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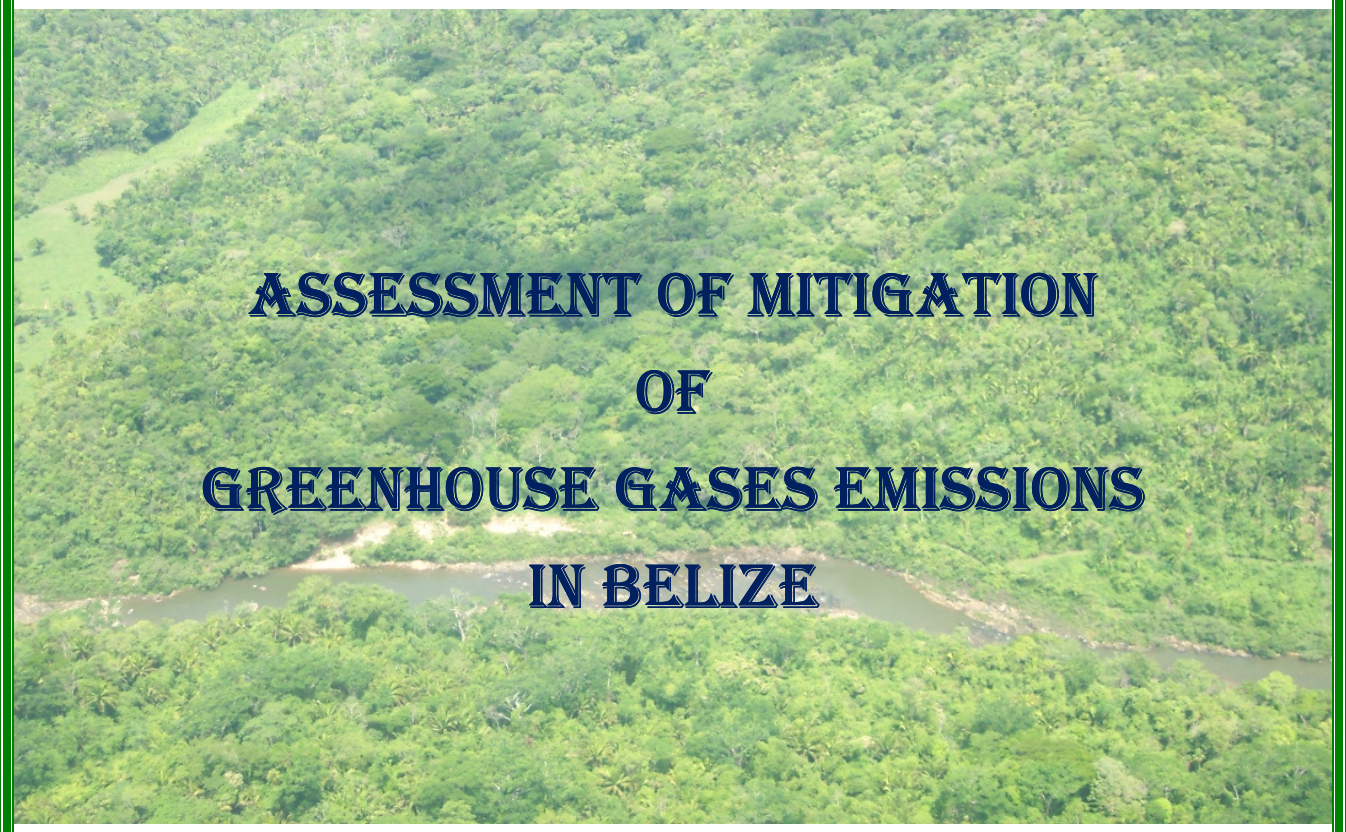

ASSESSMENT OF MITIGATION OF GREENHOUSE GASES EMISSIONS IN BELIZE

June 20, 2008

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REPORT

On the

Analysis of the Mitigation (Abatement) Potential

on Greenhouse Gases Emissions through Hydropower Generation

and Biomass Co-generation of Electrical Energy.

