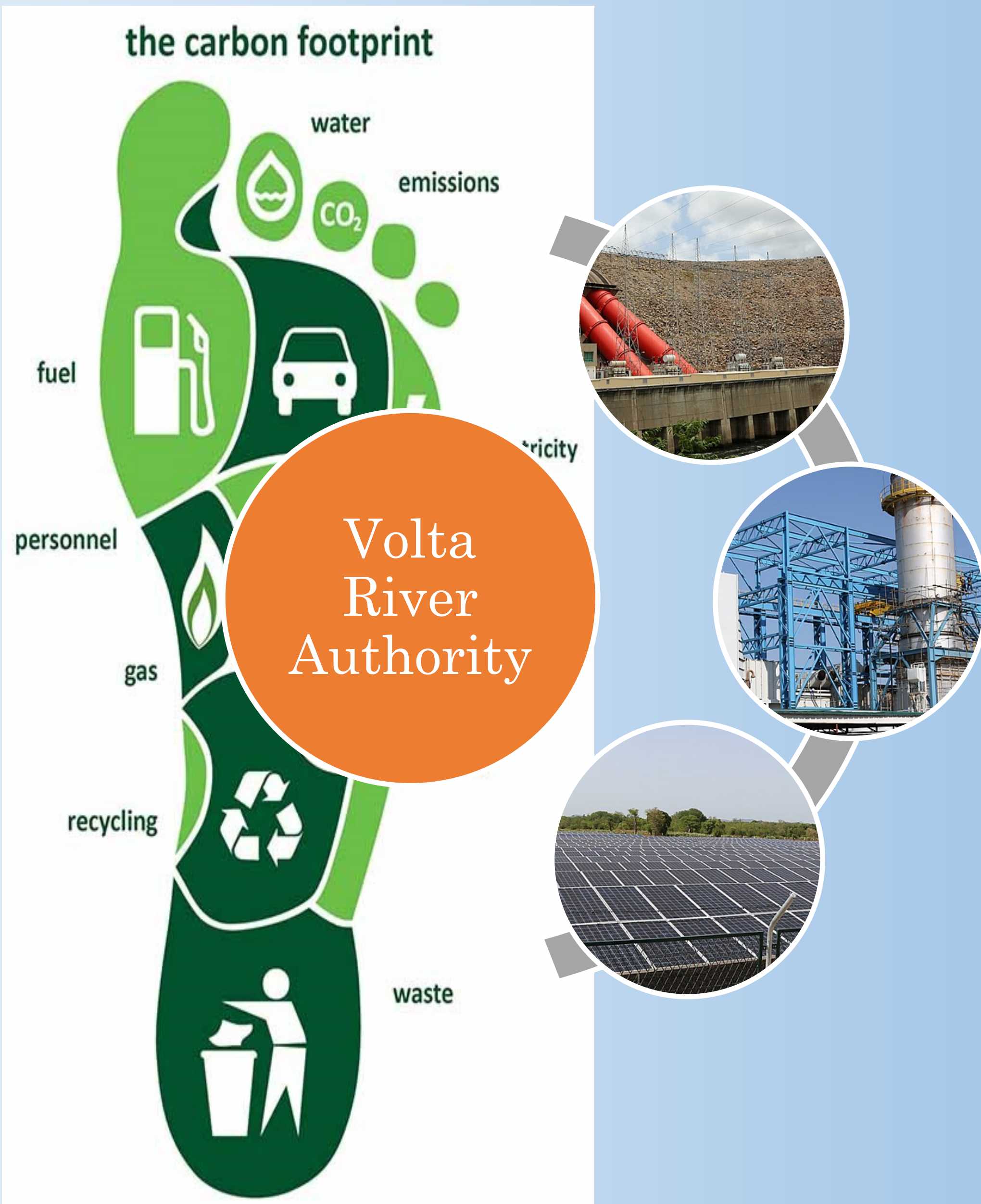
2012 -2018 Greenhouse Gas Inventory Report



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☐ No ☒ Yes (if yes, fill in verifier contact information below and attach verification statement)
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ACRONYMS & ABBREVIATIONS

AERs	-	Annual Environmental Reports
AHL	-	Akosombo Hotels Limited
APML	-	Akosombo Paper Mill Limited
AR2	-	Second Assessment Report
AR5	-	Fifth Assessment Report
CAT	-	Carbon Accounting Team
CDM	-	Clean Development Mechanism
CEB	-	Communaute Electrique du Benin
CEMS	-	Continuous Emission Monitoring System
CFMP	-	Corporate Carbon Footprint Management Program
CH_4	-	Methane
CIE	-	Compagnie Ivorienne d'Electricite
CO_2	-	Carbon Dioxide
CWSP	-	Corporate Solid Waste Segregation Program
DFO	-	Distillate Fuel Oil
E&SDD	-	Environment & Sustainable Development Department
ECG	-	Electricity Company of Ghana
EPA	-	Environmental Protection Agency
ESI	-	Environment & Social Impact
GHG	-	Greenhouse Gases
GRIDCo	-	Ghana Grid Company
GWPs	-	Global Warming Potentials
HF_6	-	Sulfur Hexafluoride
HFCs	-	Hydroflorocarbon
HVAC	-	Heating Ventilation Air Condition
IPCC	-	Inter-Governmental Panel on Climate Change
KTPS	-	Kpone Thermal Power Station
LCO	-	Light Crude Oil
LNG	-	Liquified Natural Gas
MWH	-	Megawatts Hour
N_2O	-	Nitrous Oxide
NDA	-	Non-Disclosure Agreement
NDC	-	Nationally Determined Contributions
NED	-	Northern Electricity Department
NEDCo	-	Northern Electricity Distribution Company
NF_3	-	Nitrogen Trifluoride
PFCs	-	Perfluorocarbons
PDD	-	Project Design Document
R&M	-	Regulatory & Metering
SF_6	-	Sulphur Hexafluoride
SONABEL	-	Societe Nationale d'electricite du Burkina Faso
T1	-	Takoradi 1 Thermal Power Station
T3	-	Takoradi 3 Thermal Power Station
TICO	-	Takoradi International Company
TT1PS	-	Tema Thermal 1 Power Station
TT2PS	-	Tema Thermal 2 Power Station

TTPC	-	Tema Thermal Power Complex
UNFCC	-	United Nations Framework Convention on Climate Change
VLTC	-	Volta Lake Transport Company Limited
VRA	-	Volta River Authority
WAPCo	-	West African Gas Pipeline Company
WAPP	-	West Africa Power Pool

EXECUTIVE SUMMARY

The Volta River Authority's (VRA) "Corporate Carbon Footprint Management Programme" (CFMP) was initiated in 2016 as part of its Corporate Strategic Objectives to allow for the measuring and reporting of Greenhouse Gases (GHG). The initial GHG Inventory Report, covering the period 2012 – 2015, was prepared using the GHG Protocol Corporate Accounting and Reporting Standard Methodology (Revised Edition). This protocol is the most widely used standard for mandatory and voluntary GHG reports and is compatible with other international GHG standards such as ISO 14064.

The duration of the initial report was selected to coincide with that of the Fourth National Communication Report and the Second Biennial Update Report that was being submitted by Ghana to the United Nations Framework Convention on Climate Change (UNFCC). Going forward, VRA has set 2012 as the baseline year in our GHG Inventory Reporting. Establishing a baseline year for GHG emissions is important because it provides the basis for measuring future successes in reducing emissions. Typically, GHG emission reduction goals are established as a certain percentage below a particular year (referred to as the baseline year), in this case 2012.

The 2012-2015 GHG Inventory Report covered emissions from VRA's stationary and vehicle combustions. Experts from ICF International of USA in November 2017 reviewed the initial GHG Report and submitted their review comments in December 2017. The Ghana Environmental Protection Agency (EPA) also audited and verified the initial GHG report and submitted their comments in January 2020.

Based on these reviews, the initial report has been updated to cover the period 2012-2018 for stationary and mobile combustions, covering thermal power plants, road and water transport. In addition, GHG savings from its "2.5MW ***Navrongo Solar Power Station***", five (5No) ***Mini Solar Grid with installed capacity totaling 237.5KW*** and "***Office Paper Waste Recycling Programme***" have been included in the updated report.

VRA has selected the Operational Control approach, to define its organizational and operational boundaries. Under this approach, VRA has included in its emissions inventory all sources and sinks over which it has hundred percent (100%) operational control. The emissions are categorized by source to allow commitments to be made regarding both the potential for and strategies to be adopted for reducing GHG emissions. VRA will voluntarily maintain and update this GHG emissions inventory each fiscal year and use this inventory to develop and publish its GHG emissions reduction strategy.

Regarding Global Warming Potential, since the national inventory utilizes Second Assessment Report, 1995 (AR2), VRA has adopted that for reporting and uniformity purposes. Based on engagement with the EPA, VRA has adopted the following GHG quantification tools:

a) World Resources Institute (2015) Stationary Combustion Tool Version 4.1
b) Mobile Combustion GHG Emissions Calculation Tool Version 2.6.
c) Tool for GHG Accounting for Energy Projects, developed by KfW Development Bank
d) Waste Reduction Model (WARM), Version 12 (February 2012).

The Total GHG emissions from 2012-2018 was 9,379,211.39 CO_2 Equiv. VRA's GHG emissions are broken down by scope and source categories as shown below. Stationary combustion contributed 95.13%, whilst vehicle and water transport combustion contributed 0.13% and 4.74% respectively.

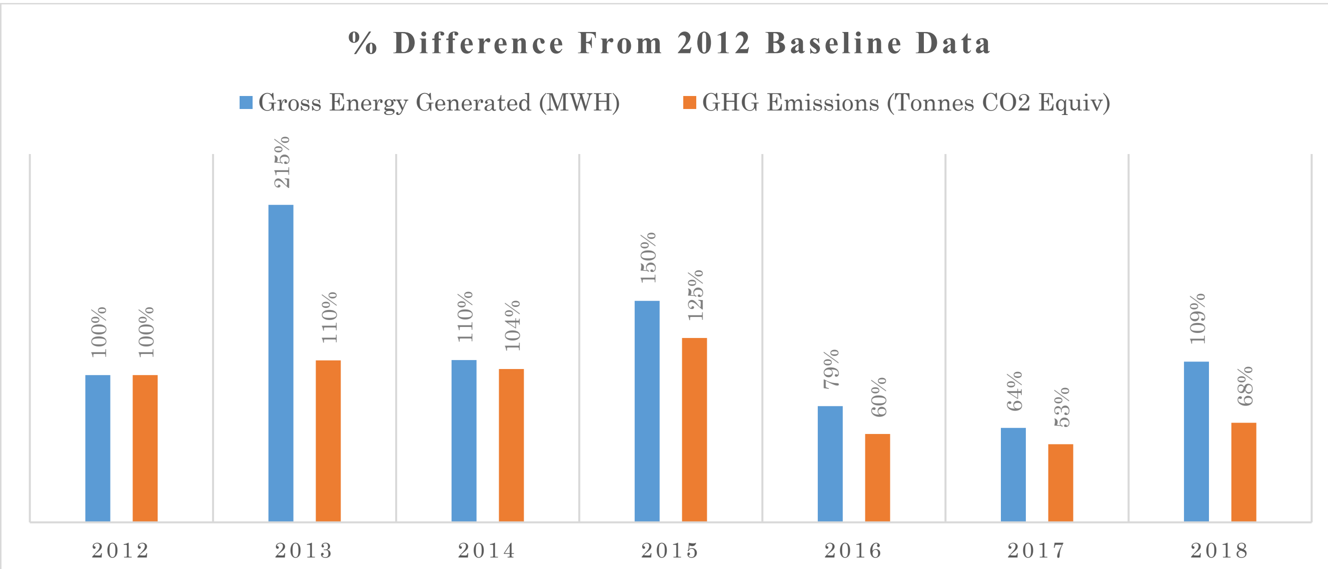
Operational Emissions Category	Emissions Source Category	Corporate emissions source	Total emissions Tonnes CO2 Equiv	Percentage of total corporate emissions
Direct Emission Sources	Stationary Combustion	T1	5,116,494.49	54.55%
		T3	135,112.56	1.44%
		TT1PS	2,508,112.11	26.74%
		TT2PS	500,984.84	5.34%
		MRPS	321,253.36	3.43%
		KTPS	340,564.11	3.63%
	Mobile Combustion	Vehicles	12,181.41	0.13%
		Water Transport	444,508.504	4.74%
Total Emissions From Direct Sources			9,379,211.39	100.00%

Annual trends of emissions from stationary combustion, which is the major source of GHG emissions, and the gross energy generated for each year as well as the percentages differences from the 2012 baseline data is shown in the table below. The figure below also shows the percentage differences from the baseline data during the period. In Year 2013, even though the gross energy generated was 115% over the baseline data, equivalent GHG emissions increased by only 10%. The highest percentage difference in GHG emissions of 25% was experienced in 2015, during which period gross energy generated was 50% over the baseline data. There was considerable decrease in GHG emissions from 2016-2018, with the lowest being in 2017, which achieved 47% less the baseline data. Indeed, in 2018, the gross energy generated was 9% above the baseline level whilst equivalent GHG emissions was 32% below the baseline data.

Fuel utilised for combustion are Light Crude Oil (LCO), Natural Gas and Diesel Fuel Oil (DFO). It must be noted that anytime natural gas was available, it was automatically the first-choice fuel for operating the power plants. The use of LCO was highest from 2013 - 2015, and this was during the country's power crises, where VRA also experienced shortfalls in gas supply from Nigeria. The Atuabo Gas Processing Plant came on stream in 2016 and VRA in 2017, took a decision to operate mainly on natural gas, and for most part of 2018, depended largely on natural gas for power generation. Indeed, the significant decrease in GHG emission in 2018 despite the high gross energy generated can largely be attributed to the use of natural gas for power generation.

Period	Gross Energy Generated		GHG Emissions	
	MWH	% Difference from 2012 baseline figure	Tonnes CO2 Equiv	% Difference from 2012 baseline figure
2012	1,801,619.00	-	1,439,685.83	-
2013	3,881,438.00	215%	1,582,068.07	110%
2014	1,986,105.13	110%	1,499,949.00	104%
2015	2,708,120.88	150%	1,801,005.43	125%

Period	Gross Energy Generated		GHG Emissions	
	MWH	% Difference from 2012 baseline figure	Tonnes CO2 Equiv	% Difference from 2012 baseline figure
2016	1,421,260.19	79%	863,425.71	60%
2017	1,154,895.10	64%	763,967.24	53%
2018	1,965,081.62	109%	972,420.20	68%



Total GHG Savings from our conservation programmes from the 2.5MW Navrongo Solar Power Station, the five (5No.) Mini Off grids and the office waste paper recycled amounted to 8,695 Tonnes CO_2 Equiv. and this is shown in the table below:

Source	GHG Emission Savings (Tonnes CO2e)
Navrongo Solar Power Station	8,627.00
Office Paper Recycled	9.00
0.054MW Aglakope	17.00
0.0405MW Atigagorme	6.00
0.054MW Kudorkope	14.00
0.05MW Perdiatorkope	17.00
0.03MW Wayokope	5.00
Total	8,695.00

VRA has initiated a variety of conservation programs, involving renewable energy projects (Wind/Solar), Retooling Single Cycle Plants to Combine Cycle, Reforestation programs, Solid Waste Management Programs, Utilization of Fuel-Efficient Stoves, Paper Usage Reduction, Reduction in Travel/Transportation, and all these are expected to result in significant reductions in GHG emissions. A summary of these conservation programs is provided in the report.

The following actions are to be pursued to improve future data capture and reporting as well as reduce GHG emissions:

1. Centralizing (through the business oracle system) requisite data for the activity data for fuel consumption for mobile emissions, vehicular/water transport, by 2020.
2. Continue with implementation of resource use efficiencies programmes under the Financial Recovery Programme, targeting reduction in paper and fuel usage as well as adoption of video conferencing for meetings.
3. Continue with the "Eco-Friendly Department" awards.
4. Initiate strategies to collate data on fugitive emissions such as Methane from natural gas distribution systems within the Tema Area under Scope 2 and report on outcome by 2021.
5. Initiate strategies to collate data on Hydrofluorocarbon emissions from specifically office Air Condition systems by 2021. Basically, responsible staff will be trained on data collection methods and input into the spreadsheets.
6. Undertake area and ground survey to assess carbon sequestration of VRA Reforestation program to offset VRA's carbon emissions within its carbon accounting programme by 2021.
7. Establish the "**Akosombo Plastic Waste Processing & Recycling Centre**" for the segregation and processing of plastic bottles within the Akosombo and its environs by 2021.
8. Assess the utilization of the fuel-efficient stoves for riparian communities and estimate carbon savings achieved by 2021.
9. Capacity building of staff using safety meetings to effectively embrace carbon caring values throughout the operation of VRA and report on outcome by 2021.
10. Organise capacity building activities by Mid-2021 for subsidiary companies, namely the Volta Lake Transport Company, Akosombo Hotels Limited, Kpong Farms Limited, and Northern Electricity Distribution Company to enable them publish their own GHG Report.

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TABLE OF CONTENT

FIGURES

TABLES

1 INTRODUCTION & BACKGROUND

The Volta River Authority's (VRA) "Corporate Carbon Footprint Management Programme" (CFMP) was initiated in 2016 as part of its Corporate Strategic Objectives to allow for the measuring and reporting of Greenhouse Gases (GHG). The CFMP is intended to help the VRA:

- Gain a better understanding of exposure to the risks of climate change, improve the environmental sustainability of its business
- Ensure adherence to national and international environmental requirements of GHG emissions,
- Help strengthen its green credentials in the marketplace.

The CFMP therefore embodies VRA's intent to reduce its impact on the environment over the long term, and a Carbon Accounting Team (CAT) has been formally appointed by Top Management to coordinate the process. The initial GHG Inventory Report, covering the period 2012- 2015, was prepared using the GHG Protocol Corporate Accounting and Reporting Standard Methodology (Revised Edition). This protocol is the most widely used standard for mandatory and voluntary GHG reports and is compatible with other international GHG standards such as ISO 14064. The duration of the initial report was selected to coincide with that of the Fourth National Communication Report and the Second Biennial Update Report that was being submitted by Ghana to the United Nations Framework Convention on Climate Change (UNFCC). Going forward, VRA has set 2012 as the baseline year in our GHG Inventory Reporting. Establishing a baseline year for GHG emissions is important because it provides the basis for measuring future successes in reducing emissions. Typically, GHG emission reduction goals are established as a certain percentage below a particular year (referred to as the baseline year), in this case 2012.

The report covered GHG emissions from VRA's stationary and mobile combustions. Through the Ghana Environmental Protection Agency (EPA), nationally designated authority for coordinating climate change related actions in Ghana, experts from ICF International of USA in November 2017 reviewed the initial GHG Report and submitted their review comments in December 2017. ICF International are consultants for the United States Agency for International Development. The Ghana EPA also audited and verified the initial GHG report and submitted their comments in January 2020. It must be noted that the Ghana EPA is the nationally designated authority for coordinating climate change related actions in Ghana.

Using the review comments from ICF International and the EPA, the initial report has been updated to cover the period 2012-2018 for stationary and mobile combustions, covering thermal power plants, road and water transport. In addition, GHG savings from its "2.5MW ***Navrongo Solar Power Station***", five (5No) ***Mini Solar Grid with installed capacity totaling 237.5KW*** and "***Office Paper Waste Recycling Programme***" have been included in the updated report. The emissions are categorized by source to allow commitments to be made regarding both the potential for and strategies to be adopted for reducing GHG emissions. VRA will voluntarily maintain and update this GHG emissions inventory each fiscal year and use this inventory to develop and publish its GHG emissions reduction strategy.

2 REPORTING ENTITY

The Volta River Authority (VRA) was established on April 26, 1961 under the Volta River Development Act, 1961 (Act 46) of the Republic of Ghana with the mandate to generate, transmit and distribute electricity. VRA until 1997, owned and operated the Akosombo Hydroelectric Power Plant and the Kpong Hydroelectric Power Plant. These two hydropower plants have since been complimented with thermal and solar power plants. The hydropower plants resulted in the formation of the Volta Lake Basin.

VRA as of December 2018 had an installed electricity generation capacity of 2,729.50MW, comprising of 1180MW (43.2) from the two hydroelectric plants, 2.5MW (0.1%) from one solar power plant and 1547MW (56.7%) from six thermal power plants. The 80MW Mines Reserve Power Plant was decommissioned in 2016.

PLANT	Current Installed Capacity (MW)
RENEWABLES	
Akosombo-Hydro	1,020
Kpong-Hydro	160
Navrongo-Solar	2.5
Sub-Total	1,182.5
THERMAL	
Takoradi Power Company (TAPCo)	330
Takoradi International Company (TICo)	345
Tema Thermal 1 Power Plant (TT1PP)	110
Tema Thermal 2 Power Plant (TT2PP)	80
*Takoradi T3 (Broken Down)	132
AMERI Plant	250
Kpone Thermal Power Station (KTPS)	220
Sub-Total	1,547
Overall Total	2,729.5

The VRA Act 46 of 1962 was amended by the Volta River Development Amendment Act 2005 (Act 692) in the context of the Ghana Government Power Sector Reforms, and the power transmission function of the VRA was transferred to a separate transmission utility, known as the Ghana Grid Company (GRIDCo), which became operational in August 2008. Based on this, VRA's current mandate has now been largely restricted to generation of electricity and distribution of electricity in the northern parts of the country, through the Northern Electricity Distribution Company (NEDCo), a stand-alone, wholly owned, subsidiary of VRA with the responsibility of electricity distribution in Northern Ghana.

Various departments and outfits are responsible for the variety of activities performed by the company. In fulfilment of its responsibility to provide facilities for its staff as well as assistance for the socio-economic development of the Volta Basin, the VRA also has seven (7No.) non-power subsidiary companies. The Corporate organizational Structure as at close of 2018 is provided in Appendix 1. Additional company information can be located at www.vra.com.

NEDCo became operational in May 2012 and is currently the sole distributor of electricity in the Upper West, Upper East, North East, Northern, Savannah, Bono, Bono East, Ahafo, and parts of Ashanti and Oti Regions of Ghana. Aside NEDCo, VRA's regulated customers in Ghana include Electricity Company of Ghana (ECG) and Enclave Power located within the Tema Export Processing Zone. Bulk sales are also made to de-regulated customers (mining/industrial companies) as well as import/export of power with Communauté Electrique du Benin of Togo and Benin, Compagne Ivoirienne d'électricité – La Cote d'Ivoire and SONABEL (Burkina Faso).

The 2018 Annual Report of the VRA indicates that of the 15,964GWh generated nationwide in 2018, VRA generated 9,635GWh, representing 60.4 percent of total energy generated. VRA's Group revenue from the sale of electricity in 2018 increased by 6.6 percent to GH¢3.2 billion over the previous years' sale of GH¢3.0 billion. This was mainly due to the combined effects of a marginal increase in the volume of energy sold and the upward adjustment in tariffs in the regulated market.

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3 DESCRIPTION OF EMISSION SOURCES

3.1. Inventories Boundaries

3.1.1 Organizational Boundary

Organizational boundaries represent the distinction of GHG emissions that will be included or not included in an inventory. These boundaries define the portion of emissions for which an organization is responsible. The GHG Protocol Corporate Standard outlines two approaches from consolidating GHG data:

- **Equity share**: Accounts for an organization's GHG emissions based on its percentage ownership.
- **Operational Control**: Accounts for an organization's GHG emissions based on its financial or operational control.

VRA has selected the "**Operational Control** approach, to define our organizational and operational boundaries. This is to ensure that we focus on emission sources from operations over which it has both interest and control and can implement management actions consistent to its corporate environmental policy objectives. Under this approach, we have included emissions inventory from all sources and sinks over which we have 100% operational control during the reporting period and these are listed in Table 3-1.

