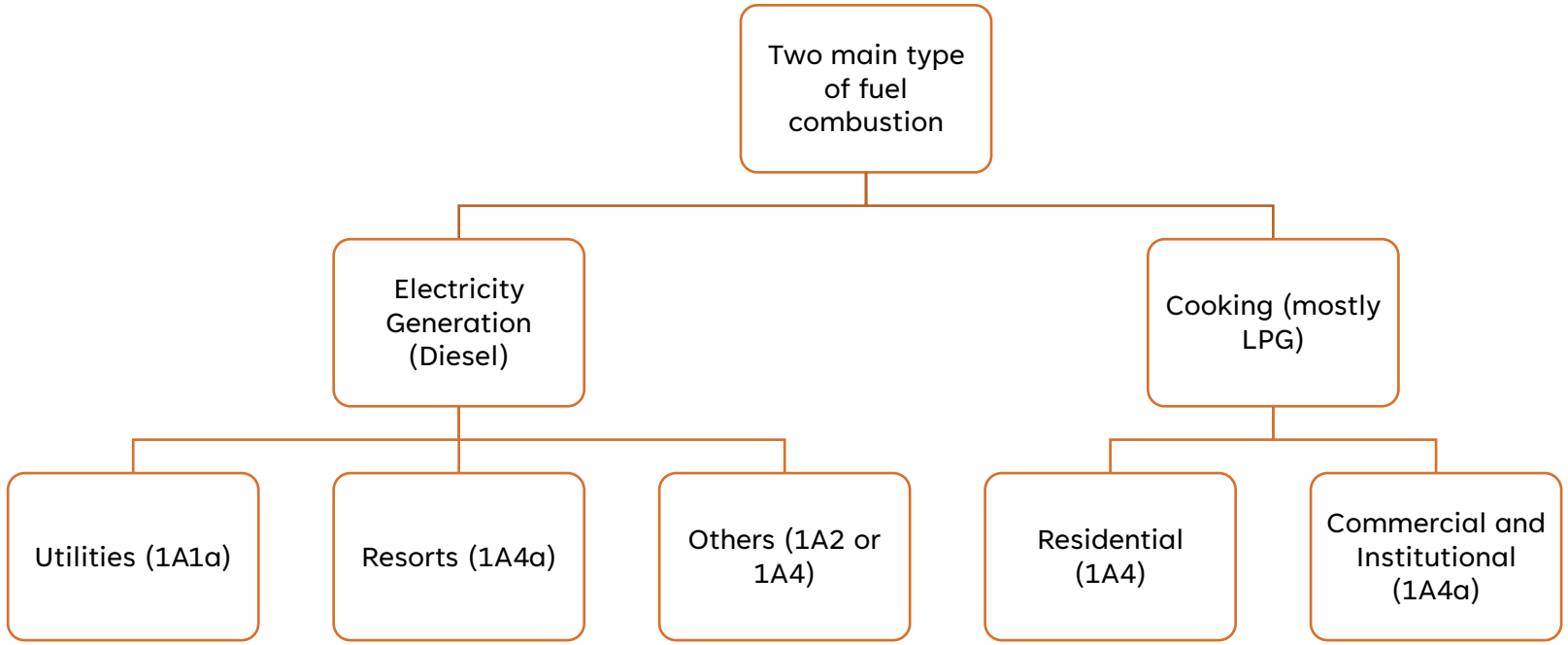
Category Code	Category	Relevance to Maldives Context
1A	Fuel Combustion Activities	Refer to subcategories for relevance
1A2	Manufacturing Industries and Construction	Some activities under this category does occur in Maldives. Details given below
1A2 a	Iron and Steel	This activity does not occur in Maldives
1A2 b	Non-Ferrous Metals	This activity does not occur in Maldives
1A2 c	Chemicals	This activity does not occur in Maldives
1A2 d	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
1A2 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.**
1A2 f	**Non-Metallic Minerals**	**This activity does occur and should cover on site power generation for cement factories operated by Villa and STO**
1A2 g	**Transport Equipment**	**This activity does occur and should cover onsite power generation at boat building, boat yards and slipways operating across Maldives**
1A2 h	Machinery	This activity does occur however does not have standalone power generation and draws power from the utility producers and therefore included in 1A1ai
1A2 i	Mining (excluding fuels) and Quarrying	**Sand mining activity for dredging, habour and reclamation projects**
1A2 j	Wood and Wood Products	This activity does occur however does not have stand-alone power generation or onsite fuel combustion
1A2 k	Construction	This activity does occur however does not have stand-alone power generation and draws power from the utility producers
1A2 l	Textile and Leather	This activity does occur however does not have standalone power generation and draws power from the utility producers
1A2 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 1A4c and therefore this sub-category for Maldives is assumed to be Not Occuring

