

# **GREENHOUSE GAS INVENTORY OF THE ENERGY SECTOR IN BELIZE**

## **BELIZE'S SECOND NATIONAL COMMUNICATION CLIMATE CHANGE PROJECT**

**Submitted to  
The Ministry of Natural Resources and the Environment**

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## ***1.0 SUMMARY***

The First Greenhouse Gas Inventory was completed in 1999 using 1994 as the base line year. For this the Second Greenhouse Gas Inventory the baseline years 1997 and 2000 are being used as the reporting years. In order to be able to capture a more representative representation of emissions, two baseline years are being reported. However, each year reported is actually a three consecutive-year average. This study included the recalculation of the first Greenhouse Gas Inventory, which was done for the baseline year 1994. The results of the recalculation, using the improved UNFCCC software, did not show any significant difference in the estimates.

The results of this study show that total emissions due to the energy sector activities for 1997 were 609.47 Gg and 619.87 Gg for the year 2000. Considering emissions for 1994 of 579.07 Gg, the trend shows an increase in emissions, but the study also showed that these emissions were from the same sources. No new sources were identified in any of the two reference years considered in this study.

Emissions classified as International Bunkers showed 41.27 Gg for 1994, 276.02 Gg for 1997 and 94.35 Gg for 2000. Data indicated that this was primarily due to trade within the Commercial Free Zone (CFZ) in the Corozal district, which peaked in 1998.

## **2.0 METHODOLOGY**

For the two reporting years (1997 and 2000) it was agreed that an average of three years would be used. In the case of the 1997 reporting year the emission data for the years 1996, 1997 and 1998 was be averaged while for the reporting year 2000 the emissions for the years 1999, 2000, and 2001 was averaged.

For the Energy Sector, raw data collected included imports from the main sources, namely Esso Standard Oil S.A. Ltd and Belize Electricity Limited who are the principal importers of petroleum products into the country, as well Belize Sugar Industries Ltd, who is the only producer and consumer of bagasse. Moreover, data was also collected from other importers, including importers of Bunker C and lubricants Data. This data included imports (and production of bagasse) by fuel type. One major assumption was that inventory levels (year-end) were constant. This assumption allowed to the conclusion that imports were equal to consumption. The different data sources coincided that this was a valid assumption. In order to estimate the amounts of fuels consumed in the different energy sectors, interviews were conducted with the three major local oil companies, private sector consumers, as well as service station operators. A list of these sources is provided in Table A.

## **2.1 ASSUMPTIONS**

Following are the main assumptions made for this study:

1. The aspect of contraband fuel into the country is limited to the two northern districts of Corozal and Orange Walk. Even though these are estimated at 3% of the national consumption of gasoline and diesel, it is not taken into account for this study, as Mexico would be including it as part of their “local consumption”. To estimate the amount of fuel (mainly gasoline) smuggled into the country, interviews were conducted with Esso, the major importer of fuel into the country, three service station operators in the Orange Walk and Corozal districts, as well as interviews with two “gaseros”, as contraband fuel peddlers are called in Corozal Town.

In addition to this, Mexican fuel peddlers purchase fuel from the CFZ at duty free prices, smuggle it across the border to the Mexican side and then resell this fuel to Belizean consumers that go across to purchase it. Many informed Belizeans don't purchase fuel at the Mexican service stations any more but do so at these "clandestine" outlets on the Mexican side of the border.

These two contraband elements, when combined, result in an estimated 3% of our local consumption. This estimate was arrived at as a result of interviews with Esso.

2. All fuel imported into the country is consumed. This assumption was made since no "beginning and ending" inventory data were available. According to the interviews conducted concerning this issue the principal sources indicated that this was an acceptable assumption. On the other hand, it was also considered a practical approach as it would have been extremely difficult to account for the many storage facilities in the country (for example industrial sites and service stations), who might not carry inventory controls or proper records.
3. In most cases default emission factors had to be assumed since there exist no locally derived factors that could be applied in the equations.
4. In the case of aircraft emissions, local flights included mostly the consumption of aviation gasoline, whereas international flights consumed mostly jet kerosene. However, flights from Belize City to Flores, Guatemala, by locally registered or owned carriers were also taken into account.
5. Due to the fuel industry's volumetric units used, fuel was reported in kilo-barrels. This then made it necessary to convert the default conversion and emission factors to be compatible with this unit.
6. In order to establish the imported quantities of lubricants, these estimates were obtained mainly from the petroleum companies.