Table 3-1: Power Plants under VRA's Operational Control

#	Commissioning Date	Power Plant	Plant Type	Installed Capacity (MW)	Dependable Capacity (MW)	Location
1	1965	Akosombo Hydropower Plant	Hydro	1080	900	Akosombo
2	1982	Kpong Hydropower Plant	Hydro	160	140	Akuse
3	1997	Takoradi 1 Thermal Power Plant	Thermal	330	300	Aboadze
4	2007	Mines Reserve Power Plant	Thermal	80	40	Tema
5	2009	Tema Thermal 1 Power Plant	Thermal	110	100	Tema
6	2010	Tema Thermal 1 Power Station	Thermal	87	70	Tema
7	2013	Takoradi 3 Thermal Power Plant	Thermal	132	120	Aboadze
8	2013	Navrongo Solar Power Plant	Solar	2.5	0	Navrongo
9	2016	Kpone Thermal Power Station	Thermal	220	200	Kpone

Note: Mines Reserve Power Plant was decommissioned in 2016

3.1.2 Operational Boundaries

An operational boundary defines the scope of direct and indirect emissions for operations that fall within a company's established organizational boundary. It determines the business activities of the company that generate emissions, which of these activities should be included in the calculation, and how these activities would be classified. Establishing operational boundaries helps to verify that all applicable GHG emission sources are appropriately accounted for and "double counting" is avoided.

Subsequently, our operational boundary are the locations of the related infrastructure and offices of the nine (9) power generating facilities as listed in Table 3-1, and these are Akosombo, Akuse, Aboadze, Navrongo, Tema, Kpone. It also includes Accra, the country's capital, where company's group head office is located. The various departments and outfits shown in Appendix 2 are distributed within these operational boundaries.

As indicated, VRA currently operates seven (7No.) subsidiary companies which are wholly owned by the company. Three of these, the VRA Health Services Limited, VRA International School Limited and Property Management Company were still under direct management of VRA as of close of 2018, and have been included in the GHG inventory.

3.2. GHG Emissions Scope

3.2.1 Scope 1 - Direct Sources

A facility's direct GHG emission sources (Scope 1) is considered as those direct emissions resulting from sources that are within the 'fence line' of the facility (i.e., are under the operational control of the operator of the facility). Direct emissions may include emissions from stationary combustion, mobile combustion, process emissions and fugitive sources resulting from the combustion of fossil fuels.

Our direct emissions are included in the following categories:

a) Stationary Combustion:

Direct combustion of fossil fuels from the thermal power projects, located in Aboadze, Tema and Kpone. Significant emissions of these plants are from the direct combustion of fossil fuels that it uses, which are distillate fuel oil (DFO), light crude oil (LCO), Liquified Natural Gas (LNG).

b) Mobile Combustion:

This involve combustion of fuels, mostly diesel and petrol, in VRA owned/controlled mobile sources, such as trucks, buses, cars and motorbikes. It also includes marine fleets being operated on the Volta Lake System for various activities.

c) Fugitive Emissions:

This includes emissions from the following:

1. Refrigeration and air conditioning equipment at the various offices.
2. Mobile air conditioning sources from vehicles and marine fleets.
3. Emissions from fixed and portable fire suppression equipment at VRA power plant facilities.
4. Direct emissions from purchased industrial gases for use by VRA workshops and laboratories.

3.2.2 Scope 2 - Indirect Sources

Scope 2, also referred to as Energy Indirect GHG emissions are emissions that are a consequence of the activities of the reporting company but occur at sources owned or controlled by another company. VRA's indirect sources of emissions include those from purchased electricity and electrical line transmission/conversion losses and includes:

1. Electricity consumed at Akosombo, Akuse, Aboadze. Tema and Kpone as well the related various office buildings are accounted for in the direct emissions from VRA's owned generating facilities.
2. Purchased electricity at Office buildings outside its power generating enclaves, which are the Electro Volta House (Head office), Heritage Towers and Ridge Towers, all in Accra.
3. The natural gas distribution lines associated with thermal power generation facilities at Aboadze, Tema and Kpone.

3.2.3 Scope 3 – Other indirect Sources

Scope 3 or Other Indirect GHG emissions are defined as 'emissions that are a consequence of the operations of an organization but are not directly owned or controlled by the organization'. Indirect Optional sources of information that VRA could provide includes emissions associated with power purchased to meet customer demand and support grid operations. Other indirect sources are employee business travel and full lifecycle/supply chain emissions.

Our Scope 3 are included in the following categories:

1. Employee business air travels, both internal and external.
2. VRA owned Akosombo waste land fill site
3. Power purchased to meet electricity demand from utility companies in neighboring countries as shown in Table 3-2, averaged 2.08% during the period.

Table 3-2: VRA Generation & Import Data (2012-2018)

Year	Total Generation (GWh)	Total Import (GWh)	Percentage Import
2012	11,082.88	127.67	1.15%
2013	11,357.82	26.95	0.24%
2014	10,460.57	50.72	0.48%
2015	9,052.22	223.24	2.47%
2016	8,151.35	573.77	7.04%
2017	8,117.56	246.80	3.04%
2018	8,619.29	140.97	1.64%
Total	66.841.69	1,390.12	2.08%

Source: Engineering Services Dept.

3.3. Exclusions

The following sources of GHG emission have been excluded in the current quantification:

3.3.1 Scope 1 – Direct Sources

1. Fugitive emissions such as Hydrofluorocarbon (HFCs) from building Heating Ventilation Air Condition (HVAC) systems and mobile air conditioning sources (vehicles/mobile fleets) as described under Section
2. Scope 1 - Direct Sources3.2. *For air-conditions and refrigeration, VRA intends adopting the guidelines for "**Calculating HFC and PFC Emissions from the Manufacturing, Servicing, and/or Disposal of Refrigeration and Air-Conditioning Equipment (Worksheet Version**), which was developed by ICF Inc, USA, with and for the GHG Protocol Initiative.*

3. Emissions associated with employee transport in their own vehicle and business-related air travels have also been excluded. *The exclusion of these sources is because such data has not been readily available and therefore difficult to incorporate.*

3.3.2 Scope 2 – In Direct Sources

1. With respect to purchased electricity, with the exception of Accra, all VRA offices and facilities utilizes electricity from the company's power plants. In Accra, it is not clear where exactly it comes from as electricity supply is not segregated in the country. It is however assumed that the electricity supply will be from power generating facilities in Tema as these are the nearest power plants, of which VRA's generating plants forms about 30% of the power from Tema. Aside the Electro Volta House which VRA shares with only ECG, the Heritage Towers and Ridge Towers are shared with various other companies. Thus, purchased electricity at these facilities is considered insignificant to the total GHG emissions and is excluded from the accounting.

2. Emissions from natural gas distribution lines associated with thermal power generation in Aboadze, Tema and Kpone facilities have not been considered at this initial stage of the VRA's GHG calculation and reporting. *It is planned that this will might done in future reports following detailed consultation with the EPA.*

3.3.3 Scope 3 – Other indirect Sources

Emission sources under Scope 3 are not mandatory under WRI reporting protocols. Therefore, at this initial stage of reporting, VRA is also not considering optional sources under Scope 3. VRA will however provide information on actions initiated to allow for a holistic view of the organisations activities in the area of carbon footprint management.

3.3.4 VRA Subsidiary Companies

The underlisted subsidiary companies are also excluded.

1. Northern Electricity Distribution Company (NEDCo), was incorporated in 1997 and became operational in May 2012
2. Akosombo Hotels (AHL), incorporated in 1991, runs the Volta Hotel in Akosombo, a 3-star hotel, restaurant and modern conference/seminar facilities and pleasure activities including cruising on the lake by MV Dodi Princess to promote tourism.

3. Volta Lake Transport Company Limited (VLTC), incorporated in 1970, operates river transportation for passengers, bulk haulage of petroleum products and significant quantities of cement, and cross-lake ferry services along the Volta Lake. responsible for inland water transport on the Volta lake The company's current operational stations are Yeji, Dambai, Kete Krachi, Adawso and Akosombo. It operates inland water transportation with a ferry fleet of nineteen (19) made up of passenger vessels/water buses, cargo ferries and barges. The company carries the average of 647,000 passengers and 57,000 cars per year, on all its ferries.

4. Kpong Farms Limited (KFL), incorporated in May 1982, is a wholly-owned agricultural commercial venture, to carry out mechanized commercial farming, agro-processing, and provision of machinery services. KFL was established to harness the water resources of the Volta Lake at Kpong for the use of viable agricultural ventures and for the Farm to serve as a demonstration project in a modern agricultural system. Over the years, KFL has evolved into a commercial venture with a huge potential for expansion with the private sector.

These subsidiaries were not directly under VRA Management at the period of reporting. It is actually planned that by June 2021, VRA in collaboration with the EPA will roll out a series of capacity building programme on Corporate GHG Reporting for the Subsidiary companies.

3.3.5 Thermal Power Plants

In line with the opted inventory boundary, the underlisted thermal power plants in which VRA owns an interest but has no operational control are also excluded:

1. 345MW Takoradi International Company (TICO) owned as a joint venture with TAQA, from Abu Dhabi in the United Arab Emirates.
2. 250MW AMERI Plant currently being operated on a BOOT basis by AMERI Energy.

3.4. Scope of GHG Savings

3.4.1 Renewable Energy

In line with national actions in the renewable energy sector, VRA in February 2010 adopted a Renewable Energy Policy in order to develop and operate RE plants in an efficient, cost effective and environmentally sustainable manner. The REDP sets a 5-10 years' Renewable generation capacity target, taking cognisance of the local and export demand and the system constraints and is being rolled out in two (2) phases.

The Navrongo Solar Power Station was commissioned in 2013, with an installed capacity of 2.5MW, and has since been in operation. In 2018, the Ministry of Energy formally handed over the underlisted 5 mini solar power off grid to VRA for operation and maintenance:

1. 50KW Perdiatorkope
2. 40.5KW Atigagorme
3. 39KW Wayokope

4. 54KW Aglakope
5. 54KW Kudorkope

The solar power infrastructure facility represents an investment in clean, renewable energy infrastructure, which given the challenges created by climate change, represents a positive social benefit for society, as it would indirectly reduce/eliminate considerable percentage of air pollutants emissions due to consistent use of thermal power generation to support the exiting hydropower plants.

3.4.2 Waste Management Practices

VRA in 2017 adopted an "**Office Waste Segregation Policy**" aimed at reducing the total volume of office waste generated at its Offices and disposed of at landfills. The policy also seeks to address the control, management and disposal of electrical and electronic waste on the operations of the Authority as required by the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917).

Under this policy, VRA in August 2017 commenced an "Office Waste Paper Exchange Programme" with Akosombo Paper Mill Limited (APML), involving the exchange involves the supply of 80 pieces of unwrapped toilet rolls for 1 ton of office waste paper supplied to APML. Office Waste Paper exchanged are weighed at the factory premises and signed by both parties on an ***Office Paper Waste Logsheet***, which is then used as source document for reporting purpose.

4 METHODOLOGY

4.1. Emission Factors

Emission factor refers to the rate at which a pollutant is released into the atmosphere (or captured) because of some process activity or unit throughput. Emission factors convert activity data (e.g. amount of fuel used, kilometers driven, and kilowatt-hours of purchased electricity) into a value indicating carbon dioxide equivalent (CO_2 Equiv.) emissions generated by that activity. Default values are used by the GHG Protocol to assist businesses that are unable to develop accurate customized values. These default values are representative averages based on the most extensive data sets available and are largely identical to those used by the IPCC, the premier authority on greenhouse gas accounting practices at the global level.

The GHG Protocol recommends, however, that businesses should use customized values whenever possible, as industrial processes or the composition of fuels used by businesses may differ with time and by region. This report uses default emission factors from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

4.2. Global Warming Potential & Carbon Dioxide Equivalent

ISO 14064 recognizes that not all GHGs have the same properties. Due to the varying ability of greenhouse gases to trap heat in the atmosphere, some are more harmful to the climate than others. Each greenhouse gas has a 'global warming potential' (GWP), which refers to its heat trapping potential relative to that of CO_2. GWPs compare the climate impact of different greenhouse gases with that of CO_2, and they are used to calculate emissions in terms of CO_2-equivalents. Therefore, to provide a comparable final figure, all emissions are reported as a relative figure to CO_2, i.e. as CO_2e values as required by the GHG Protocol. As scientific understanding advances, the GWP values of GHGs can change. The IPCC's Fifth Assessment Report, 2014 (AR5) values are the most recent. However, discussions with officials of the Ghana EPA indicates that national inventory utilizes Second Assessment Report, 1995 (AR2) and VRA should adopt that for reporting and uniformity purposes. The AR2 has subsequently been adopted for the VRA reporting

Thus, the levels of the individual emissions have been presented in Carbon Dioxide Equivalents (CO2e) terms using the 100-year global warming potentials (GWPs) contained in the 1995 IPCC Second Assessment Report (IPCC 1996).

4.3. Quantification Method

The combustion of fuels produces emissions of the following greenhouse gases: Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O). Carbon Dioxide accounts for the majority of greenhouse gas emissions from most stationary combustion units. When weighted by their Global Warming Potentials (GWPs), CO_2 typically represent over 99 percent of the GHG emissions from the stationary combustion of fossil fuels. The GHG Protocol provides tools that present a step by-step guidance and electronic worksheets to help users calculate GHG emissions from specific sources or industries. These tools are consistent with those proposed by the Inter-Governmental Panel on Climate Change (IPCC) for compilation of emissions at the national level (i.e. latest versions of IPCC, 1996). Furthermore, they are designed to be user-friendly for non-technical company staff and to increase the accuracy of emissions data at a company level.

Based on engagement with the Environmental Protection Agency, VRA has adopted the following GHG quantification tools:

a) World Resources Institute (2015) Stationary Combustion Tool Version 4.1
b) Mobile Combustion GHG Emissions Calculation Tool Version 2.6.
c) Tool for GHG Accounting for Energy Projects, developed by KfW Development Bank
d) Waste Reduction Model (WARM), Version 12 (February 2012).

4.3.1 Stationary Combustions Emissions

The Corporate Accounting and Reporting Standard quantification methodology, "**World Resources Institute (2015) Stationary Combustion Tool Version 4.1**", has been adopted for VRA' s stationary combustion from its thermal power plants. GHG emission estimation is based on activity data (based on fuel consumption) and on the emission factors (whether they are calculated or obtained from official sources) in line with the national strategy for GHG calculations. This tool calculates the CO_2, CH_4 and N_2O emissions for the combustion of fuels in boilers, furnaces and other stationary combustion equipment. One needs to supply information on the types and amount of fuel burnt as well as the industry sector. Emissions are then automatically calculated using default emissions factors, chosen to reflect this information.

The reporting of emissions regarding operations from VRA's thermal power generation power plants is regulated by the EPA and we are mandated to report on emissions levels on a periodic basis. A Continuous Emission Monitoring System (CEMS) is used at most plants to directly monitor emissions, specifically NOx, SOx, CO and PM_{10}. During the reporting period, direct emissions of CO_2 was not required by the Ghana EPA and therefore not measured. We therefore monitor and report on data on fuel usage (DFO/LCO/Natural Gas) as well as power generated, and this information is made available in quarterly environmental monitoring progress reports as well as annual environmental reports to the EPA. Data on fuel usage, as indicated in Table 4-1, was utilised in quantifying GHG emission from the stationary combustion plants. Data on Gross Energy Generated from each thermal power plant during the period is also provided in

Table 4-2, and this was used to calculate Specific GHG emissions per energy in order to help assess plant efficiency.

Table 4-1: Fuel Usage in VRA Thermal Power Plants (2012-2018)

Power Plant	Amount of Fuel Utilised								
	Fuel Type	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
T1	Gas (mmBTU)	3908264	2190365	2049310	15615347	7073154	4961819	8447440	44245699
	LCO (ltrs)	257577300	358490410	183580690	50975800	109034080	27127110	10718790	997504180
	DFO (ltrs)	1003300	988830	641480	458250	609860	333030	593336	4628086
T3	Gas (mmBTU)	0		778185	338930	0	0	0	1117115
	LCO (ltrs)	0	27654720	0	0	0	0	0	27654720
	DFO (ltrs)	0	36570	0	0	0	0	0	36570
TT1PS	Gas (mmBTU)	1317219	1758458	3536265	3121148	0	2363056	3693511	15789657
	LCO (ltrs)	143102248	124932730	138546900	102756300	57476700	61661000	0	628475878
	DFO (ltrs)	1131020	664900	642800	473500	139000	86400	0	3137620
TT2PS	Gas (mmBTU)	1560257	1062298	2717206	2420967	308296	0	30960	8099983
	LCO (ltrs)	0	0	0	0	0	0	0	0
	DFO (ltrs)	4645000	3209600	0	0	0	0	0	7854900
MRPS	Gas (mmBTU)	0	0	2645692	2401936	0	0	0	5047628
	LCO (ltrs)	0	0	0	0	0	0	0	0
	DFO (ltrs)	8267300	0	0	0	0	0	0	8267300
KTPS	Gas (mmBTU)	0	0	0	0	0	35187	3282665	3317852
	LCO (ltrs)	0	0	0	0	0	0	0	0
	DFO (ltrs)	0	0	0	0	3599000	39397800	10622830	53619630

Source: E&SDD – Station's Annual Environmental Reports

Table 4-2: Gross Energy Generated from VRA Thermal Power Plants

Gross Energy Generated (MWH)							
Period	**T1**	**T3**	**TT1PS**	**TT2PS**	**MRPS**	**KTPS**	**Total**
2012	1,061,020.00	-	602,710.00	137,889.00	N/A	-	1,801,619.00
2013	1,755,087.60	87,122.00	1,946,070.00	93,158.40	-	-	3,881,438.00
2014	789,582.83	87,061.00	697,050.00	211,703.00	200,708.30	-	1,986,105.13
2015	1,750,399.68	30,619.00	544,730.00	210,152.10	172,220.10	-	2,708,120.88
2016	1,215,715.49	-	169,944.00	25,713.50	-	9,887.20	1,421,260.19
2017	668,594.00	-	365,630.00	-	-	120,671.10	1,154,895.10
2018	1,393,933.62	-	316,040.00	2,584.00	-	252,524.00	1,965,081.62
Total	8,634,333.22	204,802.00	4,642,174.00	681,200.00	372,928.40	383,082.30	14,918,519.92

Source: E&SDD – Station's Annual Environmental Reports

4.3.2 Mobile Combustion Emissions

According to the GHG Protocol - Mobile Guide (03/21/05) v1.3, for all mobile sources, one may apply either a fuel-based or distance-based methodology to calculate CO_2 emissions. In the fuel-based approach, fuel consumption is multiplied by the CO_2 emission factor for each fuel type. This emission factor is developed based on the fuel's heat content, the fraction of carbon in the fuel that is oxidized (generally approximately 99% but assumed to be 100% in this tool), and the carbon content coefficient. Since this approach uses previously aggregated fuel consumption data, it is considered "fuel-based." Fuel based approach can be used also when vehicle activity data and fuel economy factors are available that enables calculation of fuel consumption. In the distance-based method, emissions can be calculated by using distance-based emission factors to calculate emissions. The Mobile Combustion GHG Emissions Calculation Tool Version 2.6 calculates the CO2, CH4 and N2O emissions from:

- Vehicles that are owned/controlled by the reporting entity, including freight lorries.
- Public transport by road, rail, air and water.
- Mobile machinery, such as agricultural and construction equipment.

Activity data could be in terms of vehicle kilometers (or miles) traveled, freight ton-kilometers (or miles), passenger-kilometers (or miles), etc. Because the data on fuel are generally more reliable, the fuel-based method is the preferred approach for this tool. The distance-based method should only be used as a last resort as it can introduce considerably higher levels of uncertainty in the CO_2 estimates. In view of this, the "fuel based" approach has been used in calculating the emissions levels from VRA owned/controlled mobile sources.

There is a detailed inventory of vehicles owned throughout the company and this is maintained by the Transport Section, under the then General Services Department. This Section has since August 2019, been transferred to the Technical Services Department. The Transport Section also tracks information regarding the fleet's fuel usage and distance in kilometers traveled. All departments are required to make available data on fuel usage and distance travelled for their mobile sources to the General Services Department, using what is called the "Vehicle Operational Chart". The key challenge was that some were not complying with the reporting requirements and data from such departments were obtained directly from the departments from the source books. During the assessment, some of the departments had sent data to the archives and these were difficult to retrieve, and therefore not assessed.

The data regarding fuel usage from the vehicular sources were sourced from this outfit for quantification purposes and provided in Table 4-3. Data not Available (DNA) is indicated in the table.

Table 4-3: Vehicular Fuel Usage (2012-2018)

Department	Fuel Type	2012	2013	2014	2015	2016	2017	2018
Board Secretariat	Diesel	DNA	DNA	DNA	DNA	DNA	120	DNA
	Petrol	DNA	DNA	55	DNA	DNA	DNA	DNA
Corporate Strategy	Diesel	405	DNA	2847	4018	9791	12534	8016
	Petrol	38	941	752	1960	639	975	60
Deputy Chief Executives	Diesel	DNA	DNA	981	7390	119270	232608	3776
	Petrol	DNA	DNA	829	3494	9620	27234	960
Engineering Services	Diesel	49171	33667	63440	297857	142989	123222	23386
	Petrol	5630	16080	12366	52708	6154	5035	4070
Environment & Sustainable Development	Diesel	44818	18226	43229	50231	36992	76199	23991
	Petrol	1840	20767	33369	34514	35691	6699	826
Finance	Diesel	40863	18019	11616	24542	22772	47823	14187
	Petrol	817	12365	1523	13620	706	1187	235

Department	Fuel Type	2012	2013	2014	2015	2016	2017	2018
Health Services	Diesel	18384	DNA	60154	30051	22795	63415	31129
	Petrol	4729	DNA	495526	17638	4456	22054	6502
Human Resources	Diesel	5414	5500	5837	2902	4974	9919	16801
	Petrol	DNA	4492	270	1926	432	625	335
Hydro Generation	Diesel	51743	11542	38306	25547	21396	69660	27739
	Petrol	2845	772	1807	1582	497	12789	609
Internal Audit	Diesel	1510	1991	988	730	1063	1530	45
	Petrol	334	1146	2293	4174	961	1079	55
Investment	Diesel	DNA	DNA	DNA	DNA	264	100	100
	Petrol	DNA	DNA	DNA	DNA	DNA	DNA	DNA
Legal Services	Diesel	3750	6116	DNA	170	1187	70	38
	Petrol	337	3733	DNA	170	DNA	45	45
Management & Information System	Diesel	47762	10532	5111	6487	9164	11639	6829
	Petrol	3719	5516	1082	3532	410	701	75
Planning & Power Business	Diesel	6659	6192	1889	5709	438	2544	DNA
	Petrol	DNA	3429	894	2893	175	510	DNA
Procurement	Diesel	14427	12196	51328	51783	51149	96007	39272
	Petrol	600	11871	2559	10305	90	734	90
PropCo	Diesel	DNA	DNA	65	236	9872	32369	4466
	Petrol	DNA	DNA	DNA	DNA	DNA	150	250
Real Estate and Security	Diesel	22256	20605	53651	40991	37147	70860	18694
	Petrol	1109	484	DNA	32499	460	1255	DNA
Technical Services	Diesel	87138	17278	21194	56548	79125	71114	46792
	Petrol	6204	11594	1164	17788	892	755	1489
Thermal Generation SBU	Diesel	DNA	8012	3597	26594	7985	64716	96695
	Petrol	DNA	6060	1372	16128	1340	2265	6504
VRA Academy & Schools	Diesel	9982	746	637	5642	1867	18322	27187
	Petrol	176	746	DNA	60	DNA	45	110
VRA Corporate Parent	Diesel	1070	1238	3124	25558	12177	20353	16953
	Petrol	338	DNA	1661	5089	2340	3190	2199
Grand Total	Diesel	361647	198452	342991	655984	605656	985917	458304
	Petrol	28716	99996	557522	220080	64863	87327	25523

Source: General Services Department – Vehicle Operational Chart

Marine fleets are maintained by the Environment & Sustainable Development Department (E&SDD). Thus, regards to water transport, E&SDD is responsible for operating marine fleets as well as machinery such as sand/weed dredgers on the Volta Lake System. Data on fuel usage taken from tankers for water transport in liters are recorded in a Bin Card and amount utilised provided in the vessels logbook and reported upon on a monthly basis. Source data utilised was primary information from the logbooks and a total of 166,089 liters of diesel fuel was utilised by the marine vessels as shown in from 2012-2018. Data from the sand/weed dredgers are yet to be compiled and this will be completed and results provided in the next updated GHG Inventory Report.