Category Code	Category	Relevance to Maldives Context
1A4	Other Sectors	Refer to subcategories for relevance
1A4 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-catgarory**
1A4 b	Residential	**This occurs in Maldives and covers all onsite fuel combustion activities in residential dwellings. Mostly covers LPG use of for cooking**
1A4 c	Agriculture/Forestry/Fishing/Fish farms	Refer to subcategories for relevance
1A4 c i	Stationary	**This occurs in Maldives and covers onsite fuel combustion activities (including power generation) in fish processing plants and agricultural islands**
1A4 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 scattered to very small quantities and needs a survey to collect
1A5	Non-Specified	Refer to subcategories for relevance
1A5 a	Stationary	**This occurs in Maldives and covers stationary fuel combustion onsite at military facilities/training facilities (eg. Girifushi etc) including cooking, power production.**

DATA FOR SECTORAL APPROACH

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

1. Total fuel used for electricity generation (litres),
2. total number of units produced (kWh) segregated by sources including those produced by renewable energy sources,
3. total billed units and total lube oil consumption for all of their powerhouses.

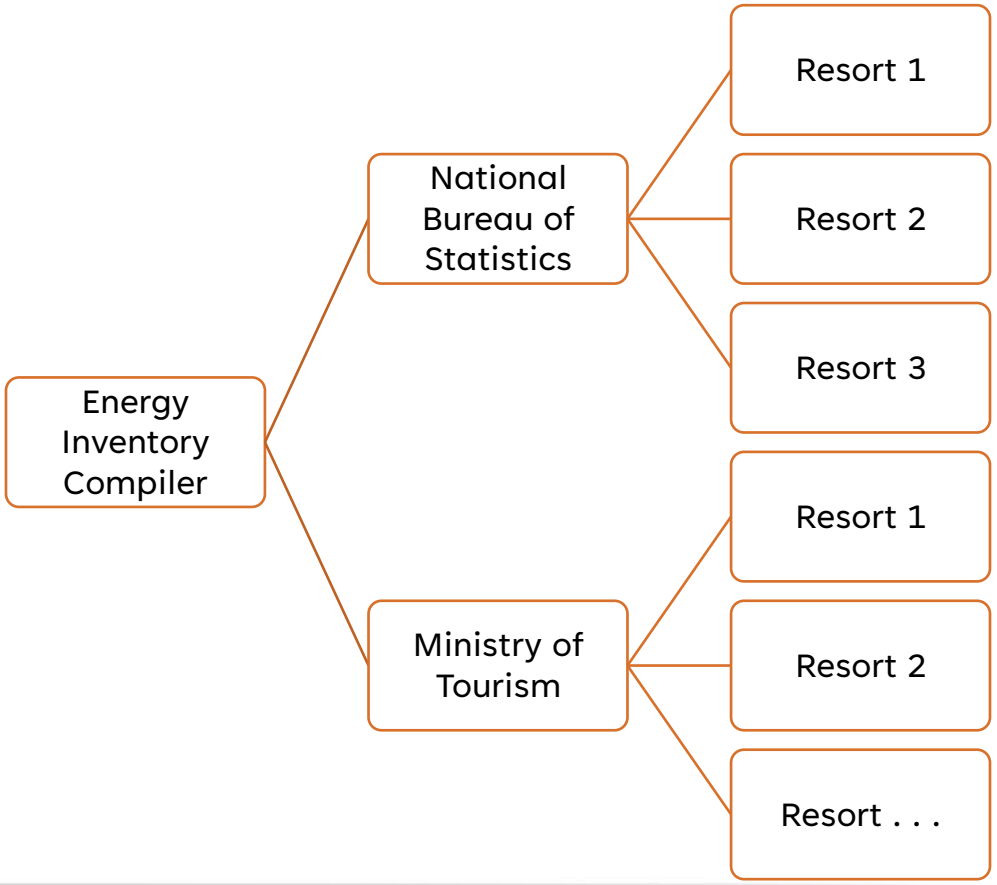


	Default Emission factor (EF) kg/TJ		
Fuel	CO_2	CH_4	N_2O
Gas/Diesel Oil	74100	3	0.6
LPG	63100	1	0.1

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 (related to some industrial and construction activities): **Annual Fuel used for electricity generation**
- **Below table highlights some of these sectors and potential sources of data to capture**

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 machineries	Slipways and other boat building operations (eg: Al-Shaali and Gulfcraft)
1A4a – Commercial and institutional	MPL, MACL and other ports and airports power generation
1A4ci – Fisheries/Agriculture	Power generation and heating/cooking fuel use from fish processing factories and plants like MIFCO, Horizon and ENSIS.