Submitted by

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On behalf of

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1.0 INTRODUCTION

Belize became a Party to the UNFCCC in 1992, and is classified as a Non-Annex 1 country. Belize joined the Kyoto Protocol in 2003, and is designated as an Annex B member.

The physical features and location in the western Caribbean Sea, combined with the state of its economic development, in the western Caribbean Sea (on the Central American isthmus) make Belize a country with similar characteristics of vulnerability to global climate change like the Caribbean islands and other low states.

Belize is among those countries presently preparing the Second National Communication according to the decisions made at the 11th Conference of the Parties. This is being facilitated by the UNDP office in Belize through the project PIMS # 3299 CC EA SNC of Belize.

The Second National Communication is also intended to report on progress made in mitigation (abating) the production of greenhouse gases in Belize. It will describe any technologies, practices, and policy reforms that have been applied or implemented and resulted in or is intended to result in the reduction or avoidance of greenhouse gases emissions while contributing to sustainable development goals.

Reporting on the accomplishments and Belize's status, various activities have been undertaken to address and access the Electrical Industry. The only supplier of Energy to the Belizean consumer is Belize Electricity Limited. BEL, however, has been moving away from the generating aspect of the industry and focusing mainly on the transmission, distribution and sale of energy. They source their energy from three main suppliers, BECOL, CFE and HydroMaya. BEL still have a small generating capacity of 36.2 MW use to help with the peak demand of 70.0 MW, if necessary. This indicates that BEL still relies on fossil fuel for all of its in-house generation.

While BSI self generate as well as, they purchase energy from BEL. BSI bagasse project has been delayed and will not be on line until 2009. This project will see renewable energy from bagasse,

being used to supply BEL with16 MW of Power, thus further reducing BEL need for the 36.2 MW generated from fossil fuel.

2.0 The Project

The general project is to analyze/assess the mitigation (abatement) potential and status on Greenhouse Gases Emissions through Hydropower Generation and Biomass Co-generation of Electrical Energy in Belize. The consultants analyzed/assessed the greenhouse gases abatement (mitigation) impact of the Macal River Hydro Project and the potential of the Belize Sugar Industries (BSI) Bagasse Co-Generation Plant on greenhouse gasses emissions in Belize. This project aims to obtain the present status of activities and projects that should have been implemented to assist in the abatement of greenhouse gases emissions. The project is centered on the power-generating sector and actions put in place to minimize the use of fossil fuel for this industry.

3.0 Overview

The country of Belize covers some 8,867 sq. miles and is occupied by 311,500 people, a population density of 35.1. While the distribution of the population is almost even with 152,500 occupying the urban areas and 148,800 the rural areas, the majority of the population is located in the Belize District with Belize City being the highly populated area in excess of 63,000 people. The entire country is electrified by Belize Electricity Limited, who has a customer base of over 70,000. BEL shows an average growth rate of 9%.

While BEL supply energy to the entire country, there are still 1,394 privately own generating systems that supplies energy to their respective establishment. This does not account for the private generators that are used for standby purposes. Similarly over 1,000 households supply their household with light using gas and 6,859 use kerosene for lighting purposes. The use of the kerosene and gas for light is concentrated in the Toledo and Cayo Districts.

The First Greenhouse Gas Inventory was competed in 1999 using 1994 as the base line year. For the Second Greenhouse Gas Inventory the baseline years 1997 and 2000 were being used as the reporting years. In order to capture a more representative representation of emissions, two baseline years were 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 did not show any significant difference in emissions.

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. By reviewing only that which is generated by BEL or that which is purchased by BEL, we find that it does not give the total picture as was compiled previously for the energy sector. However what is clearly demonstrated is that the use of Hydro generated energy contributes tremendously to a cleaner environment and is a part of mitigating GHG.

