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# Carbon Footprint of An Offshore Survey by Oil and Gas Service Provider Company

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**Abstract**

The rapid development of global economy has leaded to climate change issues. The greenhouse gases including carbon dioxide have driven the issues of climate change and become one of the concerns confronting human society. An offshore survey project that carried out by a service provider company in oil and gas industry was chosen for the carbon footprint estimation during the project's operation in this study. The major objective of this study is to calculate the carbon footprint of the above-mentioned project in terms of $CO_{2,\,eq}$ and use it as a benchmark or reference for the company, as well as to create an Excel Tool that can be used as a carbon footprint calculator. Greenhouse Gas Protocol methodology is to generate the framework for the project in this study. There have three unavoidable sources: fuel combustion by survey vessel, transportation involved and water consumption during the operation of the project. The emission factors approach is used in this study to quantify the emission of GHGs from the project. Emission factor values are obtained from the published report that revised by Federal Register of Legislation in 2020. The carbon footprint of the project was calculated to be 130.44 tons of $CO_{2,\,eq}$. Scope 1 accounted for 96.05% of the carbon footprint, which comprised fuel combusted by survey vessel.

Keywords: carbon footprint; carbon accounting; climate change; greenhouse gas emission; greenhouse gas protocol.



## 1.0 INTRODUCTION

The global economy's expansion has resulted in a series of environmental issues, such as energy shortages, pollution, ecological damage, and climate change. Climate change which caused by emitted greenhouse gas (GHG) from anthropogenic activity has become one of the greatest global challenges According to the fourth assessment report of Intergovernmental Panel on Climate Change, excessive GHG emission caused 90% of the global climate abnormalities [1].

The annual increment rate of 1°C on global averaged surface air temperature was recorded during the last 115 years (1901-2016). The observed warming has driven the changes of many other components of global climate, largely as a result of human activities. Since the mid-20th century, the greenhouse gases that released from anthropogenic activities are the primary source of the global warming [2]. Climate changes has been brought a noticeable impact on all of the world continents. The shrinking sea rise, rising of sea level, disappearing snow cover, melting of glaciers and increasing of atmospheric water vapor have occurred due to human activities [3].

Anthropogenic activities have disrupted the Earth's radiative balance and affected the global climate. Climate change is exacerbated by increased industrial activity. Increased greenhouse gas emissions and aircraft contrails have shifted the Earth's radiative balance [4]. Agriculture is significant in promoting and sustaining the economic life and culture of people. The modern technique used in agriculture causes the negative impact on environment. The carbon emission increases due to the consumption of energy and fertilizer [5]. The process of enteric fermentation releases methane, usage of soil releases nitrous oxide and the usage of manure and fertilizer emit the most GHGs emission. Almost 80% of the total emission from agriculture is due to the application of fertilizer [6]. The expansion of population and fast urbanization in Malaysia caused a 3-3.3% annual increase in waste generation. Landfill gas and leachate will migrate into the surrounding ecosystem if proper waste management is not implemented. GHG emissions, air pollution, explosion incidents, fire, health issues, soil contamination, and water pollution are all major concerns [7]. Coal-fired power plants are a major source of GHGs emissions around the world [8]. Transportation is one of the most significant sources of GHGs and air pollutant emissions. A fast glowing of transportation sector will increase the rate of GHGs emission and release a higher emission than other sector in future [9].

The occurrence of climate change has created a new risk for human and natural systems. The climate-related impacts are the result of the complex interaction between climate-related hazards and exposure, vulnerability and adaptive capacity of human and natural systems [10]. Water availability and supply, food security, agricultural earnings, and infrastructure all react to rising global temperatures. Climate change could increase the risk for ecosystems, economics, people and assets [11]. By meeting the Paris Agreement's mitigation commitments could save millions of lives. Reducing of carbon emissions and air pollution by targeted actions are needed to save over two million lives each year [12].

In 1992, United Nations Framework Convention on Climate Change was approved at the United Nations Conference on environment and development as the first convention to restrict greenhouse gas emissions in the world. In 1997, the participating countries of United Nations Framework Convention on Climate Change deliberate and drafted the Kyoto agreement on climate change, which aims to stabilize the GHG emission while minimizing the damage to the ecosystem. Kyoto Protocol is the first form of regulation which limit GHG emission from 2005 [1].

Greenhouse Gas (GHG) Protocol and ISO 14064 standard are most widely used accounting tool for quantification and reporting on organizational level greenhouse gas. ISO 14064 first published by International Organization for Standardization in 2006 and being revised continuously [13]. GHG emission are quantified, monitored, reported and verified according to ISO 14064 [14]. Both frameworks provide the similar methodology by categorized the GHG emission into three scopes according to the control ability to the source [13].

GHG protocol acts as a guidance, standards and tool for calculating and reporting the GHG emission from an organization directly or indirectly. World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) developed GHG protocol. GHG protocol is widely utilized by many businesses from various industries around the world [15]. About 63% of the Fortune 500 company used GHG protocol as a GHG emission calculating tool [13].