ACTIVITY DATA FROM UTILITIES

	Generated Units (kWh)			Consumed Units (kWh)			Demand (kW)		Consumption (Lits)		Consumers			Production %		%			
Power House	by Diesel	by PV	Generated Total	Billed	P.H Usage	Total Consumed	Minimum	Maximum	Fuel	Lub Oil	Connection	Disconnection	Total	Diesel	PV	Billed	P.H	Usage	Loss
Kaashidhoo	105,120.00	-	105,120.00	97,606.00	3,982.00	101,588.00	110.00	215.00	30,430.00	53.00	3	0	450	100.00	0.00	92.85	3.79	96.64	3.36
Kaashidhoo	101,320.00	-	101,320.00	96,599.00	3,716.00	100,315.00	110.00	198.00	29,360.00	162.00	1	1	450	100.00	0.00	95.34	3.67	99.01	0.99
Kaashidhoo	116,850.00	-	116,850.00	108,842.00	4,348.00	113,190.00	119.00	220.00	33,382.00	128.00	3	3	450	100.00	0.00	93.15	3.72	96.87	3.13
Kaashidhoo	120,630.00	-	120,630.00	111,124.00	4,348.00	115,472.00	98.00	290.00	34,930.00	130.00	0	0	450	100.00	0.00	92.12	3.60	95.72	4.28
Kaashidhoo	123,036.00	-	123,036.00	114,987.00	4,625.00	119,612.00	112.00	219.00	34,622.00	102.00	2	0	452	100.00	0.00	93.46	3.76	97.22	2.78
Kaashidhoo	105,690.00	1,384.00	107,074.00	102,684.00	4,219.00	106,903.00	89.00	209.00	30,630.00	97.00	2	1	453	98.71	1.29	95.90	3.94	99.84	0.16
Kaashidhoo	111,140.00	6,537.00	117,677.00	109,968.00	4,184.00	114,152.00	99.00	211.00	32,241.00	165.00	0	0	453	94.44	5.56	93.45	3.56	97.00	3.00
Kaashidhoo	115,810.00	6,153.00	121,963.00	115,087.00	3,957.00	119,044.00	100.00	248.00	33,606.00	113.00	1	0	454	94.96	5.04	94.36	3.24	97.61	2.39
Kaashidhoo	106,800.00	6,780.00	113,580.00	106,370.00	4,008.00	110,378.00	93.00	248.00	30,499.00	135.00	0	0	454	94.03	5.97	93.65	3.53	97.18	2.82
Kaashidhoo	109,670.00	6,328.00	115,998.00	110,072.00	3,715.00	113,787.00	99.00	209.00	31,437.00	139.00	4	1	457	94.54	5.46	94.89	3.20	98.09	1.91
Kaashidhoo	103,910.00	5,728.00	109,638.00	104,186.00	3,637.00	107,823.00	100.00	240.00	29,572.00	115.00	2	0	459	94.78	5.22	95.03	3.32	98.34	1.66
Kaashidhoo	102,470.00	5,367.00	107,837.00	100,996.00	3,710.00	104,706.00	88.00	191.00	28,790.00	169.00	1	0	462	95.02	4.98	93.66	3.44	97.10	2.90
Kaashidhoo	**1,322,446.00**	**38,277.00**	**1,360,723.00**	**1,278,521.00**	**48,449.00**	**1,326,970.00**	**88.00**	**290.00**	**379,499.00**	**1,508.00**	**19**	**6**	**462**	**97.21**	**5.37**	**93.99**	**3.56**	**97.55**	**2.45**
Gaafaru	59,044.00	-	59,044.00	55,565.00	667.00	56,232.00	55.00	110.00	17,920.00	52.00	2	0	205	100.00	0.00	94.11	1.13	95.24	4.76
Gaafaru	55,550.00	-	55,550.00	52,898.00	799.00	53,697.00	52.00	109.00	18,345.00	61.70	2	0	207	100.00	0.00	95.23	1.44	96.66	3.34
Gaafaru	64,857.00	-	64,857.00	54,786.00	1,212.00	55,998.00	58.00	118.00	22,706.00	92.00	1	0	208	100.00	0.00	84.47	1.87	86.34	13.66
Gaafaru	69,337.00	-	69,337.00	65,095.00	940.00	66,035.00	44.00	137.00	22,090.00	79.00	1	0	209	100.00	0.00	93.88	1.36	95.24	4.76
Gaafaru	66,830.00	-	66,830.00	59,162.00	840.00	60,002.00	54.00	116.00	22,856.00	81.00	3	1	211	100.00	0.00	88.53	1.26	89.78	10.22
Gaafaru	57,322.00	-	57,322.00	45,947.00	765.00	46,712.00	42.00	113.00	20,486.00	42.00	1	0	212	100.00	0.00	80.16	1.33	81.49	18.51
Gaafaru	61,909.00	-	61,909.00	59,927.00	830.00	60,757.00	41.00	119.00	22,952.00	54.00	1	0	213	100.00	0.00	96.80	1.34	98.14	1.86
Gaafaru	68,615.00	-	68,615.00	64,646.00	885.00	65,531.00	57.00	126.00	24,886.00	103.00	0	0	213	100.00	0.00	94.22	1.29	95.51	4.49
Gaafaru	61,139.00	-	61,139.00	57,919.00	846.00	58,765.00	47.00	129.00	20,097.00	75.30	0	0	213	100.00	0.00	94.73	1.38	96.12	3.88
Gaafaru	63,055.00	-	63,055.00	59,213.00	839.00	60,052.00	50.00	122.00	20,432.00	78.00	3	0	216	100.00	0.00	93.91	1.33	95.24	4.76
Gaafaru	55,724.00	-	55,724.00	51,636.00	775.00	52,411.00	59.00	118.00	18,938.00	55.00	0	0	216	100.00	0.00	92.66	1.39	94.05	5.95
Gaafaru	63,297.00	-	63,297.00	59,508.00	775.00	60,283.00	58.00	121.00	19,836.00	54.00	4	0	220	100.00	0.00	94.01	1.22	95.24	4.76
Gaafaru	**746,679.00**	**-**	**746,679.00**	**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**	**93.25**	**6.75**