While the BSI program is delayed, the stored baggasse is approximately the same and thus produces the 385,794 Gg CO_2. This will be mitigated upon completion of the project that proposes to utilize all the baggasse.

Table I.

FUEL TYPES			*1994*	*1997*	*2000*	*2007*
Liquid Fossil	Secondary Fuels					
		Gas / Diesel Oil	545	824.35	645.12	69.52*
		Other Oil				
Liquid Fossil Totals			545.00	824.35	645.12	69.52
Solid Fossil	Primary Fuels	Anthracite [(a)]				
		Coking Coal				
	Secondary Fuels	BKB & Patent Fuel				
		Coke Oven/Gas Coke				
Solid Fuel Totals						
Gaseous Fossil		Natural Gas (Dry)				
Total			545.00	824.35	645.12	69.52
Biomass total						
		Solid Biomass (Bagasse)	293,244	297,352	301,525	385,794

* This figure represents only what BEL generate from Diesel and that which is purchase from Mexico.

4.0 History

Belize Electricity Limited

Prior to 1950, an American investor who owned a DC generator and an ice plant provided electricity supply in Belize City. On July 8, 1950, an ordinance was passed creating the Belize Electricity Board (BEB) as an autonomous statutory corporation. The Electricity Light and Power Ordinance, was revised and renamed in September 1958 as the Belize Electricity Board Ordinance, chapter 156 of the laws of Belize.

At that time, BEB was supplying electricity only to Belize City. The respective town councils supplied the other municipalities in the country with four hours of electricity every night, from 6:00 p.m. to 10:00 p.m.

Under the revised ordinance, BEB was the sole authority for generating, distributing, supplying and selling energy for public and private purposes within Belize City. However, the Minister of Electricity had the authority to declare other areas of the country to be within the area of supply of BEB. Eventually, Belmopan, Corozal, Orange Walk, San Ignacio, Dangriga, Punta Gorda and the islands of Ambergris Caye and Caye Caulker were all declared as areas of supply for BEB.

In those early years, the generating facilities were all diesel electric, and because of the shortage of serviceable generating capacity, the firm capacity often fell short of consumer demand for power.

In 1971, BEB coordinated and implemented a program to increase the generating, transmission and distribution capacity in all districts of Belize and again in 1980, BEB undertook another program expansion. Among other things, this program included a study to determine the future system development. By 1992, BEB had eight stations generating an aggregate amount of 97,000,000 kilowatt hours. The "Board" had approximately BZ$35 million in Revenue and 27,000 customers.

Up to 1992, the government of Belize was the sole owner of the Belize Electricity Board. Then under the Electricity Act, no. 13 of 1992, BEB ceased to function as it was privatized and became Belize Electricity Limited (BEL). In that year, the Minister of Energy and Communications issued a license under section 15 of the Electricity Act, 1992, granting BEL the exclusive authority to generate, transmit and supply electricity. The license was effective starting January 7, 1993, and is valid for 15 years.

Under the license, BEL has exclusive power to:

- Generate electricity for the purposes of giving a supply to or enabling a premises in Belize;
- Transmit electricity for the purposes of giving a supply to or enabling a supply to be given to any premises in Belize; and
- Distribute and supply electricity to any premises in Belize as a public electricity supplier.

The license also defines BEL's areas of supply over which it has exclusive rights.

The Government of Belize divested itself of its 51% holding in the Company in October 1999. As of June 2006, Fortis Inc. of Canada held a 70.2% interest in BEL and the Social Security Board of Belize held 26.9% interest in the Company. The remaining shares are held by smaller shareholders in Belize.

At December 31, 2007, BEL had approximately 73,000 customer accounts and was meeting peak demand of 70 Megawatts. The Company's operating revenue was $159.6 million.

Belize Electricity Limited (BEL) is the primary distributor of electricity in Belize, Central America. The Company, which is 70% owned by Fortis Inc. of Canada, serves a customer base of approximately 73,000 accounts and is regulated by the Public Utilities Commission (PUC).