7. The API gravity factors for fuels imported and consumed in Belize were obtained directly from the Esso Belize terminal. This company imports most fuels from North and South America.
  
8. Even though “import” data was considered appropriate for this project, no “consumption by sector” data was directly available. These estimates were obtained based on interviews conducted with industry stakeholders. For example, Aviation fuel was available directly from the only Terminal source in-country since the airport is presently operated through a “joint venture” between Esso Standard Oil S.A. Ltd. and Texaco Belize Ltd., but marine fuel consumption had to be obtained through interviews with the different petroleum companies that supply marinas countrywide. In the case of aviation fuel, an interesting fact was that the consumption (or sales at the Phillip Goldson Airport) depended on the fluctuating international prices, and on supply agreements between the petroleum companies and the different carriers operating from or through Belize.
  
9. Direct data was also available in the case fuel consumed for Energy (from Belize Electricity Ltd.) and Biomass – bagasse and fuel wood (from Belize Sugar Industries Ltd. and the Central Statistical Office respectively). The same methodology was employed to establish other consumption estimates.
  
10. Interviews with a Commercial Free Zone (CFZ) service station operator also confirmed fuel sold through the CFZ. These volumes of gasoline and diesel fuel have been classified as “International Bunkers” since this fuel is purchased by Mexican consumers living across the border. This also confirmed that commercial activity had peaked in 1998. This commercial activity with regards to fuel was a direct result of lower acquisition costs through Belize that allowed a price differential between the CFZ and Chetumal, Quintana Roo, Mexico pump prices. As international crude prices began rising, this pump price gap began to shrink thereby reducing the purchasing incentive by Mexican consumers to purchase at the CFZ. During its peak of commercial activity, five service stations were operating in the CFZ. By 2001, only three remained in business. In fact, one service station

that sold 450,000 gallons of fuel per month in 1998, today sells 50,000 gallons of fuel and has reduced staff from 60 employees in 1998 to 7 in 2007.

## 2.2 DATA SOURCES

**Table 1: Summary by Fuel Type**

FUEL TYPES			<i>1994</i>	<i>1997</i>	<i>2000</i>
Liquid Fossil	Primary Fuels	Crude Oil			
		Orimulsion			
		Natural Gas Liquids			
	Secondary Fuels	Gasoline	310.1	634.56	433.83
		Jet Kerosene	100.1	112.73	125.89
		Other Kerosene	19.1	16.33	14.87
		Shale Oil			
		Gas / Diesel Oil	545	824.35	645.12
		Residual Fuel Oil	15	19.21	27.3
		LPG	93	146	167
		Ethane			
		Naphtha			
		Bitumen			
		Lubricants	11	22.1	22.2
		Petroleum Coke			
Refinery Feedstocks					
Other Oil					
Liquid Fossil Totals			1,093.3	1,775.28	1,436.21
Solid Fossil	Primary Fuels	Anthracite <sup>(a)</sup>			
		Coking Coal			
		Other Bit. Coal			
		Sub-bit. Coal			
		Lignite			
		Oil Shale			
		Peat			
	Secondary Fuels	BKB & Patent Fuel			
		Coke Oven/Gas Coke			
Solid Fuel Totals					
Gaseous Fossil		Natural Gas (Dry)			
<b>Total</b>			1,093.3	1,775.28	1,436.21
Biomass total					
		Solid Biomass (Bagasse)	293,244	297,352	301,525
		Solid Biomass (fuel Wood)	100,120	109,852	111,614
		Gas Biomass			

Note: Liquid fuels are stated in Kilo-barrels (thousands of barrels) and biomass is stated in metric tons.