Table 4-4: Marine Fleet Fuel Consumption (2012-2018)

Period	Vessels	Diesel Fuel (Road) - Liters
2012	MV. Ohemaa LX1	5,149
	MV. Tilapia	2,975
	MV. Dodi Princess 1	21,165
	MV. Volta Princess	4,200
	TOTAL	**33,489**
2013	MV. Ohemaa LX1	12,366
	MV. Volta Queen	10,389
	MV. Onipanua	4,000
	TOTAL	**26,755**
2014	MV. Buffalo	817
	MV. Ohemaa LX1	6,232
	MV. Volta Queen	4,000
	TOTAL	**11,049**
2015	MV. Onipanua	1,845
	MV. Buffalo	280
	MV. Volta Queen	8,500
	MV. Volta Princess	2,500
	MV. Ohemaa LX1	1,600
	TOTAL	**14,725**
2016	MV. Ohemaa LX1	1,600
	MV. Volta Queen	11,400
	MV. Onipanua	7,900
	MV. Buffalo	474
	MV. Volta Princess	1,000
	TOTAL	**22,374**
2017	MV. Volta Queen	4,000
	Dipa Generator set	420
	MV. Ohemaa LX1	1,798
	MV. Volta Princess	2,500
	MV. Onipanua	3,000
	MV. Buffalo	209
	TOTAL	**11,927**
2018	MV. Volta Queen	32,400
	MV. Onipanua	9,756
	MV. Ohemaa LX1	1,334
	Dipa Generator set	200
	MV. Buffalo	80
	MV. Volta Princess	2,000
	TOTAL	**45,770**

Period	Vessels	Diesel Fuel (Road) - Liters
TOTAL FUEL CONSUMPTION		**166,089**

Source: E&SDD - Marine Services Unit Fleet Log Books

4.3.3 GHG Savings from Renewable Power Plants

The "**Tool for GHG Accounting for Energy Projects**", developed by KfW Development Bank has been adopted and this allows for calculating carbon emissions as well as emissions savings. For renewable energy projects (solar / wind / hydro / geothermal / bioenergy), this is achieved by calculating the amount of electricity generated annually, on average, by the renewable energy project will be multiplied by and thus compared to the combined grid margin Operating Margin (OM) 75% / Build Margin (BM) 25 % for Solar and Wind, the rest assumes OM ⅓ and BM⅔. It is assumed that this amount of renewable electricity displaces electricity that would be generated per the country-specific fuel mix.

The power house equipment at the Hydro Generation Department is connected to a Data logger which logs and records the generation and other parameters from the PV Plants onto an external Secure Digital (SD) card. Data on Gross Annual Energy Generated (MW hours) is utilized for the calculations of the GHG savings, supported by the plant's Project Specific Capacity Factor, Default Capacity Factor and Default Emission Factor, in the case of solar energy.

The 2.5MW Navrongo Solar Power Station (NSPS) commenced operation in June 2013, and as in all solar power plants, and a 18,626 MWhrs was generated during the period. Again, the 5 mini solar power off grid, totaling 237.5KW was handed over to VRA in July 2018 for operations and maintenance, and a total of 80.4619 MWhrs was generated during the period.

Table 4-5 gives the breakdown of the energy generated by each plant from 2012-2018. Years that are Not Applicable (N/A) because the PV plant was not operational is indicated. The PV power plant utilises polycrystalline technology, with an expected default operational life time of 20 years.

Table 4-5: Gross Annual Energy Generated (2012-2018)

Period	Solar Power Plant					
	Navrongo	Wayokope	Atigagorme	Kudorkope	Perdiatorkope	Aglakope
	2.5MW	0.030MW	0.0405MW	0.054MW	0.05MW	0.054MW
2012	N/A	N/A	N/A	N/A	N/A	N/A
2013	2672	N/A	N/A	N/A	N/A	N/A
2014	3843	N/A	N/A	N/A	N/A	N/A
2015	3272	N/A	N/A	N/A	N/A	N/A
2016	2938	N/A	N/A	N/A	N/A	N/A
2017	2537	N/A	N/A	N/A	N/A	N/A
2018	3364	6.67170	8.807	18.36660	23.3083	23.30830

Source: Hydro Generation Department – Power Generation Data

4.3.4 GHG Savings for Waste Reduction

VRA has adopted the Waste Reduction Model (WARM), created by the U.S. Environmental Protection Agency (EPA), to help solid waste planners and organizations estimate greenhouse gas (GHG) emission reductions and economic impacts from several different waste management practices. WARM calculates GHG emissions for baseline and alternative waste management practices, including source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in metric tons of carbon dioxide equivalent (MT CO_2e) and metric tons of carbon equivalent (MTCE) across a wide range of material types commonly found in municipal solid waste (MSW).

VRA has adopted the WARM Version 12 (February 2012), instead of the latest Version 15 of May 2019. This is because the GWP values in WARM Version 12 include those from the Intergovernmental Panel for Climate Change (IPCC) Second Assessment Report, which Ghana subscribes to. The model has been used to calculate GHG savings from the amount of office waste paper recycled by VRA (in Short Tons). It is assumed that the office waste paper, if not recycled will have otherwise been landfilled for decomposing. Under the Office Waste Paper Recycling Programme, VRA had by close of 2018, recycled a total 2083 Kg (2.296 Short Tons), as shown in **Error! Reference source not found.** and Figure 4-1.

Table 4-6: Office Waste Paper Recycled

Period	Weight (kg)	Weight (Short Tons)
2017 (Aug – December)	453	0.499
2018	1630	1.796
Total	2083	2.296
Total	2083	2.296

Source: E&SDD - Office Paper Waste Logsheet

Figure 4-1: Quarterly Trends for Office Waste Paper Recycled

4.4. Greenhouse Gases Covered in the Inventory

The seven main greenhouse gases covered by the GHG Protocol and reported as CO_2e are Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3). GHGs identified for the VRA's inventory are CO_2, CH_4 and N_2O.

Based on earlier discussion under Chapter 0, the following GHG gases are excluded in this GHG Report.

1. Sulfur Hexafluoride (HF_6) from power transmission and distribution equipment, and Hydrofluorocarbon (HFCs) from building Heating Ventilation Air Condition (HVAC) systems and mobile air conditioning sources (vehicles)

2. Perfluorocarbons and Nitrogen Trifluoride, because given the nature of its business, this class of chemicals is not used in any of VRA's operations in any sizeable amount.

3. Methane from the Akosombo waste land fill site

4.5. Uncertainties In The GHG Inventory

4.5.1 Potential Sources of GHG Emissions Excluded

Uncertainties may exist in the inventory because of the failure to include or properly allocate emission sources within the boundaries of the inventory. Only those emissions believed to be of significant relevance to VRA's operations were included. Those excluded are:

1. HFCs and PFCs emissions from refrigeration equipment leaks and Methane (CH_4) from natural gas distribution systems.

2. To avoid double counting, purchased electricity at VRA office facilities in Accra are excluded in the inventory.

3. Scope III emissions were also not included in this inventory. These emission sources were not quantified in the inventory because it was determined that the large effort necessary to estimate their emissions was not warranted by the scale of their potential emissions in relation to the overall inventory. VRA will commence discussions on how to systematical gather data and calculate emissions from these sources for inclusion in future reports.
4. Exchange of electricity resulting in the wheeling of power between Ghana and its neighboring countries as shown in Table 3-2 have also been excluded in the inventory, as it is considered minimal and of little significance.

4.5.2 Uncertainty Associated with Data Sources and Methodology

Uncertainties may also exist in the inventory because of the failure to properly estimate emissions from each source. This issue could pertain to inaccurate emission estimation methods or erroneous input data (e.g., fuel throughput) that were used to estimate emissions. The GHG Protocol specifies that neither assumptions nor methodology should introduce systematic errors that would lead to either high or low estimates of emissions. The methodology generally used to estimate emissions is to apply generally accepted emission factors to translate the amount of activity (e.g., kWh, Volume of fuel) into GHG emissions. One of the most likely sources of systematic error can result from the improper use of emission factors, or the use of inaccurate emission factors. As indicated, this report utilized default emission factors from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories as well as GWP from the Intergovernmental Panel for Climate Change (IPCC) Second Assessment Report. The selection of these emission factors was recommended by the Ghana EPA and is based on assumptions regarding their suitability for the specific application.

Any errors resulting from improper use of emission factors could be evaluated in detail through emissions testing of equipment to develop equipment or source-specific emission factors. The VRA currently does not measure CO_2 emissions from its thermal generating plants as it is not a requirement by the Ghana EPA. However, it is not practical to perform this exercise for each specific emission source in this inventory. This detailed level of evaluation is outside the scope of this inventory. All emission factors used in this inventory are based on commonly accepted practices and best professional judgment to minimize sources of error to the maximum extent possible within the defined scope of the inventory.

With respect to actual fuel usage, inputs were obtained from data as recorded by stationary plant facilities during generation. The primary data is recorded at the plant level and made available as part of the Annual Environmental Reports (AERs) that VRA submits to the EPA and the Energy Commission, the national regulatory agencies of the powers sector. The secondary data as provided in the AERs formed the source of this report. Thus, if the information is utilized without confirmation from the source data at the power plant there could be challenges with the data if source entry is inaccurate. Primary data from the power plants was therefore obtained and crosschecked for use.

In their review comments, ICF International recommended the need to also include CO_2 in the direct measurement as a means of using the data to confirm the calculations. Going forward, facilities with CEMS that can undertake CO_2 measurements, like the KTPS will be used for such confirmatory exercises.

Uncertainties in calculating transportation emissions from mobile sources may result from several factors:

- If fuel-based method is used, fuel receipts are incomplete or do not clearly indicate purchases of specific fuel types;
- If fuel-based method is used, conversion of fuel expenditure data to fuel quantity based on fuel price data;
- If distance-based method is used, estimates of distance traveled and/or fuel economy are roughly estimated; and
- Emission factors are not customized to reflect actual conditions (e.g., default CO2 emission factors are used for highway sources, instead of customized factors based on location of fuel purchases).

In general, the use of the fuel-based methods produces less uncertainty than use of the distance-based methods and as indicated, VRA adopted this method. With respect to VRA owned/controlled mobile sources, VRA has allocated logbooks for all its vehicles for recording fuel purchased and distance covered. Drivers are subsequently required to input manually such primary data for compilation at the end of each month. Fuel attendants at VRA owned fuel stations endorsed data on fuel obtained. Thus, data on fuel purchased from VRA fuel stations are all captured in the logbooks. At the end of the month, the respective departments are to compile information in the logbooks and submit returns on fuel usage and distances covered to the owner department. Such secondary data was utilized for the calculations.

The key challenge here is that individuals using the vehicles may not log in the required data especially if the fuel is purchased outside the VRA owned fuel stations and therefore information provided may not be actual. In addition, data may be omitted during the compilation. Again, the secondary information as obtained was utilized without confirmation from the primary source data from the departments or the logbooks. All these could result in data uncertainties. As earlier indicated, the main issue has been that due to the period under consideration, some of the departments had sent data to the archives and these were difficult to retrieve and therefore not included in this report.

VRA in 2016 adopted the oracle-based fuel requisition methodology and all fuel requests are generated on line. The exception is fuel purchased outside the VRA system. The data is submitted monthly to the General Services Dept. It is expected that going forward, data on fuel usage from all departments can be captured accurately and on time using the online based system.

Data of diesel fuel utilised was obtained from the vessels logbooks and utilised for the GHG calculations. This data is cross checked using the Bin Cards at the filling point by all parties prior to inputting. It must be noted that these vessels are available for hiring and clients are expected to purchase their fuel whilst in use. The data obtained is from the use of only VRA's internal activities and there is the need to also compile fuel data usage for external clients for inclusion.

Data on amount of office waste paper recycled is obtained through weighing at the recycling facility by both parties, and the information provided in monthly reports of the E&SDD using the ***Office Paper Waste Logsheet***. Key assumptions included the paper is produced from 100% virgin material, lack of landfill gas conversion system in place, and default transport distances, as the paper is sourced from various work location areas.

4.6. Potential Sources of GHG Sequestration

Cognisant of the need to ensure continuous flow of water resources in the Volta Lake basin for sustainable generation of hydro-electricity for economic development of Ghana; the global need for reduction of greenhouse gas emissions; and the influence trees have on local climate as well as erosion control, VRA has embarked on various watershed management activities along the Volta lake. VRA's watershed management activities focus on an integrated approach to the management of the Volta Lake Basin environment, by incorporating the environmentally friendly livelihood options into the reforestation and wild fire management activities around the water bodies in the Basin. Current ongoing ones are the Volta Gorge Protection Programme and the Buffer Zone Tree Planting Programme. Activities being undertaken are seedling raising, tree planting, bush fire management, community and school environmental advocacy and education programmes and provision of alternative livelihood programme, including non-farm activities.

The Volta Gorge is an area of about 5,149.24 hectares bordering the hills before the Akosombo dam. Areas being planted are degraded areas with grassy areas and fire prone and as at December 2018, about 1,576 hectares of the Volta Gorge area had been planted. Tree species adopted are *Senna siamea* (cassia), *Acacia mangium, Khaya senegalensis (*Mahogany), *Cedrella odorata,* and *Leuceana leucocephala.*

The Buffer Zone Reforestation Programme, which started in 2007 is being implemented in collaboration with forty (40) communities within three (3) riparian Districts and these are the South Dayi, Kpando and Biakoye in the Volta Region. As at close of December 2018, close to 188.1 hectares of forest tree plantation had been established along the Volta Lake and its tributaries to serve as buffer to minimize siltation, water pollution and landslide along the catchment and has also introduced number of interventions as sources of livelihood to the implementers of the project.

VRA has engaged an expert from the Forest Services Division under the Forestry Commission as CAT Member to advise on strategies to calculate the carbon sequestration potential of forest tree species planted and being maintained. The 2008 IPCC Guidelines for National GHG Inventory is to be adopted for calculating the carbon stock, using tree dimensions (girth, wood density, basal area, height, etc), depending on the tree species and types.

5 RESULTS OF GHG QUANTIFICATION

Summary of results obtained for GHG quantifications during the period under review are discussed below.

5.1. Stationary Combustion

GHG emissions arising from stationary combustion of fuel types for each power station or the period 2012 to 2018 is summarised in Table 5-1. The total GHG emission for the seven year period was 8,922,521.48 Tonnes CO_2 Equiv. The detailed spreadsheet calculations for GHG estimations from stationary combustion of the various thermal power stations are provided as Appendix 2 in the calculation sheet.

Table 5-1: GHG Emissions from Stationary Combustion - (Tonnes CO_2 Equiv.)

Period	T1	T3	TT1PS	TT2PS	MRPS	KTPS
2012	875,326.90	-	437,244.19	104,913.03	22,201.72	-
2013	1,024,671.93	68,927.99	416,911.96	71,556.19	-	-
2014	580,049.70	46,104.33	556,064.85	160,983.52	156,746.60	-
2015	1,053,250.60	20,080.24	441,937.00	143,432.55	142,305.04	-
2016	692,068.41	-	143,426.94	18,265.30	-	9,665.06
2017	362,378.78	-	293,701.53	-	-	107,886.92
2018	528,748.17	-	218,825.65	1,834.26	-	223,012.13
Sub-total	5,116,494.49	135,112.56	2,508,112.11	500,984.84	321,253.36	340,564.11
Total	8,922,521.48					
% Contribution	57.34%	1.51%	28.11%	5.61%	3.60%	3.82%

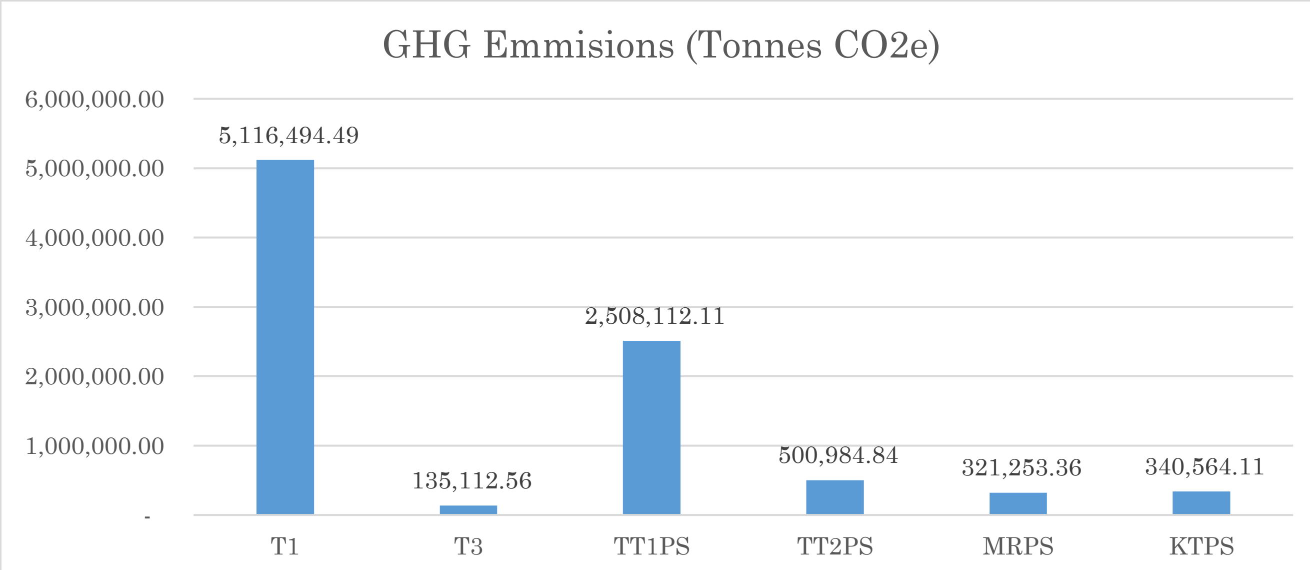


Figure 5-1: GHG Emissions from Stationary Combustion (2012-2018)

5.2. Vehicle Combustion

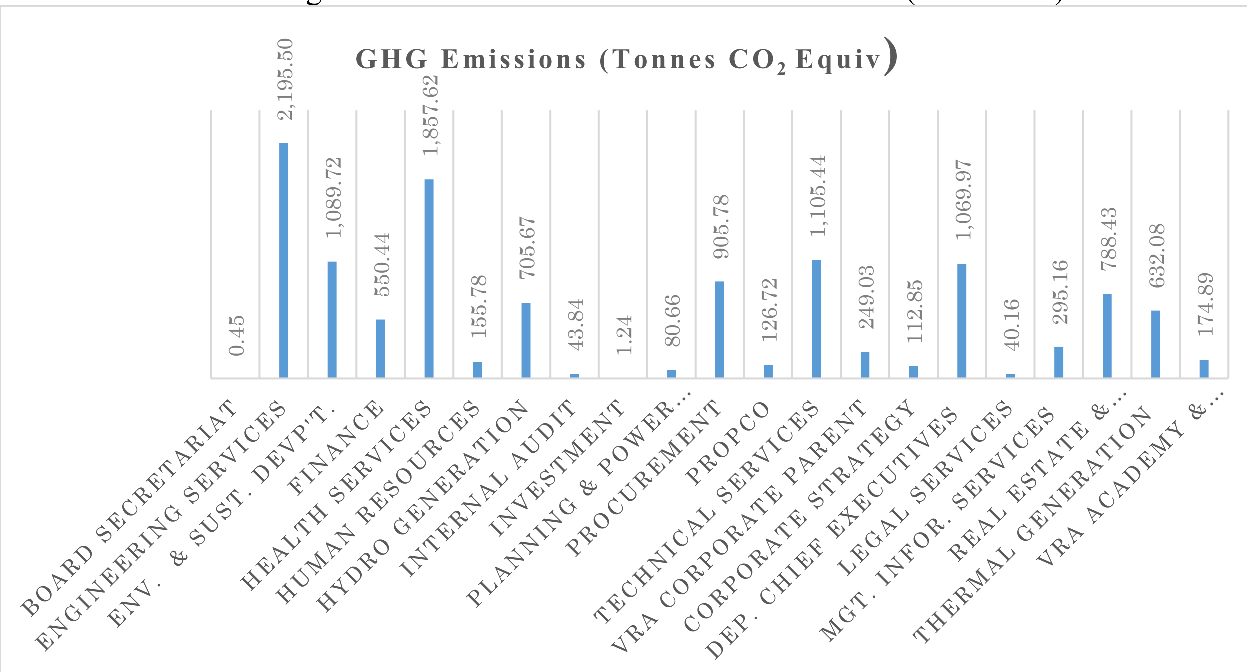
The total GHG emissions for emissions arising from vehicle combustion of fuel on road is 12,81.40 Tonnes CO_2 Equiv. A breakdown of the emission contributed by each individual department is provided in Table 5-2 and Figure 5-2. The detailed spreadsheet calculations for GHG estimations from mobile combustion from diesel and petrol are respectively provided as Appendix 3 in the calculation sheet.

Table 5-2: Cumulative Mobile GHG Emissions (2012-2018)

Department / Outfit	GHG Emissions (Tonnes CO_2 Equiv.)
Board Secretariat	0.45
Engineering Services	2,195.50
Environment & Sustainable Development	1,089.72
Finance	550.44
Health Services	1,857.62
Human Resources	155.78
Hydro Generation	705.67
Internal Audit	43.84
Investment	1.24
Planning & Power Business	80.66
Procurement	905.78
PropCo	126.72
Technical Services	1,105.44
VRA Corporate Parent	249.03
Corporate Strategy	112.85
Deputy Chief Executives	1,069.97
Legal Services	40.16
Management & Information System	295.16

Department / Outfit	GHG Emissions (Tonnes CO_2 Equiv.)
Real Estate and Security	788.43
Thermal Generation SBU	632.08
VRA Academy & Schools	174.89
Total	**12,181.41**

Figure 5-2: Cumulative Mobile GHG Emissions (2012-2018)



5.3. Water Transport Combustion

The total GHG emissions for emissions arising from combustion of fuel from water transport from the total of 166,089 liters of fuel (diesel). is 444,508 Tonnes CO_2 Equiv as shown in

Table 5-3 and detailed out in Appendix 4 in the calculation sheet.