The GHG Protocol has divided GHGs into three categories [13]: (a) Scope 1 – Emissions of direct GHGs from sources owned or operated by the organization including but not limited to site fuel combustion, company vehicle, manufacturing and process emissions and generation of electricity and fugitive emission; (b) Scope 2 – Indirect GHGs emission from electricity purchased, heat or stream that used by the organization; (c) Scope 3 – Other indirect GHGs emission from sources outside the organization's direct control including but not limited business travel, outsourced transportation and employee commuting.

A few steps are applied to ensure the calculation of carbon footprint (CF) from the project is conformance with GHG Protocol. Firstly, defining organizational and operational boundaries followed by identifying the GHG emission sources for each scope. The next phase is to collect data on fuel and other energy sources followed by selecting the global warming potentials for each GHG and appropriate emission factors [15].

As a measurement of environmental impacts of services, products and organizations, many footprints have been developed to act as an indicator. CF approach is the most extensively utilized method in the world. The word of CF is referred to the quantity of direct or indirect GHG emission from an activity, organization, individual, event, product or country [15]. The British scholars first proposed the concept of carbon footprint to evaluate the impact of carbon dioxide ($CO_2$) emitted by daily energy consumption of individual or organization on environment.

Carbon footprint usually refers to the six GHGs emitted directly or indirectly from production and activities over a given time period. Carbon footprint usually will be expressed as $CO_2$ equivalent ($CO_{2, eq}$) [1]. $CO_{2, eq}$ is a common scale that used to compare the emissions of different GHG. Each GHG has their own global warming potential (GWP) value, which is used to assess the impact on global warming of different gases over time. $CO_{2, eq}$ is defined as the quantity of $CO_2$ that would result in the same amount of global warming [16].

In this study, the main interest is the carbon footprint of an offshore survey project by an oil and gas service provider company. The company provides services and cost-effective solutions to their clients in oil and gas exploration industry. This can be study by conducting methodology based on GHG Protocol in respect to one of the company's projects. This assessment is very important for the company to benchmark their carbon footprint and further reduce their cost while reducing the unnessery utility usage and activitive. The effort of the company in reducing CF can bring a good image, raise awareness and motivate others company within the same field. Although there has much research abound with the focus on the development of methodologies and framework for the carbon accounting but the research studies on project-based carbon footprint estimation in Malaysia is very limited, causing difficulties in obtaining solid data such as GHG emission factor of transportation and electric used. In addition, plenty of the existing online carbon footprint calculators in global developed by government or non-government organization are focusing on household use only.

The objectives of this study are to estimate the GHG emitted from various activities during the operation of offshore survey project based on GHG Protocol, to quantify the total emission of GHGs generated by the project in terms of carbon dioxide equivalency ($CO_{2,\,eq}$), and to develop an Excel Tool for the carbon footprint estimation of the mentioned project of this company.

In this study, the sources of GHG emission are identified as fuel combustion by survey vessel for propulsion and electricity generation, transportation which involving third parties and water consumption throughout the operation of project mentioned above.

## 2.0 METHODOLOGY

The overall methodology used to accomplish the objective of this study is discussed in this section. This research study aims to calculate the carbon footprint of an offshore project within the organization. In this study, the emission factors approach was chosen for estimating the GHG emissions from the project in the company. The overall procedure of the whole research study basically consisted of six major steps and could be categorized into two different phases. In this study, both qualitative and quantitative research methodology were applied throughout the whole research work. The process data for the GHG emissions estimation was dependent on the fuel combusted for vessels propulsion and electricity generation, transportation involved as well as water consumption throughout the project.

### 2.1 Preliminary Study

A deep understanding of concept of carbon footprint and GHGs emission act as a cornerstone of the research study. The concept and issues of GHG due to anthropogenic activities were studied in preliminary study phase. This study is aimed to calculate the carbon footprint of the project mentioned above using GHG protocol. This research will also serve as a benchmark or reference for the company in order to lessen future environmental effect. Although much research stated that LCA is an alternative tool to estimate GHG emission from a product or project, LCA is not suitable for this study which aims for quick assessment on the carbon footprint during the operation of a project. The objective and scope of this study could be outlined by identifying the problem statement. This is to make sure the research study could be done systematically. The boundary of this research work was limited to the GHGs emission from the operation of the project only. The GHGs emissions from the workers during the operation of the project were included in this research work but limited to community.

A search of relevant information on carbon footprint estimation was carried out to get a deeper understanding on it from associated journals articles, books and reports. The emission factors are very important for the estimation of GHGs emission in this study. The process, equipment, vessel, fuels needed, and transportation involved of the project were studied to get a clear understanding on the project operation. The study on the project aimed to identify the possible carbon emission sources exists in this project. Identification of quantity of fuel combusted by vessel during the operation were able to achieve through the study of project. The preliminary study stage includes all primary materials, such as research reports, journal articles, conference proceedings and conference proceedings, as well as secondary resources, such as articles, newspapers, and textbooks.