BEL meets the country’s peak demand of about 70 megawatts (MW) from multiple sources of energy. These sources include electricity purchases from Belize Electric Company Ltd. (BECOL), which operates the Chalillo and Mollejon Hydroelectric Facilities in Western Belize; from Comisión Federal de Electricidad (CFE), the Mexican state owned electricity company; and from BEL's gas

turbine unit and diesel fired generators and HydroMaya –a small 3 MW hydro plant in the Toledo District. All major load centers are connected to the country's national electricity system, which in turn is connected to the Mexican electricity grid, allowing BEL to optimize its power supply options.

Belize Electricity Limited...

- is the primary distributor of electricity in Belize, Central America.
- serves a customer base of approximately 73,000 accounts countrywide.
- has a peak demand of about 70 megawatts (MW).
- sells almost 382 GWh of electricity yearly.
- purchases up to 32.5 MW from Belize Electric Company Limited and 15 MW firm from Comisión Federal de Electricidad.
- owns and operates a 22 MW Gas Turbine Unit at its West Lake Generating Plant and Substation.
- operates 7 diesel plants and maintains 16 substations.
- Purchases a combined total of 93% of electricity from CFE, Mexico's National Grid and BECOL
- Has a total assets of $408.9 million
- Employs 260 personnel

Table II: BEL Profile

Year	BEL	Demand	Installed Capacity	
	GWh	MW	MW	Customers
1991	105.56	20.20	40.00	27472.00
1992	112.02	23.39	40.00	31808.00
1993	124.77	25.59	43.30	36684.00
1994	138.08	27.73	43.30	39396.00
1995	143.99	29.39	40.95	42610.00
1996	100.97	31.76	38.76	45649.00
1997	92.96	31.31	37.84	49080.00
1998	109.40	36.59	31.30	51175.00
1999	60.59	42.80	30.80	50835.00
2000	45.81	44.50	26.30	53151.00
2001	48.79	49.30	27.00	57083.00
2002	51.84	53.70	27.00	59815.00
2003	109.15	57.40	49.30	63076.00
2004	88.86	61.10	43.60	66081.00
2005	92.48	63.50	43.50	68635.00
2006	34.32	66.60	36.90	70957.00
2007	40.77	70.00	36.20	72691.00

Belize Electric Company Limited

Belize Electric Company Limited is a Fortis owned company and supplies BEL with approximately 39% of BEL's total energy needs. BECOL has two generating facilities presently a 7.3 MW plant at the base of its storage dam facility located at the Challilo site and a 25.2 MW generating facility at Mollejon. The Challilo facility dams the Macal River and stores 124 million cubic meters of water for power generation, inundating 9.5 km^2. This provided to BEL over 174 GWh of energy in 2007. The entire BECOL projects calls for three facilities, two already completed and operating, Challilo Dam and

Generating Station and the Mollejon Dam and station, and the third, Vaca under construction. Upon completion this will up BECOL's contribution to the energy demand from 39% to 69%.

BELCOGEN/BSI

Belize Sugar Industries Limited, the Cane Processor, is the only private Sector Led, Owned and Managed sugar factory processing 1.25 M tons of cane. 95% of cane is grown by independent cane farmers under Belize Cane Farmers Association who represent 9000 Farmers. This industry is regulated through the Sugar Act of 2001.

Belize Cogeneration Energy Limited (BELCOGEN) is a 100% subsidiary of Belize Sugar Industries Limited. Belcogen is an Independent Power Producer (IPP) established to manage the US$62 million, 31.5 MW renewable energy power plant project. This project is designed to meet Government's National Security Interest of reducing the reliance on imported energy supply, fulfilling the policy of promoting renewable energy sources, provide the much needed additional capacity of Energy to the National Grid, facilitate displacement of Fossil Fuel based Energy and reduce Foreign Exchange Demand.