Table 5-3: GHG Emissions from Water Transport

Period	Vessels	GHG Emission (Tonnes CO2 Equiv.)
2012	MV. Ohemaa LX1	13,780.41
	MV. Tilapia	7,962.07
	MV. Dodi Princess 1	56,644.46
	MV. Volta Princess	11,240.57
	SUB-TOTAL	89,627.51
2013	MV. Ohemaa LX1	33,095.46
	MV. Volta Queen	27,804.36
	MV. Onipanua	10,705.31
	SUB-TOTAL	71,605.13

Period	Vessels	GHG Emission (Tonnes CO2 Equiv.)
2014	MV. Buffalo	2,186.56
	MV. Ohemaa LX1	16,678.87
	MV. Volta Queen	10,705.31
	SUB-TOTAL	29,570.74
2015	MV. Onipanua	4,937.82
	MV. Buffalo	749.37
	MV. Volta Queen	22,748.78
	MV. Volta Princess	6,690.82
	MV. Ohemaa LX1	4,282.12
	SUB-TOTAL	39,408.91
2016	MV. Ohemaa LX1	4,282.12
	MV. Volta Queen	30,510.13
	MV. Onipanua	21,142.98
	MV. Buffalo	1,268.58
	MV. Volta Princess	2,676.33
	SUB-TOTAL	59,880.14
2017	MV. Volta Queen	10,705.31
	Dipa Generator set	1,124.06
	MV. Ohemaa LX1	4,812.04
	MV. Volta Princess	6,690.82
	MV. Onipanua	8,029.00
	MV. Buffalo	559.35
	SUB-TOTAL	31,920.58
2018	MV. Volta Queen	86,713.00
	MV. Onipanua	26,110.25
	MV. Ohemaa LX1	3,570.22
	Dipa Generator set	535.27
	MV. Buffalo	214.11
	MV. Volta Princess	5,352.65
	SUB-TOTAL	122,495.50
	GRAND TOTAL	444,508.51

5.4. Renewable Power Plants

5.4.1 Navrongo Solar Power Station

Specific capacity Factor, Default Capacity Factor and Default Emission Factor of the 2.5MW Navrongo Solar Power Stations has been determined to be 16%, 15.5% and 0.509 Tonnes CO_2/MWh. Based on data on Annual Energy Generated (MW hours) from 2013 – 2018 totaling 16,933 MWhrs, GHG Savings for the period is 8,627 Tonnes CO_2 Equiv. and detailed out in Appendix 5 in the calculation sheet.

Table 5-4: GHG Emission Savings from NSPS

Year	Annual GHG Emission Savings (Tonnes CO_2 Equiv)
2013	1,120.00
2014	1,958.00
2015	1,272.00
2016	1,573.00
2017	1,389.00
2018	1,315.00
Grand Total	**8,627.00**

5.4.2 Mini Off Grids

Based on data on Annual Energy Generated (MW hours) from July – December 2018, when the mini grids were handed over to VRA, totaling 80.4619 MWhrs, the GHG Savings for the period is 59 Tonnes CO_2 Equiv. as shown in Table 5-5 and Figure 5-3 and detailed out in Appendix 5 in the calculation sheet.

Table 5-5: GHG Emission Savings from Mini Off Grids (2018)

Solar Plant	GHG Emission Savings (Tonnes CO2 Equiv)
0.054MW Aglakope	17.0
0.0405MW Atigagorme	6.0
0.054MW Kudorkope	14.0
0.05MW Perdiatorkope	17.0
0.03MW Wayokope	5.0
Grand Total	59.0

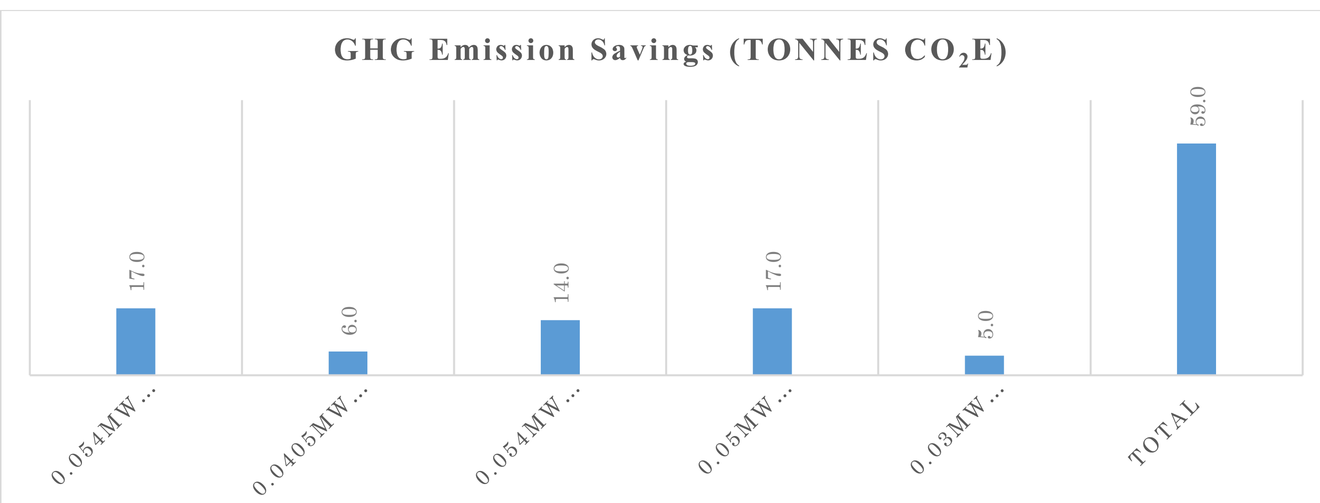


Figure 5-3: GHG Emission Savings from Mini Off Grids Solar Plants (2018)

5.9. Office Waste Paper GHG Emissions Savings

Under the Office Waste Paper Recycling Programme, VRA had by close of 2018, recycled a total 2083 Kg (2.30 Short Tons). Assuming this amount of office paper will have been landfilled, instead of recycled, the total emission savings was 9 Tonnes CO_2 Equiv. and it is shown in Table 5-6 diagrammatically in Figure 5-4.

Table 5-6: GHG Emission Savings of Office Waste Paper Recycling

Solar Plant	GHG Emission Savings (Tonnes CO2 Equiv)
2017	2
2018	7
Grand Total	9

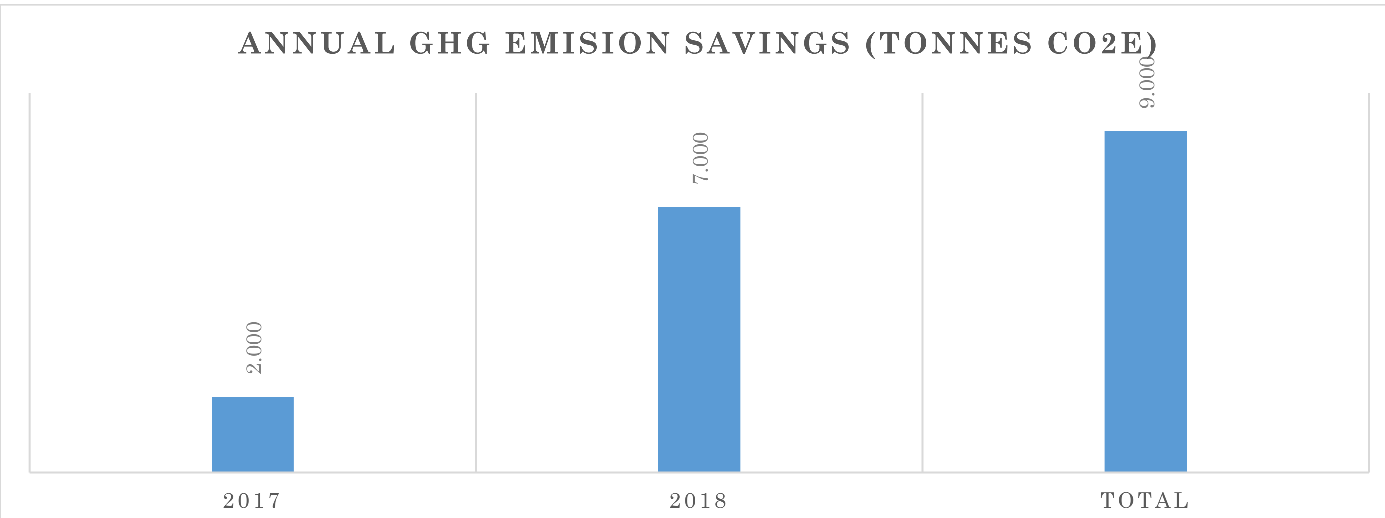


Figure 5-4: GHG Emission Savings of Office Waste Paper Recycling (2017-2018)

5.10. Summary

5.6.1 GHG Emissions

Total GHG emissions from 2012-2018 was 9,379,211.39 CO_2 Equiv. VRA's GHG emissions are broken down by scope and source categories in Table 5-7. Stationary combustion contribute 95.13% , whilst vehicle and water transport combustion contributed 0.13% and 4.74% respectively as illustrated in in Figure 5-5.

Table 5-7: Summary of Corporate GHG Emissions breakdown by Scope and Source Category

Operational Emissions Category	Emissions Source Category	Corporate emissions source	Total emissions Tonnes CO2 Equiv	Percentage of total corporate emissions
Direct Emission Sources	Stationary Combustion	T1	5,116,494.49	54.55%
		T3	135,112.56	1.44%
		TT1PS	2,508,112.11	26.74%
		TT2PS	500,984.84	5.34%

Operational Emissions Category	Emissions Source Category	Corporate emissions source	Total emissions Tonnes CO2 Equiv	Percentage of total corporate emissions
		MRPS	321,253.36	3.43%
		KTPS	340,564.11	3.63%
	Mobile Combustion	Vehicles	12,181.41	0.13%
		Water Transport	444,508.504	4.74%
Total Emissions From Direct Sources			9,379,211.39	100.00%

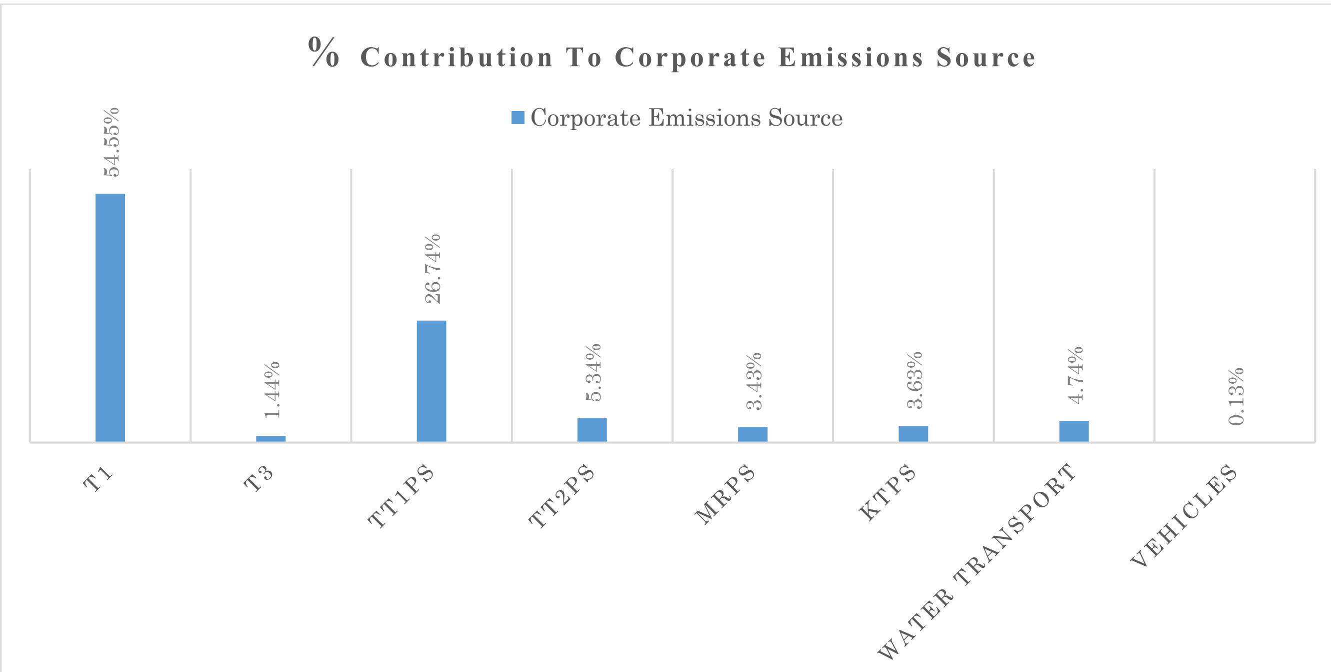


Figure 5-5: Percentage Share of VRA Scope 1 GHG Emissions (2012-2018)

5.6.2 GHG Emissions Savings

Total GHG Savings from our conservation programmes from the 2.5MW Navrongo Solar Power Station, the five (5No.) Mini Off grids and the office waste paper recycled amounted to 8,695 Tonnes CO_2 Equiv. and this is shown in Table 5-8 and Figure 5-6.

Table 5-8: GHG Emission Savings from Conservation Programmes (2012-2018)

Source	Annual GHG Emission Savings (Tonnes CO2e)
Navrongo Solar Power Station	8,627.00
Office Paper Recycled	9.00
0.054MW Aglakope	17.00
0.0405MW Atigagorme	6.00
0.054MW Kudorkope	14.00
0.05MW Perdiatorkope	17.00
0.03MW Wayokope	5.00
Total	8,695.00

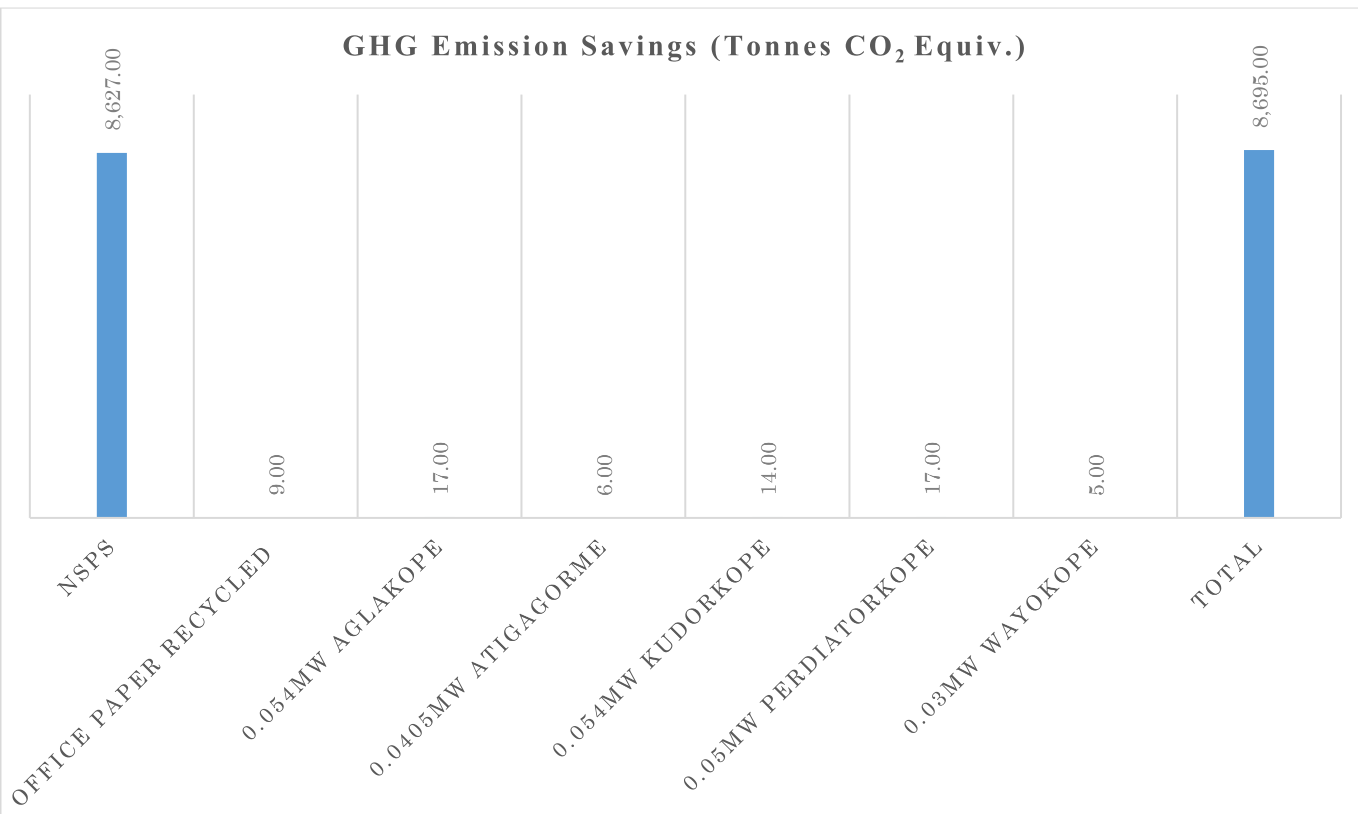


Figure 5-6: GHG Emission Savings from Conservation Programmes (2012-2018)

6 GHG EMISSION TRENDS

6.1. GHG Emissions Trends From Power Plants

The seven-year trend of GHG emissions from the various stationary combustion power plants of VRA are shown in Figure 6-1 and Figure 6-2 respectively. As indicated, the total emissions of Scope 1 stationary combustion from power plants was 8,922,521.48 Tonnes CO_2 Equiv. Emissions from T1 of 5,116,494.64 Tonnes CO_2 Equiv represented the dominant contribution accounting for approximately 57.3% of the total annual average accountable GHG emissions, and this is followed by TT1PS (2,508,112.11 Tonnes CO_2), which make up 28.1% of the total annual average. Indeed, T1 and TT1PS have been the most utilized for power generating plants during the period as shown in

Table 4-2, and used the most light crude oil of 997,504,180 liters and 628,475,878 liters respectively during the time.

T3 was not in operations in 2012, 2016 and 2017 and hence no emissions were recorded. The plant was also not operational for almost half of the year in 2014. MRPS was also not operational in 2013 and decommissioned in 2016. KTPS commenced operation in 2016.

The highest emission periods were from 2012-2015, where the total GHG emissions were all well over 1.4 Million Tonnes CO_2 Equiv, with the highest in 2015 of 1.8 Million Tonnes CO_2 Equiv. It is noted that the use of LCO was predominant during these period. From 2016-2018, when the use of Natural gas was predominant, GHG emission were below 1.0 Million Tonnes CO_2 Equiv, with the lowest emission of 763,927.64 Tonnes CO_2 Equiv being experienced in Year 2017. It must however be noted that the MRPS, T3 and TT2PS were not in operation in 2017.

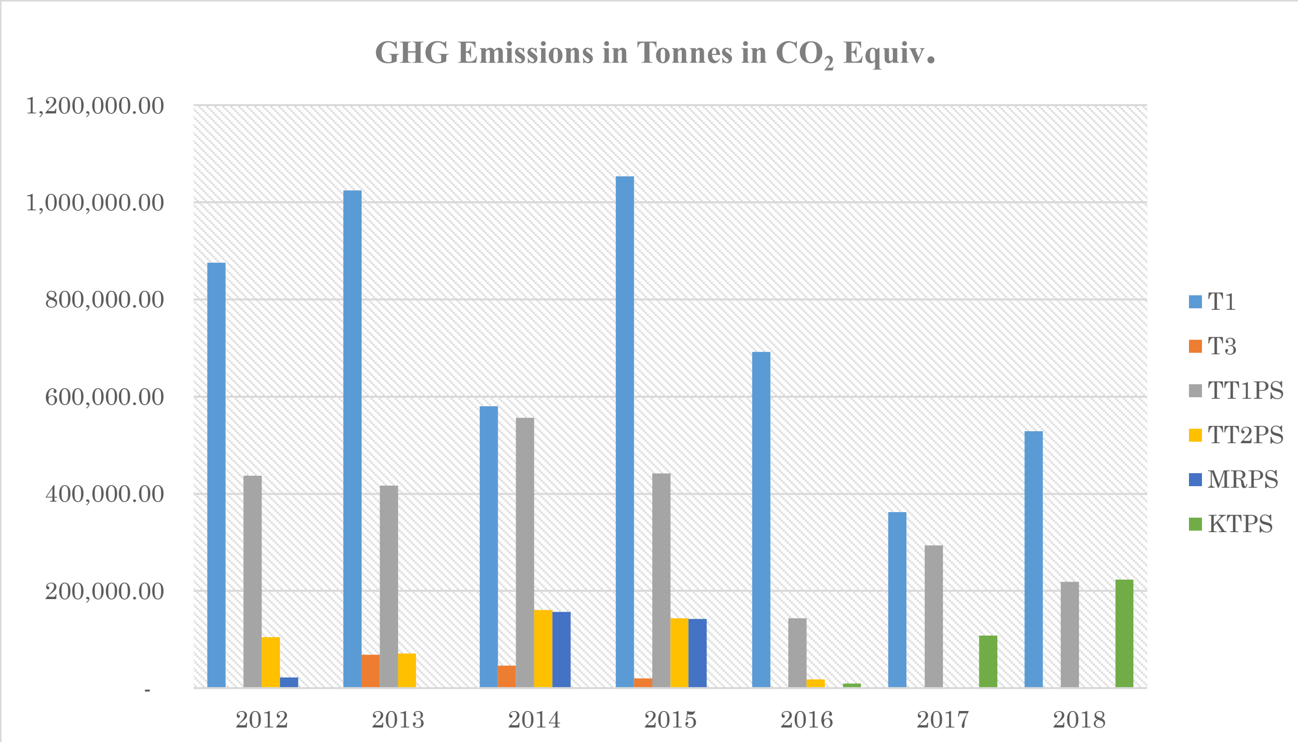


Figure 6-1: Trends of GHG Emissions from VRA Stationary Combustion Plants By Year

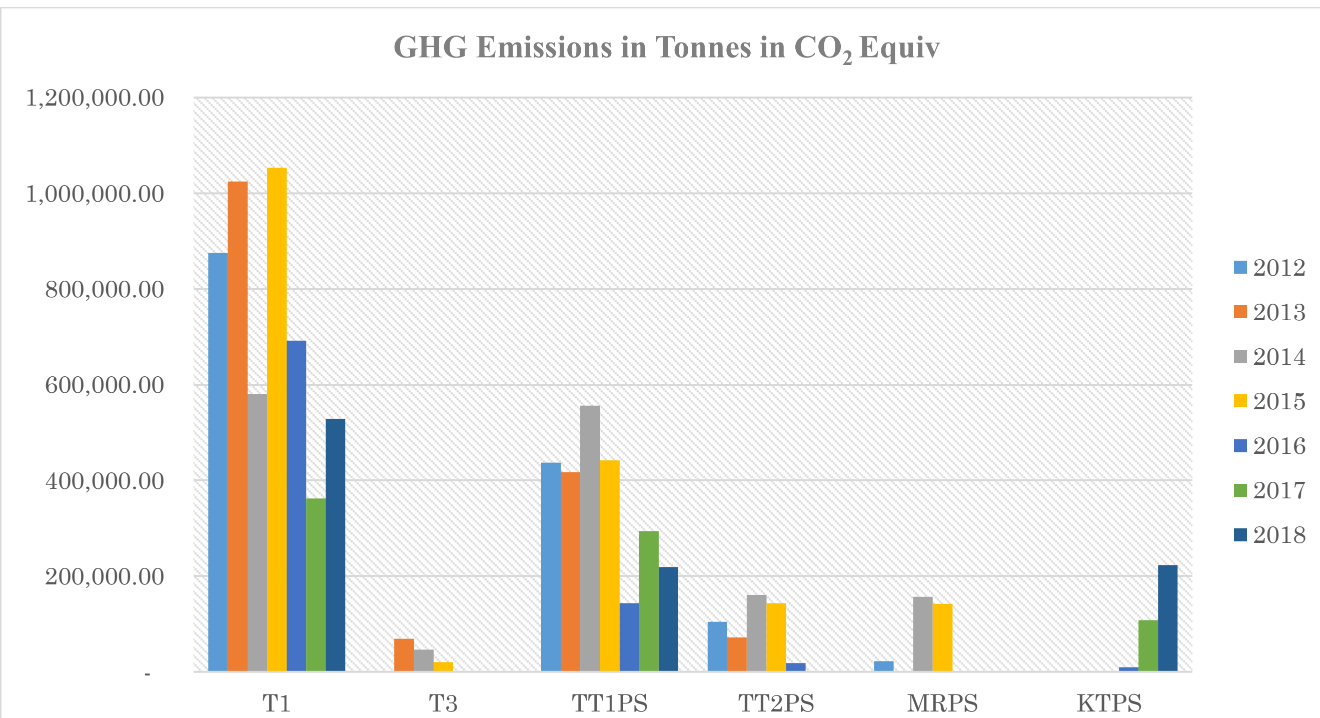


Figure 6-2: Annual Trends of GHG Emissions By VRA Stationary Combustion Plants

Annual trends of emissions from stationary combustion, which is the major source of GHG emissions, and the gross energy generated for each year as well as the percentages differences from the 2012 baseline data is shown in the Table 6-1. The Figure 6-3 also shows the percentage differences from the baseline data during the period. In Year 2013, even though the gross energy generated was 115% over the baseline data, equivalent GHG emissions increased by only 10%. The highest percentage difference in GHG emissions of 25% was experienced in 2015, during which period gross energy generated was 50% over the baseline data. There was considerable decrease in GHG emissions from 2016-2018, with the lowest being in 2017, which achieved 47% less the baseline data. Indeed, in 2018, the gross energy generated was 9% above the baseline level whilst equivalent GHG emissions was 32% below the baseline data.