### 2.2 Collecting Data and Information

The information on the survey vessel used in this project was obtained from the company. In order to proceed with further calculations on GHG emissions, information on the vessel was required for the determination of diesel oil consumption for electricity generation and propulsion. The survey is owned by the company, hence the vessel's GHG emissions are classified as Scope 1. Basically, the daily diesel oil combusted by electricity generator could be obtained based on the size and load of the generator. The quantity of fuel combusted by the vessel was collected in a monthly basis thus the daily fuel consumption of the vessel was assumed to be the same because the duration of the crew onboarded at the vessel lasted 8.5 days and the diesel oil was bunkered to the survey vessel every 24 days. The duration of project’s operation was collected for the result analysis. As there is no any electricity purchased during the project operation, an assumption of no carbon emission from scope 2 was made.

The number and type of transportation involved in this project need to also be taken into consideration in the calculation. The commuting details for all the employees and shipping of the equipment involved in the operation of this project were also recorded I.E., fuel type used such as petrol oil, kerosene and diesel oil as well as the travel distance.

The water consumption on the vessel during the operation of project was collected as well. An assumption of daily water usage on the vessels is same because the fresh water was replenished to the vessel at port for every month. Transportation involved and water consumption are categorized as scope 3. All the information and data mentioned above were collected throughout the whole duration of the project in order to estimate the total GHGs emission from the whole operation of the offshore survey project.

Then, the emission factors value of the purchased water, fuel combustion for vessel propulsion, electricity generation, transportation purpose and etc. needed to be determined. Such data could be obtained from the existing published reports or guidelines by an authorized organization. The National Greenhouse and Energy Reporting (Measurement) Determination revised by Federal Register of Legislation in 2020 was chosen as a guideline for data analysis throughout this research work After all the data and information needed had been collected, the study was proceeded to the next steps of data analysis and result interpretation.

## 2.3 Analyzing Data and Results Interpretation

After collecting the data and information, a carbon footprint calculating tool was developed by using the Excel spreadsheet. The Excel Tool is created to serve as a carbon footprint calculator that presents the data for every work activity and utilities usage in the project. The carbon emission was manually calculated as well to ensure the accuracy of the Excel Tool prepared. In this study, the sources of GHG emission were categorized into three main categories: fuel consumed by survey vessel for propulsion and electricity generation, transportation involved and water consumption. The emission from fuel combusted by survey vessel was categorized in scope 1 while emissions from fuel combusted for transportation involved and from water usage were categorized into scope 3. The operation of whole offshore survey project does not include any purchase of electricity or heat as the electricity consumed during the operation of project was generated from diesel electrical generator. Thus, the carbon footprint of scope 2 in this project will be zero. The equation and emission factors provided in National Greenhouse and Energy Reporting (Measurement) Determination were used in this report to ensure the consistency of the data.

The survey vessel owned by company was consumed diesel oil for propulsion and electricity generation. Based on the size and load of the diesel generator, the total fuel consumed for electricity generation will be able to be obtained. Two genset on the survey vessel were running alternately to ensure the operation of 24 hours per day. Assumption of each generator will be operated 12 hours per day was made. A 380kW of diesel generator with a half load will consumed 1271.89 L of diesel oil for every 24 hours. The diesel oil consumed by vessel engine was 4155.67L per day. The duration of fuel combustion was dependent on the duration of the crew onboarded at the vessel which was eight and half days.

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1{,}000{,}000} \times D \quad (1)$$

Equation 1 is the equation used to estimate the carbon emission from fuel combusted by survey vessel [17]. Where; $E_{ij}$ = emission of type of GHG (j), in term of carbon dioxide equivalent, from fuel type (i) (tonne $CO_{2\text{-}eq}$), Q= quantity of fuel type (i) combusted (L/day), $EC_i$= energy content factor of fuel type (i), $EF_{ijoxec}$= emission factor for gas type (j) for fuel type (i) used for stationery energy or propulsion purpose (kg $CO_{2,\ eq}$/GJ) and D= duration of the fuel combustion (day).

