



TRANSPORTATION SECTOR ENERGY AUDIT, BARTICA, GUYANA

Contract #30/2017/Italian Government/CCCCC

LOCALIZED STUDY REPORT

R141A.18-18/06.05

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Project: Transportation Sector Energy Audit, Bartica, Guyana

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July 31, 2018

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1 Introduction

Since coming to power in May 2015 the President of Guyana has advocated and pursued Green Economy as a development paradigm for Guyana. This trajectory builds on the Low Carbon Development Strategy (LCDS) developed and promoted under the previous political Administration, but seeks a more comprehensive outreach in its outlook. Within this framework effective land use planning, energy security, water security, and waste management, inter alia, are delineated.

Under this large political framework Bartica has been designated the model town for Green Initiatives in Guyana. This initiative is located within the agenda of the Green Economy Framework in lieu of Guyana's overarching sustainable development architecture, and hence as a small state subject to the vicissitudes of the global climate and economy, treats environmental security as a key development issue. According to its promoters clean energy solutions supported by behavioral changes in Bartica are pivotal to reducing its local energy intensity and promoting economic and social development far beyond the boom-bust cycles associated with the gold mining industry.

The primary objective of the "Bartica: Transitioning to a National Energy Security" project is to establish a reliable point of reference for the existing state of energy use in Bartica from which the data generated will be used for future measurements and predictions for evidence-based decision making and pursuance of projects and programs.

The secondary objectives listed below are the practical interventions that are expected to stimulate and expedite a comprehensive and robust renewable energy uptake program in the new Bartica Township:

- The Sensitization and Awareness of the Bartician Populace;
- Conduct an Household Baseline Study of The Bartica Community;
- Complete an Energy Audit of public institutions, facilities and street lighting in Bartica;
- Implement an Energy Efficiency Pilot program within government agencies;
- Develop a Transportation Sector energy audit.

The objective of this assignment is to conduct an audit of the energy use of the transport sector in Bartica, Guyana. The focus on the transport sector is justified by the fact that data provided by the Guyana Energy Agency (GEA) shows that this sector is Guyana's largest energy user reaching about 39% of the total imported petroleum products in 2017. Moreover, the importance of the transportation sector in the total volume of fuel imports is gradually increasing as depicted in Figure 1.

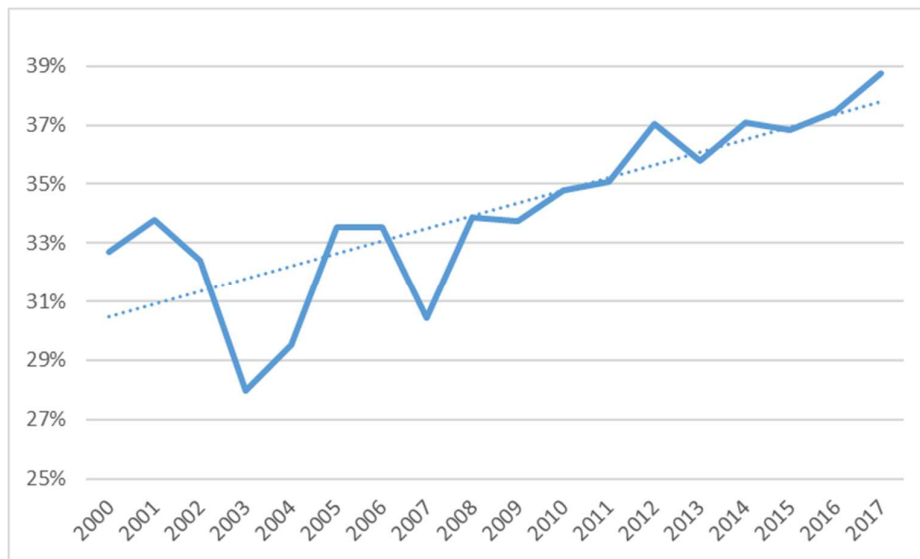


Figure 1. Ratio of fuel consumption (volume) used by the transport sector with total fuel imports in Guyana from 2000 to 2017 (Base data provided by GEA).

Same data indicates that since 2006 there was a systematic increase of fuel consumption by the transport sector in the country (see Figure 2).

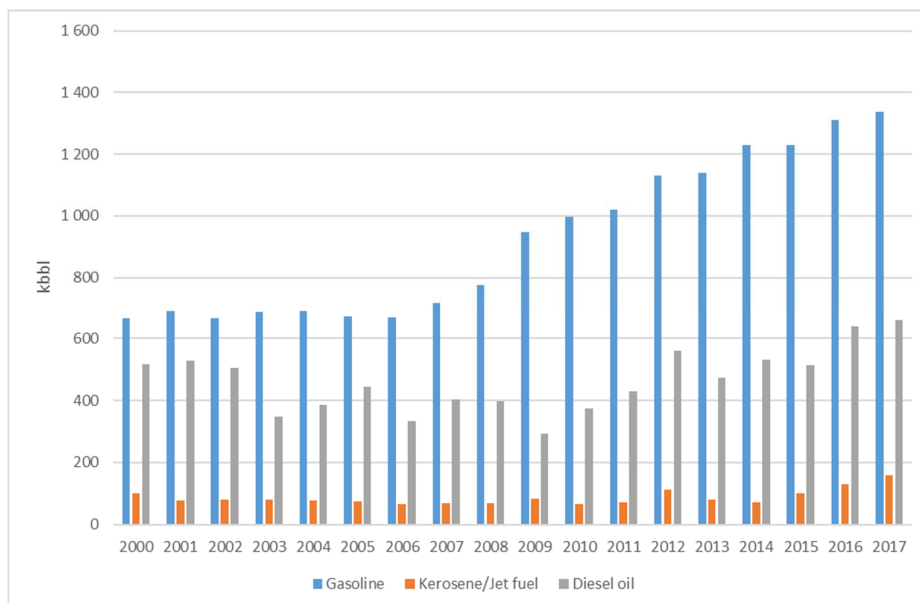


Figure 2. Fuel consumption used by the transport sector in Guyana from 2000 to 2017 (Base data provided by GEA).

Comparison of total transport fuel consumption from 2007 to 2017 indicates an increase of 81% in 11 years that represents a continuous yearly increase of circa 5.6%. A detailed evaluation by type of fuel shows:

- A consistent increase of gasoline consumption since 2006 from 669 kbbbl/yr to more than 1330 kbbbl/year in 2017 (almost double);
- That diesel consumption reached its maxima in 2016 and 2017 with values above 600 kbbbl/yr.

- That jet fuel consumption is steadily increasing since 2014 from 72 kbbl/yr to almost 160 kbbl/yr in 2017.

These numbers emphasize the relevance of tackling the transportation sector for Guyana to transition to a less externally dependent energy system. The reduction of energy consumption in the transportation sector is essential for a strategic framework, in order to achieve a better optimization of mobility of people and goods. To achieve this, local quantification of energy consumption is necessary, through the development of an energy audit for the transportation sector. Knowledge of the energy matrix for the transportation sector is an essential tool for the analysis and planning of future actions to be implemented in Bartica.

This Transportation Sector energy audit will encompass all major areas of energy consumption and its carbon footprint in Bartica transportation sector. The energy audit/study will investigate and analyse how motorized transportation (including river transportation) in Bartica uses energy, calculate carbon footprint, identify the sources of inefficiency, and develop recommendations on how to address energy savings opportunities.

After the submission of the inception report (which had the main objective to describe the methodological procedure for data gathering in Bartica), the specific objective of this localized study report is the description of the data collection procedure and presentation of the preliminary results of the audit.

To assess the energy consumption of the different transportation modes the proper selection of methods is essential for a correct estimation, since they will be used as inputs of the energy reduction policies; thus, their reliability is very important.

During this phase, the energy auditing team will establish the existing energy performance situation of Bartica transport system. The existing energy performance situation will become a reference against which improvements can be measured. It shall include:

- a breakdown of the energy consumption by mode, use and type of vehicle;
- energy flows and an energy balance of Bartica township;
- pattern of energy demand through time;
- one or more energy performance indicators suitable to evaluate the audited object will be defined at a later stage of the project.

Based on the existing energy performance situation of the audited object, the assignment will identify energy efficiency improvement opportunities. The team will evaluate the impacts of energy efficiency improvement opportunities on the existing energy performance situation, including recommendations on reduction of inefficiencies in this sector in Bartica. Whenever adequate economically feasible proposals will be evaluated through costs, savings and payback period. Analysis will include estimates of greenhouse gases emissions.

2 Methodology

An energy audit is an important step for a city, whatever its size, wanting to improve its energy efficiency, reduce energy consumption and bring related environmental benefits.

The methodology for this assignment will be based in the principles of the European standard EN 16247-1:2012 (Part 1: General Requirements) and EN 16247-4:2014 (Part 4: Transport). EN 16247-4:2014 defines the procedures to apply to the different modes of transport (road, rail, marine and aviation) as well as the different ranges (local to long distances) and what is transported (basically, goods and people).

Nevertheless, it is important to state that EN 16247 standards apply to commercial, industrial, residential and public sector organisations and not to municipalities independently of its geographical scale (town, city, metropolitan area). Consequently, EN 16247 will serve as methodological framework for the assignment because these standards cover the general requirements common to all energy audits and define the attributes of a good quality energy audit stating the requirements for energy audits and corresponding obligations within the energy auditing process.