The project is the initiative of BSI as Project Promoter and BSI has engaged Booker Tate as the Project Developer. This project upon completion will supply approximately 20% of the National Energy Demand by 2009. This project was to have been completed as early as 2006 but had encountered a number of setbacks, thus the new date has been established as 2009.

Belcogen will generate power and steam to supply BSI's Tower Hill Sugar Factory and BEL's power grid. The BSI Sugar factory uses approximately 1.25 M tons of cane, harvested from 60,000 acres, to produce 97 thousands long tons of sugar creating 430,000 tons of waste, baggasse. Belcogen will utilize the 430,000 tons of baggasse to generate:

1. 585,000 tons of process steam for BSI

2. 32.5MW Cogeneration Power as follows:
   Extracting Condensing Steam Turbine 15 MW
   Back Pressure Steam Turbine 12.5 MW
   Two Parallel HFO Generators each 2.5 MW
3. Up to 16.5 MW to be sold to BEL as base load Power
4. Generate 106 GWh for supply to BEL
5. Generate 44 GWh for supply to BSI

Belcogen has signed a 15 year power purchase agreement with BEL to supply 16.5 MW of base load power and a 20 year power purchase agreement with BSI to supply 9 MW of power and 135 t/h of process steam.

HydroMaya

The HydroMaya generating station is a 3.1 MW run-of-river power plant located in the Toledo District. This is an independent power producing station and sells its power to BEL. While this station is small, this project is dependent on the water levels and water flow of the river. This station came on line in 2006 and has been producing some 10 GWh of energy for BEL.

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5.0 Belize's Electrical Demand Profile

BEL is the sole distributor and supplier of power to the Belizean population. This is done through BEL purchasing power from various generating companies both in country and across the borders. As is demonstrated by the table below, BEL obtains its power from four main supplies.

1. BECOL supplies approximately 170GWh of energy, this is depends on the water flow and the type of weather conditions experienced for the year,
2. CFE, Mexico sale of power to BEL based on a standing agreement, but is also subjected to Mexico's needs and in-country demand. The power purchased is tied to fuel prices.
3. HydroMaya, a small 3 MW run-of-the-river hydro plant located in the Toledo district
4. BEL fossil fuel (diesel) generation. BEL's power stations are used mainly for addressing any short falls in power purchased from any of the present three suppliers,

energy conditions and restoring the system when there is a failure. Presently BEL has one stand alone power station located in Caye Caulker. The power for this Island is 100% from the fossil fuel plant located on the Island.

As can be seen by the table below, BEL is minimizing their operations of power generation. While BEL had been the sole generating company, they have been closing their stations after the regulations establish that other companies can generate power. BEL still remains as the only distributor and supplier of energy to the households.

Energy demand has seen a constant growth over the past 16 years. The growth or demand rate averages to 9% annually over this period. With the rise in fuel prices over this period, as well as the regulation established by the government and the privatizing project, BEL has migrated from a generating company to mainly a distributing company. This has seen BEL closing almost all of its power stations as well as developing a national power line grid linking the entire country. With the grid in place, BEL has been able to supply the entire country through some 1700 miles of line. Energy is sold at an average rate of $0.441 per kWh.

Table III: Generating Profile

Year	BEL	BECOL	Hydro Maya	BSI	BAL	CFE	Total
	GWh	GWh	GWh	GWh	GWh	kWh	GWh
1991	105.56					6.01	111.57
1992	112.02					12.08	124.10
1993	124.77					18.18	142.95
1994	138.08					20.45	158.52
1995	143.99					22.99	166.98
1996	100.97	46.70				24.32	171.98
1997	92.96	62.38				25.99	181.33
1998	109.40	72.03				28.79	210.22
1999	60.59	75.53				100.35	236.47
2000	45.81	93.62				126.81	266.23
2001	48.79	91.37				158.63	298.80
2002	51.84	88.24				180.51	320.60
2003	109.15	61.15				188.71	359.01
2004	88.86	63.22				235.80	387.87
2005	92.48	68.28				253.80	414.55
2006	34.32	177.73				209.81	421.87
2007	40.77	174.39	10.68			225.23	451.06
2008	40.77	175.00	10.68			265.21	491.66
2009	BEL diesels would not be needed	332.68	10.68	106.00	87.60	86.55	535.91
2010		332.68	10.68	106.00	87.60	134.78	584.14