The shipping of equipment and personnel movements involving third parties such as Airline, Grab, and others as well as water consumption throughout the project's operation are included in scope 3 of the carbon footprint. Every movement of equipment or personnel was tracked, including the mode of transport, such as road, air, or sea, as well as the distance traveled. The mode of transportation can determine the vehicle's type and fuel consumption. According to the circumstances of this project, the fuel used for road transport will be petrol oil, the fuel used for marine transport will be diesel oil, and the fuel used for air transport will be kerosene.

$$E_{ij} = \frac{d \times FI \times EC_i \times EF_{ijoxec}}{1000} \times Q \quad (2)$$

Equation 2 is the equation used to estimate the carbon emission from transportation [17]. Where; $E_{ij}$ = emission of type of GHG (j), in term of carbon dioxide equivalent, from fuel type (i) (tonne $CO_{2\text{-}eq}$), d=distance of the vehicle travel (km), FIi= fuel intensity of fuel type (i) consumed for transport (GJ or kL), $EC_i$= energy content factor of fuel type (i), $EF_{ijoxec}$= emission factor for gas type (j) for fuel type (i) used for transpoer energy purpose (kg $CO_{2,\ eq}$/GJ) and Q= quantity of passengers or vehicle.

$$\text{E} = \frac{Q_w \times \text{EF}}{1000} \times D \quad (3)$$

Equation 3 is used to calculate the emission of GHG from water consumption. The duration of water consumption was dependent on the duration of the crew onboarded at the vessel which was eight and half days. The emission factor for water usage according to the 2020 Sustainability and Performance Report by Air Selangor was $0.442kgCO_2/m^3$. Both carbon emission from transportation involved and water consumption throughout the project will be categorized into scope 3. Where; E=emission of carbon dioxide (tonne $CO_2$), $Q_W$= Quantity of water consumption ($m^3$/day), EF= Emission factor $kgCO_2/m^3$ and D=duration of the water consumption (day). Table 1 below shows the energy content and emission factors of fuel combuseted retrived from Federal Register of Legislation, 2020 while Table 2 shows the fuel intensity of different mode of transport with sources. These data listed in the table are utilised for CF calculations.

**Table 1** Energy Content and Emission Factors of Fuel Combusted (Adapted from Federal Register of Legislation, 2020)

| Fuel | Energy Content Factor (GJ/kJ) | Purpose | Emission Factor ($kgCO_{2, eq}$/GJ) | | |
|---|---|---|---|---|---|
| | | | $CO_2$ | $CH_4$ | $N_2O$ |
| Petrol oil | 26.2 | Transportation | 60.2 | 0.7 | 0.6 |
| Diesel oil | 38.6 | Transportation | 69.9 | 0.1 | 0.4 |
| Kerosene | 36.8 | Transportation | 69.9 | 0.01 | 0.6 |
| Diesel oil | 38.6 | Stationery Energy | 69.6 | 0.1 | 0.2 |

**Table 2** Fuel Intensity of Different Mode of Transport with Sources

| Mode of Transport | Fuel Intensity (kL/km) | Sources |
|---|---|---|
| Air | 0.000035 | [18] |
| Water | 0.000015 | [19] |
| Land | 0.000084 | [20] |

## 3.0 RESULTS AND DISCUSSION

### 3.1 Emission by Sources

Figure 1 shows the distribution of carbon emissions by source. Figure 2 shows that throughout the operation of the project, fuel combustion for vessel propulsion contributes the most to overall GHG emissions in terms of carbon dioxide equivalent, accounting for 73.59 % carbon footprint. The second greatest contribution is fuel combustion for electricity generation (22.46%), followed by transportation (3.94%) and water usage (0.01%). The pie chart's most essential message is that vessel propulsion produced a lot of GHG during the operation of offshores survey project.

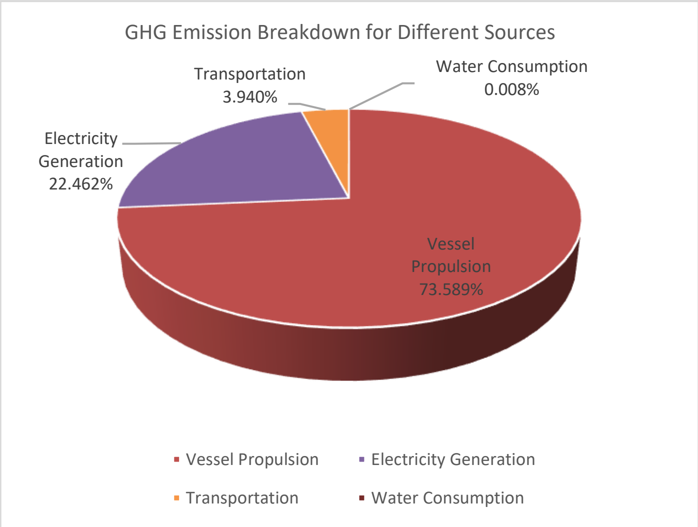


**Figure 1** The graph of GHG Emission Breakdown for Different Sources

### 3.2 Emision by Scopes

The total emissions from fuel combustion by the survey vessel for propulsion and electricity generation were categorized into scope 1, electricity purchased during the project's operation was categorized into scope 2, and total emissions from transportation involving third parties and water usage were categorized into scope 3. Figure 2 shows that scope 1 contributed the most to the project's carbon footprint (96.05%), which corresponds to Figure 2, which shows that vessel propulsion contributes the most to carbon emissions. The emission from scope 2 is zero since no power is purchased throughout the project's operation. The transportation involved third parties and water consumption contributed 3.95% of the carbon emissions.