The standards recognize that there are differences in approach to energy auditing in terms of scope, aims and thoroughness, and the need to adapt the methodology to the local circumstances but seek to harmonize common aspects of energy auditing in order to bring more clarity and transparency to the energy auditing services.

The methodology for the elaboration of the energy matrix of the town of Bartica for the transportation sector was designed in order to analyse the energy consumption of the various transportation modes in the town.

Traffic data collection is a basic requirement for a transport energy audit. Traffic flow pattern appears to be random in distribution, as it reflects people's motivation in terms of different composition of vehicles on different types of roads under varying environmental conditions. It follows then that data being collected is a methodological statistic, because traffic flow pattern follows a random distribution. Despite such complexities, it does follow fairly and clearly defined patterns that are possible to classify and analyse. Thus, traffic data collection and analysis follow varying trends and play an important role in the preparation of a transport energy audit.

It is essential to know the magnitude of traffic data required or to be collected, which will then determine its quality and type of vehicle classification to be adopted. In cooperation with the client IDAD will collect the following data where available:

- list of transport subsystems to be audited (road, river, air);
- detailed characteristics of the audited objects including known adjustment factors (such as weather conditions, road maintenance, driving behaviour, etc.) and how the organisation believes they influence energy consumption;
- historical data:
 - energy consumption;
 - adjustment factors;
 - relevant related measurements;
- local urban development history and past events that could have affected energy consumption in the period covered by the data collected;
- energy audits or previous studies related to energy, energy efficiency and transport sector in Guyana;
- Guyana Second National Communication to the UNFCC;

- other relevant economic data;

The following hard data is needed to prepare the energy audit:

- Road mode:
 - Number of circulating vehicles
 - Category of vehicles: light duty (passengers, hired and private, freight), heavy duty (passengers, freight), motorcycles
 - Vehicles age distribution (if not at city level, at least at country level)
 - Type of engine (petrol, diesel) by vehicle category
 - Cylinder size of light duty vehicles (if not at city level, at least at the country level)
 - Gross weight of heavy duty vehicles
 - Fuel consumption (at monthly or annual level), by type of fuel used
 - Average monthly or annual mileage by vehicle category
 - Type of infrastructure (urban or rural roads, national roads) and posted speed allowed
- River mode:
 - Number of boats
 - Category of Boats
 - Gross Tonnage by boat category
 - Passenger Capacity
 - Type of Engine by boat category
 - Power by boat category
 - Fuel Consumption by boat category and engine fuel
 - Number of daily trips by boat category
 - Operating time by boat category

In relation to air transportation mode, there is the need to get information on number and type of aircrafts as well as the number of movements and origin-destination pairs.

The data collection adopted in this project involves 3 phases:

1. Stakeholder's consultation
2. Field survey
3. Field work

2.1 Stakeholder Consultation

Stakeholder's engagement is a crucial aspect in this assignment enabling the consolidation and validation of priorities and help to maintain focus on the root causes of problems. Thus, the success of the assignment will depend to a large extent on its ability to understand and integrate into the process other perspectives as well as supporting and conflicting interests.

The diversity of stakeholders to be involved will ensure that different perspectives are incorporated into the project, taking into account the various sensitivities involved.

Meetings with relevant stakeholders occurred in two workshops held in Georgetown (19.June.2018) and in Bartica (20.June.2018). List of participants in both workshops are included in the Annex I.

Additionally one-on-one interviews and request letters were utilized to follow-up with various institutions to glean the data required for this study (see Table 1 for details).

Table 1. Stakeholders interviewed/contacted during the consultation process

Date	Mode of Contact	Agency	Representative
June 19, 2018	Interview	BK International	Mr. Lindon Stephney, Office Manager
June 19, 2018	Interview	Bureau of Statistics	Mr. Andre Phillips
June 19, 2018	Interview	Guyana Energy Agency	Ms. Shevon Wood, Economist
June 19, 2018	Letter	Guyana Energy Agency	Dr. Mahender Sharma, Chief Executive Officer
June 19, 2018	Interview	Maritime Administration Department, Ministry of Public Infrastructure	Mr. Patrick Mentore, Human Resource Officer
June 19, 2018	Interview	Ministry of Public Infrastructure	Mr. Joel Flatts, Transport Planning Officer
June 19, 2018	Letter	Ministry of Public Infrastructure	Mr. Kenneth Jordon Permanent Secretary,
June 19 and July 17 2018	Interview	Atlantic Service Station	Mr. Carol Fredricks Mr. Harris, Manager
June 20, and July 20 2018	Interview	SIR Service Station	Mr. Adjit, Manager
June 20, and July 20 2018	Interview	Bartica Service Station	Mr. Doobay, Proprietor
June 20, 2018	Interview	SOL Service Station	Mrs. Sabrina Adams, General Manger
June 21, 2018	Letter	Guyana Revenue Authority	Mr. Godfrey Statia, Commissioner – General
June 22, 2018	Interview	Guyana Revenue Authority, Publication and Operational Procedures Section Communication and Tax Advisory Services Division	Khemraj Persaud, Manager
June 27	Electronic Letter via Email	Guyana Oil Company Limited	Ms. Renatha Exeter, Chief Executive Officer
July 10, 2018	Electronic Letter via Email	Guyana Civil Aviation Authority	Lt. Col. (Ret'd) Egbert Field, Director General
July 10, 2018	Electronic Letter via Email	Guyana Bureau of Statistics	Mr. Lennox Benjamin, Chief Statistician

IDAD, in cooperation with the client, asked the following data to aforementioned of institutions and service providers:

- **Guyana Oil Company Limited:**
 1. Fuel sales by type 2008 to 2017 (National)
 2. Fuel sales by type 2008 to 2017 (Bartica)

- **Guyana Revenue Authority**
 1. National fleet composition as per registration from 2008 to 2017
 - a. No. of vehicles, Category of vehicles, Manufacture age of vehicles, Engine capacity of vehicles, Fuel type, Gross weight (for trucks),
 2. Bartica fleet composition as per registration from 2008 to 2017
 - a. No. of vehicles, Category of vehicles, Manufacture age of vehicles, Engine capacity of vehicles, Fuel type, Gross weight (for trucks),
 3. Collection of fuel taxes, road taxes, vehicle sales from 2008 to 2017
 - a. National
 - b. Bartica

- **Ministry of Public Infrastructure:**
 1. Private Boats/Vessels registered/licensed to operate in Bartica
 - a. Number of Boats with respect to category
 - b. Gross Tonnage by boat category
 - c. Passenger Capacity
 - d. Type of Engine by boat category
 - e. Power (horsepower) by boat category
 - f. Fuel Consumption by boat category and engine fuel
 2. Government Boats/Vessels registered/licensed to operate in Bartica
 - a. Number of Boats with respect to category
 - b. Gross Tonnage by boat category
 - c. Passenger Capacity
 - d. Type of Engine by boat category
 - e. Power (horsepower) by boat category
 - f. Fuel Consumption by boat category and engine fuel
 - g. Number of daily trips by boat category
 - h. Operating time by boat category
 3. **Energy audits other studies related to Maritime transport sector at national/local level**

- **Guyana Energy Authority:**
 1. National Fuel imports with respect to category;
 2. Fuel Purchase/Distribution in Bartica with respect to category;
 3. Energy estimation for transport sector at national level;
 4. Energy audits other studies related to transport sector ant national or regional level.

- **Guyana Civil Aviation Authority:**
 1. Land and Take-off cycles in Bartica airfield (IATA:GFO) from 2008 to 2017
 - a. Number of aircrafts
 - b. Type of aircrafts
 - c. Origin-Destination

- **Guyana Bureau of Statistics**
 1. 2012 Census data for Bartica:
 - a. Age groups;
 - b. Attending school;
 - c. Current economic activity;
 - d. Educational institution attended;

- e. Form or Class attended;
- f. Gender;
- g. Main occupation;
- h. Major industry;
- i. Transport to school;
- j. Transport to work.

- **Local Service Stations (Bartica)**

- 1. Fuel Sales/Distribution

- a. Volume;
 - b. Purpose of Sale;
 - c. Customer Type;

Information depicted in orange has already been delivered to IDAD.

2.2 Household Survey

In parallel with the transportation sector energy audit, the Office of Climate Change required the services of a consultant to provide assistance in the design and conduct of a household baseline survey to capture baseline socio-economic and energy related data at the household level in Bartica. The field survey was conducted by TCG (The Consultation Group) staff during the 3rd and 4th week of July: field surveyors contacted more than 300 households.

Dialogue between IDAD and TGC enabled the insertion of a set of questions (see Annex II) regarding citizen's mobility into the household survey.

Results of the survey are not yet available and will be included in future reports.

2.3 Field Survey

The field survey was conducted between Monday July 16 and Friday July 20, 2018. Training for field staff was facilitated by the Survey Coordinator on July 16 at the Board Room of the Bartica Town Council. The field staff consisted of ten (10) enumerators and a Supervisor. The main responsibility of the enumerators was to accurately record data as the assigned data collection sites. The supervisor was responsible for ensuring that the enumerators were fulfilling their responsibilities in a respectable manner and the collection of survey reports on a daily basis.