Fuel utilised for combustion are Light Crude Oil (LCO), Natural Gas and Diesel Fuel Oil (DFO). It must be noted that anytime natural gas was available, it was automatically the first-choice fuel for operating the power plants. The use of LCO was highest from 2013 - 2015, and this was during the country's power crises, where VRA also experienced shortfalls in gas supply from Nigeria. The Atuabo Gas Processing Plant came on stream in 2016 and VRA in 2017, took a decision to operate mainly on natural gas, and for most part of 2018, depended largely on natural gas for power generation. Indeed, the significant decrease in GHG emission in 2018 despite the high gross energy generated can largely be attributed to the use of natural gas for power generation.

Table 6-1: Gross Energy Generated Vrs GHG Emissions

Period	Gross Energy Generated		GHG Emissions	
	MWH	% Difference from 2012 baseline figure	Tonnes CO2 Equiv	% Difference from 2012 baseline figure
2012	1,801,619.00	100%	1,439,685.83	100%
2013	3,881,438.00	215%	1,582,068.07	110%
2014	1,986,105.13	110%	1,499,949.00	104%
2015	2,708,120.88	150%	1,801,005.43	125%
2016	1,421,260.19	79%	863,425.71	60%
2017	1,154,895.10	64%	763,967.24	53%
2018	1,965,081.62	109%	972,420.20	68%

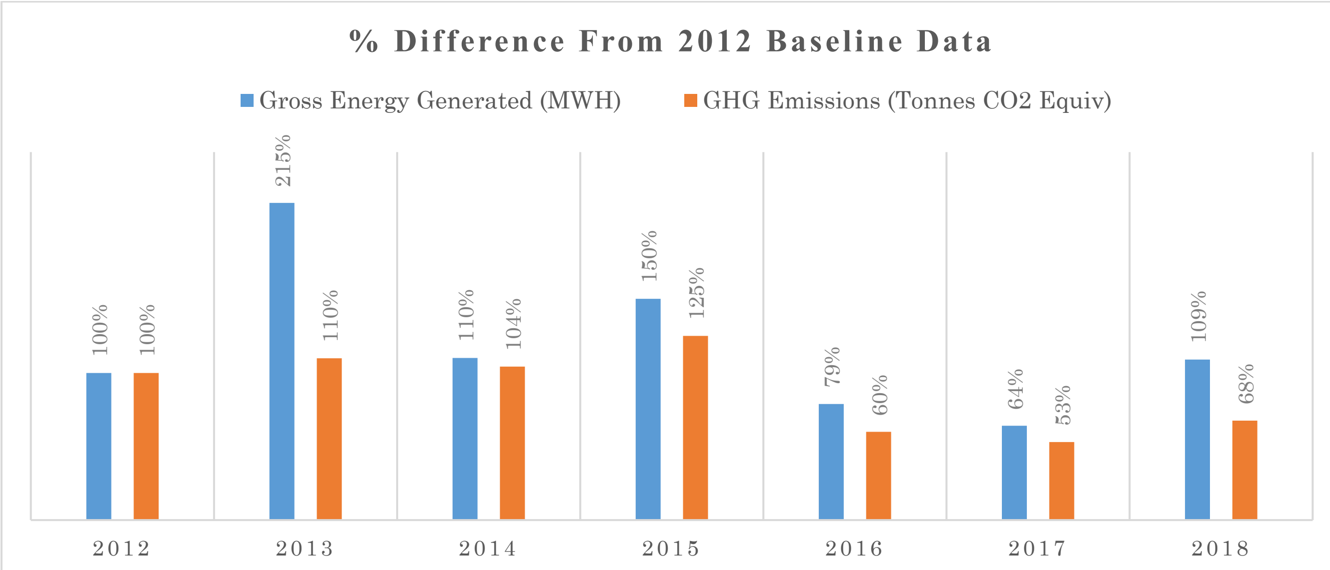


Figure 6-3: Percentage Difference from 2012 Baseline Data

Emission trends of the combustion plants from the different fuel sources is summarised in Figure 6-4 and detailed out by the various plants in Figure 6-5. From the trends, it is noted that emissions from the combustion of natural gas contributed the most to the emissions. It must be noted that anytime natural gas was available, it was automatically the first-choice fuel for operating the gas turbine. Thus, times that there has been gas, the use of light crude oil was limited. Diesel Fuel Oil is used as start-up fuel for the power plants thus its limited use and low emission levels, except for MRPS in 2012, where DFO was used as the only source of fuel for power generation. MRPS operates only on DFO and Natural Gas and therefore there was no combustion from LCO. With the coming of natural gas on site in 2010, the MRPS was rendered redundant as the TT1PS and TT2PS were rather being utilized for power generation. Power generation on DFO resumed in 2012 due to challenges in gas flows as shown in Figure 6-5. The MRPS was retrofitted to utilize natural gas only in 2013 and therefore there has not been any utilization of DFO on site for power generation since then, until the plant was decommissioned. Operations of KTPS commenced in 2016, and the plant's main fuel for power generation is DFO and Natural Gas. Due to lack of natural gas, combustion from KTPS in 2017, was largely from DFO.

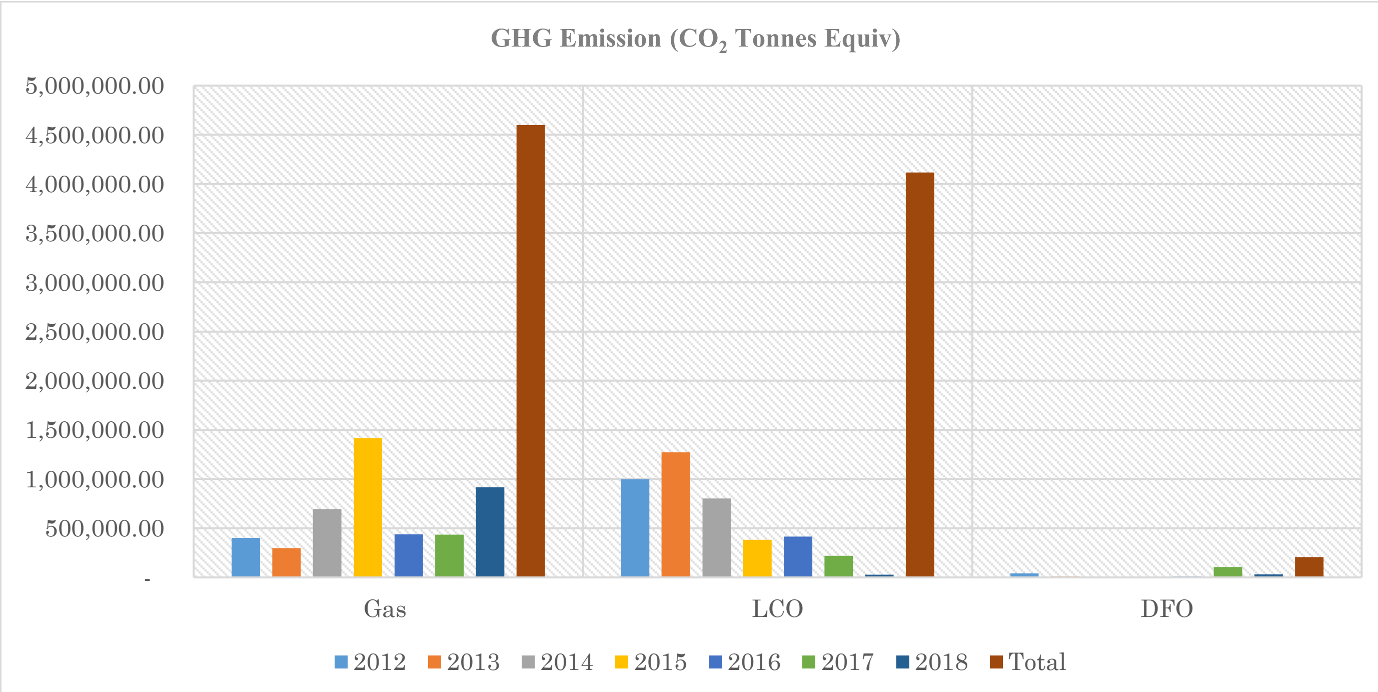
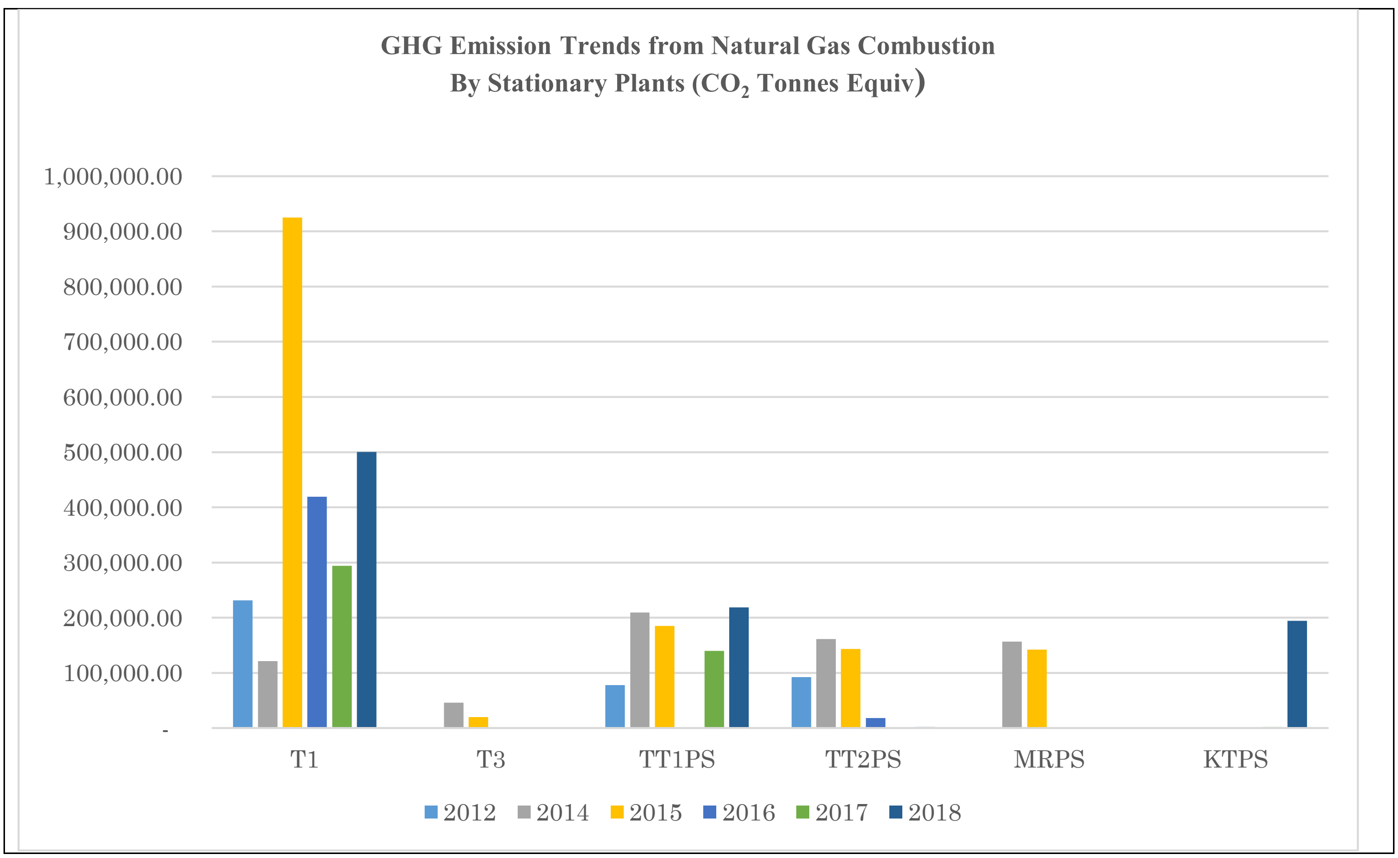
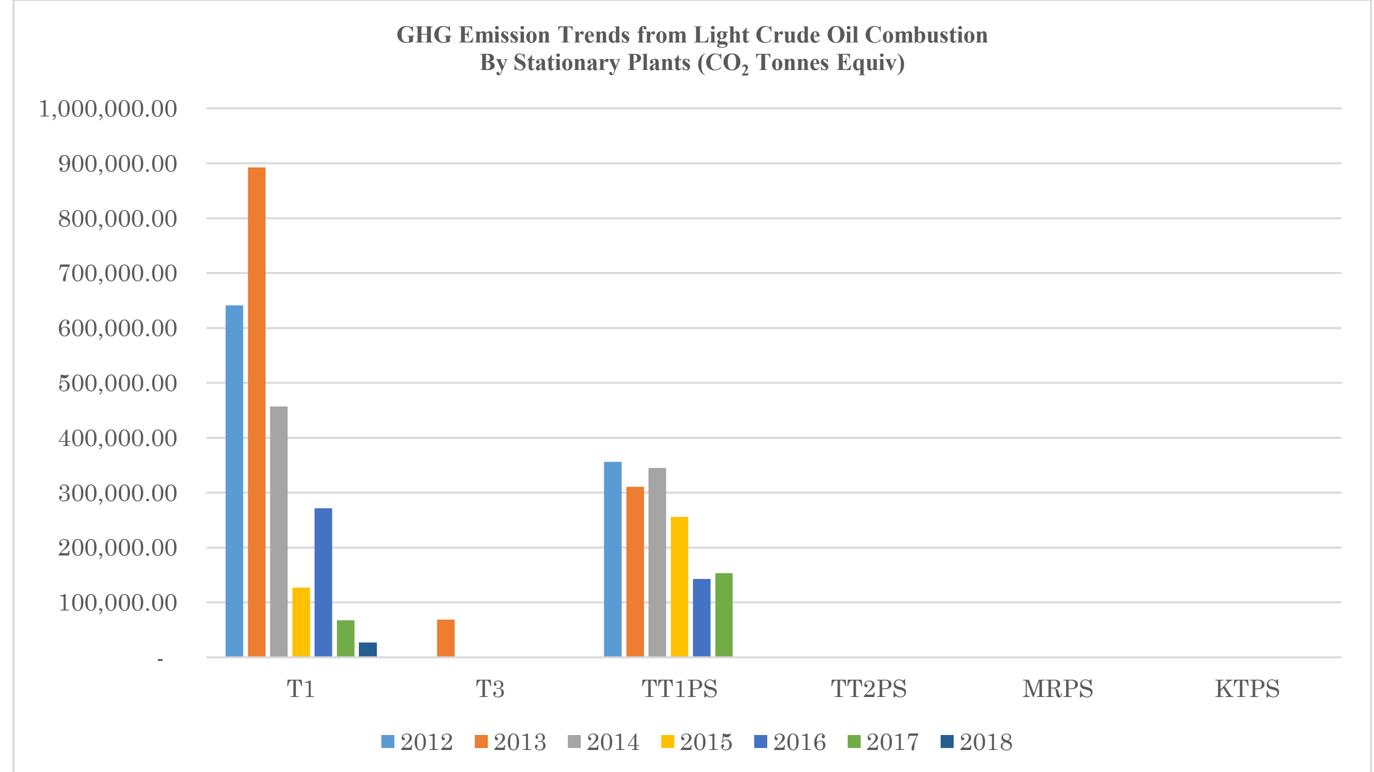


Figure 6-4: Annual Trend of GHG Emissions by Fuel Type from Stationary Combustion Plants





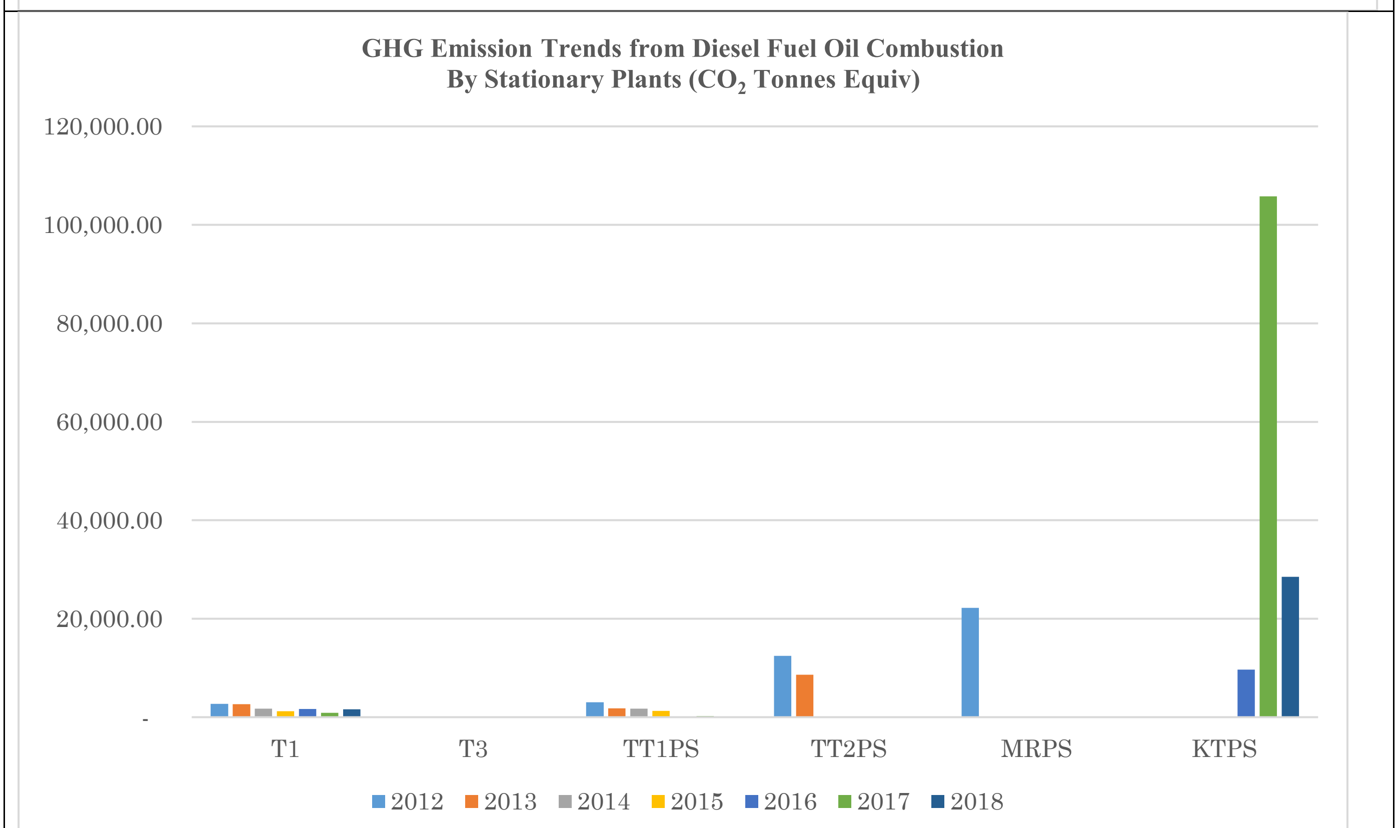


Figure 6-5: Trends of GHG Emissions By VRA Stationary Combustion Plants by Fuel Type

6.1.1 Specific GHG Emissions Per Energy

To help assess plant efficiency, the specific GHG emissions per energy generated for the power plants is to be determined, and compared with standards in the industry. Specific GHG Emissions Per Energy are calculated for individual fuels. However, for the most part of the data provided in this report, the total power generated (MWHrs) in any particular year was not segregated based on the individual fuel used.. Subsequently, to be able to assess specific GHG emissions per energy for each plant, only data on plants that utilised one source of fuel per any year has been determined and provided in Table 6-2. As shown, applicable power plants for the period were TT1PS and TT2PS for natural gas and KTPS for Diesel Fuel Oil. The Specific GHG Emissions per energy generated (Tonnes CO2e /MWh) with natural gas ranged from 0.683 – 0.76, whilst that for DFO was 0.978. VRA is yet to get industry standards for natural gas and diesel fuel oil for comparison purposes. Since T3 and MRPS are no longer operational, the specific GHG emissions per energy generated for these plants have not been determined.

Table 6-2: Specific GHG Emissions (Tonnes CO2e /MWh)

Station	TT2PS				TT1PS	KTPS
Period	**2014**	**2015**	**2016**	**2018**	**2018**	**2016**
Fuel Type	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	DFO
Energy Generated (MWH)	211,703.00	210,152.10	25,713.50	2,584.00	316,040.00	9887.20
Total emissions (Tonnes CO2e)	160,983.52	143,432.55	18,265.30	1,834.26	218,825.65	9665.064
Specific GHG Emissions (Tonnes CO2e /MWh)	0.760	0.683	0.710	0.710	0.692	0.978

6.1.2 GHG Emissions Trends From Water Transport Combustion

The total emission for water transport for the seven year period was 444.51 Tonnes CO_2 Equiv. and the yearly trend is shown in Table 6-3 and Figure 6-6. In 2012, the MV Dodi Princess I, which belonged directly to VRA was in operation for ferrying passengers on weekends and holidays for tourism purposes. The MV Dodi Princess I got destroyed during the said period and has since not been in operation. Thus, with the Dodi Princess 1 out of operation, GHG emissions decreased significantly from 2013 to 2017. The highest percentage difference in GHG emissions was in 2018 and this was basically due to the commercialization of the VRA fleets in 2018 for private developers.