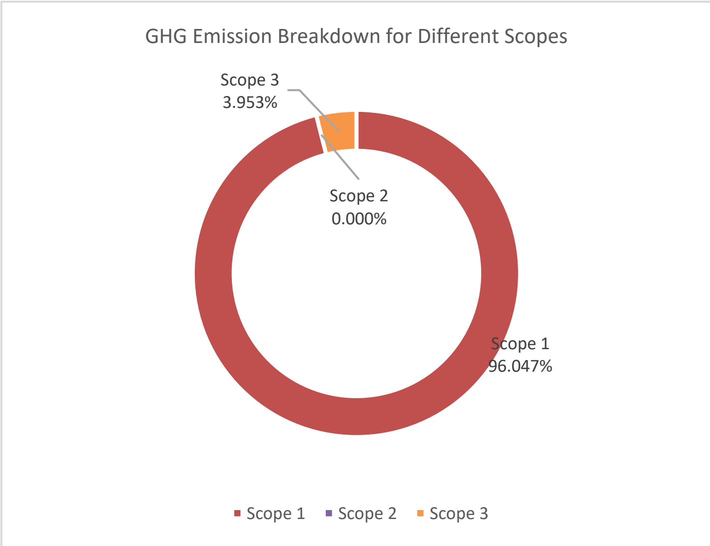


**Figure 2** The graph of GHG Emission Breakdown for Different Scopes

### 3.3 Emission from Fuel Combusted by Survey Vessel

All the personnel onboarded to the survey vessel and subjected to an offshore survey. For propulsion, the diesel oil is burned by the survey vessel’s engine, and for energy generation, it is burned by the diesel generator. The electricity is generated to support the daily needs of the crew onboard as well as the equipment employed throughout the project's operation. The GHG emission due to the vessel propulsion activity is much higher than electricity generation activity. The GHG emission from vessel propulsion activities is 95.99 tons of $CO_{2,\ eq}$ while GHG emission from electricity generation activities is 29.30 tons of $CO_{2,\ eq}$. The total emission from fuel combustion by survey vessel for propulsion and electricity generation is 125.284 tons of $CO_{2,\ eq}$.

### 3.4 Emission from Transportation

The GHG emissions from equipment transportation were lower than from personnel movement, as indicated in Table 2. This might be due to the number of personnel movements was four times higher than the number of equipment shipments as reported in Table 3. One of the reasons for the differences is the participation of planes during the personnel relocation. Based on Figure 3, the carbon emission from air transportation is the highest among the three different modes of transport. The air transportation involved during the project had emitted almost 4.6 tons of $CO_{2,\ eq}$. Circumstances such as climatic uncertainty and the amount of people onboard will result in greater GHG emissions than a car [21]. Transportation was attributed for a total GHG emission of 5.1444 tons $CO_{2,\ eq}$.

**Table 3** The GHG Emission from Transportation Involved

| Transport Details | GHG emission (tons $CO_{2,\ eq}$) |
|---|---|
| Shipment of Equipment | 0.3545 |
| Crew Movement | 4.7899 |
| Total GHG Emission | 5.1444 |

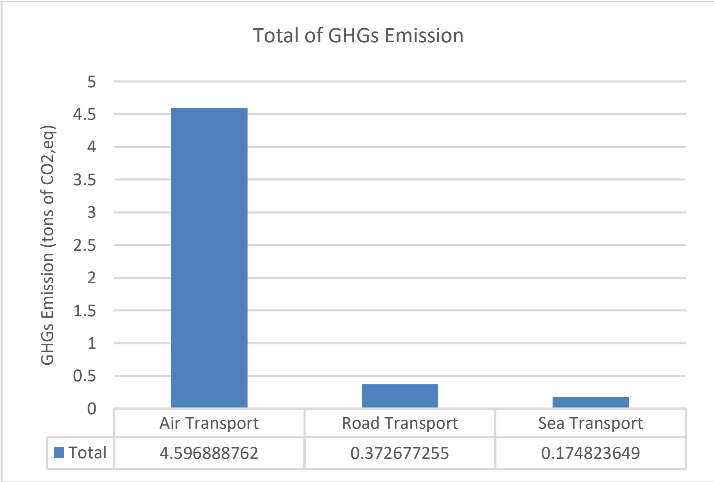


**Figure 3** The graph of GHG Emission Breakdown for Different Mode of Transport

### 3.5 Emission from Water Consumption

Every 30 days, 90.63m3 of water is replenished on the survey vessel. The purpose of the water replenishment is to ensure that the crew onboard consumes enough water on a regular basis. On the vessel, the daily water use is assumed to be the same. With a quantity of 0.0114 tons of $CO_{2,\ eq}$, water consumption released the least amount of GHG into the atmosphere.