**Table 2: Distribution of Fuel Type Use by Sector for 1994**

FUEL TYPES			Energy	Manu- facturing	Trans- portation	International Bunker	Commercial	Residential	Agriculture	T O T A L	
Liquid Fossil	Primary Fuels	Crude Oil									
		Orimulsion									
		Natural Gas Liquids									
	Secondary Fuels	Gasoline	0.5		293.3	3.5			12.8	310.1	
		Jet Kerosene			7	93.1				100.1	
		Other Kerosene					4	15.1		19.1	
		Shale Oil									
		Gas / Diesel Oil	276.5	83.3	133	7	2	0.2	43	545	
		Residual Fuel Oil	15							15	
		LPG		10	2.3		40	40.7		93	
		Ethane									
		Naphtha									
		Bitumen									
		Lubricants	2.5	8.5							11
		Petroleum Coke									
Refinery Feedstocks											
Other Oil											
Liquid Fossil Totals			294.5	101.8	435.6	103.6	46	56	55.8	1,093.3	
Solid Fossil	Primary Fuels	Anthracite <sup>(a)</sup>									
		Coking Coal									
		Other Bit. Coal									
		Sub-bit. Coal									
		Lignite									
		Oil Shale									
	Peat										
	Secondary Fuels	BKB & Patent Fuel									
Coke Oven/Gas Coke											
Solid Fuel Totals											
Gaseous Fossil		Natural Gas (Dry)									
<b>Total</b>			294.5	101.8	435.6	103.6	46	56	55.8	1,093.3	
Biomass	Total		298,244	0	0	0	0	95,120	0	393,364	
		Solid Biomass (Bagasse)	293,244							293,244	
		Solid Biomass (fuel Wood)	5000					95,120		100,120	
		Gas Biomass									

Note: Liquid fuels are stated in Kilo-barrels (thousands of barrels) and biomass is stated in metric tons.

**Table 3: Distribution of Fuel Type Use by Sector for 1997**

FUEL TYPES			Energy	Manu- facturing	Trans- portation	International Bunker	Commercial	Residential	Agriculture	T O T A L	
Liquid Fossil	Primary Fuels	Crude Oil									
		Orimulsion									
		Natural Gas Liquids									
	Secondary Fuels	Gasoline	0.75		320.6	295.6				17.61	634.56
		Jet Kerosene			8.1	104.63					112.73
		Other Kerosene					2.5	13.83			16.33
		Shale Oil									
		Gas / Diesel Oil	166.96	7.72 / 85	204.1	301	3	1.5	55		824.35
		Residual Fuel Oil	19.21								19.21
		LPG	2	2.7 / 17	11		52	61.3			146
		Ethane									
		Naphtha									
		Bitumen									
		Lubricants	6.1	0.9 / 4	7.1					4	22.1
		Petroleum Coke									
Refinery Feedstocks											
Other Oil											
Liquid Fossil Totals			195.02								
Solid Fossil	Primary Fuels	Anthracite <sup>(a)</sup>									
		Coking Coal									
		Other Bit. Coal									
		Sub-bit. Coal									
		Lignite									
		Oil Shale									
	Peat										
	Secondary Fuels	BKB & Patent Fuel									
		Coke Oven/Gas Coke									
Solid Fuel Totals											
Gaseous Fossil		Natural Gas (Dry)									
<b>Total</b>			195.02	117.32	550.97	701.23	57.5	76.63	76.65	1,775.28	
Biomass		Total	309,852					97,352		407,204	
		Solid Biomass (Bagasse)	297,352							297,352	
		Solid Biomass (fuel Wood)	12,500					97,352		109,852	
		Gas Biomass									

Note: Liquid fuels are stated in Kilo-barrels (thousands of barrels) and biomass is stated in metric tons.