Table 6-3: Yearly Emissions from Water Transport

Period	GHG Emissions (Metric Tonnes CO2 Equiv)	% Difference from 2012 baseline Figure
2012	89.628	100%
2013	71.605	79.9%
2014	29.571	33.0%
2015	39.409	44.0%
2016	59.880	66.8%
2017	31.921	35.6%
2018	122.495	136.7%
Total	444.51	

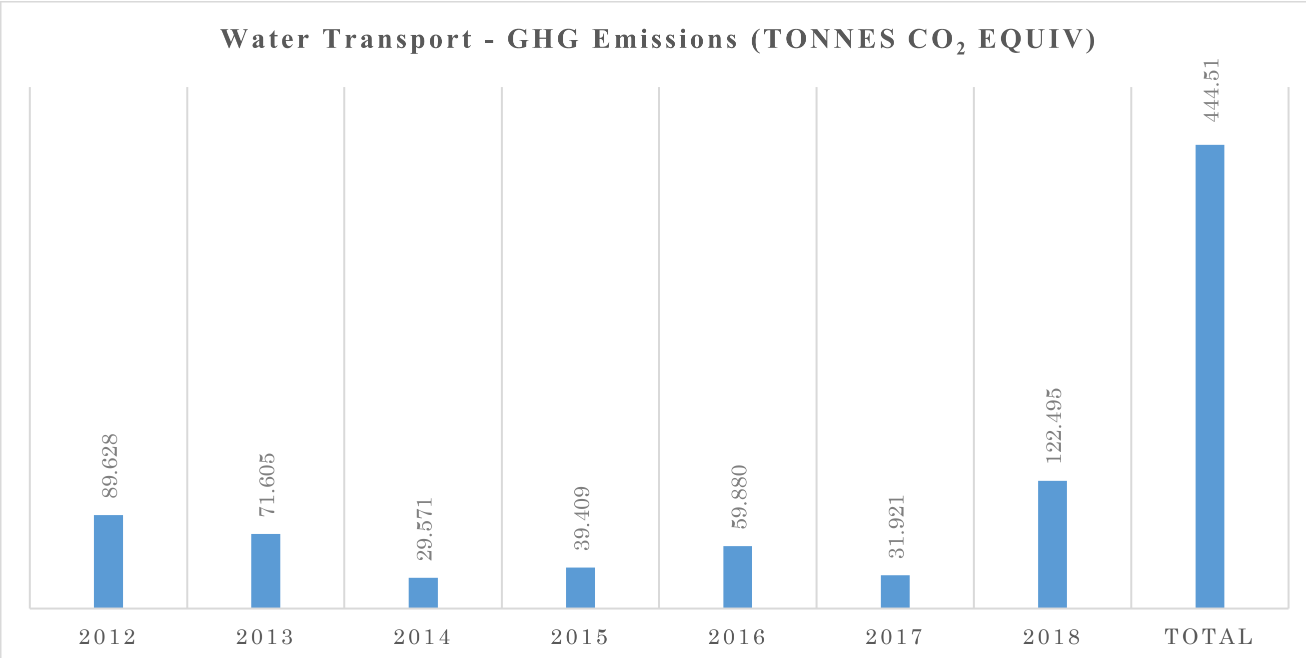


Figure 6-6: Yearly Trends of GHG emissions from VRA Water Transport

6.2. GHG Emissions Trends from Vehicle Combustion

The functions of the departments in VRA are diverse and this determine fuel usage by each of them. Subsequently, there cannot be a comparison between the various departments with respect to GHG emissions. In view of this, the yearly trend in GHG emissions from vehicular sources from the various departments is provided in Figure 6-7. The highest emission periods were in 2017, 2015, 2014 in that order. Even though, there was much data on fuel usage in 2018, the emission level was the lowest within the last 4 years. This is because, VRA under its 2018 Corporate Financial Recovery Plan initiated a target of 15% reduction in transport/travel costs. Under this initiative, all departments are to identify meetings/activities that can be undertaken through video conferencing and not to travel but use the video conferencing facilities instead. It is evident that this initiative helped reduce GHG emission in 2018, reducing it about 60% of the 2017 emission levels. VRA shall continue to report on this initiative and any others that will help reduce associated vehicular GHG emission in subsequent reports.

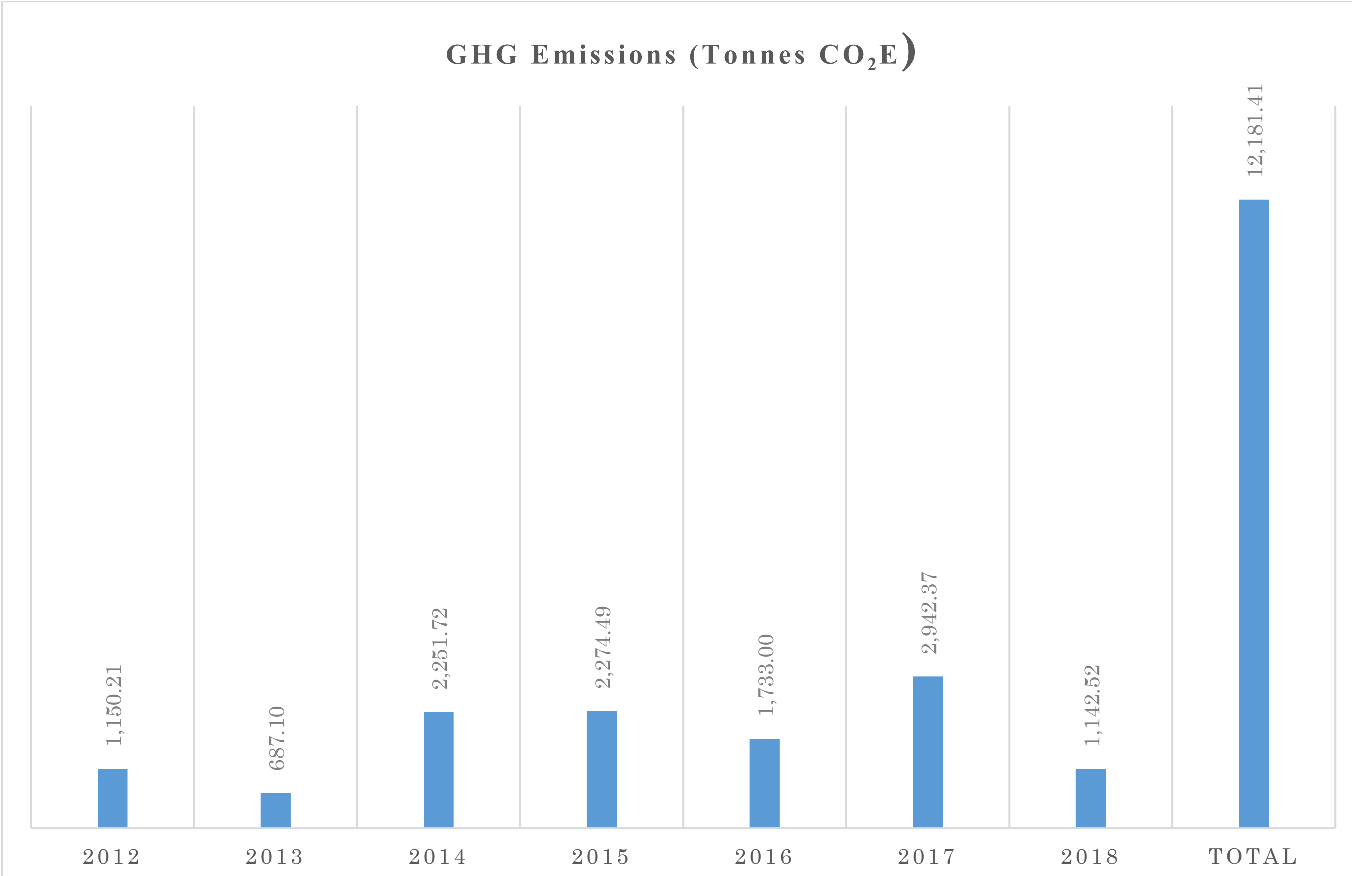


Figure 6-7: Yearly Trends of GHG emissions from VRA Vehicular Transport

7 DATA MANAGEMENT

7.1. Administrative Management

A twelve (12) member Carbon Accounting Team (CAT) led by the Director, Environment & Sustainable Development Dept. has been formally appointed by the Chief Executive to be responsible for developing the Corporate Greenhouse Gas Emission Inventory Report on an annual basis under the ongoing CFMP. The team includes four (4) external individuals who have been engaged to provide technical backstopping in various areas to the CAT.

The Terms of Reference for the CAT is as follows:

a) To calculate net Greenhouse Gas (GHG) emissions of the Authority on an annual basis.
b) Prepare annual "***GHG Emission Inventory Report***" for the Authority in line with international standards for Executive consideration and approval for public disclosure.
c) Develop and make recommendations on strategies for reducing the Authority's Carbon footprint for Executive approval for implementation.
d) Evaluate the Authority's planned power projects and advise Management on which project can be presented as candidate for carbon trading and financing.

The Secretariat for the CAT is within E&SDD and some key staff have been co-opted to assist with associated administrative responsibilities. Appendix 6 provides membership of the CAT, as at close of 2018.

7.2. Activity Data

The following source data have been utilised for capturing GHG calculations and inventory:

a. Environmental Progress Reports for the various power plants that VRA submits to the Ghana EPA on quarterly/annual basis provides data for fuel usage as well as power generated and consumed at each plant.
b. Procurement Department is responsible for purchasing fuel and each department reports on their fuel usage to the General Services Department, using what is called a "***Vehicle Operational Chart"***, and these data are eventually stored as part of records by both departments.
c. Marine Logbooks are used for recording fuel utilised by marine fleets, and this provides source data for water transport combustion.
d. Office Paper Waste Logsheet signed by VRA and APML provides source data for progress reporting of office waste paper recycled by E&SDD.

7.3. Data Management

Th Director, E&SDD through Manager, Environment and Social Impact (ESI) is responsible for coordinating the collection of inventory for all data required and maintain this information in relevant format, such as reports, electronic files and calculation spreadsheets.

The specific steps of the process are as follows:

a) **Data Receipt**

- Data on the amount of fuel consumed and energy produced from the power stations are recorded by the operational team and made available by the respective departments through their Quarterly Environmental Monitoring Progress reports and annual environmental reports to the Director, E&SDD and then
- Fuel utilised by company vehicles is received from all departments via the General Services Department, using the "***Vehicle Operational Charts***". That for marine fleets are provided by E&SDD through the marine Logbooks
- Waste office paper from the various VRA outfits are transported to Akosombo, mainly through the mail van and stored at the Environment & Social Impact (ESI). The waste office paper, when in sufficient volumes, are then transported to the Akosombo Paper Mill. The volumes are then weighed and recorded on a signed Waste Transfer Notes, which is then reported in monthly progress reports of E&SDD.
- All the data received are then inputted into spreadsheet files, and saved to a directory under the 'Corporate Carbon Footprint' folder in the Corporate One Drive.
- DATA REVIEW AND MANIPULATION – spreadsheets are accessed and reviewed for the relevant information. In some cases, the data are sorted, totaled and formatted to facilitate entry into the inventory spreadsheet. The data also is reviewed during this step to evaluate the overall magnitude to identify any obvious errors or omissions.
- DATA ENTRY – data is entered in the draft-working version of the GHG inventory. During this step, an additional review for data reasonableness and completeness is performed. Any obvious errors or omissions are addressed directly with the data manager by phone or email, as needed. All the data sources either are entered directly into the inventory or are used for further calculation of the necessary data points required to develop the overall inventory.
- QA/QC AND TECHNICAL REVIEW – where data entry is required, a double check and a reverse double check is always performed. A double check review is simply another review of the numbers entered in the working draft version of the inventory, while a reverse double check is an evaluation of the data entered against the working draft version of the inventory to ensure all data points are included. Once the review is completed, the draft version is circulated to the Carbon Accounting Team within the company; feedback is used to modify the inventory as needed.

7.3.1 Data Collection Process Quality Assurance

The owners of data identified in the previous section are responsible for maintaining data quality assurance. Every effort would be made to ensure that the data reported are accurate and complete. Manager ESI will evaluate the data, once collected, to ensure that it is reasonable and consistent with past years. Manager ESI will also conduct and document QA checks during the production of the inventory. All possible errors as well as the QA/QC actions used to maintain accuracy will be defined and documented as part of the process for collecting the GHG data. Any departures from these data quality measures (i.e. non-compliance events) would be communicated. Any inconsistencies and large unexpected changes from the previous year's data would be sufficiently explained when the data is transmitted. The Manager, ESI will also compare the current year's data for each source category to the previous year's data to identify any large, unexpected variations. Data will be reviewed, and all calculations validated to ensure that calculations are correct.

7.3.2 Frequency

The VRA GHG Reports are to be updated on an annual basis. Annual inventories will be published and on VRA's Corporate website (www.vra.com). VRA will continue to use and update the inventory template in future years to remain as consistent as possible.

8 CONSERVATION PROGRAMMES AND PROJECTS

8.1. VRA's Renewable Energy Development Programme

In line with national actions in the renewable energy sector, VRA in February 2010 adopted a Renewable Energy Generation Policy in order to develop and operate RE plants in an efficient, cost effective and environmentally sustainable manner. To achieve the purpose set out in the VRA RE Generation Policy, the Renewable Energy Development Programme (REDP) was formulated. The VRA REDP sets a 5-10 years' Renewable generation capacity target, taking cognisance of the local and export demand and the system constraints and is being rolled out in phases. So far, the 2.5 MW Navrongo Solar Power Plant has been operational since Operational since 2013 and emission savings till date, estimated at 8,627 Tonnes CO_2 Equiv has been discussed. Other planned renewable energy projects are listed in Table 8-1 and the Annual GHG Emission savings estimated at 98,808 Tonnes CO_2 Equiv for the solar power (122.584MW) and 98.077 Tonnes CO_2 Equiv for the wind power projects (75MW).

Table 8-1: GHG Savings from VRA's Proposed Power Projects

Project	
17MW	Solar (Kaleo, Lawra) – Phase 1 (Construction Ongoing)
15 MW	Solar (Kaleo, Lawra) – Phase 2 (Construction Planned for 2021)
40MW	Bongo Solar Power Project (Feasibility study ongoing)
0.448MW	Akuse Residential & Institutional Office Buildings Solar PV Rooftop Project (Construction planned for 2020 Q4)
0.057MW	Head Office Solar Car Park (Construction planned for 2020 Q4)
0.079MW	Head Office Rooftop Project (Construction planned for 2019)
75MW	Wind Power Project -1 (Anloga, Srogbe, Anyanui) Construction expected to commence by Q4 2021 and commissioned in Q1 2023
50MW	Solar Power Component - Pwalugu Multipurpose Dam (Construction planned for 2024)

8.2. Tree Planting Programmes

As indicated in Section 4.6 VRA is engaged in two major tree planting programmes along the Volta lake known as the Volta Gorge Reforestation Project and the Buffer Zone Project. Tree species adopted are *Senna siamea* (cassia), *Acacia mangium, Khaya senegalensis (*Mahogany), *Cedrella odorata,* and *Leuceana leucocephala.* As at close of 2018, about 1,576 hectares of the Volta Gorge area had been planted, whilst 188.1 hectares of forest tree plantation established under Buffer Zone Project. Thus, the total area covered is 1764.1 ha.

VRA is yet to calculate the carbon sequestration potential of its tree planting programme. However, considering the type of species being planted, it is estimated that 28 Tonnes of CO_2 Equiv. is sequestrated annually per hectare Thus, the total 49,394.8 Tonnes of CO_2 Equiv could be sequestrated annually. (*Source: VRA - Immediate Opportunities Ecosystem Services Trading Enam Eyiah, reNew, 2020*).

VRA intends to utilise both aerial and ground survey to capture data on the tree dimensions for use in calculating the amount of carbon sequestrated by this plantation. The reduction in the amount of carbon emissions can then be measured and used to offset VRA's carbon emissions within its carbon accounting programme.

8.3. Energy Efficiency & Fuel Switch

Simple cycle power plants (SCPP) use fuel and compressed air in gas turbines, which drive a generators producing electrical energy. The hot exhaust gases are released to the environment without further use of the containing energy in form of heat. The purpose of combined cycle power plant (CCPP) is to utilize the energy from the hot turbine exhausts for steam generation in a down-stream heat recovery steam generator (HRSG). This steam is used for power generation in a steam turbine. Therefore, the total electrical power generation capacity of a CCPP is made up from the power output of gas turbines and of the steam turbine without the need of additional fuel.

VRA currently plans, under the KTPS Phase 1 - Stage 2 development, to convert the Gas Turbine Generating Units into a 330MW Combined Cycle Uni. The Project Idea Note submitted to CDM operational entity for the West Africa Region as a CDM Programme Activity Design Document in May 2011 estimated the GHG annual savings at 400,000 Tonnes of CO_2 Equiv.

8.4. Cleaner Cooking Solutions through adoption of fuel-efficient stoves

Our Climate Smart Stove project aims to minimize the harvesting and utilization of trees as firewood in the Volta Lake basin. The Authority in 2016 successfully piloted this fuel efficient and energy saving improved domestic cook stoves in twenty-one (21) riparian communities. As at close of 2018, a total of three hundred (300) cook stoves had been constructed. The provision of these fuel-efficient domestic cook stoves, termed, "Climate Smart Stoves" is to complement our commitment to ensuring the communities minimize the consumption of firewood and re-enforce attitudinal change among the community members. These stoves are built from clay, which is locally available in the area, and accommodates two (2) cooking pots with an elevated chimney primarily designed to remove the smoke from the cooking area. The use of the CSS has shown to have immense economical and health benefits to users as it contributes to financial savings of the families and the reduction in exposure of wood smoke, heat and fire burns from open fires, which mostly affect women and children that are engaged in this activity.

An assessment of the Climate Smart Stoves by the Council for Scientific & Industrial Research showed that an efficiency in terms of fuelwood savings of 51.45% and processing rate of 76.6%. According to the CSIR, this performance met international requirement of a minimum of 40% fuel saving. The CSIR results also show an estimated annual carbon savings of 664 kg CO2 per stove as against the traditional "3-Legged Cook Stoves". VRA in 2019 provided funding for two MPhil students and one PhD student at the Institute of Environmental & Sanitation Studies (IESS) of the University of Ghana, to undertake an assessment of the health, environmental and economic impacts of the "climate smart stoves". The research will involve a detailed assessment of the carbon savings of the stoves.

8.5. Resource Use Efficiency

VRA has embarked on a three year (2018-2020) Financial Recovery Plan basically to help:

a. Achieve a sustainable level of profitability that exceeds VRA's aggregate financial performance during the period of 2012 – 2016 and

b. Attain a composite financial performance that is comparable to electricity producers in the international industry

Under this Plan, the underlisted targets have been set for all departments to achieve resource use efficiency:

- Reduction in paper usage
- Reduction in transport / travel costs.
- No. of video conferencing organised.

To achieve the above, a paperless system, using "**Laserfiche**" as well as a "**Skype for Business**" app for virtual meetings have been made available to staff. The implementation of these are geared towards reducing administrative costs and will in addition, invariably also reduce GHG emissions and corporate carbon footprint.

8.6. Most Eco-Friendly Department Awards

VRA in 2019 instituted the "**Most Eco-Friendly Department**" awards and this has been incorporated in the annual Corporate Safety Awareness Day Celebration, held each year on the third Thursday of November. The awards involves using the average vehicular emissions data for the preceding three years as baseline for which department's annual performance is compared to that of the award year. As fuel usage requirements differ for each department due to the separate workloads, the use of annual percentage reduction of the baseline data has been adopted.

8.7. PET Segregation & Processing Programme

Under the Corporate Solid Waste segregation Pprogramme, VRA intends embarking on the segregation and disposal of Polyethylene Terephthalate (PET) bottles or plastic drinking bottles, targeting Akosombo and its environs. This will involve the setting up a "**Waste Plastic Recycling Center**" in Akosombo to serve all VRA facilities (including institutional houses), the Akosombo community and its environs. The procurement process to solicit for a partner company for a joint collaboration is ongoing and is expected to be completed by close of 2020. The partner company will be required to process waste PET Bottles, in the first instance, as well as any other plastic waste that may be required.

The recycling effort of VRA is to be incentivized through a waste exchange programme to be determined by the amount of plastic waste generated and recovered. The Partner Company will be required to provide VRA with the quantitative data of the amount of plastic recovered in tonnes relying solely on the United Nations Framework Convention on Climate Change assessment standards. This information is expected to feed into the Corporate Annual GHG Inventory Report as well as the Sustainability Report.

9 PLANNED IMPROVEMENTS

The following actions are to be pursued to improve future data capture and reporting as well as reduce GHG emissions:

1. Centralizing (through the business oracle system) requisite data for the activity data for fuel consumption for mobile emissions, vehicular/water transport, by 2020.

2. Continue with implementation of resource use efficiencies programmes under the Financial Recovery Programme, targeting reduction in paper and fuel usage as well as adoption of video conferencing for meetings.

3. Continue with the "Eco-Friendly Department" awards.

4. Initiate strategies to collate data on fugitive emissions such as Methane from natural gas distribution systems within the Tema Area under Scope 2 and report on outcome by 2021.

5. Initiate strategies to collate data on Hydrofluorocarbon emissions from specifically office Air Condition systems by 2021. Basically, responsible staff will be trained on data collection methods and input into the spreadsheets.

6. Undertake area and ground survey to assess carbon sequestration of VRA Reforestation program to offset VRA's carbon emissions within its carbon accounting programme by 2021.

7. Establish the "**Akosombo Plastic Waste Processing & Recycling Centre**" for the segregation and processing of plastic bottles within the Akosombo and its environs by 2021.

8. Assess the utilization of the fuel-efficient stoves for riparian communities and estimate carbon savings achieved by 2021.

9. Capacity building of staff using safety meetings to effectively embrace carbon caring values throughout the operation of VRA and report on outcome by 2021.

10. Capacity building of subsidiary companies, by Mid-2021, namely VLTC, AHL, KFL, and NEDCO to enable them publish their own GHG Report.

10 REFERENCES

1. Annual Environmental Reports (2012): Mines Reserve Power Plant: March 2013
2. Annual Environmental Reports (2012): Takoradi 1Thermal Power Station: March 2013
3. Annual Environmental Reports (2012): Takoradi 3 Thermal Power Station: March 2013
4. Annual Environmental Reports (2012): Tema Thermal 1 Power Station: March 2013
5. Annual Environmental Reports (2012): Tema Thermal 2 Power Station: March 2013
6. Annual Environmental Reports (2013): Mines Reserve Power Plant: March 2014
7. Annual Environmental Reports (2013): Takoradi 1Thermal Power Station: March 2014
8. Annual Environmental Reports (2013): Takoradi 3 Thermal Power Station: March 2014
9. Annual Environmental Reports (2013): Tema Thermal 1 Power Station: March 2014
10. Annual Environmental Reports (2013): Tema Thermal 2 Power Station: March 2014
11. Annual Environmental Reports (2014): Mines Reserve Power Plant: March 2015
12. Annual Environmental Reports (2014): Tema Thermal 1 Power Station: March 2015
13. Annual Environmental Reports (2014): Tema Thermal 2 Power Station: March 2015
14. Annual Environmental Reports (2015): Mines Reserve Power Plant: March 2016
15. Annual Environmental Reports (2015): Takoradi 1Thermal Power Station: March 2016
16. Annual Environmental Reports (2015): Takoradi 3 Thermal Power Station: March 2016
17. Annual Environmental Reports (2015): Tema Thermal 1 Power Station: March 2016
18. Annual Environmental Reports (2015): Tema Thermal 2 Power Station: March 2016
19. Annual Environmental Reports (2016): Mines Reserve Power Plant: March 2017
20. Annual Environmental Reports (2016): Takoradi 1Thermal Power Station: March 2017
21. Annual Environmental Reports (2016): Takoradi 3 Thermal Power Station: March 2017
22. Annual Environmental Reports (2016): Tema Thermal 1 Power Station: March 2017
23. Annual Environmental Reports (2016): Tema Thermal 2 Power Station: March 2017
24. Annual Environmental Reports (2017): Takoradi 1Thermal Power Station: March 2018
25. Annual Environmental Reports (2017): Takoradi 3 Thermal Power Station: March 2018
26. Annual Environmental Reports (2017): Tema Thermal 1 Power Station: March 2018
27. Annual Environmental Reports (2017): Tema Thermal 2 Power Station: March 2018
28. Annual Environmental Reports (2018): Takoradi 1Thermal Power Station: March 2019
29. Annual Environmental Reports (2018): Tema Thermal 1 Power Station: March 2019
30. Annual Environmental Reports (2018): Tema Thermal 2 Power Station: March 2019
31. GHG Calculation Tool for the Energy Sector, KfW Development Bank
32. Greenhouse Gas Inventory Guidance: Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases; USEPA, November 2014
33. Intergovernmental Panel on Climate Change (IPCC). 2007. IPCC Fourth Assessment Report - Working Group I Report "*The Physical Science Basis*."
34. International Organization for Standardization (ISO), 2006: “14064-1 Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals”.
35. WARM User’s Guide - Calculating Greenhouse Gas Emissions with the Excel© Version of the Waste Reduction Model, 2012
36. World Resources Institute (2015). GHG Protocol tool for stationary combustion. Version 4.1.