The field survey sought to capture data from two sources namely; service stations and boat landings. At these locations information was collected from vehicle owners/drivers and boat captains/operators. At each site data collection was done during two three (3) hour time periods. Two time period options utilized to ensure that data was collected for each period of the day from all sites over the three (3) day survey period (July 17 to 19): the time period options were:

1. 7:00am to 10:00am, 11:00am to 2:00pm and 3:00pm to 6:00pm
2. 9:00am to 12:00noon and 1:00pm to 4:00pm

For the conduct of the field survey seven sites were allocated; three (3) service stations and four (4) boat landings. However, one of the designated boat landings changed when it was discovered that the site only serves a private operator. The survey coordinator assigned a pair of enumerators (team) and designated the survey periods for the conduct of data collection at each site. The monitoring points and the corresponding team assignments schedule are outlined in the table below.

Table 2. Field Work Schedule.

Sample Points	Team Assignments		
	Tuesday, July 17	Wednesday, July 18	Thursday, July 19
SIR Service	Team 1 - (9:00 to 12:00hrs) and (13:00 to 16:00hrs)		Team 1 - (7:00 to 10:00hrs) and (15:00 to 18:00hrs)
Bartica Service Station	Team 2 - (11:00 to 14:00hrs) and (15:00 to 18:00hrs)	Team 2 - (9:00 to 12:00hrs) and (13:00 to 16:00hrs)	
Atlantic Service Station		Team 1 - (11:00 to 14:00hrs) and (15:00 to 18:00hrs)	Team 2 - (7:00 to 10:00hrs) and (15:00 to 18:00hrs)
Landing 1 - Stelling	Team 3 - (9:00 to 12:00hrs) and (13:00 to 16:00hrs)	Team 3 - (7:00 to 10:00hrs) and (15:00 to 18:00hrs)	Team 3 - (15:00 to 18:00hrs)
Landing 2 - (Vulture)	Team 4 - (11:00 to 14:00hrs) and (15:00 to 18:00hrs)		Team 4 - (9:00 to 12:00hrs) and (13:00 to 16:00hrs)
Landing 3 - Market Landing		Team 4 - (7:00 to 10:00hrs) and (11:00 to 14:00hrs)	Team 5 - (9:00 to 12:00hrs) and (13:00 to 16:00hrs)
Landing 4 - (5th Avenue)*	Team 5 - (9:00 to 12:00hrs)		
Landing 5 - Administrative Warf**	Team 5 (13:00 to 16:00hrs)	Team 5 - (7:00 to 10:00hrs) and (15:00 to 18:00hrs)	Team 3 - (11:00 to 14:00hrs)

**Survey site that was replaced, **Replacement site*

The survey instruments utilized for the field survey are included in Annex III.

3 Transport and Energy

Transport is fundamental to development in a global scale and it has a profound and personal impact on individual lives. In many cases, transport involves choice—whether to move or to stay in place, whether to walk, cycle, take public transport or a private car, whether to ship a product overnight or with more flexible deadlines. The transport options available in a country reflect its level of development. At the same time, transport is a driver as well as a marker of economic development. It enables individuals and communities to rise out of poverty and overcome social exclusion, connecting goods to markets and linking rural areas and market towns to large cities and the global marketplace (UN. 2016).

The world’s population reached 6 billion in 2000 and will be around 10 billion in 2050 (Word Bank, 2018a). Coupled with growing incomes, this will lead mobility to expand through 2040. Despite political and technological advances, demand for transportation still be able for answering to the future mobility needs. According to the United Nations Statistics Division database (UNSD, 2018), transportation, storage and communication related activities accounted for 7% and 6% of Gross Value Added (GVA) respectively worldwide and in South America (illustrated in Figure 33).

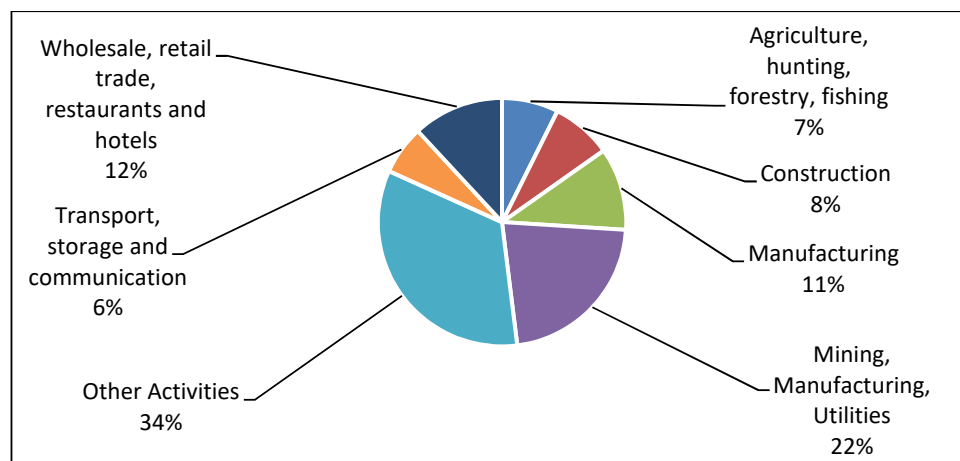


Figure 3. Share of GVA in 2014 by kind of activity (%) in South America (UNSD, 2018).

Figure 4 shows the world total final consumption of different type of fuels by sector in 2015. The worldwide transportation sector contributed to 55% of total end-use sector liquid fuels consumption in 2015 (EIA, 2018a). It was found that transportation consumed more than 2,600 million ton of oil equivalent – Mtoe. The distribution of different transportation modes also confirms the impacts of the road traffic activity on world delivered energy consumption. In 2015, it represented almost half of world transportation energy based on oil production (2,000 Mtoe).

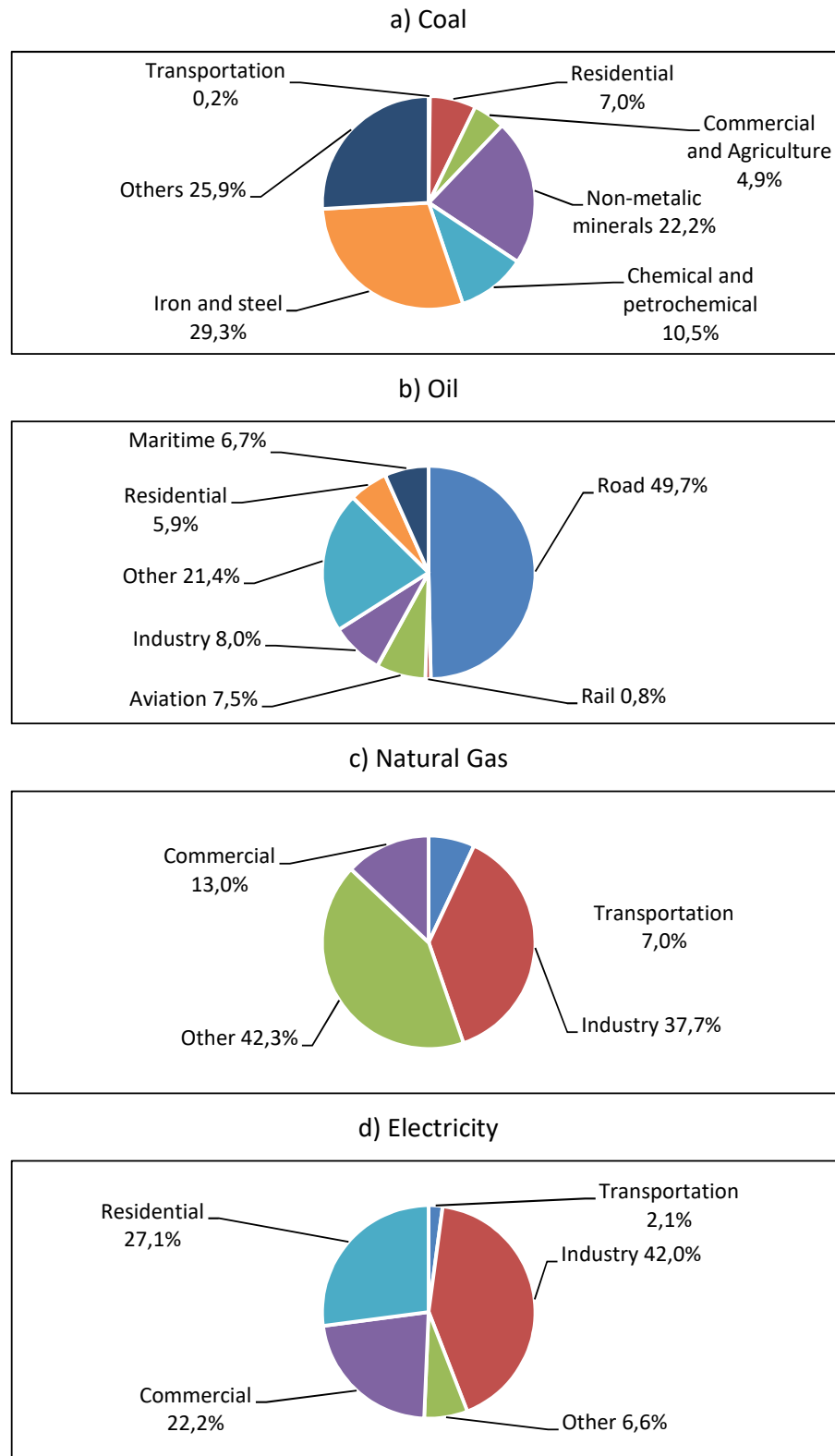


Figure 4. Share of world consumption in 2015 (EIA, 2018): a) coal (total = 1,044 Mtoe); b) oil (total = 3,840 Mtoe); c) natural gas (total = 1,401 Mtoe); and d) electricity total = 1,737 Mtoe).