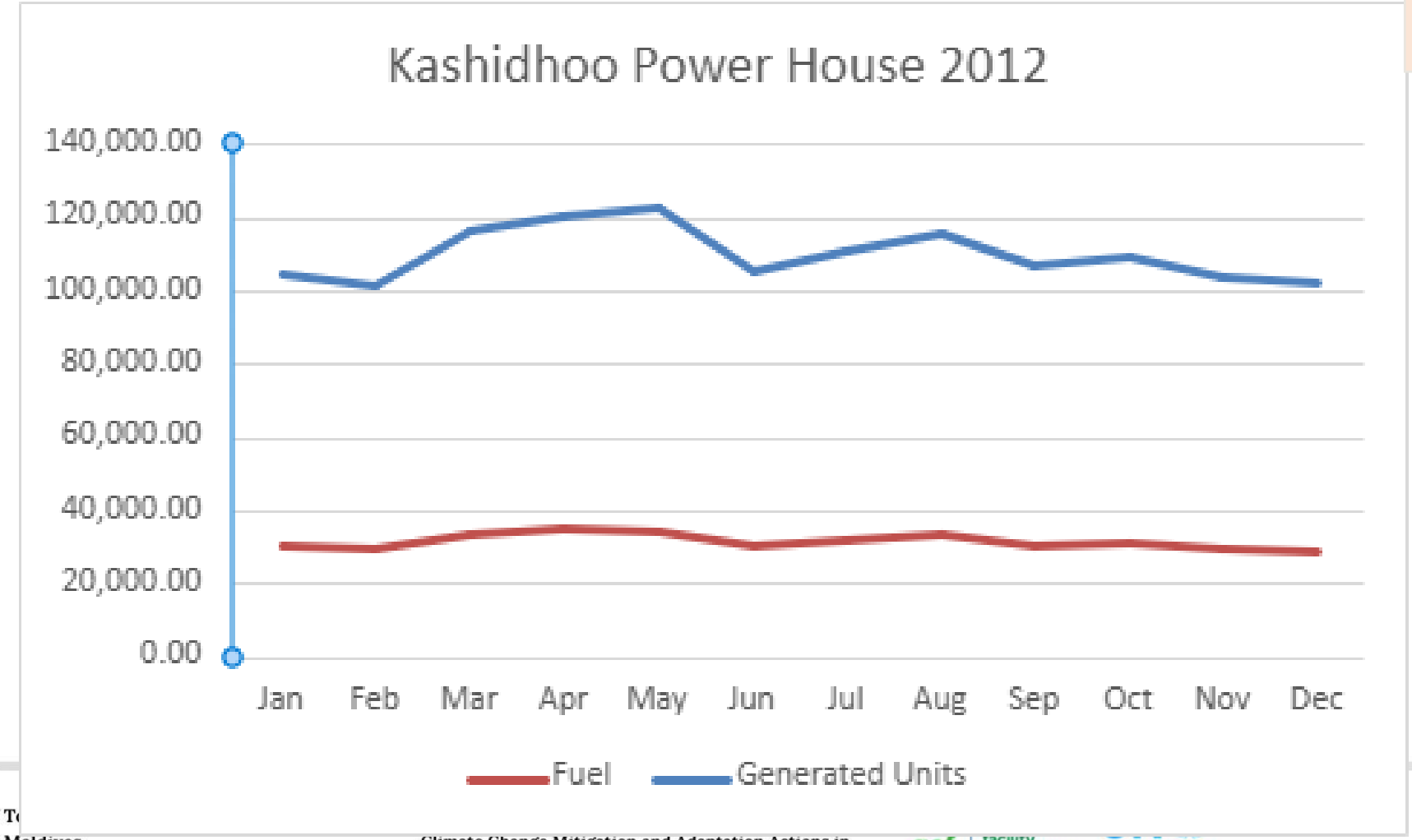
QUALITY ASSURANCE (QA)/ QUALITY CONTROL (QC)