6.0 Projections:

Figures are not yet available for 2008, however the profile appears to be remaining similar to 2007. Commencing 2009 the following projects should be coming on line. BECOL should complete VACA Hydro Plant that should be supplying a base load supply of power to BEL of 18 MW. This translate into approximately 158 GWh of energy, this is demonstrated in the increase of BECOL's supply to 332.68 GWh. The Belcogen project is also scheduled to be on line in 2009. This agreement will supply 106 GWh of renewable energy to BEL. Both these projects will reduce BEL's need to utilize its fossil fuel power plants. The further reduction of the use of fossil fuel by BEL is enhanced by the projection of placing Caye Caulker, the only self generation fossil fuel Power Plant, on the National Grid. This will result with the closing of that station causing further reduction in the use of fossil fuel and the generating of GHG. Table II indicates this by showing no values in the BEL column. Although these are the projections and this is based on a 9% average growth rate, BEL will still need to be generating on emergency basis, line maintenances, and the contract status with CFE. The additional benefit of these projections is that 75% of BEL power supply will not be dependent of fossil fuel and variation in fuel prices.

With the remaining power demand contracted from CFE, BEL's contribution to green house gasses will be reduced to a negligible value, almost nil. While this is projected and appears to be the ideal case in eliminating GHG generation, a second scenario exist to assist or ensure that Belize becomes self sufficient with in-country power generation. BEL has signed an agreement with BAL to purchase some 10 MW of base-load power. The BAL project is a heavy fuel generation plant and will result in approximately 22 Gg of CO_2 emissions. While the in-country self sufficiency will be satisfied by BECOL, BSI/BELCOGEN, HydroMaya and BAL, the introduction of BAL brings the emission of GHG. This project however cannot be seen in isolation. Data shows that 1,394 private power generations exist in Belize. This figure, while does not indicate how much energy is generated, it does indicate that these generation are mainly by fossil fuel. This can clearly be seen from the BAL project. While BAL will be supplying BEL with 10 MW, this project was implemented to supply power to the shrimp farms in the south. The project will be generating some 20 MW of power.

Green House Gasses Status

Over the period of 1991 to 2007 the energy growth went from 111.57 GWh to 451.06 GWh. The generation of this energy has gone from being supplied from only fossil fuel generating stations to a combination of fossil fuel, hydro and purchase from Mexico. While growth or demand for energy took place and increased over 4 times, similarly the emission of green house gasses should have increased proportionally. The table indicates that GHG emission should have gone from 29.16 Gg of CO_2 to 117.88 Gg CO_2. This was not the case. As BEL searched for ways of meeting the power demand, the advent of renewable energy sources entered the development process. While there was a constant increase between the periods of 1991 to 1995, from 1996 to present shows less and less dependency on fossil fuel. This was a result of the Mollejon Hydro project that came on line in 1995 and was fully operational in 1996. The advent of this plant showed the reduction of GHG to 26.39 Gg. While the following years showed a constant decrease in GHG emissions as the Hydro systems became more operational, the overall effect appears to be fluctuating. This is evident as two opposite force tried to balance off. As the energy demand increase, the emission of GHG started to increased, this was mitigated by two factors. The first was the clean energy produced by the Mollejon run-of-the-river plant. This was complimented with power being purchased from Mexico. While the power purchased from Mexico result in less GHG produced in Belize, we must also note that one of Mexico's sources of energy generation is the burning of fossil fuel. GHG does not respect borders, thus Mexico's generation of GHG will contribute to the problem.