When looking at the European Union’s 28 countries (EU-28), transportation was the largest energy consumer at 33% (538 Mtoe) in 2015 (Eurostat, 2018). Long term-projections concerning the transportation sector delivered energy consumption show an increase at an annual average rate of 1.4% from 2012 to 2040 (EIA, 2018b). In non-OECD countries in America, growth in transportation energy use could be up to 2% (EIA, 2018b).

At global scale the transportation sector produced about 7 GtCO_{2eq} of direct greenhouse gases emissions (GHG) in 2010, being responsible for approximately 14% of 2010 global GHG (Sims et al., 2014). Long term-projections for carbon dioxide (CO₂) emissions concerning the passenger transportation in cities above 300,000 inhabitants show an increase up to 27% in 2050 compared with 2015 levels (Chen and Kauppila, 2017).

Most recent data showed that transportation accounted for 20% (EEA, 2018) and 28% (IEA, 2018) of GHG emissions in the EU-28 (2014 reference year) and in the United States (2016 reference year), respectively. There are no doubts that transportation is one of the largest contributors of GHG emissions (Figure 55).

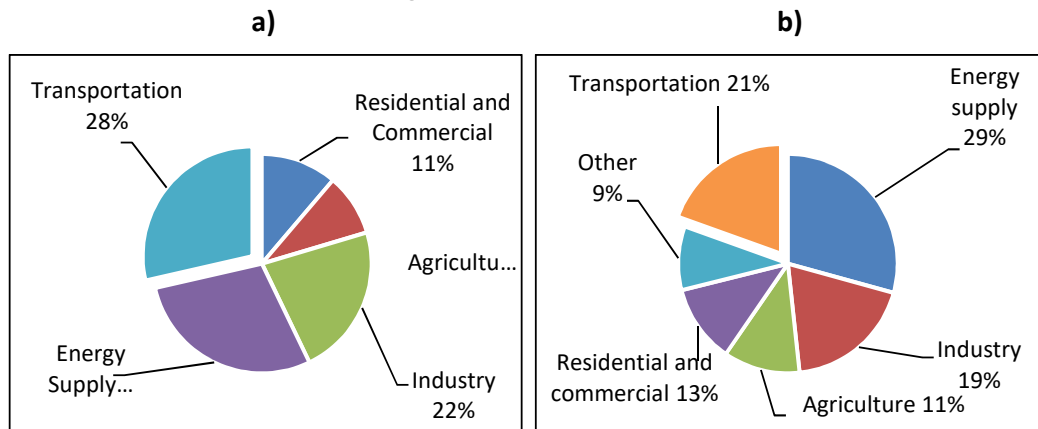


Figure 5. Share of GHG Emissions by sector: a) US - 2016 (EPA, 2018); b) EU - 2014.

Similar trends are observed in Latin America and the Caribbean region: transportation has a major impact on energy consumption levels and represents 36% of total fuel consumption in 2012 (IEA, 2015). The distribution of transportation mode revealed road transportation as the largest contributor to CO₂ emissions (73%) followed by international air transportation, and domestic marine and river transportation (8%), with small shares each (Figure 66). Approximately 50% of transportation-related emissions are due to freight and passenger transportation (Viscidi and O’Connor).

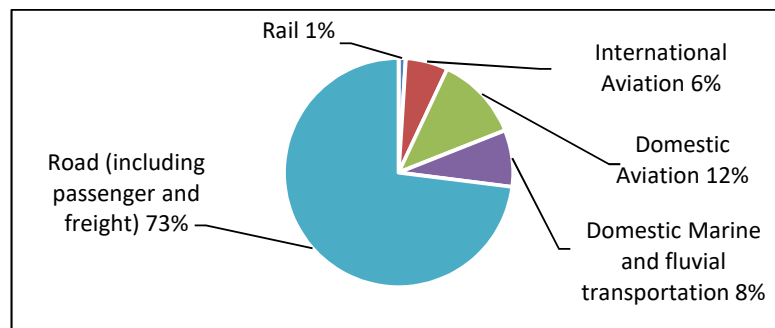


Figure 6. Share of Latin America’s CO₂ Emissions from transportation in 2010 (Viscidi and O’Connor, 2017).

Figure 7 displays the variation in CO₂ emissions from transportation (in relation to the total fuel consumption) from 2000 to 2014 in several countries and regions. The bars in Figure 7 confirmed two main facts about South America: 1) its transportation-related CO₂ emissions accounted for more than 40% of total fuel consumption; 2) it presented a higher share of transportation-related CO₂ emissions than observed in high-income countries such as European Union and in the US.

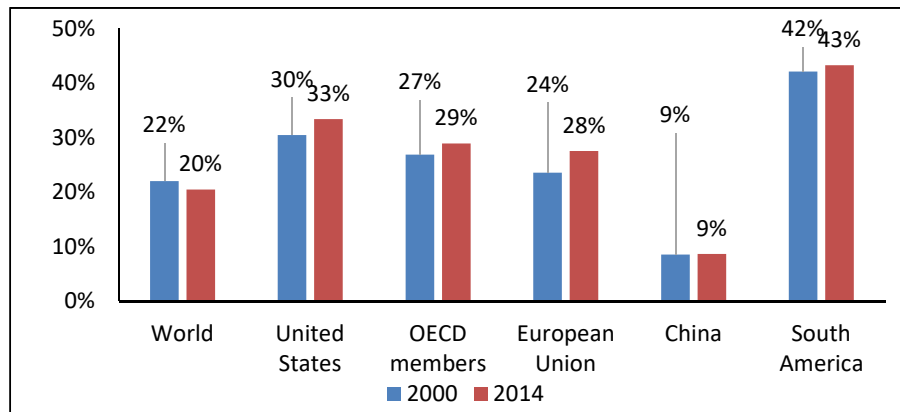


Figure 7. CO₂ emissions from transportation (percentage of total fuel combustion) in selected countries and region (World Bank, 2018b). No data available for Guyana.

According to the International Energy Agency (IEA), the economic growth in South America has been linked with energy use (IEA, 2015). Sustained economic growths in combination with urbanization have imposed pressure (Hidalgo and Huizenga, 2013) on both transportation infrastructure and services in South America where countries and cities have not been able to keep up with the increased travel demand.

This region still faces a greater dependence on imported fossil fuel. The increase in mobility demand results in new challenges for transportation system, planning and infrastructure, especially in largest cities in Latin America.

4. Transport Energy Audit of Bartica

Bartica is a small community situated on the Essequibo River, 80 km inland from the Atlantic Ocean (Figure 8). It is perfectly nestled at the confluence of the Essequibo, Cuyuni and Mazaruni rivers bounded north and east by the Essequibo River, south by the forest and west by the Mazaruni River.

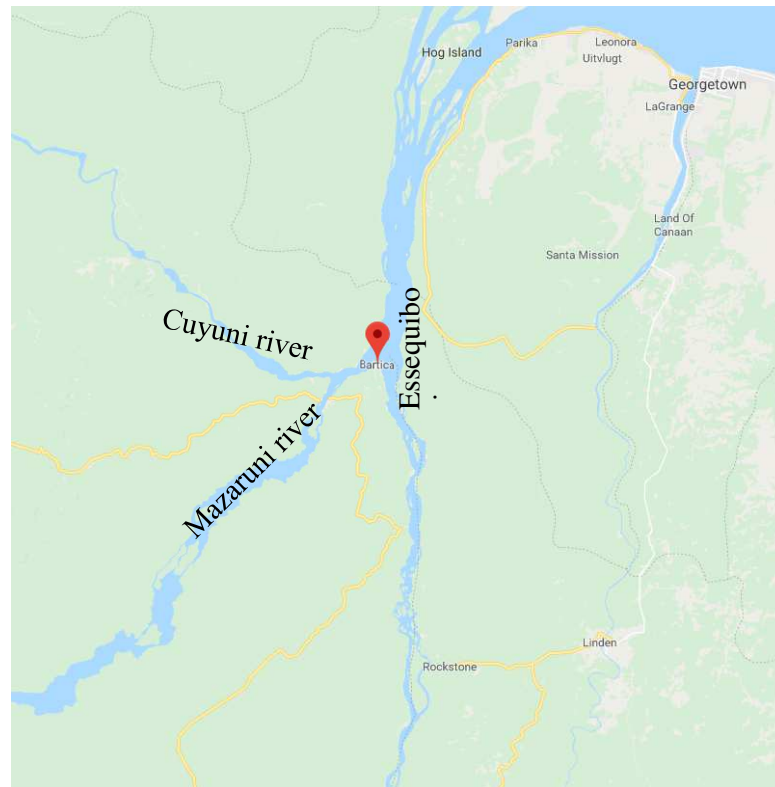


Figure 8. Map with geographical location of Bartica.

Bartica is the capital of Region 7 – Cuyuni-Mazaruni one of the least densely populated regions of Guyana with less than 0.5 inhabitants per km²; in 2012 the population was estimated in 20820 inhabitants for an area of 47213 km². Before becoming a town Bartica was approximately 12.95 km² in land mass. Today, Bartica’s Township extends geographically to approximately 168,350 km² with most of the new area largely underdeveloped and with low population densities. This community of approximately 15 000 residents, popularly known as the “gateway” to Guyana’s interior is economically driven by gold, diamond mining and to a lesser extent the hospitality industries.