**Table 4: Distribution of Fuel Type Use by Sector for 2000**

FUEL TYPES			Energy	Manu- facturing	Trans- portation	International Bunker	Commercial	Residential	Agriculture	T O T A L	
Liquid Fossil	Primary Fuels	Crude Oil									
		Orimulsion									
		Natural Gas Liquids									
	Secondary Fuels	Gasoline	2.1		339.4	72.6				19.73	433.83
		Jet Kerosene			13.2	112.69					125.89
		Other Kerosene					2.2	12.67			14.87
		Shale Oil									
		Gas / Diesel Oil	184.7	9.1 / 88	241.7	52.52	3.7	2.2	63.2		645.12
		Residual Fuel Oil	27.3								27.3
		LPG	3	3.1 / 17.5	13.45		57.6	67.35	5		167
		Ethane									
		Naphtha									
		Bitumen									
		Lubricants	7.9	1.2 / 8.1						5	22.2
		Petroleum Coke									
Refinery Feedstocks											
Other Oil											
Liquid Fossil Totals			225	127	607.75	237.81	63.5	82.22	92.93	1,436.21	
Solid Fossil	Primary Fuels	Anthracite <sup>(a)</sup>									
		Coking Coal									
		Other Bit. Coal									
		Sub-bit. Coal									
		Lignite									
		Oil Shale									
	Peat										
	Secondary Fuels	BKB & Patent Fuel									
		Coke Oven/Gas Coke									
Solid Fuel Totals											
Gaseous Fossil		Natural Gas (Dry)									
<b>Total</b>			225	127	607.75	237.81	63.5	82.22	92.93	1,436.21	
Biomass	Total		313,525					99,614		413,139	
		Solid Biomass (Bagasse)	301,525							301,525	
		Solid Biomass (fuel Wood)	12,000					99,614		111,614	
		Gas Biomass									

Note: Liquid fuels are stated in Kilo-barrels (thousands of barrels) and biomass is stated in metric tons.

### 3.0 RESULTS

**Table 3.1: Carbon Dioxide emissions by Sector by Reference Year due to Liquid Fuels.**

CO <sub>2</sub> EMISSIONS (Gg)		1994	1997	2000	
Energy Industries		136.05	81.16	93.21	
Manufacturing Industries and Construction		39.98	44.71	46.73	
Transport	Domestic Aviation <sup>(a)</sup>	11.87	15.65	20.85	
	Road	263.58	275.94	330.55	
	Railways				
	National Navigation <sup>(a)</sup>	35.51	57.03	77.54	
	Pipeline Transport				
Other Sectors	Commercial/Institutional	3.17	15.29	16.87	
	Residential	16.39	21.62	22.96	
	Agriculture / Forestry / Fishing	Stationary			1.25
		Mobile	89.22	107.59	33.63
Other (not elsewhere specified)					
Total <sup>(a)</sup>		597.77	618.99	643.59	
Memo: International Bunkers		4.52	233.84	57.49	
Memo: International Aviation Bunkers		36.33	41.95	45.18	

The results show a general increase in emissions of carbon dioxide of 7% from 1994 to 1997 and an increase of 4% from 1997 to 2000. This gives a total increase of 64.53 Gg of carbon dioxide emissions or an 11.1% increase over this six-year period.

Emissions in all sectors show a growing trend. This is due to a greater activity in manufacturing, construction, domestic aviation and national navigation (which are directly related to the growing tourism industry), In the case of road transportation, this is as a result of an increase in motor vehicles in the country. This trend was corroborated with service station sales countrywide.

In the case of carbon dioxide emissions by energy industries, it is important to note that Belize Electricity Limited (BEL) imports its own diesel fuel for the production of electricity. The importation of diesel fuel is dependent on the acquisition cost as well as rain frequency in the country. During this period, the Mollejon dam also came on stream, thereby reducing the dependency on imported

fuel for the production of electricity. This data was obtained directly from this utility company. The data obtained from BEL for the consumption of diesel fuel for the production of electricity is as follows:

**Table 3.2: Diesel Fuel Imports for the production of Electricity by Belize Electricity Limited.**

Year	1994	1997	2000
Diesel Fuel consumed (gallons)	276.5	166.96	184.7

Another result that is worthwhile of mention is the “International Bunkers” carbon dioxide emissions. In the 1994 base year study, “International Bunkers” included only the marine sector. However, by the end of 1996, the CFZ came on stream and was responsible for significant re-exports of fuel to Mexico (therefore considered International Bunker). In fact, of the 233.84 Gg carbon dioxide emissions calculated for 1997, (an average of 1996, 1997 and 1998), 227.57 Gg correspond to the CFZ fuel re-exports. On the other hand, of the 57.49 Gg carbon dioxide emissions calculated for 2000, 48.23 Gg correspond to CFZ re-exports.