37. WRI/WBCSD, The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition). 2004, World Resources Institute and World Business Council for Sustainable Development. Available at: http:// www.ghgprotocol.org / standards /corporate-standard.

11 APPENDIX

Appendix 1 - VRA Corporate Organizational Chart

Appendix 2 - GHG Emission Calculation Sheets for Stationary Combustion Thermal Power Project

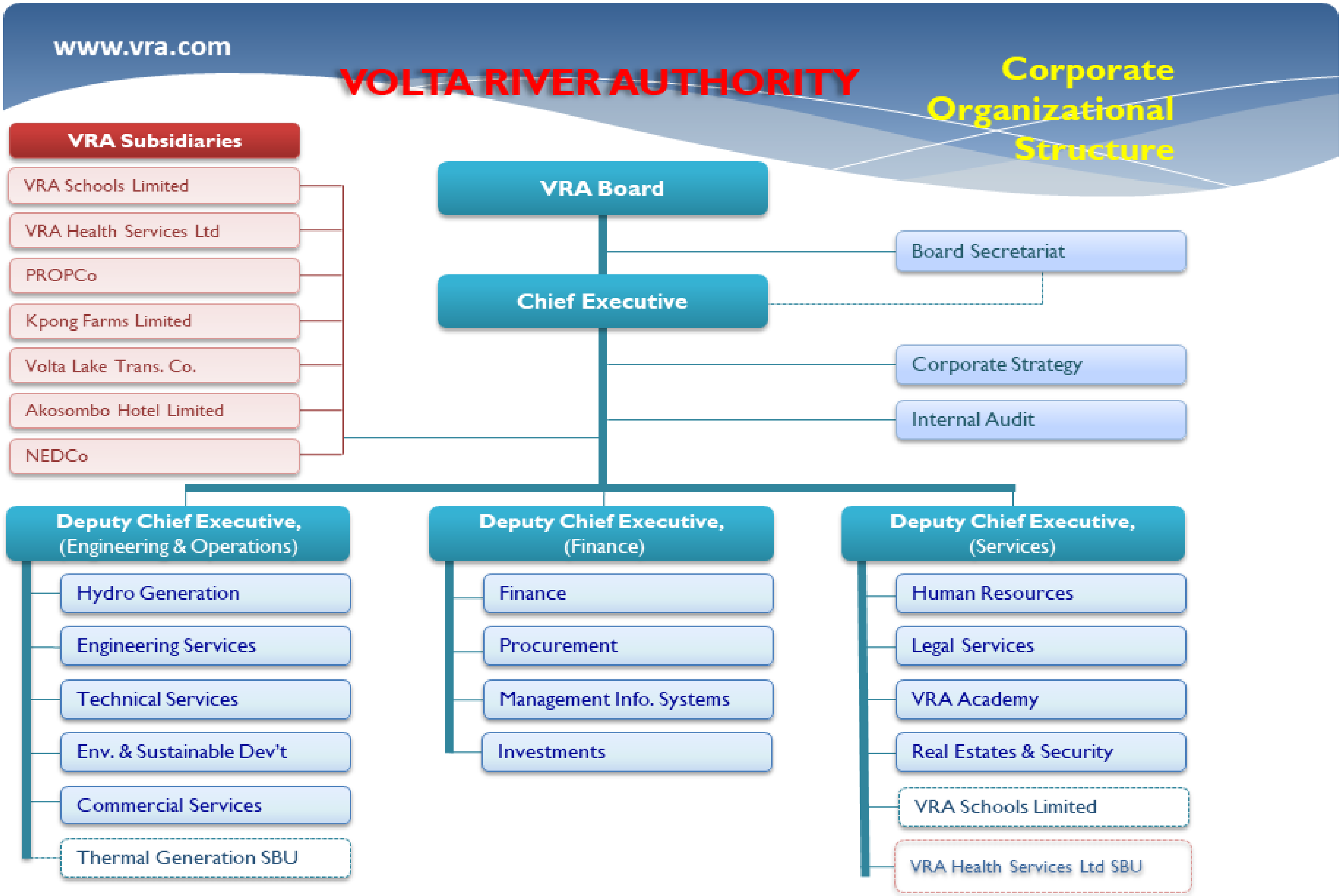
Appendix 3 - GHG Emission Calculating Sheet for Vehicular Combustion

Appendix 4 - GHG Emission Calculating Sheet for Water Transport Combustion

Appendix 5 - GHG Savings Calculating Sheet for Solar Power Project

Appendix 6 - Membership of Carbon Accounting Team

APPENDIX 1: VRA CORPORATE ORGANIZATIONAL CHART


www.vra.com
VOLTA RIVER AUTHORITY
Corporate Organizational Structure
VRA Subsidiaries
VRA Schools Limited
VRA Health Services Ltd
PROPCo
Kpong Farms Limited
Volta Lake Trans. Co.
Akosombo Hotel Limited
NEDCo
VRA Board
Board Secretariat
Chief Executive
Corporate Strategy
Internal Audit
Deputy Chief Executive, (Engineering & Operations)
Hydro Generation
Engineering Services
Technical Services
Env. & Sustainable Dev't
Commercial Services
Thermal Generation SBU
Deputy Chief Executive, (Finance)
Finance
Procurement
Management Info. Systems
Investments
Deputy Chief Executive, (Services)
Human Resources
Legal Services
VRA Academy
Real Estates & Security
VRA Schools Limited
VRA Health Services Ltd SBU

APPENDIX 2:

GHG EMISSION CALCULATION SHEETS FOR STATIONARY COMBUSTION THERMAL POWER PROJECT

GREENHOUSE
GAS PROTOCOL

When entering activity data using energy units (e.g., mmBtu or GJ), please ensure you select the heating value metric these data are based on. For default emission factors, this tool applies Lower Heating Values, unless told otherwise. For a custom emission factor, it assumes that the activity data are on the same heating value basis as the emission factor.

User supplied data							GHG emissions (tonnes)			
Source ID	Sector	Fuel type (e.g., solid fossil)	Fuel	Amount of fuel	Units (e.g., kg or kWh)	Heating value basis	CO_2	CH_4	N_2O	All GHGs (tonnes CO_2e)
2012-T1	Energy	Gaseous fossil	Natural gas	3908263.62	mmBtu	Lower	231334.462	4.124E+00	4.124E-01	231548.890
2012-T1	Energy	Liquid fossil	Crude oil	257577300	litres (l)		638913.280	2.615E+01	5.230E+00	641083.668
2012-T1	Energy	Liquid fossil	Gas/Diesel oil	1003300	litres (l)		2685.324	1.087E-01	2.174E-02	2694.348
2013-T1	Energy	Gaseous fossil	Natural gas	2190365.2	mmBtu	Lower	129650.147	2.311E+00	2.311E-01	129770.322
2013-T1	Energy	Liquid fossil	Crude oil	358490410	litres (l)		889225.424	3.639E+01	7.279E+00	892246.122
2013-T1	Energy	Liquid fossil	Gas/Diesel oil	988830	litres (l)		2646.596	1.071E-01	2.143E-02	2655.489
2014-T1	Energy	Gaseous fossil	Natural gas	2049310.29	mmBtu	Lower	121300.951	2.162E+00	2.162E-01	121413.387
2014-T1	Energy	Liquid fossil	Crude oil	183580690	litres (l)		455366.761	1.864E+01	3.727E+00	456913.642
2014-T1	Energy	Liquid fossil	Gas/Diesel oil	641480	litres (l)		1716.916	6.951E-02	1.390E-02	1722.685
2015-T1	Energy	Gaseous fossil	Natural gas	15615346.5	mmBtu	Lower	924289.695	1.648E+01	1.648E+00	925146.434
2015-T1	Energy	Liquid fossil	Crude oil	50975800	litres (l)		126444.045	5.175E+00	1.035E+00	126873.575
2015-T1	Energy	Liquid fossil	Gas/Diesel oil	458250	litres (l)		1226.502	4.966E-02	9.931E-03	1230.624
2016_T1	Energy	Gaseous fossil	Natural gas	7073154.23	mmBtu	Lower	418667.850	7.463E+00	7.463E-01	419055.920
2016_T1	Energy	Liquid fossil	Crude oil	109034080	litres (l)		270455.982	1.107E+01	2.214E+00	271374.721
2016_T1	Energy	Liquid fossil	Gas/Diesel oil	609860	litres (l)		1632.285	6.608E-02	1.322E-02	1637.770
2017_T1	Energy	Gaseous fossil	Natural gas	4961819.19	mmBtu	Lower	293695.585	5.235E+00	5.235E-01	293967.817
2017_T1	Energy	Liquid fossil	Crude oil	27127110	litres (l)		67288.037	2.754E+00	5.508E-01	67516.614
2017_T1	Energy	Liquid fossil	Gas/Diesel oil	333030	litres (l)		891.352	3.609E-02	7.217E-03	894.347
2018_T1	Energy	Gaseous fossil	Natural gas	8447440.4	mmBtu	Lower	500013.374	8.913E+00	8.913E-01	500476.844
2018_T1	Energy	Liquid fossil	Crude oil	10718790	litres (l)		26587.658	1.088E+00	2.176E-01	26677.977
2018_T1	Energy	Liquid fossil	Gas/Diesel oil	593335.7	litres (l)		1588.058	6.429E-02	1.286E-02	1593.395
							Total GHG emissions from fossil fuels (tonnes C			5116494.590
							Total CO_2 emissions from biomass (tonnes):			0.000

GREENHOUSE GAS PROTOCOL

When entering activity data using energy units (e.g., mmBtu or GJ), please ensure you select the heating value metric these data are based on. For default emission factors, this tool applies Lower Heating Values, unless told otherwise. For a custom emission factor, it assumes that the activity data are on the same heating value basis as the emission factor.

User supplied data							GHG emissions (tonnes)			
Source ID	Sector	Fuel type (e.g., solid fossil)	Fuel	Amount of fuel	Units (e.g., kg or kWh)	Heating value basis	CO_2	CH_4	N_2O	All GHGs (tonnes CO_2e)
2013-T3	Energy	Liquid fossil	Crude oil	27654720	litres (l)		68596.759	2.808	0.562	68829.782
2013-T3	Energy	Liquid fossil	Gas/Diesel oil	36570	litres (l)		97.879	0.004	0.001	98.208
2014-T3	Energy	Gaseous fossil	Natural gas	778185	mmBtu	Lower	46061.634	0.821	0.082	46104.329
2015-T3	Energy	Gaseous fossil	Natural gas	338930	mmBtu	Lower	20061.643	0.358	0.036	20080.238
							Total GHG emissions from fossil fuels (tonnes CO_2e):			135112.558
							Total CO_2 emissions from biomass (tonnes):			0.000

GREENHOUSE GAS PROTOCOL

When entering activity data using energy units (e.g., mmBtu or GJ), please ensure you select the heating value metric these data are based on. For default emission factors, this tool applies Lower Heating Values, unless told otherwise. For a custom emission factor, it assumes that the activity data are on the same heating value basis as the emission factor.

User supplied data							GHG emissions (tonnes)			
Source ID	Sector	Fuel type (e.g., solid fossil)	Fuel	Amount of fuel	Units (e.g., kg or kWh)	Heating value basis	CO_2	CH_4	N_2O	All GHGs (tonnes CO_2e)
2012-TT1P	Energy	Gaseous fossil	Natural gas	1317219.1	mmBtu		77967.661	1.390E+00	1.390E-01	78039.930
2012-TT1P	Energy	Liquid fossil	Gas/Diesel oil	1,131,020	litres (l)		3027.165	1.226E-01	2.451E-02	3037.337
2012-TT1P	Energy	Liquid fossil	Crude oil	143,102,248	litres (l)		354961.119	1.453E+01	2.906E+00	356166.921
2013-TT1P	Energy	Gaseous fossil	Natural gas	1758457.6	mmBtu		104085.057	1.855E+00	1.855E-01	104181.535
2013-TT1P	Energy	Liquid fossil	Crude oil	124932730	litres (l)		309892.139	1.268E+01	2.537E+00	310944.842
2013-TT1P	Energy	Liquid fossil	Gas/Diesel oil	664900	litres (l)		1779.600	7.205E-02	1.441E-02	1785.580
2014-TT1P	Energy	Gaseous fossil	Natural gas	3536265.4	mmBtu		209315.474	3.731E+00	3.731E-01	209509.492
2014-TT1P	Energy	Liquid fossil	Crude oil	138546900	litres (l)		343661.706	1.407E+01	2.813E+00	344829.124
2014-TT1P	Energy	Liquid fossil	Gas/Diesel oil	642800	litres (l)		1720.449	6.965E-02	1.393E-02	1726.230
2015-TT1P	Energy	Gaseous fossil	Natural gas	3121148	mmBtu		184744.215	3.293E+00	3.293E-01	184915.457
2015-TT1P	Energy	Liquid fossil	Crude oil	102756300	litres (l)		254884.125	1.043E+01	2.086E+00	255749.966
2015-TT1P	Energy	Liquid fossil	Gas/Diesel oil	473500	litres (l)		1267.319	5.131E-02	1.026E-02	1271.578
2016_TT1F	Energy	Liquid fossil	Crude oil	57476700	litres (l)		142569.345	5.835E+00	1.167E+00	143053.653
2016_TT1F	Energy	Liquid fossil	Gas/Diesel oil	139000	litres (l)		372.032	1.506E-02	3.012E-03	373.283
2017_TT1F	Energy	Gaseous fossil	Natural gas	2363056	mmBtu		139871.908	2.493E+00	2.493E-01	140001.557
2017_TT1F	Energy	Liquid fossil	Crude oil	61661000	litres (l)		152948.384	6.260E+00	1.252E+00	153467.949
2017_TT1F	Energy	Liquid fossil	Gas/Diesel oil	86400	litres (l)		231.249	9.362E-03	1.872E-03	232.026
2018_TT1F	Energy	Gaseous fossil	Natural gas	3693510.8	mmBtu		218623.004	3.897E+00	3.897E-01	218825.649
							Total GHG emissions from fossil fuels (tonnes CO			2508112.110
							Total CO_2 emissions from biomass (tonnes):			0.000

GREENHOUSE GAS PROTOCOL

When entering activity data using energy units (e.g., mmBtu or GJ), please ensure you select the heating value metric these data are based on. For default emission factors, this tool applies Lower Heating Values, unless told otherwise. For a custom emission factor, it assumes that the activity data are on the same heating value basis as the emission factor.

User supplied data							GHG emissions (tonnes)			
Source ID	Sector	Fuel type (e.g., solid fossil)	Fuel	Amount of fuel	Units (e.g., kg or kWh)	Heating value basis	CO_2	CH_4	N_2O	All GHGs (tonnes CO_2e)
2012-TT2P	Energy	Gaseous fossil	Natural gas	1560257	mmBtu	Lower	92353.344	1.646E+00	1.646E-01	92438.948
2012-TT2P	Energy	Liquid fossil	Gas/Diesel oil	4645000	litres (l)		12432.305	5.033E-01	1.007E-01	12474.082
2013-TT2P	Energy	Gaseous fossil	Natural gas	1,062,298	mmBtu	Lower	62878.574	1.121E+00	1.121E-01	62936.857
2013-TT2P	Energy	Liquid fossil	Gas/Diesel oil	3,209,600	litres (l)		8590.469	3.478E-01	6.956E-02	8619.335
2014-TT2P	Energy	Gaseous fossil	Natural gas	2717206	mmBtu	Lower	160834.439	2.867E+00	2.867E-01	160983.519
2015-TT2P	Energy	Gaseous fossil	Natural gas	2420967	mmBtu	Lower	143299.724	2.554E+00	2.554E-01	143432.551
2016_TT2P	Energy	Gaseous fossil	Natural gas	308,296	mmBtu	Lower	18248.382	3.253E-01	3.253E-02	18265.297
2018_TT2P	Energy	Gaseous fossil	Natural gas	30960	mmBtu	Lower	1832.557	3.267E-02	3.267E-03	1834.255
							Total GHG emissions from fossil fuels (tonnes CO_2e):			500984.845
							Total CO_2 emissions from biomass (tonnes):			0.000

GREENHOUSE
GAS PROTOCOL

When entering activity data using energy units (e.g., mmBtu or GJ), please ensure you select the heating value metric these data are based on. For default emission factors, this tool applies Lower Heating Values, unless told otherwise. For a custom emission factor, it assumes that the activity data are on the same heating value basis as the emission factor.

User supplied data							GHG emissions (tonnes)			
Source ID	Sector	Fuel type (e.g., solid fossil)	Fuel	Amount of fuel	Units (e.g., kg or kWh)	Heating value basis	CO_2	CH_4	N_2O	All GHGs (tonnes CO_2e)
2016_KTPF	Energy	Liquid fossil	Gas/Diesel oil	3599000	litres (l)		9632.695	3.900E-01	7.800E-02	9665.064
2017_KTPF	Energy	Gaseous fossil	Natural gas	35,187.00	mmBtu	Lower	2082.758	3.713E-02	3.713E-03	2084.688
2017_KTPF	Energy	Liquid fossil	Gas/Diesel oil	39397800	litres (l)		105447.897	4.269E+00	8.538E-01	105802.236
2018_KTPF	Energy	Gaseous fossil	Natural gas	3,282,664.61	mmBtu	Lower	194304.562	3.464E+00	3.464E-01	194484.666
2018_KTPF	Energy	Liquid fossil	Gas/Diesel oil	10622830	litres (l)		28431.920	1.151E+00	2.302E-01	28527.460
							Total GHG emissions from fossil fuels (tonnes CO			340564.113
							Total CO_2 emissions from biomass (tonnes):			0.000

GREENHOUSE GAS PROTOCOL

When entering activity data using energy units (e.g., mmBtu or GJ), please ensure you select the heating value metric these data are based on. For default emission factors, this tool applies Lower Heating Values, unless told otherwise. For a custom emission factor, it assumes that the activity data are on the same heating value basis as the emission factor.

User supplied data							GHG emissions (tonnes)			
Source ID	Sector	Fuel type (e.g., solid fossil)	Fuel	Amount of fuel	Units (e.g., kg or kWh)	Heating value basis	CO_2	CH_4	N_2O	All GHGs (tonnes CO_2e)
2012-MRPS	Energy	Liquid fossil	Gas/Diesel oil	8267300	litres (l)		22127.3623	0.8958	0.1792	22201.7174
2014-MRPS	Energy	Gaseous fossil	Natural gas	2,645,692	mmBtu	Lower	156601.4462	2.7915	0.2791	156746.6026
2015-MRPS	Energy	Gaseous fossil	Natural gas	2,401,936	mmBtu	Lower	142173.2580	2.5343	0.2534	142305.0407
							Total GHG emissions from fossil fuels (tor			321253.3607
							Total CO_2 emissions from biomass (tonne			0.000

APPENDIX 3:
GHG EMISSION CALCULATING SHEET FOR VEHICULAR COMBUSTION

VRA Corporate Greenhouse Gas Report (2012-2018)

GREENHOUSE GAS PROTOCOL

Total GHG Emissions, exclude Biofuel CO2	5741.093
Biofuel CO2 Emissions (metric tonnes)	0

Activity Data

The default emission factors are sourced from the US EPA Climate Leaders program or from the UK DEFRA (for air travel only).

Source Description	Inventory Year	Region	Mode of Transport	Scope	Type of Activity Data	Activity Data					GHG Emissions					Type of activity data
						Vehicle Type (For air transport, see footnote)	Distance Travelled	Fuel Used	Fuel Amount	Unit of Fuel Amount	Fossil Fuel CO2 (metric tonnes)	CH4 (kilograms)	N2O (kilograms)	Total GHG Emissions, exclude Biofuel CO2 (metric tonnes CO2e)	Biofuel CO2 Emissions (metric tonnes)	
Board Secretariat	2011															0
	2012															0
	2013															0
	2014															0
	2015															0
	2016															0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	120	Litre	0.321			0.321	0	Fuel Use
	2018															0
	2019															0
	2020															0
Commercial Services	2011															0
	2012															0
	2013															0
	2014															0
	2015															0
	2016															0
	2017															0
	2018															0
	2019															0
	2020															0
Corporate Strategy	2011															0
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	405	Litre	1.084			1.084	0	Fuel Use
	2013															0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	2846.81	Litre	7.619			7.619	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	4018.45	Litre	10.755			10.755	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	9790.76	Litre	26.203			26.203	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	12534.341	Litre	33.546			33.546	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	8016	Litre	21.453			21.453	0	Fuel Use
	2019															0
	2020															0
Deputy Chief Executives	2011															0
	2012															0
	2013															0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	981	Litre	2.625			2.625	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	7390.21	Litre	19.779			19.779	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	119270.45	Litre	319.207			319.207	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	232607.606	Litre	622.534			622.534	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	3776	Litre	10.106			10.106	0	Fuel Use
	2019	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel		Litre	0			0	0	Fuel Use

VRA Corporate Greenhouse Gas Report (2012-2018)

	2020												0
Engineering Services	2011	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel		Litre	0	0	0	Fuel Use
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	49171	Litre	131.596	131.596	0	Fuel Use
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	33666.75	Litre	90.103	90.103	0	Fuel Use
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	63439.71	Litre	169.785	169.785	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	297856.58	Litre	797.162	797.162	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	142988.73	Litre	382.685	382.685	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	123222.106	Litre	329.783	329.783	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	23386	Litre	62.589	62.589	0	Fuel Use
	2019	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel		Litre	0	0	0	Fuel Use
	2020												0
Environment & Sustainable Development	2011	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel		Litre	0	0	0	Fuel Use
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	44818	Litre	119.948	119.948	0	Fuel Use
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	18226.18	Litre	48.779	48.779	0	Fuel Use
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	43229.245	Litre	115.696	115.696	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	50231.465	Litre	134.436	134.436	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	36981.54	Litre	99.001	99.001	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	76186.86	Litre	203.903	203.903	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	23991	Litre	64.208	64.208	0	Fuel Use
	2019												0
	2020												0
Finance	2011	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	9646	Litre	25.816	25.816	0	Fuel Use
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	40863.4	Litre	109.364	109.364	0	Fuel Use
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	18016.58	Litre	48.224	48.224	0	Fuel Use
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	11615.6	Litre	31.087	31.087	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	24542.29	Litre	65.683	65.683	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	22771.52	Litre	60.944	60.944	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	47822.83	Litre	127.990	127.990	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	14187	Litre	37.969	37.969	0	Fuel Use
	2019	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	130	Litre	0.348	0.348	0	Fuel Use
	2020												0
Health Services	2011	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	3161	Litre	8.460	8.460	0	Fuel Use
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	18383.95	Litre	49.201	49.201	0	Fuel Use
	2013												0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	60153.5	Litre	160.990	160.990	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	30051.186	Litre	80.427	80.427	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	22795.03	Litre	61.007	61.007	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	63414.59	Litre	169.718	169.718	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	31129	Litre	83.311	83.311	0	Fuel Use
													0
	2020												0
Human Resources													0
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	5414	Litre	14.490	14.490	0	Fuel Use
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	5500.03	Litre	14.720	14.720	0	Fuel Use
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	5836.8	Litre	15.621	15.621	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	2902	Litre	7.767	7.767	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	4974	Litre	13.312	13.312	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	9919.2	Litre	26.547	26.547	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present	On-Road Diesel Fuel	16801	Litre	44.965	44.965	0	Fuel Use
													0

	2020															0
Hydro Generation																0
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	51743	Litre	138.461			138.461	0	Fuel Use
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	11541.50	Litre	30.889			30.889	0	Fuel Use
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	38306	Litre	102.519			102.519	0	Fuel Use
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	25547	Litre	68.372			68.372	0	Fuel Use
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	21398	Litre	57.263			57.263	0	Fuel Use
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	69659.754	Litre	186.432			186.432	0	Fuel Use
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	27739	Litre	74.239			74.239	0	Fuel Use
	2019															0
	2020															0
Add Row											5741.093	0	0	5741.093	0	

* Please note the following distance categories when calculating air transport emissions.