4.1 Information on data collection

At the present stage, the audit team has the information on the fuel sales per day for the road and river mode gathered from the local fuel stations, distributed by type of fuel used and type of vehicle. These are still provisional values that need further update.

There is also information on airplanes, namely aircraft type, flying minutes per year, fuel consumption, passenger capacity and number of flights. This gives the possibility to quantify fuel consumption in gal/year.

The results of the household surveys were not sent yet to the audit team, for data management and the interpretation of results.

4.1.1 Fuel sales

The names of the service stations are not disclosed to keep data confidentiality.

Service Station #1

Gasoline Sales

- Sales over a four day period = 1000 gallons
- Sales for a one day period = 250 gallons
 - 90% or 225 gallons of all gasoline sales are used for Transportation
 - 10% or 25 gallons of all gasoline sales were for other activities in the mining sector
- For transportation sales
 - Trucks = 15%
 - Private/Hire Cars = 65%
 - Bus = 10 %
 - Boats = 10%

Diesel Sales

- Sales over a four day period = 15,000 gallons
- Sales for a one day period = 3,750 gallons
- Sales utilized for Mining = 95%
 - Sold to trucks = 70% (cargo)
 - Sold to boats = 25% (cargo)
- Sales utilized for Transportation
 - Trucks = 4%
 - SUV's and Other Vehicles = 1%

Service Station #2

Gasoline Sales

- Sales for a one day period = 2,300 gallons
 - Boats = 1700 gallons
 - Close range = 30%
 - Long range = 70%
 - Road vehicles = 600 gallons
 - Buses = 100 gallons
 - Hire cars = 450 gallons
 - Private cars = 50 gallons

Diesel Sales

- Sales for a one day period = 4,500 gallons
- Sales utilized for transportation = trucks 10%
- Sales utilized for Mining
 - Sold to trucks = 65% (cargo)
 - Sold to boats = 35% (cargo)
 - Close range = 45%
 - Long range = 55%

Service Station #3

Gasoline Sales

- Sales for a one month period = 6,500 gallons
 - Boats = 900 gallons
 - Road vehicles = 5,600 gallons
 - Buses = 25%
 - Hire cars = 50%
 - Private cars = 25%

Diesel Sales

- Sales for a one month period = 24,000 gallons
 - Road
 - Sales utilized for transportation = 500 gallons (2.1%)
 - Sales utilized for Mining = 23,500 gallons (97.8%)
 - Sold to trucks = 60% (cargo)
 - Sold to boats = 40% (cargo)

Service Station #4

Diesel Sales

- Sales for a one day period = 8,000 gallons
 - Boat
 - Cargo: Sales utilized for transportation = 500 gallons
 - Small: Sales utilized for transportation = 200 gallons
 - Road
 - Sales utilized for transportation = 500 gallons
 - Sales utilized for Mining = 6,800 gallons

4.1.2 River mode

Parika – Bartica ferry

During the collection of data for the audit T&HD (Transport and Harbours Department) provided a Fuel Consumption value of 10 gallons per hour of steaming for the M.V. Malali and M.V. Makouria the two vessels that operate in the Parika – Bartica route. However, upon further inquiry, it became evident that this fuel consumption figure was in fact the manufacturer’s specification or the consumption rate expected when the vessels were new.

Both of these vessels are now 56 years old. As such, their fuel efficiency has severely reduced and T&HD reports using 1,500 gallons per week for the route. Data recently published (GDS+, 2019) refer that M.V. Makouria and M.V. Malali have a fuel efficiency of 0.5 km/gal. This value was estimated based on the distance covered per week along the route and it is indeed a more accurate estimation of the actual fuel efficiency of the vessels.

The distance between Parika and Bartica is 64.8 km. Consequently fuel consumption for one-way trip will be:

- $64.8 \text{ km} / 0.5 \text{ km per gal} = 129.6 \text{ gal/ one-way trip.}$

Same report refers that the ferry operates 4 days a week. Consequently the yearly fuel consumption is:

- $129.6 \text{ gal/one way trip} \times 4 \text{ trips/ week} \times 52 \text{ weeks/year} = 26,957 \text{ gal diesel/year}$

Parika-Bartica speedboats

According to the President of the speedboat association of Bartica there are more than 50 vessels that operate in the Parika-Bartica route. Every day there are between 7 and 8 speedboats each way. This is a highly regulated business and consequently each of the licensed speedboats travel circa one trip per week. Typically, these speedboats include two engines of 200 HP each and consume approximately 23 gallons of gasoline per round trip.

Detailed data sent by the Maritime Administration Department confirmed the above-mentioned scenario. In Bartica (See Figure 9) there 56 vessels licensed for passenger transport and 6 for transport of cargo. Close to 70% of the licensed vessels for transport of passengers have a total engine power above or equal to 350 hp.

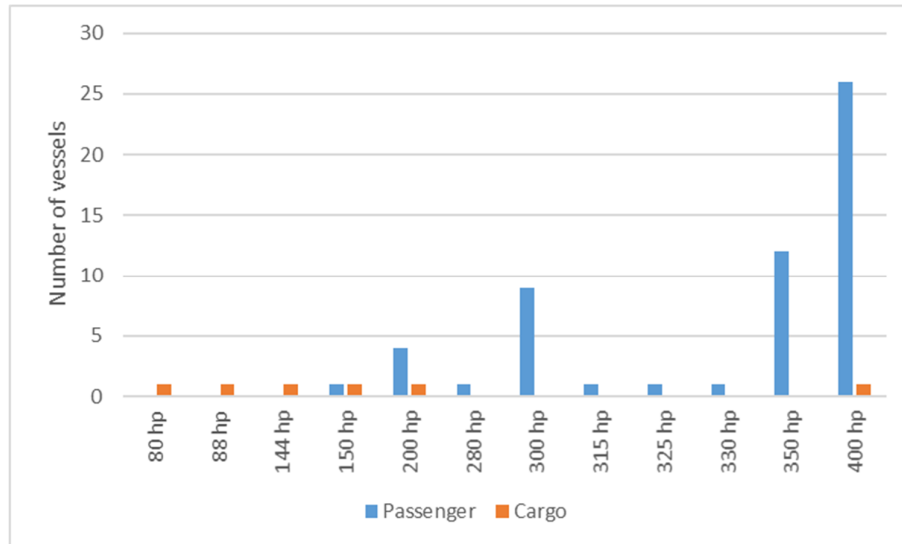


Figure 9. Engine power of cargo and passenger vessels licensed to operate in Bartica.

Passenger capacity of the fleet varies from 14 to 28 (see Figure 10) with an average of 25 passengers per vessel.

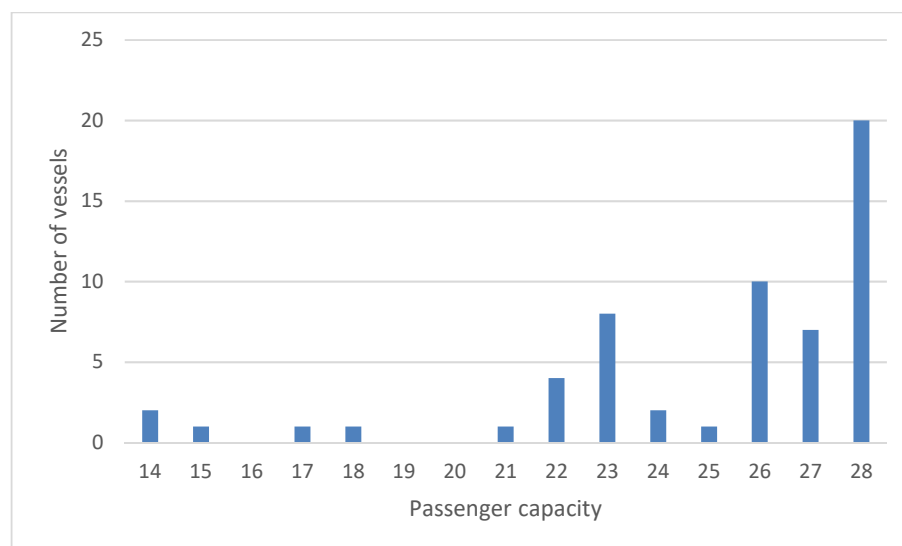


Figure 10. Passenger capacity of vessels licensed to operate in Bartica.

4.1.3 Aviation

GCAA – Guyana Civil Aviation Authority provided the record of Land Take-Off (LTO) cycles that occurred in Bartica airstrip in 2016 and in 2017. The information included the aircraft type, airstrip of origin or destination, time duration of each flight and flight level.

In 2017 there were 319 LTO cycles in Bartica that represent an increase of 8.0% from previous year. As far as the Energy Audit is concerned only departure flights were treated. As represented in Figure 11 almost 90% of the flights were directed to Ogle Airport in Georgetown. Krishna Sankar (2.9%) and Kamarang (2.1%) were the second and third destinations in number of flights. These three destinations represented 95% of the flights.