**Table 3.3: Carbon Dioxide emissions by Sector by Base Line Year due to Biomass.**

CO <sub>2</sub> EMISSIONS (Gg)			1994	1997	2000
Energy Industries			262.22	285.19	288.06
Manufacturing Industries and Construction					
Transport	Domestic Aviation <sup>(a)</sup>				
	Road				
	Railways				
	National Navigation <sup>(a)</sup>				
	Pipeline Transport				
Other Sectors	Commercial/Institutional				
	Residential		316.84	324.28	331.81
	Agriculture / Forestry / Fishing	Stationary			
		Mobile			
Other (not elsewhere specified)					
Total <sup>(a)</sup>			579.07	609.47	619.87
Memo: International Bunkers					
Memo: International Aviation Bunkers					

In the case of emissions due to biomass, the two main contributors are fuel wood and bagasse. In the case of fuel wood, the bulk of the consumption is for domestic use (a CSO estimate shows that 13% of the population uses fuel wood as their energy source for cooking). Bagasse is produced and consumed by Belize Sugar Industries Limited (BSI), which is the only sugar factory currently in operation the country. This production / consumption is projected to increase dramatically with the co-generation project by BSI in the near future.

Compared to carbon dioxide, other emissions were insignificant. These were calculated using the Source Category (Tier 1) Method. These include CH<sub>4</sub>, N<sub>2</sub>O, NO<sub>x</sub>, CO, NMVOC's and SO<sub>2</sub>. Of these, however, sulfur dioxide was estimated to be more significant than the others. This methodology, unlike the study for the 1994 base year, included calculations for sulfur dioxide emissions by sector. The global results for sulfur dioxide emissions were as follows:

**Table 3.4: Sulfur Dioxide emissions per year by Source Categories (Tier 1)**

Year	1994	1997	2000
Sulphur Dioxide Emissions (t)	530.6	417.0	462.68

Values for 1994 were re-calculated and the same results were obtained. The difference for 1997 and 2000 is that the upgraded software (methodology) allows a more detailed estimation of emissions by sector (energy industries, manufacturing industries and construction, transportation, commercial, institutional, residential, agriculture, forestry and fishing). It is the considered opinion of the consultant that this more detailed methodology accounts for a more accurate estimation of emissions of sulfur dioxide.

For the estimation of aircraft emissions (Tier 3), the only significant emissions were those of carbon dioxide. It is noteworthy to highlight that all calculations were done using default values as no local data is available.

**Table 3.5: Carbons Dioxide emissions per year from Aircraft (Tier 2)**

Year	<b>1994</b>	<b>1997</b>	<b>2000</b>
Carbon Dioxide Emissions (Gg)	24.52	41.1	46.9

There were no activities in the areas of coal mining and handling, oil and gas activities nor oil refining, for the period under consideration

#### **4.0 CONCLUSIONS AND RECOMMENDATIONS**

The following conclusions were arrived at as a result of this consultancy:

- The same sources of emissions were identified for the three base years under consideration. However, except for energy industries as a sub-sector, all are shown to have increased their emissions as a result of higher consumption of fuel due to higher commercial activity.
- Belize Electricity Limited (BEL) has contributed to the energy industry producing lower emissions, over the six-year period since the company produced less electricity by fossil-fuel generation during this time. Instead, the company supplied electricity to the consumers through hydroelectric sources or procuring energy from Mexico. In 1994, BEL consumed 94% of all fuel used for energy production. This consumption decreased to 86% and 82% for 1997 and 2000 respectively.

This decreasing emission trend will more than likely be offset by the bio generation project of BSI scheduled to come on stream in the near future. It is worthwhile to mention that BEL, through its Procurement Department, has been most helpful to the completion of this report. The consultant is most appreciative of their openness and frank support in this endeavor.