Domestic = < 463 km

Short-haul = ≥ 463 <1108 km

Long haul = ≥ 1108 km

VRA Corporate Greenhouse Gas Report (2012-2018)

GREENHOUSE GAS PROTOCOL

Total GHG Emissions, exclude Biofuel CO_2	2029.951
Biofuel CO_2 Emissions (metric tonnes)	0

Activity Data

The default emission factors are sourced from the US EPA Climate Leaders program or from the UK DEFRA (for air travel only).

Source Description	Inventory Year	Region	Mode of Transport	Scope	Type of Activity Data	Activity Data					GHG Emissions				
						Vehicle Type (For air transport, see footnote)	Distance Travelled	Fuel Used	Fuel Amount	Unit of Fuel Amount	Fossil Fuel CO_2 (metric tonnes)	CH_4 (kilograms)	N_2O (kilograms)	Total GHG Emissions, exclude Biofuel CO_2	Biofuel CO_2 Emissions (metric tonnes)
Board Secretariat	2011														
	2012														
	2013														
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	55	Litre	0.125			0.125	0
	2015														
	2016														
	2017														
	2018														
	2019														
	2020														
Commercial Services	2011														
	2012														
	2013														
	2014														
	2015														
	2016														
	2017														
	2018														
	2019														
	2020														
Corporate Strategy	2011														
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	38	Litre	0.086			0.086	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	941	Litre	2.138			2.138	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	752.29	Litre	1.709			1.709	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1959.87	Litre	4.452			4.452	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	638.72	Litre	1.451			1.451	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	974.79	Litre	2.214			2.214	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	60	Litre	0.136			0.136	0
	2019														
	2020														
Deputy Chief Executives	2011														
	2012														
	2013														
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	829	Litre	1.883			1.883	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	3493.51	Litre	7.936			7.936	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	9620	Litre	21.852			21.852	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	27234.284	Litre	61.864			61.864	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	960	Litre	2.181			2.181	0

VRA Corporate Greenhouse Gas Report (2012-2018)

Engineering Services	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	5630	Litre	12.789			12.789	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	16079.97	Litre	36.526			36.526	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	12365.76	Litre	28.089			28.089	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	52707.56	Litre	119.728			119.728	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	6154.18	Litre	13.979			13.979	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	5034.93	Litre	11.437			11.437	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	4070	Litre	9.245			9.245	0
Environment & Sustainable Development	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1840	Litre	4.180			4.180	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	20767	Litre	47.173			47.173	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	33368.635	Litre	75.798			75.798	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	34513.605	Litre	78.399			78.399	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	35691.18	Litre	81.074			81.074	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	6699.01	Litre	15.217			15.217	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	826	Litre	1.876			1.876	0
Finance	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	817	Litre	1.856			1.856	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	12365.15	Litre	28.088			28.088	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1522.74	Litre	3.459			3.459	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	13620.41	Litre	30.939			30.939	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	706	Litre	1.604			1.604	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1187	Litre	2.696			2.696	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	235	Litre	0.534			0.534	0
Health Services	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	4729	Litre	10.742			10.742	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	495525.6	Litre	1125.609			1125.609	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	17637.67	Litre	40.065			40.065	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	4456.21	Litre	10.122			10.122	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	22053.63	Litre	50.096			50.096	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	6502	Litre	14.770			14.770	0
Human Resources	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	4492.03	Litre	10.204			10.204	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	270	Litre	0.613			0.613	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1926	Litre	4.375			4.375	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	432	Litre	0.981			0.981	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	625	Litre	1.420			1.420	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	335	Litre	0.761			0.761	0

Hydro Generation	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	2845	Litre	6.463			6.463	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	772.24	Litre	1.754			1.754	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1807	Litre	4.105			4.105	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1582	Litre	3.594			3.594	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	497	Litre	1.129			1.129	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	12780.274	Litre	29.051			29.051	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	609	Litre	1.383			1.383	0
Add Row											2029.951	0	0	2029.951	0

* Please note the following distance categories when calculating air transport emissions.

Domestic = < 463 km

Short-haul = ≥ 463 <1108 km

Long haul = ≥ 1108 km

VRA Corporate Greenhouse Gas Report (2012-2018)

GREENHOUSE GAS PROTOCOL

Total GHG Emissions, exclude Biofuel CO2	3755.840
Biofuel CO2 Emissions (metric tonnes)	0

Activity Data

The default emission factors are sourced from the US EPA Climate Leaders program or from the UK DEFRA (for air travel only).

Source Description	Inventory Year	Region	Mode of Transport	Scope	Type of Activity Data	Activity Data: Vehicle Type (For air transport, see footnote)	Distance Travelled	Fuel Used	Fuel Amount	Unit of Fuel Amount	GHG Emissions: Fossil Fuel CO2 (metric tonnes)	CH4 (kilograms)	N2O (kilograms)	Total GHG Emissions, exclude Biofuel CO2 (metric tonnes CO2e)	Biofuel CO2 Emissions (metric tonnes)
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1510	Litre	4.041			4.041	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1991	Litre	5.329			5.329	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	987.94	Litre	2.644			2.644	0
Internal Audit	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	729.75	Litre	1.953			1.953	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1062.92	Litre	2.845			2.845	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1529.66	Litre	4.094			4.094	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	45	Litre	0.120			0.120	0
	2019														
	2020														
	2011														
	2012														
	2013														
	2014														
Investment	2015														
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	264	Litre	0.707			0.707	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	100	Litre	0.268			0.268	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	100	Litre	0.268			0.268	0
	2019														
	2020														
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	3750	Litre	10.036			10.036	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	6116.11	Litre	16.369			16.369	0
	2014														
Legal Services	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	169.7	Litre	0.454			0.454	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1187.25	Litre	3.177			3.177	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	70	Litre	0.187			0.187	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	38	Litre	0.102			0.102	0
	2019														
	2020														
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	47761.99	Litre	127.827			127.827	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	10531.57	Litre	28.186			28.186	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	5110.72	Litre	13.678			13.678	0
Management & Information System	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	6486.718	Litre	17.361			17.361	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	9164.28	Litre	24.527			24.527	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	11638.98	Litre	31.150			31.150	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	6829	Litre	18.277			18.277	0
	2019	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	7636	Litre	20.436			20.436	0

VRA Corporate Greenhouse Gas Report (2012-2018)

	2020														
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	14427	Litre	38.611			38.611	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	12196.3	Litre	32.641			32.641	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	51328	Litre	137.371			137.371	0
Procurement	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	51783	Litre	138.588			138.588	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	51149.48	Litre	136.893			136.893	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	96007.39	Litre	256.947			256.947	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	39272	Litre	105.105			105.105	0
	2020														
	2011														
	2012														
	2013														
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	65	Litre	0.174			0.174	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	236	Litre	0.632			0.632	0
PropCo	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	9871.971	Litre	26.421			26.421	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	32368.592	Litre	86.629			86.629	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	4466	Litre	11.952			11.952	0
	2020														
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	22256	Litre	59.564			59.564	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	20605.48	Litre	55.147			55.147	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	53650.9	Litre	143.587			143.587	0
Real Estate and Security	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	40991.248	Litre	109.706			109.706	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	37146.572	Litre	99.416			99.416	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	70859.682	Litre	189.644			189.644	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	18694	Litre	50.031			50.031	0
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	87137.69	Litre	233.209			233.209	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	17277.68	Litre	46.241			46.241	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	21194	Litre	56.722			56.722	0
Technical Services	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	56548.246	Litre	151.342			151.342	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	79125.24	Litre	211.765			211.765	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	71113.85	Litre	190.324			190.324	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	46792	Litre	125.231			125.231	0
	2012														
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	8011.86	Litre	21.442			21.442	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	3597	Litre	9.627			9.627	0
Thermal Generation SBU	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	26593.79	Litre	71.174			71.174	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	7985	Litre	21.370			21.370	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	64716.32	Litre	173.202			173.202	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	96695	Litre	258.787			258.787	0

VRA Academy & Schools															
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	9982	Litre	26.715			26.715	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	745.9	Litre	1.996			1.996	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	637.28	Litre	1.706			1.706	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	5642	Litre	15.100			15.100	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1867	Litre	4.997			4.997	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	18322	Litre	49.036			49.036	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	27187	Litre	72.761			72.761	0
	2020														
Add Row											3755.840	0	0	3755.840	0

* Please note the following distance categories when calculating air transport emissions.

Domestic = < 463 km

Short-haul = ≥ 463 <1108 km

Long haul = ≥ 1108 km

VRA Corporate Greenhouse Gas Report (2012-2018)

GREENHOUSE GAS PROTOCOL

Total GHG Emissions, exclude Biofuel CO2	378.337
Biofuel CO2 Emissions (metric tonnes)	0

Activity Data

The default emission factors are sourced from the US EPA Climate Leaders program or from the UK DEFRA (for air travel only).

Source Description	Inventory Year	Region	Mode of Transport	Scope	Type of Activity Data	Activity Data					GHG Emissions				
						Vehicle Type (For air transport, see footnote)	Distance Travelled	Fuel Used	Fuel Amount	Unit of Fuel Amount	Fossil Fuel CO_2 (metric	CH_4 (kilograms)	N_2O (kilograms)	Total GHG Emissions, exclude Biofuel CO_2 (metric tonnes CO_2e)	Biofuel CO_2 Emissions (metric tonnes)
Internal Audit															
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	334	Litre	0.759			0.759	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1146	Litre	2.603			2.603	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	2293	Litre	5.209			5.209	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	4173.78	Litre	9.481			9.481	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	960.85	Litre	2.183			2.183	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1078.57	Litre	2.450			2.450	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	55	Litre	0.125			0.125	0
	2019														
	2020														
Investment	2011														
	2012														
	2013														
	2014														
	2015														
	2016														
	2017														
	2018														
	2019														
	2020														
Legal Sevices															
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	337	Litre	0.766			0.766	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	3733.11	Litre	8.480			8.480	0
	2014														
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	169.7	Litre	0.385			0.385	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol		Litre	0			0	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	45	Litre	0.102			0.102	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	45	Litre	0.102			0.102	0
	2019														
	2020														
Management & Information System															
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	3719.31	Litre	8.449			8.449	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	5515.61	Litre	12.529			12.529	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1082	Litre	2.458			2.458	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	3531.678	Litre	8.022			8.022	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	410	Litre	0.931			0.931	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	701	Litre	1.592			1.592	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	75	Litre	0.170			0.170	0
	2019														
	2020														

VRA Corporate Greenhouse Gas Report (2012-2018)

	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	600	Litre	1.363			1.363	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	11871.3	Litre	26.966			26.966	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	2559	Litre	5.813			5.813	0
rocurement	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	10305	Litre	23.406			23.406	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	90	Litre	0.204			0.204	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	734.16	Litre	1.668			1.668	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	90	Litre	0.204			0.204	0
	2019														
	2020														
	2011														
	2012														
	2013														
	2014														
rpCo	2015														
	2016														
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	150	Litre	0.341			0.341	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	250	Litre	0.568			0.568	0
	2019														
	2020														
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1109	Litre	2.519			2.519	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	484.44	Litre	1.100			1.100	0
	2014														
eal Estate and Security	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	32498.164	Litre	73.823			73.823	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	460	Litre	1.045			1.045	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1255	Litre	2.851			2.851	0
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	6204.2	Litre	14.093			14.093	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	11590.96	Litre	26.336			26.336	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1164	Litre	2.644			2.644	0
echnical Services	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	17788.066	Litre	40.406			40.406	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	892.4	Litre	2.027			2.027	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	755	Litre	1.715			1.715	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1489	Litre	3.382			3.382	0
	2012														
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	6059.06	Litre	13.765			13.765	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1372	Litre	3.117			3.117	0
hermal Generation SBU	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	16127.79	Litre	36.636			36.636	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1340	Litre	3.044			3.044	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	2265	Litre	5.145			5.145	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	6504	Litre	14.774			14.774	0
	2020														

VRA Academy & Schools	2011														
	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	176	Litre	0.400			0.400	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	745.9	Litre	1.694			1.694	0
	2014														
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	60	Litre	0.136			0.136	0
	2016														
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	45	Litre	0.102			0.102	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	110	Litre	0.250			0.250	0
	2019														
	2020														
Add Row											378.337	0	0	378.337	0

* Please note the following distance categories when calculating air transport emissions.

Domestic = < 463 km

Short-haul = ≥ 463 <1108 km

Long haul = ≥ 1108 km

GREENHOUSE GAS PROTOCOL

Total GHG Emissions, exclude Biofuel CO2	278.080
Biofuel CO2 Emissions (metric tonnes)	0

Activity Data

The default emission factors are sourced from the US EPA Climate Leaders program or from the UK DEFRA (for air travel only).

Source Description	Inventory Year	Region	Mode of Transport	Scope	Type of Activity Data	Activity Data: Vehicle Type (For air transport, see footnote)	Distance Travelled	Fuel Used	Fuel Amount	Unit of Fuel Amount	GHG Emissions: Fossil Fuel CO2 (metric tonnes)	CH4 (kilograms)	N2O (kilograms)	Total GHG Emissions, exclude Biofuel CO2 (metric tonnes CO2e)	Biofuel CO2 Emissions (metric tonnes)
VRA Corporate Parent	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1070	Litre	2.864			2.864	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1238	Litre	3.313			3.313	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	3123.73	Litre	8.360			8.360	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	25558.25	Litre	68.402			68.402	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	12177	Litre	32.590			32.590	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	20352.75	Litre	54.471			54.471	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	16953	Litre	45.372			45.372	0
Planning & Power Business	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	6659.4	Litre	17.823			17.823	0
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	6192.01	Litre	16.572			16.572	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	1889	Litre	5.056			5.056	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	5708.5	Litre	15.278			15.278	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	438	Litre	1.172			1.172	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Diesel - Year 1983-present		On-Road Diesel Fuel	2544	Litre	6.809			6.809	0
	2011														
	2012														
	2013														
	2014														
	2015														
	2016														
	2017														
	2018														
	2019														
	2020														
	2011														
	2012														
	2013														
	2014														
	2015														
	2016														
	2017														
	2018														
	2019														

											278.080	0	0	278.080	0

Add Row

* Please note the following distance categories when calculating air transport emissions.
  Domestic = < 463 km
  Short-haul = ≥ 463 <1108 km
  Long haul = ≥ 1108 km

VRA Corporate Greenhouse Gas Report (2012-2018)

GREENHOUSE GAS PROTOCOL

Total GHG Emissions, exclude Biofuel CO2	51.506
Biofuel CO2 Emissions (metric tonnes)	0

Activity Data

The default emission factors are sourced from the US EPA Climate Leaders program or from the UK DEFRA (for air travel only).

Source Description	Inventory Year	Region	Mode of Transport	Scope	Type of Activity Data	Activity Data: Vehicle Type (For air transport, see footnote)	Distance Travelled	Fuel Used	Fuel Amount	Unit of Fuel Amount	GHG Emissions: Fossil Fuel CO2 (metric tonnes)	CH4 (kilograms)	N2O (kilograms)	Total GHG Emissions, exclude Biofuel CO2 (metric tonnes CO2e)	Biofuel CO2 Emissions (metric tonnes)
VRA Corporate Parent	2012	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	338	Litre	0.768			0.768	0
	2013														
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	1661.29	Litre	3.774			3.774	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	5088.89	Litre	11.560			11.560	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	2340	Litre	5.315			5.315	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	3190.12	Litre	7.247			7.247	0
	2018	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	2199	Litre	4.995			4.995	0
	2019														
	2020														
Planning & Power Business	2012														
	2013	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	3428.8	Litre	7.789			7.789	0
	2014	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	894	Litre	2.031			2.031	0
	2015	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	2893.18	Litre	6.572			6.572	0
	2016	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	175	Litre	0.398			0.398	0
	2017	Other	Road	Scope 1	Fuel Use	Passenger Car - Gasoline - Year 2005-present		Gasoline/Petrol	510	Litre	1.158			1.158	0
	2018														
	2019														
	2020														

											51.606	0	0	51.606	0

Add Row

* Please note the following distance categories when calculating air transport emissions.

Domestic = < 463 km

Short-haul = ≥ 463 <1108 km

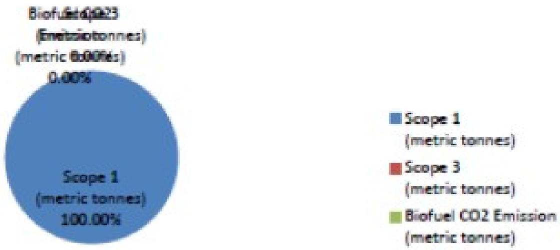
Long haul = ≥ 1108 km

APPENDIX 4:

GHG EMISSION CALCULATING SHEET FOR WATER TRANSPORT COMBUSTION

GREENHOUSE GAS PROTOCOL

Summary: Emissions by Scope



Calculation Method	Greenhouse gas	Fossil Fuel Emissions: Scope 1 (metric tonnes)	Fossil Fuel Emissions: Scope 3 (metric tonnes)	Biofuel CO2 Emission (metric tonnes)
Fuel Use	CO2	444.508	0	0
	CH4	0	0	
	N2O	0	0	
Distance	CO2	0	0	0
	CH4	0	0	
	N2O	0	0	
Total (metric tonnes CO2e)		444.508	0	0

Summary: Emissions by Mode of Transport

Mode of Transport	Scope	Fossil Fuel Emissions: Fossil Fuel CO2 (metric tonnes)	Fossil Fuel Emissions: CH4 (kilograms)	Fossil Fuel Emissions: N2O (kilograms)	Biofuel CO2 Emission (metric tonnes)
Road	Scope 1	0	0	0	
	Scope 3	0	0	0	
Rail	Scope 1	0	0	0	
	Scope 3	0	0	0	
Water	Scope 1	444.508	0	0	
	Scope 3	0	0	0	
AirCraft	Scope 1	0	0	0	
	Scope 3	0	0	0	
Total Emissions		444.508	0	0	
Total GHG Emission (metric tonnes CO2e)		444.508			

APPENDIX 5:
GHG SAVINGS CALCULATING SHEET FOR SOLAR POWER PROJECT

GHG Calculation for S O L A R Energy

KfW Development Bank

OPERATIONAL EMISSIONS
Avoided Emissions

1. Percentage of KfW fin. contribution compared to total investment amount:	100	%	The total energy savings
2. Operational lifetime*:	20		
Project specific operational lifetime:			
Is this a maintenance / life extension project:	No		
In the case of maintenance or lifetime extension add the estimated share of the residual value*:		%	
3. Select Solar Technology:	Solar PV p-Si	PV	Please add an explanati
4. a) Amount of (additional) electricity generated per year (total investment):	16,933	MWh/yr	
OR	OR		
4. b) Installed Capacity		MW	Please add an explanati
Calculated electricity generated per year:	-	MWh/yr	
Project-Specific Capacity Factor*:	16	%	
Default Capacity Factor:	15.5	%	

Project Emissions

5. Lifecycle and/or maintainance emissions* (Carbon Footprint):	0	tCO_2/yr	

Baseline Emissions

6. Select Off Grid or Country:	Ghana		
Project-Specific Emission Factor*:		tCO_2/MWh	Please add an explanati
Default Emission Factor*:	0.509	tCO_2/MWh	

RESULTS

Baseline:	8,627	Tonnes CO_2e/year
Emitted Greenhouse Gas Emissions (Carbon Footprint):	0	Tonnes CO_2e/year
Annual Greenhouse Gas Emission Savings:	8,627	Tonnes CO_2e/year
Lifetime Greenhouse Gas Emission Savings:	172,543	Tonnes CO_2e/lifeti

GHG Calculation for S O L A R Energy

KfW Development Bank

OPERATIONAL EMISSIONS

Avoided Emissions

1. Percentage of KfW fin. contribution compared to total investment amount:	100	%	Please add an explanatic
2. Operational lifetime*:	20		
Project specific operational lifetime:			
Is this a maintenance / life extension project:	No		
In the case of maintenance or lifetime extension add the estimated share of the residual value*:		%	
3. Select Solar Technology:	Solar PV p-Si	PV	Please add an explanatic
4. a) Amount of (additional) electricity generated per year (total investment):	80	MWh/yr	
OR	OR		
4. b) Installed Capacity		MW	Please add an explanatic
Calculated electricity generated per year:	-	MWh/yr	
Project-Specific Capacity Factor*:	16	%	
Default Capacity Factor:	15.5	%	

Project Emissions

5. Lifecycle and/or maintainance emissions* (Carbon Footprint):	0	tCO_2/yr

Baseline Emissions

6. Select Off Grid or Country:	Off Grid		
Project-Specific Emission Factor*:		tCO_2/MWh	Please add an explanatic
Default Emission Factor*:	0.738	tCO_2/MWh	

RESULTS

Baseline:	59	Tonnes CO_2e/year
Emitted Greenhouse Gas Emissions (Carbon Footprint):	0	Tonnes CO_2e/year
Annual Greenhouse Gas Emission Savings:	59	Tonnes CO_2e/year
Lifetime Greenhouse Gas Emission Savings:	1,187	Tonnes CO_2e/lifeti

APPENDIX 6:
MEMBERSHIP OF CARBON ACCOUNTING TEAM

Name	Position	Role
Ing. Theo Nii Okai	Director, E&SDD	Team Leader responsible for reporting on Corporate GHG exposure to VRA Management and influencing and designing Corporate direction in reducing GHG emissions.
Mr. Ben A. Sackey	E&SDD	Provide source data for carbon sinks and responsible for coordinating Team's activities
Mr. Samuel Ofosu-Boateng	Thermal Generation Dept.	Provide source data in thermal generations and plant consumption
Mr. Hans Ofedie	Thermal Generation Dept.	Provide source data in thermal generations and plant consumption
Afua Adwubi Thompson (Mrs)	Engineering Services Dept.	Provide source data in offsets projects
Mr. Samuel Lamptey	Technical Services	Provide source data in electricity consumption
Mr. Carl Asoalla	Procurement Dept.	Provide source data in fugitive emissions from corporate vehicles
Mr. Francis Apana	General Services Dept,	Provide source data in fugitive emissions from corporate vehicles
Mr. Daniel Tutu Benefor	Environmental Protection Agency	Responsible for providing technical backstopping to the VRA Team in Calculations & Reporting on Corporate Carbon Emissions
Mr. Kennedy Amankwa	Energy Commission	Responsible for providing technical backstopping to the VRA Team in Calculations & Reporting on Corporate Carbon Emissions
Mr. Kofi Affum-Baffoe	Forest Services Division	Responsible for providing technical backstopping in the area of Assessing Carbon Stocks Within VRA Plantation sites
Mrs. Enam Eyiah	reNew	Responsible for providing technical backstopping in carbon financing from its reforestation programs and Greenhouse Gas (GHG) mitigation measures.
Jonathan Hagan	VRA – E&SDD	Coopted Members to provide relevant technical and administrative support
Godfred Asare		
Lloyd Sutherland		
Baffo Blankson		
Emmanuel Mualah		