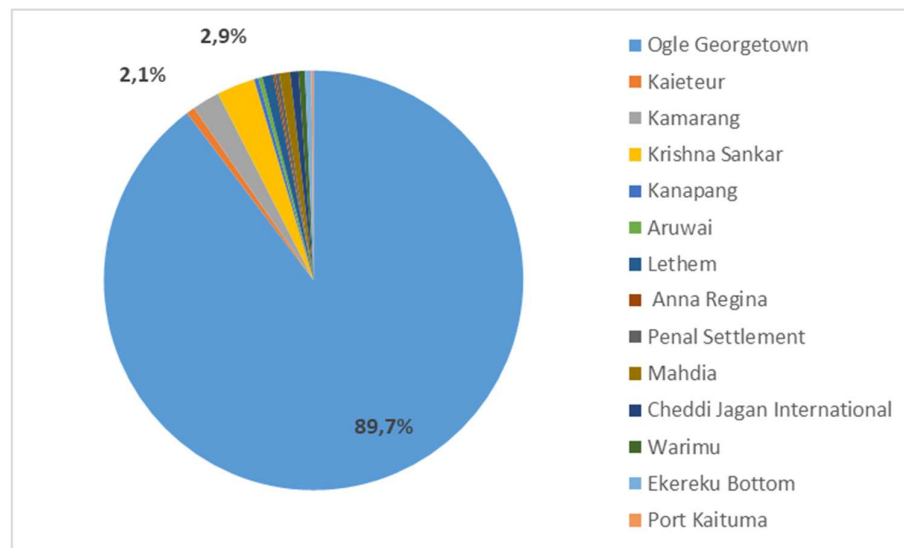


Figure 11. Destination of flights departing Bartica in 2017.

To determine fuel consumption the analysis must shift to time flied instead of number LTO cycles. Estimates show that the 619 flights that departed from Bartica in 2017 represent circa 17,806 minutes – an increase of 7.1% from 2016. To accomplish 95% of the total flied time (Figure 12) it is necessary to take into account 6 destinations: Ogle (79.4%), Kamarang (5.4%), Krishna Sankar (3.6%), Lethem (3.3%), Warimu (2.1%) and Ekereku Bottom (1.3%).

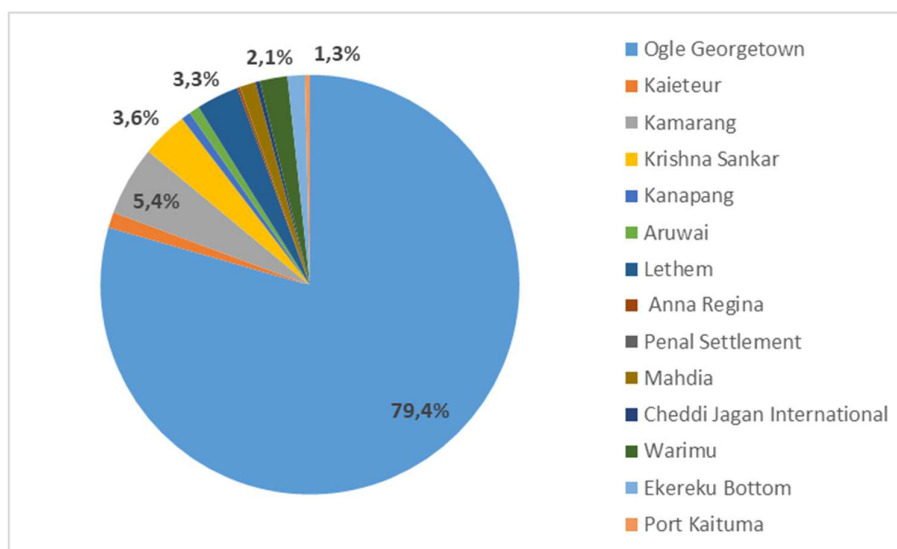


Figure 12. Total time flown by destination of flights departing Bartica in 2017.

Table 3 lists the aircraft types that depart from Bartica airstrip, as well, as the number of flights departed from Bartica and total flight time for each type of aircraft. Based on typical fuel consumptions (GPH – Gallons Per Hour) obtained through technical websites, total fuel consumption was estimated for each aircraft. The total estimate for 2017 is 7,084 gallons of fuel. The same Table includes an estimate of passengers transported from Bartica (2941) based on an occupancy rate of 70%.

Table 3. Total number of flights, time flown, fuel consumption and passengers for type of aircraft departing Bartica in 2017.

Aircraft type	Number of flights	Flying time (minutes)		GPH	Fuel (gallons)		Passenger capacity	Passengers at 70% capacity
Beagle B206	8	199	1,1%	28,7	95,2	1,3%	6	34
Britten-Norman BN2	211	5433	30,5%	32	2897,6	40,9%	9	1329
Britten-Norman BN2A	3	76	0,4%	32	40,5	0,6%	9	19
Britten-Norman BN2P	40	1068	6,0%	32	569,6	8,0%	9	252
Cessna C172	169	5534	31,1%	8,5	784,0	11,1%	3	355
Cessna C182	5	124	0,7%	12,5	25,8	0,4%	3	11
Cessna C206	84	2603	14,6%	14	607,4	8,6%	5	294
Cessna C208	36	989	5,6%	57,6	949,4	13,4%	9	227
Polz M28	16	383	2,2%	84,3	538,1	7,6%	17	190
Piper PA32	26	966	5,4%	15,8	254,4	3,6%	5	91
Piper PA34	1	19	0,1%	26,4	8,4	0,1%	5	4
Robinson R44	11	226	1,3%	14	52,7	0,7%	3	23
Britten-Norman Trislander	9	186	1,0%	84,3	261,3	3,7%	18	113
TOTAL	619	17806			7084,5			2941

Figure 13 represents flying time and fuel consumed by each type of aircraft. Fuel used on BN2, C208 and C172 flights represent more than 65% of total fuel used in the aviation mode.

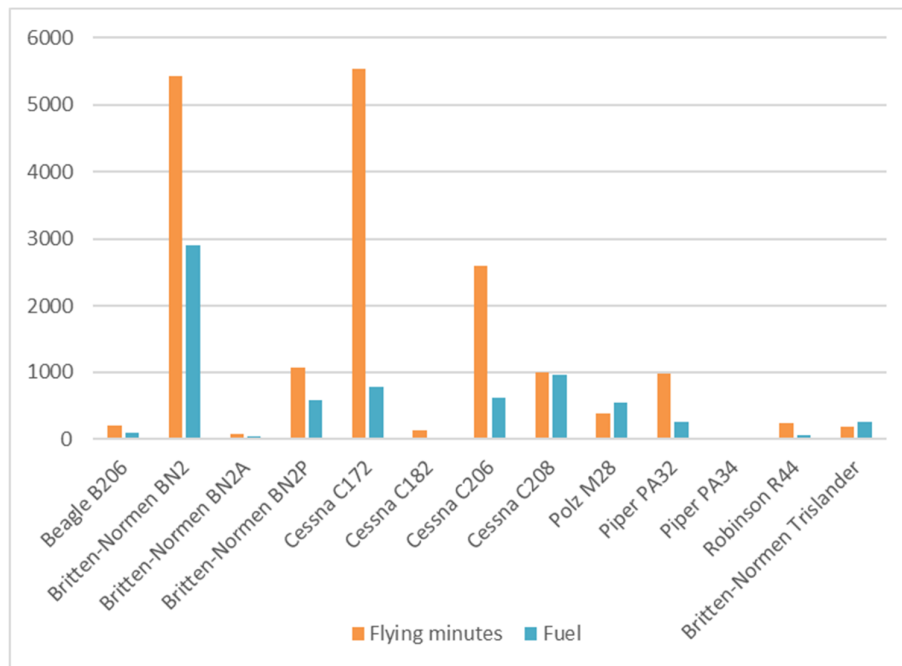


Figure 13. Flying time and fuel consumed by each type of aircraft.

4.2. Preliminary analysis of energy data

In order to compare the energy represented in each type of fuel it is necessary to convert each volume of fuel into an equivalent unit of measure. Conversion to tons of oil equivalent (toe) are used for this purpose:

- 1 toe = 317.76 gal of gasoline;
- 1 toe = 285.75 gal of diesel oil;
- 1 toe = 294.43 gal of jetfuel;

Table 4 presents the energy matrix transportation for Bartica including data of the only major supplier of electricity in Bartica: the state-owned Guyana Power and Light (GPL) Company. The company operates two diesel generating sets with a plate capacity of 2.8 MW and a nominal capacity of 2.4 megawatts MW. On an annualized basis, these sets combined consume a total of approximately 700,000 gallons (CCCCC, 2016).

The results for each activity sector confirm the relevance of mining industry that accounts for 75.5% of the energy consumption of Bartica (Figure 14). The transportation sector comes second with 15.0% followed by electricity production at the local GPL powerplant (9.5%) .

Table 4. Energy matrix transportation in the town of Bartica.