In Belize, another company which generates electricity is Farmers' Light Plant Corp., which operates in Spanish Lookout. This company was found to consume a relatively stable amount of diesel to produce electricity. Over the period 2006 to 2001, the company consumed an average of 21,500 gallons monthly, equivalent to 6.12 KB's annually.

- Local mobile emissions for small aircraft cannot be estimated due to the lack of the corresponding emission factors. Given that the methodology does not contemplate this data, and given the fact that within our region small aircraft

are commonly used, this consultancy recommends that a regional emission factor be established and adopted for small aircraft.

- The only source of biomass emissions was found to be Belize Sugar Industries Limited (bagasse) and the local Lime industry (fuel wood). Even though rice husks were used during this period by Hill Bank Agriculture Limited in Blue Creek (Mr. Peter Dyck) for the rice-drying process, this was established to be only on an experimental basis. Due to this, no records were available from the processor and therefore could not be reported on. It is recommended that, in the event this biomass fuel source continues to be tested, that proper records be kept for future reference.
- The methodology also does not contemplate mobile emission factors, as it groups all transportation emissions by using one emission factor. That is, it does not consider specific emission factors for the transportation sector; for example, the different types of motor vehicles such small cars, medium sized vehicles, trucks and tractors which are used in this sector. Also, it does not allow for the estimation of emissions by different models of vehicles. In Belize, as is the case in the region, most vehicles used are “second hand” vehicles, which due to their age and thereby combustion efficiencies, produce a range of emissions. The consultant therefore recommends that specific emission factors for this sector be estimated and used, in order to more accurately calculate the emissions produced by this sector.
- During the course of this consultancy, it was also identified that burnt oil was being used as a fuel source in the Shipyard area for metal melting. However, it was not possible to establish reliable estimates, and the methodology does not provide for an emission factor for this energy source. The recommendation here is therefore to establish, on a regional basis, the use of burnt oil as an energy source, and if feasible to establish an emission factor to be used for future estimates.

- Even though no oil or gas activities were conducted during the period under study, it is recommended that Belize Natural Energy Limited, as well as BSI (due to its upcoming bio generation project), as well as other stakeholders in the industry, be made to become involved and become active partners with the CARICOM Climate Change Center. This should be done with the objective of allowing the free flow of information, whenever it may be required.

## **5.0 LIST OF PERSONS INTERVIEWED**

Mr. Guillermo Alamina, Country Representative, Esso Standard Oil S.A. Ltd., Belize City

Mr. Freddy Flores, Sales Representative, Esso Standard Oil S.A. Ltd, Belize City

Mr. Jose Espat, Operations Manager, Esso Standard Oil S.A. Ltd., Belize City

Mr. Eladio Alamina, Service Station Dealer, Orange Walk Town

Miss Lupita Longsworth, Service Station Dealer, Commercial Free Zone, Santa Elena Border

Mr. Reynaldo Burgos, Procurement Manager, Belize Electricity Limited, Belize City

Mr. Ariel Lizama, Purchasing Officer, Belize Electricity Limited, Belize City

Mr. Antonio Herrera, Purchase Manager, NOVA Belize Limited

Mr. John Gillet, Factory Manager, Belize Sugar Industries Ltd., Orange Walk

Mr. Jose Contreras, Director Civil Aviation, Civil Aviation Department

Mr. Michael Godoy, Chief Transport Officer, Traffic Department

Mr. Peter Dyck, Proprietor, Hill Bank Agriculture Limited, Blue Creek, Orange Walk District

Mr. Jake Lekeman, Farmers' Light Plant Corp., Spanish Lookout, Cayo District

## **6.0 REFERENCES**

Perry, Chemical Engineer's Manual

Weast, Handbook of Chemistry and Physics

Greenhouse Gas Inventory Workbook, Volume 2; Intergovernmental Panel on Climate Change, UNEP

Greenhouse Gas Inventory Reference Manual, Volume 3; Intergovernmental Panel on Climate Change, UNEP