

Quantification of GHGs Emissions from Industrial Sector in Mauritius

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Abstract. Many industries generate large amounts of carbon dioxide and other greenhouse gases when they burn fossil fuels in their production processes. In addition, production of raw materials and other inputs the firms procure for their operations also generates greenhouse gases indirectly. These direct and indirect greenhouse gas emissions occur in many sectors of our economies. Industry is therefore a major source of global greenhouse gas emissions. This study was initiated to quantify the amount of CO₂ emitted from the use of fossil fuels, namely; coal, liquefied petroleum gas (LPG), diesel oil and fuel oil in the industrial sector in Mauritius. It also assessed the climate mitigation potentials of the resources through heat recovery system like an economizer to enhance the steam generating system in the textile industry and to estimate the amount of energy recovery and CO₂ emissions avoided. The results showed that out of 407,259.1 tonnes of CO₂ emitted in 2006, the emissions of CO₂ from fuel oil represented 46.3% and among the different sub-industries, the Economic Production Zone (EPZ) industry remains the largest CO₂ emitter with 57.98% of CO₂. The use of heat recovery system is estimated to displace around 609 tonnes of CO₂ in 2006. This feature can enable such a project to be eligible for Certified Emission Reduction (CER) and can benefit largely from the carbon trading system.

Keywords: GHGs emissions, Climate change, Industrial sector

1. Introduction

Mauritius is a small developing island situated in the Indian Ocean with a population of 1.2 million inhabitants. It has a diversified economy supported by manufacturing, tourism, agriculture and other services. It is highly dependent on imported fossil fuels resources like petroleum, natural gas and coal which share about 82% of the total energy consumption and the remaining 18% is derived from renewable energy [1]. Mauritius is classified among the upper middle income countries with a per capita income of US\$ 7250 in 2009 [2]. The manufacturing sector accounted for 19.4% of GDP while the share of agriculture and tourism sectors stood at 4.5% and 8.7% respectively [2].

2. Energy Consumption in Mauritius

Mauritius has no oil, natural gas or coal reserves and therefore depends exclusively on imported petroleum product to meet most of its energy requirement. In Mauritius, the major energy demand sectors are transport, commercial and distributive trade, manufacturing and households. With the rapid economic development of Mauritius, the number of manufacturing industries has increased significantly over the past decade.

As shown in Figure 1, the manufacturing sector is presently the second largest energy consuming industries after the transport sector. In 2009 the manufacturing sector consumed about 27.7% of the total energy consumption with diesel oil representing 46ktoe, fuel oil 45ktoe and bagasse 36 ktoe (CSO, 2009) [1] respectively.

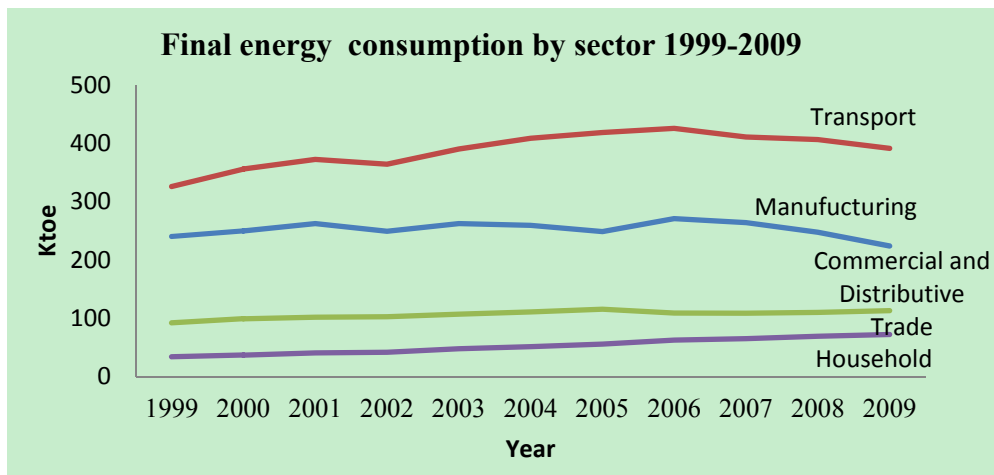


Fig. 1: Final energy consumption for year 1999 to 2009 (source: CSO, 2009) [1]

3. Energy Consumption in Sub-Industries

The manufacturing sector is further sub-divided into 4-sub industries namely tea industry, EPZ, construction, bakery, food and other miscellaneous industries, which use energy mostly for the processing of steam and for heating.