Mode	Gasoline [toe]	Diesel [toe]	Other [toe]	Total [toe]	Fraction of transport sector (%)
TRANSPORT SECTOR	2,950	784	24	3,760	100
Road	1,084	771	-	1,855	48.3
Private Cars	159	44	-	203	5.4
Hired Cars	701	-	-	701	18.6
Buses	185	-	-	185	4.9
Trucks	39	727	-	766	20.4
River	1,866	95	-	1,961	51.1
Parika-Bartica Ferry	-	95	-	95	2.5
Parika-Bartica Speed Boats	99	-	-	99	2.6
Close Range Vessels	530	-	-	530	14.1
Long Range Vessels	1,237	-	-	1,237	32.9
Aviation	-	-	24	24	0.6
MINING	26	19,348	-	19,374	
Fuel cargo in Boats	-	3,987	-	3,987	
Fuel cargo in Trucks	26	15,361	-	15,387	
ELECTRICITY PRODUCTION	-	2,450	-	2,450	
TOTAL	2,976	22,582	24	25,582	

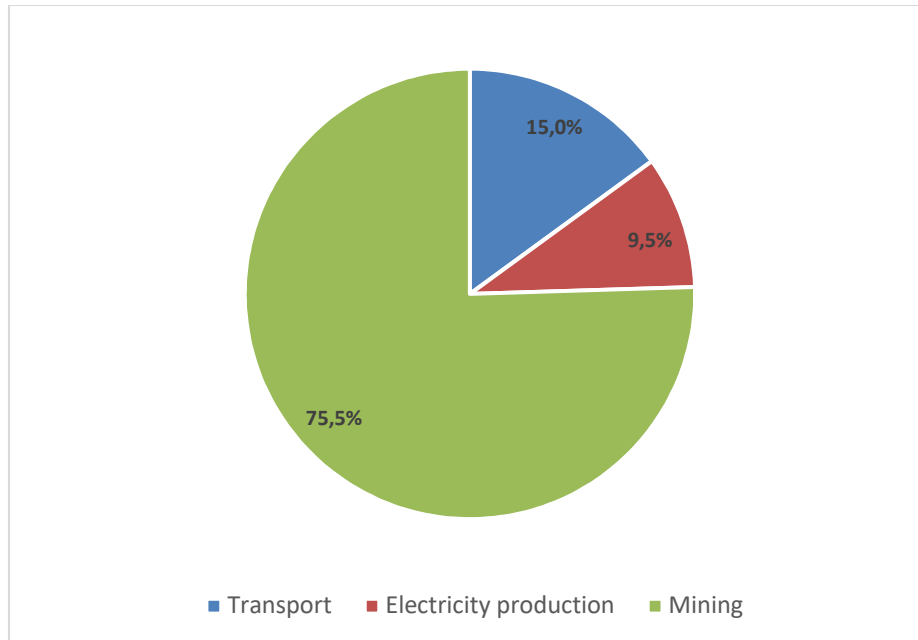


Figure 14. Energy use by sector in Bartica.

Globally, diesel represented 88.5% of total energy consumption followed by gasoline at 11.4% (Figure 15). Jetfuel is marginal with less than 0.1% of total energy consumption. Interestingly, 96% of diesel energy consumption is used for mining while 99% of gasoline energy consumption is used for the transport sector.

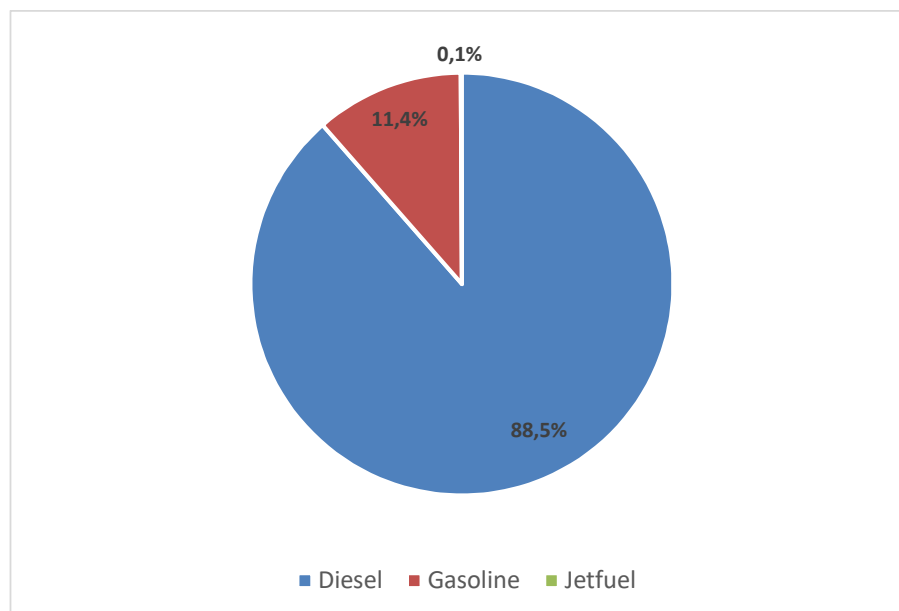


Figure 15. Energy use by type of fuel in Bartica.

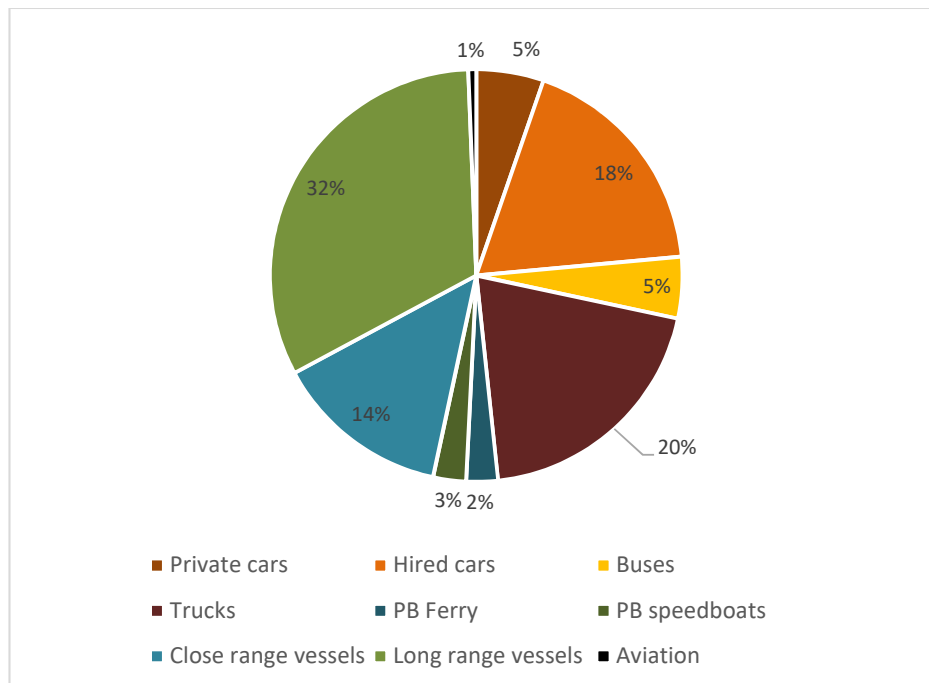


Figure 16. Energy use in the transport sector in Bartica.

The distribution of different modes for transportation activities confirmed the relevance of river (51.1%) and road (48.3%) modes over the air mode (0.6%). It is found that, in the transport sector (Figure 16), the energy consumption of long range boats (32.9%), trucks (20.4%) and close range boats (14.1%) correspond to more than 67% of the transport sector energy consumption. These three modes of transport are caused by subregional movements of people and goods. Local mobility within Bartica sums circa 29% of transport energy consumption: hired cars (18.6%), private cars (5.4%) and buses (4.9%). The connection between Parika and Bartica (PB) by speedboat and ferry amounts to approximately 5%.

Figure 17 portrays the distribution dynamics of energy consumption by type of fuel, sector and modes of transportation in the town of Bartica for 2017.