### 3.6 Excel Tool

Based on the data analysis and results obtained, an Excel Tool was prepared to act as a calculator for the company to assist them in estimating the carbon footprint of future similar projects. The calculation and result acquired were used to verify the accuracy and consistency of the data and formula entered into the Excel tool. The Excel Tool is user friendly with a clear instruction and easy to proceed to specific scope estimation. Figure 4 belows show the cover page of the excel tool.

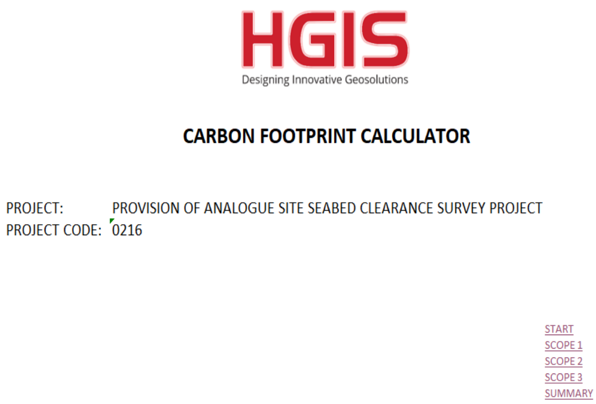


**Figure 4** Cover Page of Excel Tool

Figure 5 below shows the estimation of GHG emission from scope 1 by the Excel Tool. The users are required to input the purpose of the fuel combusted by MV Cassandra VI, the type of fuel combusted, and the duration of the fuel combusted in order to obtain the estimated emission from scope 1. Based on the database entered by users and equation set in the Excel Tool previsouly, the GHG emission will be estimated.

| No | Purpose | Type of fuel used | Activity Code | Quantiy Of Fuel (L/day) | Duration of fuel combusted (day) | Total combustion of fuel (L) | Energy Content Factor (GJ/kL) | Emission Factor (kg $CO_{2eq}$/GJ) | | | GHGs Emission (tons of $CO_{2,eq}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | $CO_2$ | $CH_4$ | $N_2O$ | |
| 1 | Propulsion Purpose | Diesel oil | 2 | 4155.666 | 8.5 | 35323.1576 | 38.6 | 69.9 | 0.1 | 0.4 | 95.98856139 |
| 2 | Electricity Generation | Diesel oil | 1 | 1271.894 | 8.5 | 10811.1024 | 38.6 | 69.9 | 0.1 | 0.2 | 29.2950604 |
| | | | | | | Total GHG Emission from Scope 1 (tonnes $CO_2$e) | | | | | 125.2836218 |

**Figure 5** Excel Tool for Carbon Emission from Scope 1

Figure 6 shows the Excel Tool for GHG emission from Scope 2 includes transportation and water consumption. The estimated emission from transportation may be calculated by inputting transportation parameters such as date, details of transport, mode of transport, distance travelled, and the number of passengers or vehicles involved. The estimated emission from water consumption could be calculated by entering the monthly freshwater intake and duration of water usage. Figure 7 shows the Excel Tool for displaying total GHG emissions from several scopes.