In 2006 we can observed a major drop in the emission of GHG. This was the result of the Challilo Dam's completion and its full operation for the year 2006. With Challilo operating in 2006 and 2007, as well as HydroMaya, we can observe that these projects have contributed tremendously to the reduction of GHG emission down to 10.65 Gg. It can clearly be seen that in 1991 when Belize was dependent solely of fossil fuel energy generation, GHG emission was 27.59 Gg. In 2007 after the completion of the Challilo and Mollejon project, as well as the purchase of power from Mexico, BEL's emission fell to 10.65 Gg. This is more than a 50 % reduction of emission with energy demand increasing to 4 times 1991's requirement.

As stated above there are indications that with the completion of the Vaca Hydro project and the BSI/BELCOGEN baggasse project, the country's dependency on fossil fuel will reduce to almost nil, similarly the GHG emission of CO_2 will also go down to negligible.

Table IV: GHG Profile – Power Generation

Year	BEL	Mollejon	CFE	Total	
	Emissions	Reduced Emissions	Emissions	Possible Emissions	Net Emissions
	(Gg CO_2)	(Gg CO_2)	(Gg CO_2)	(Gg CO_2)	(Gg CO_2)
1991	27.59		1.57	29.16	27.59
1992	29.28		3.16	32.43	29.28
1993	32.61		4.75	37.36	32.61
1994	36.08		5.34	41.43	36.08
1995	37.63		6.01	43.64	37.63
1996	26.39	-12.20	6.36	44.95	26.39
1997	24.29	-16.30	6.79	47.39	24.29
1998	28.59	-18.82	7.52	54.94	28.59
1999	15.83	-19.74	26.22	61.80	15.83
2000	11.97	-24.46	33.14	69.57	11.97
2001	12.75	-23.88	41.46	78.09	12.75
2002	13.55	-23.06	47.17	83.78	13.55
2003	28.52	-15.98	49.32	93.82	28.52
2004	23.22	-16.52	61.62	101.36	23.22
2005	24.17	-17.84	66.33	108.34	24.17
2006	8.97	-46.45	54.83	110.25	8.97
2007	10.65	-48.36	58.86	117.88	10.65

5.0 Conclusion:

Belize Electricity Limited (BEL) has contributed to the energy industry producing fewer emissions over the sixteen-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%, 82% and 42% for 1997, 2000 and 2007 respectively. This trend continues with the advent of the Vaca Falls project. This decreasing emission trend will continue by the bio generation project of BSI scheduled to come on stream in 2009. Not only will the Belcogen project will assist in BEL reducing the use of fossil fuel, but that GHGs emitted by the decaying baggasse will decrease as Belcogen use the biomass for energy generation. This project will result in a further decrease of BEL fossil fuel use as well as BSI result with a net decrease as there waste is consumed.

The environmental friendly energy generation from both the Hydro system and baggasse system benefits extends into the economic value of the energy. Presently BEL is seeking a raise in electricity rates to the consumer. This is due to the fact of increasing fuel, diesel, prices. The purchase of energy from Mexico is also tied to fossil fuel prices. With the complete BECOL project – Challilo, Mollejon and Vaca, and the BSI/Belcogen project, the electrical rates will not be dependent on fossil fuel prices. This should allow the cost of electricity to either go down or stabilized. Also, the closing of the Caye Caulker plant, which uses only fossil fuel, will also result in the further reduction of diesel use mitigating emissions and high electrical rates.

Other areas of concern would be the additional diesel generating sources that are becoming available. One such source is the BAL Company and the BNE proposed generating company. Both of these companies are utilizing the burning of fossil fuel.

Resources:

1. **Interviews & Visits**
    - **BEL personnel and CEO**
    - **BECOL personnel**
    - **BSI/Belcogen personnel**
    - **HydroMaya personnel**
    - **BAL personnel**
2. **Annual Reports - BEL**
3. **BECOL Data and Reports**
4. **BSI / Belcogen Data**
5. **UNFCCC and IPCC website**