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).

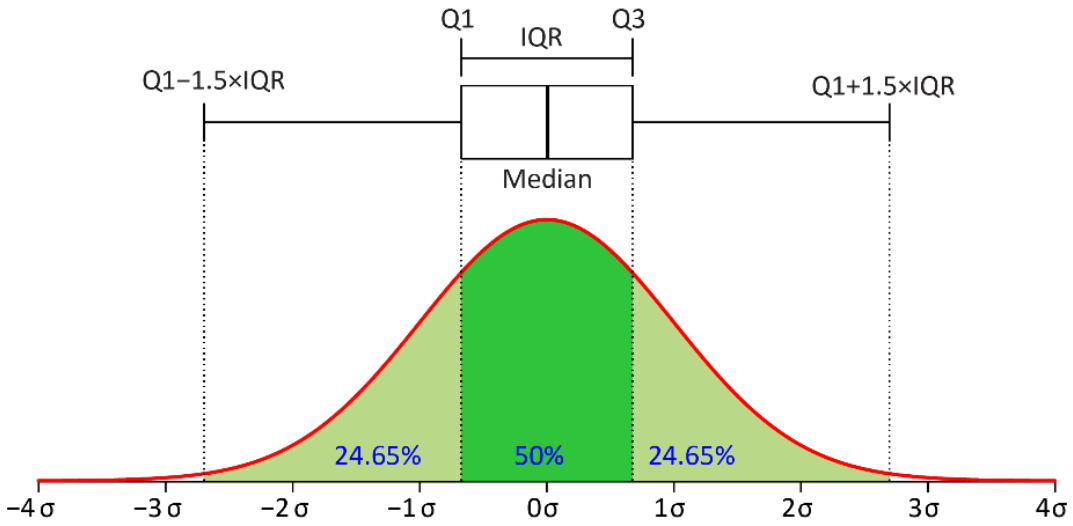
QUALITY CONTROL OF THE DATA – CONSISTENCY