| No | Date | Transportation | Mode of transport | Quantity (pax/Vehicle) | Distance (km) | Fuel Intensity (kL/km) | Quantiy Of Fuel (kL) | Type of fuel used | Energy Content Factor (GJ/kL) | Emission Factor (kg $CO_2$/GJ) | Emission Factor (kg $CH_4$/GJ) | Emission Factor (kg $N_2O$/GJ) | GHGs Emission (tons of $CO_{2,eq}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 20/0[illegible]/2021 | Equipment from Ashtead to KL | Road Transport | 1 | 371.04 | [illegible]000084 | 0.031167 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0502 |
| 2 | 22/0[illegible]/2021 | Equipment from CTSI Warehouse to Port Kelang | Road Transport | 1 | 53.73 | [illegible]000084 | 0.004513 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0073 |
| 3 | 22/0[illegible]/2022 | Equipment from Port Kelang to Miri Port | Sea Transport | 1 | 1554.29 | [illegible]000015 | 0.023314 | Diesel Oil | 38.60 | 69.90 | 0.10 | 0.40 | 0.0634 |
| 4 | 22/0[illegible]/2023 | Equipment from Miri Port to HGIS Miri | Road Transport | 1 | 21.33 | [illegible]000084 | 0.001792 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0029 |
| 5 | 20/0[illegible]/2021 | Equipment from Ampang Staffhouse to Port Kel | Road Transport | 1 | 51.05 | [illegible]000084 | 0.004288 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0069 |
| 6 | 20/0[illegible]/2022 | Equipment from Port Kelang to Miri Port | Sea Transport | 1 | 1554.29 | [illegible]000015 | 0.023314 | Diesel Oil | 38.60 | 69.90 | 0.10 | 0.40 | 0.0634 |
| 7 | 20/0[illegible]/2023 | Equipment from Miri Port to HGIS Miri | Road Transport | 1 | 21.33 | [illegible]000084 | 0.001792 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0029 |
| 8 | 28/0[illegible]/2021 | Equipment from Ashtead Singapore to Ampang | Road Transport | 1 | 371.04 | [illegible]000084 | 0.031167 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0502 |
| 9 | 27/0[illegible]/2021 | Equipment from Salt Singapore to Ampang | Road Transport | 1 | 367.96 | [illegible]000084 | 0.030909 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0498 |
| 10 | 14/0[illegible]/2021 | Equipment from HGIS Miri to Miri Port | Road Transport | 1 | 21.33 | [illegible]000084 | 0.001792 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0029 |
| 11 | 14/0[illegible]/2021 | Equipment from Miri port to Johor Port | Sea Transport | 1 | 1180.35 | [illegible]000015 | 0.017705 | Diesel Oil | 38.60 | 69.90 | 0.10 | 0.40 | 0.0481 |
| 12 | 14/0[illegible]/2021 | Equipment from Johor Port to Ashtead Singapo | Road Transport | 1 | 48.52 | [illegible]000084 | 0.004076 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0066 |
| 13 | 01/0[illegible]/2021 | Crew movement from HGIS KL to Subang Airport | Road Transport | 1 | 28.46 | [illegible]000084 | 0.002391 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0039 |
| 14 | 01/0[illegible]/2021 | Crew movement from Subang Airport to Bintulu | Air Transport | 1 | 1301.23 | [illegible]000035 | 0.045543 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.1177 |
| 15 | 02/0[illegible]/2021 | Crew movement from HGIS KL to KLIA | Road Transport | 1 | 57.73 | [illegible]000084 | 0.004849 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0078 |
| 16 | 02/0[illegible]/2021 | Crew movement from KLIA to Miri Airport | Air Transport | 2 | 1421.35 | [illegible]000035 | 0.099495 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.2571 |
| 17 | 02/0[illegible]/2021 | Crew movement from Miri Airport to HGIS Miri | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 18 | 02/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 2 | 12.28 | [illegible]000084 | 0.002063 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0033 |
| 19 | 02/0[illegible]/2021 | Crew Movement from Miri Airport to KLIA | Air Transport | 5 | 1421.35 | [illegible]000035 | 0.248736 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.6427 |
| 20 | 02/0[illegible]/2021 | Crew Movement from KLIA to HGIS KL | Road Transport | 2 | 57.73 | [illegible]000084 | 0.009699 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0156 |
| 21 | 03/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 2 | 12.28 | [illegible]000084 | 0.002063 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0033 |
| 22 | 03/0[illegible]/2021 | Crew Movement from Miri Airport to KLIA | Air Transport | 5 | 1421.35 | [illegible]000035 | 0.248736 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.6427 |
| 23 | 03/0[illegible]/2021 | Crew Movement from KLIA to HGIS KL | Road Transport | 2 | 57.73 | [illegible]000084 | 0.009699 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0156 |
| 24 | 04/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 25 | 04/0[illegible]/2021 | Crew Movement from Miri Airport to KLIA | Air Transport | 1 | 1421.35 | [illegible]000035 | 0.049747 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.1285 |
| 26 | 04/0[illegible]/2021 | Crew Movement from KLIA to Singapore Airpor | Air Transport | 1 | 297.00 | [illegible]000035 | 0.010395 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.0269 |
| 27 | 04/0[illegible]/2021 | Crew movement from HGIS KL to KLIA | Road Transport | 1 | 57.73 | [illegible]000084 | 0.004849 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0078 |
| 28 | 04/0[illegible]/2021 | Crew Movement from KLIA to Miri Airport | Air Transport | 1 | 1421.35 | [illegible]000035 | 0.049747 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.1285 |
| 29 | 04/0[illegible]/2021 | Crew movement from Miri Airport to HGIS Miri | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 30 | 04/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 31 | 04/0[illegible]/2021 | Crew Movement from Miri Airport to Bintulu | Air Transport | 1 | 172.18 | [illegible]000035 | 0.006026 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.0156 |
| 32 | 04/0[illegible]/2021 | Crew Movemenr from HGIS KL to KLIA | Road Transport | 2 | 57.73 | [illegible]000084 | 0.009699 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0156 |
| 33 | 04/0[illegible]/2021 | Crew Movement from KLIA to Bintulu Airport | Air Transport | 6 | 1278.61 | [illegible]000035 | 0.268508 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.6938 |
| 34 | 04/0[illegible]/2021 | Crew Movement from HGIS Miri to Bintulu | Road Transport | 2 | 202.62 | [illegible]000084 | 0.034040 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0548 |
| 35 | 05/0[illegible]/2021 | Crew movement from HGIS KL to KLIA | Road Transport | 1 | 57.73 | [illegible]000084 | 0.004849 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0078 |
| 36 | 05/0[illegible]/2021 | Crew Movement from KLIA to Miri Airport | Air Transport | 2 | 1421.35 | [illegible]000035 | 0.099495 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.2571 |
| 37 | 05/0[illegible]/2021 | Crew movement from Miri Airport to HGIS Miri | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 38 | 06/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 39 | 06/0[illegible]/2021 | Crew Movement from Miri Airport to KLIA | Air Transport | 3 | 1421.35 | [illegible]000035 | 0.149242 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.3856 |
| 40 | 06/0[illegible]/2021 | Crew Movement from KLIA to HGIS KL | Road Transport | 1 | 57.73 | [illegible]000084 | 0.004849 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0078 |
| 41 | 08/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 42 | 08/0[illegible]/2021 | Crew Movement from Miri Airport to KLIA | Air Transport | 1 | 1421.35 | [illegible]000035 | 0.049747 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.1285 |
| 43 | 08/0[illegible]/2021 | Crew Movement from KLIA to HGIS KL | Road Transport | 1 | 57.73 | [illegible]000084 | 0.004849 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0078 |
| 44 | 14/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 3 | 12.28 | [illegible]000084 | 0.003095 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0050 |
| 45 | 14/0[illegible]/2021 | Crew Movement from Miri Airport to KLIA | Air Transport | 9 | 1421.35 | [illegible]000035 | 0.447725 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 1.1568 |
| 46 | 14/0[illegible]/2021 | Crew Movement from KLIA to HGIS KL | Road Transport | 3 | 57.73 | [illegible]000084 | 0.014548 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0234 |
| 47 | 16/0[illegible]/2021 | Crew Movement from HGIS Miri to Miri Airport | Road Transport | 1 | 12.28 | [illegible]000084 | 0.001032 | Petrol oil | 26.20 | 60.20 | 0.70 | 0.60 | 0.0017 |
| 48 | 16/0[illegible]/2021 | Crew Movement from Miri Airport to Bintulu | Air Transport | 1 | 172.18 | [illegible]000035 | 0.006026 | Kerosene | 36.80 | 69.60 | 0.01 | 0.60 | 0.0156 |
| | | | | | | Total GHG Emission from Transportation Involved (tonnes $CO_2$e) | | | | | | | 5.1444 |