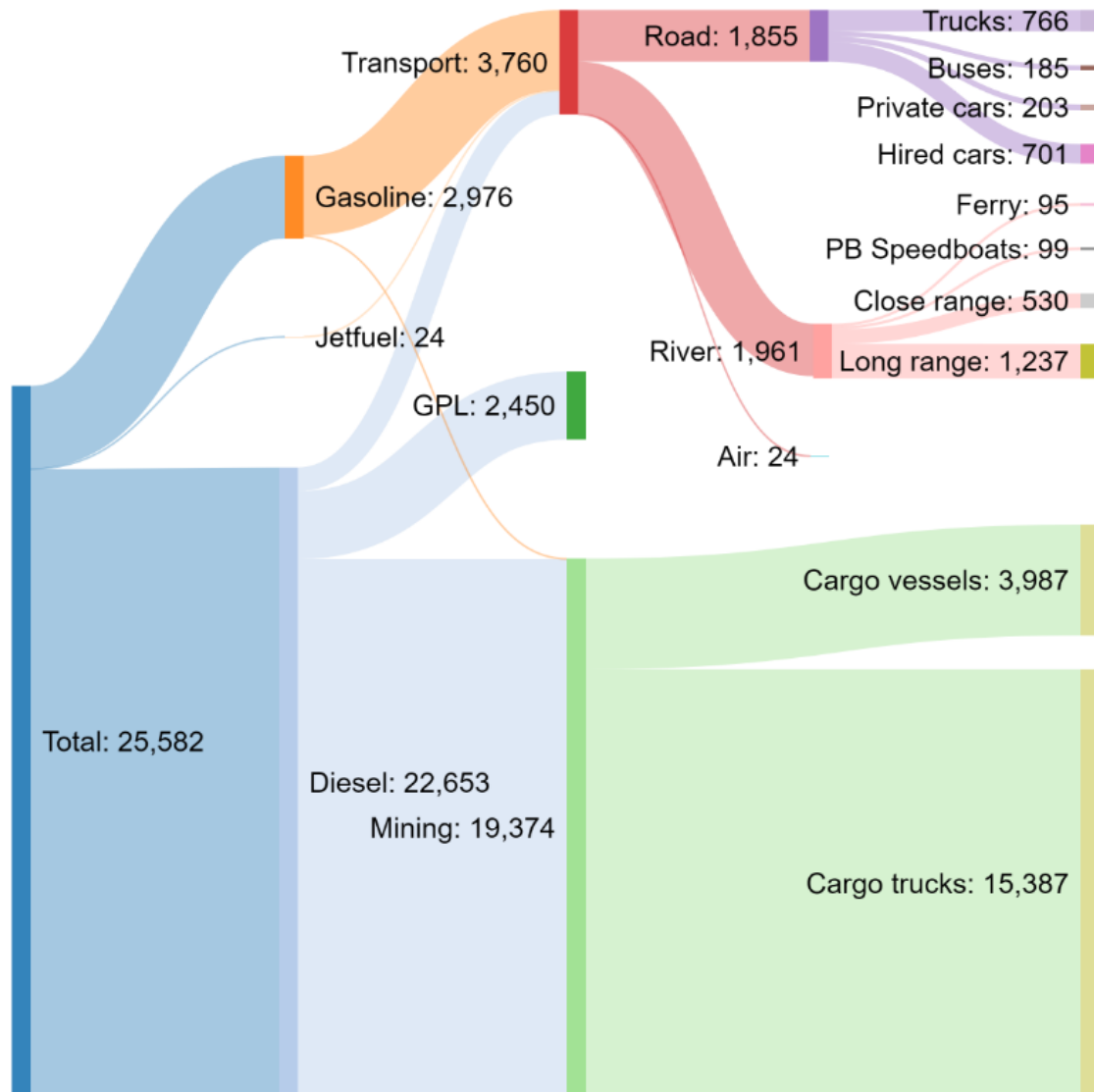


Figure 17. Distribution of energy consumption (indicated in toe) by transportation modes.

5. Final Remarks

The main motivation of this project is to present an energy audit of the transportation sector in the town of Bartica, in Guyana. This work is being developed in a process of three essential phases, chained together: 1) data collection of modes of transportation; 2) energy characterization; 3) definition of alternative scenarios to reduce energy consumption, with the aim of outlining a local strategy on reducing greenhouse gases and energy in the transportation sector (as future work for the next report).

After the data collection campaign, these elements were organized to estimate the energy consumption for each transportation mode. In the current report energy consumption estimates include also the mining and power production sectors. It must be emphasized the importance to collect the most detailed and precise information as possible; without that, the energy consumption estimation will have a high level of uncertainty. In a later stage, the households' survey data and the data collected during the field work will allow a verification of the representativeness of the data sample as well as understand the motivations behind mobility dynamics in Bartica.

Subsequently, the energy auditing team will refine the present energy performance situation of Bartica transportation system – entitled baseline scenario. The existing energy performance situation will become a reference against future scenarios to improve energy efficiency for this sector. Thus, based on the existing energy performance situation of the audited object, the team will identify opportunities for energy efficiency improvement and evaluate the impacts of these opportunities on the existing energy performance situation. This will include recommendations on inefficiencies reduction in this sector in Bartica, with the aim of outlining a local strategy to reduce energy consumption and carbon footprint in the sector in order to achieve the main aim: Bartica as a model green city.

In the final analysis, it is important to note that, despite existing data limitations, the methodology used for the analysis of energy consumption and carbon footprint is a very important planning tool. It can be applied by decision makers responsible for transportation management in order to contribute for decarbonizing this sector and to educate citizens about the energy impact caused by transportation.

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Annex I – List of participants in workshops

REGISTRATION FORM
Transitioning to National Energy Security: Bartica as a Model Green Town
First National Stakeholders Meeting
VENUE: Herdmanston Lodge

June 19, 2018

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DATE: 19th June 2018



REGISTRATION FORM
Transitioning to National Energy Security: Bartica as a Model Green Town
First National Stakeholders Meeting
VENUE: Herdmanston Lodge



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DATE: 19th June 2018

REGISTRATION FORM
Transitioning to National Energy Security: Bartica as a Model Green Town
Bartica Community Forum
VENUE: Leanna's Kiddie Park

June 20, 2018

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DATE: 20th June 2018



REGISTRATION FORM
 Transitioning to National Energy Security: Bartica as a Model Green Town
 Bartica Community Forum
 VENUE: Leanna's Kiddie Park



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DATE: 20th June 2018

Annex II – Household survey (Transportation)

1. What were the trips that you performed yesterday?

Trip	Origin	Distance traveled (miles)	Mode of Travel/Type of vehicle	Reason of trip
1	Home		(1) Truck, (2) Lorry/Canter (3) Bus, (4) Van/4*4/Pick-up (5) Private car/ (6) Taxi (7) Boat (8) Motorcycle (9) Bicycle (10) Walking	(1) Work (2) School (3) Health (4) Shopping (5) Social (entertainment, sports, visit to relatives etc.) (6) Religious (church, temple mosque) (7) Administrative issues (bank, taxes, application for personal documents)
2			Same as above	Same as above
3			Same as above	Same as above
4			Same as above	Same as above
5			Same as above	Same as above

2. During a month how often does a member of your household go to Parika?

3. What are the main reasons for going to Parika?

Reason of trip (1 -7 same as above)

4. Is any type of vehicle owned by your household? Yes () No ()

5. If yes please complete the following:

Type	Amount	Gross Weight of vehicle	Age of Vehicle (manufacture date)	Monthly Mileage	Fuel Type	Amount of fuel purchased monthly (gallon)
Truck						
Lorry/Canter						
Bus						
		Engine size (cc)?	Age of Vehicle (manufacture date)	Monthly Mileage	Fuel Type	Amount of fuel purchased monthly
Van/4*4/Pick-up						
Private car						
Taxi						
Motorcycle						
		Engine size (hP)?	Age of Vehicle (manufacture date)	Monthly Mileage	Fuel Type	Amount of fuel purchased monthly
Boat						

Annex III – Field survey

(1) Data Collection Sheet for Service Stations

Vehicle Tally Sheet

Name of Service Station: _____

Date : ____/____/2018

Survey Period:

() 7:00am to 10:00am () 11:00am to 2:00pm () 3:00pm to 6:00pm
 () 9:00am to 12:00noon () 1:00pm to 4:00pm

Vehicular Count: Please count the number of vehicles that purchase fuel from the service station

Vehicle Type	Tally	Total
1. Truck		
2. Lorry/Canter		
3. Bus		
4. Van/4*4/Pick-up		
5. Private car		
6. Taxi		
7. Motorcycle		

Completed by: _____
 Name of Enumerator

 Signature of Enumerator

Approved by: _____
 Name of Supervisor

 Signature of Supervisors

(2) Data Collection Sheet for Service Stations

Refusal/Repeat Arrivals Form

Name of Service Station: _____

Date : ____/07/2018

Survey Period:

() 7:00am to 10:00am () 11:00am to 2:00pm () 3:00pm to 6:00pm
 () 9:00am to 12:00noon () 1:00pm to 4:00pm

Vehicular Count: REFUSALS

Vehicle Type	Tally	Total
1. Truck		
2. Lorry/Canter		
3. Bus		
4. Van/4*4/Pick-up		
5. Private car		
6. Taxi		
7. Motorcycle		

Vehicular Count: REPEAT ARRIVALS

Vehicle Type	Tally	Total
1. Truck		
2. Lorry/Canter		
3. Bus		
4. Van/4*4/Pick-up		
5. Private car		
6. Taxi		
7. Motorcycle		

Completed by: _____
 Name of Enumerator

 Signature of Enumerator

Approved by: _____
 Name of Supervisor

 Signature of Supervisors

(4) Data Collection Sheet for Boat Landing

Boat Tally Sheet

Name of Boat Landing: _____ Date : ____/07/2018

Survey Period:

() 7:00am to 10:00am () 11:00am to 2:00pm () 3:00pm to 6:00pm
 () 9:00am to 12:00noon () 1:00pm to 4:00pm

Vessel Count: Please count the number of boats that arrive at the landing

Vehicle Type	Tally	Total
1. Speed boat (Passenger)		
2. Speed boat (Fuel)		
3. Speed boat (Other Cargo)		
4. Larger Vessels (Passenger)		
5. Larger Vessels (Fuel)		
6. Larger Vessels (Other Cargo)		
7. Ferry		

Completed by: _____
 Name of Enumerator Signature of Enumerator

Approved by: _____
 Name of Supervisor Signature of Supervisors

(5) Data Collection Sheet for Boat Landing

Boat Refusal/Repeat Arrivals Form

Name of Boat Landing: _____

Date : ____/07/2018

Survey Period:

() 7:00am to 10:00am

() 11:00am to 2:00pm

() 3:00pm to 6:00pm

() 9:00am to 12:00noon

() 1:00pm to 4:00pm

Vessel Count: REFUSALS

Vehicle Type	Tally	Total
1. Speed boat (Passenger)		
2. Speed boat (Fuel)		
3. Speed boat (Other Cargo)		
4. Larger Vessels (Passenger)		
5. Larger Vessels (Fuel)		
6. Larger Vessels (Other Cargo)		
7. Ferry		

Vessel Count: REPEAT ARRIVALS

Vehicle Type	Tally	Total
1. Speed boat (Passenger)		
2. Speed boat (Fuel)		
3. Speed boat (Other Cargo)		
4. Larger Vessels (Passenger)		
5. Larger Vessels (Fuel)		
6. Larger Vessels (Other Cargo)		
7. Ferry		

Completed by: _____

Name of Enumerator

Signature of Enumerator

Approved by: _____

Name of Supervisor

Signature of Supervisors