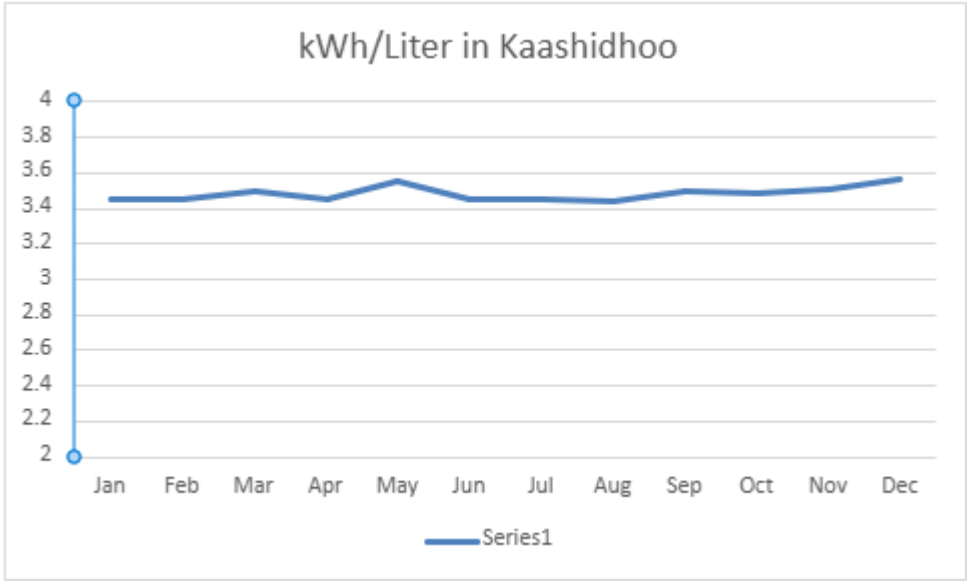
Example



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 ≈2 kWh/L
- Upper bound, 1.5*IQR = Q3+1.5*IQR = 3.986 ≈ 4 kWh/L

EXAMPLES

ADAPTING DATA FOR INVENTORY

	2021 Diesel Consumption (liters)	Population (2014 Census)	% of Pop in islands with data	Total Diesel Use in Liters
Utility A	90,151,697.04	183,738.00	94%	?
Utility B	140,575,448		100%	140,575,448

ADAPTING DATA FOR INVENTORY

	2021 Diesel Consumption (liters)	Population (2014 Census)	% of Pop in islands with data	Total Diesel Use in Liters
Utility A	90,151,697.04	183,738.00	94%	96,266,689
Utility B	140,575,448		100%	140,575,448

ADAPTING DATA FOR INVENTORY

- Convert fuel liters to mass units

$$Total\ fuel\ use\ (Gg) = Total\ fuel_{Litres} * Density_{fuel} / 1000{,}000$$

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

ADAPTING DATA FOR INVENTORY

- Convert fuel liters to mass units

$$Total\ fuel\ use\ (Gg) = Total\ fuel_{Litres} * Density_{fuel} / 1000{,}000$$

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

GHG ESTIMATION

- The following formula will give the apparent consumption in energy units (TJ)

$$Consumption\ in\ (TJ) = Total\ fuel\ mass_{Gg} * NCV_{of\ the\ fuel}$$

The following formula can be used to calculate the emissions of the respective gas in terms of Gg.

$$Emissions\ in\ (Gg) = Consumption_{TJ} * EF_{of\ the\ fuel} / 1000{,}000$$

		Default Emission factor (EF) kg/TJ		
Fuel	Net Calorific Value, NCV (TJ/Giga grams)	CO_2	CH_4	N_2O
Gas/Diesel Oil	43	74100	3	0.6

	Mass (Gg)	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
A	81	257.657	0.0104315	0.002086
B	118	376.2491	0.0152328	0.003047

GHG AGGREGATION

	Mass (Gg)	CO_2 (Gg)	CH_4 (Gg)	N_2O (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_2O
1	28	265

	CO_2 (Gg)	CH_4 in CO_2 eq (Gg)	N_2O in CO_2eq (Gg)	Total emissions Gg of CO_2 eq
A	257.657			
B	376.2491			

GHG AGGREGATION

	Mass (Gg)	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
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Global Warming Potential (GWP_{100})		
CO_2	CH_4	N_2O
1	28	265

	CO_2 (Gg)	CH_4 in CO_2 eq (Gg)	N_2O in CO_2eq (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

ACTIVITY DATA FOR COOKING

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

	Company A		Company B	
	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

$$Emissions\ in\ (Gg) = Consumption_{TJ} * EF_{of\ the\ fuel} / 1000{,}000$$

	Net Calorific Value, NCV (TJ/Gg	Default Emission factor (EF) kg/TJ		
Fuel		CO_2	CH_4	N_2O
LPG	47.3	63100	1	0.1

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

	Company A		Company B	
	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

$$Emissions\ in\ (Gg) = Consumption_{TJ} * EF_{of\ the\ fuel} / 1000{,}000$$

	Net Calorific Value, NCV (TJ/Gg	Default Emission factor (EF) kg/TJ		
Fuel		CO_2	CH_4	N_2O
LPG	47.3	63100	1	0.1