| No | Monthly Fresh Water Consumption ($m^3$/month) | Duration of Water Usage (Day) | Fresh Water Consumption ($m^3$) | Emission Factor ($kgCO_{2,eq}/m^3$) | GHGs Emission $CO_2$(tonnes) |
|---|---|---|---|---|---|
| 1 | 90.63085 | 8.5 | 25.57874083 | 0.442 | 0.01135 |
| | Total GHG Emission from Water Consumed (tonnes $CO_2$e) | | | | 0.01135 |

**Figure 6** Excel Tool for Carbon Emission from Scope 2

| Scope | GHG Emission (tons of $CO_{2,eq}$) | Total GHG Emission (tons of $CO_{2,eq}$) |
|---|---|---|
| **Scope 1** (Fuel Combusted by MV Cassandra VI) | | 125.2836218 |
| 1.1 Propulsion Propose | 95.98856139 | |
| 1.2 Electricity Generation | 29.2950604 | |
| **Scope 2** | **0** | 0 |
| **Scope 3** | | 5.155739669 |
| 3.1 Transportation | 5.144389666 | |
| 3.2 Water Consumption | 0.011350003 | |
| Total GHG Emission | | **130.4393615** |

**Figure 7** Excel Tool for Total GHG Emissions from Different Scope

## 4.0 CONCLUSION

The main focus of this research study is on the carbon footprint of offshore survey project operated by a service provider company in oil and gas industry. This research discusses about the GHG emissions from various activities during the project in order to serve as a benchmark or reference for the company in terms of future environmental impact reduction. A detailed assessment of current carbon emissions estimating methodologies was undertaken, and the GHG protocol was chosen to provide the framework for this research study, as well as the emission factor-based approach to estimate the quantity of GHGs emissions in this study.

As mentioned in the first objective, the sources of GHG emission throughout the operation of the offshore survey project were identified using the GHG protocol framework. As indicated in the second objective, the GHG released from each source was manually computed using an emission factor approach in terms of carbon dioxide equivalency. According to the sources identified while achieving the first objective, an Excel Tool was prepared to serve as a calculator to the company for estimating the carbon footprint of similar projects, as indicated in the third objective, and the manual computation was utilized to ensure the database's correctness.

In conclusion, a total of 130.44 tons of $CO_{2,\ eq}$ were released throughout the operation of offshore survey project. Fuel combusted by survey vessel throughout the project's operation accounted for 96.05% of the overall carbon footprint. During the project, the fuel combusted by survey vessel for propulsion emitted 95.99 tons of $CO_{2,\ eq}$ while fuel combusted by vessel for electricity generation emitted 29.3 tons of $CO_{2,\ eq}$. Scope 3 which includes transportation and water consumption, contributes for about 3.95% of the project's carbon footprint.

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