Table 1: Energy consumption in sub-industries (Source: CSO, 2009)[1]

Year	2000	2001	2002	2003	2004	2005	2006
Diesel oil/Tonnes							
Tea industry	1379	549	323	253	212	-	-
EPZ	14197	1269 5	1245 4	15069	1665 4	1195 4	19200
construction	2860	3010	3200	3530	3550	3390	3560
Miscellaneous industries	22045. 7	2021 5.6	2039 2.6	21355. 2	2192 8.0	2469 5.9	25348. 1
Fuel oil/Tonnes							
Tea industry	229	594	496	517	450	400	420
EPZ	40692	5080 6	5210 0	46366	4020 4	4215 0	45220
construction	-	-	-	-	-	-	-
Miscellaneous industries	7710	8753	8530	8168	8845	6418	14747
LPG/Tonnes							
Tea industry	373	378	285	164	-	-	-
EPZ	2374	2267	2118	1707	1696	3493	766
construction	-	-	-	-	-	-	-
Miscellaneous industries	942	990	1097	1046	1060	411	3199
Coal							
Tea industry	-	-	-	-	-	-	-
EPZ	17124. 8	1804 6.7	1812 1.6	20300	1695 4	1621 3.4	15166. 2
construction	-	-	-	-	-	-	-
Miscellaneous industries	7339.2	7734. 3	7766. 4	8700	7266	6948. 6	6499.8

The textile industry is the most energy intensive industry. It relies heavily on heavy oil and diesel oil as fuel in boilers to generate steam to produce thermal energy for use in the subsequent processes. Similarly, the tea industry uses fossil fuel namely LPG, diesel oil and fuel oil (CSO, 2009) [1] to dry tea leaves in very hot oven. These industries also emits large amount of GHGs emissions in the atmosphere.

4. Methodology

The methodology used for quantifying CO₂ emission and the carbon dioxide emissions avoided using a heat recovery system like an economizer was estimated using the general Tier 1 method from the Intergovernmental Panel on Climate Change (IPCC) emission model of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories [3] based on the fuel consumption and emission factor of the fuel. The equation is given as follows:

$$CO_2 = \sum_{p=1}^n Fuel_p \times NCV_p \times EF$$

where:

CO₂ = Annual CO₂ emissions for a specific fuel type, tonnes/year.

n = Number of required heat content measurements for the year as specified

Fuel_p = Mass or Volume of the fuel combusted during measurement period “p”

NCV_p = Net Calorific value of the fuel for the measurement period provided by supplier

EF = Fuel –specified default CO₂ emission factor, kg CO₂/GJ

The fuel data for manufacturing sector was obtained from the Central Statistic Office. The steam generating system of the industry was assessed to determine the energy recovered and fuel saved using an economizer. Ultimately, the data generated from the heat recovery system namely economizer was then used to quantify the CO₂ emissions avoided. The economizer will reduce amount of fuel and subsequently will reduce CO₂ emissions.

5. Findings

The EPZ sector remains the primary energy consuming industry with a share of 59.1% of fossil fuel consumption in 2006. As shown in Figure 2, the CO₂ emission in the EPZ industry was increased from 216,700 to 248,000 tonnes from the year 2000 to year 2002.

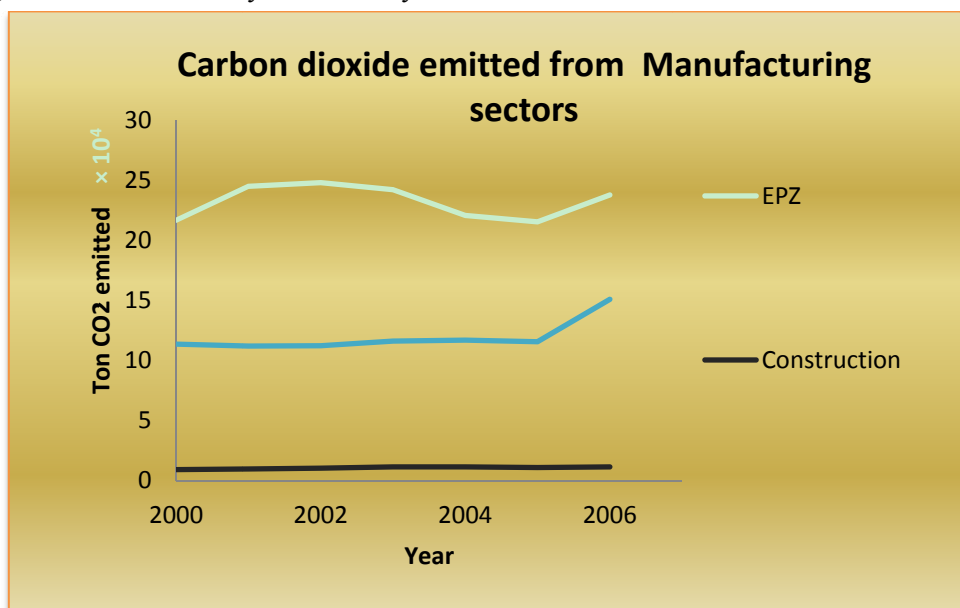


Fig. 2: Carbon dioxide emission by sub-industries

The Bakery, food and other miscellaneous industries is the second major polluting industry. The CO₂ emission as from 2000 to 2005 was more or less the same. This is a result of the high inflation rate for the years 2002 to 2004. Moreover, as from 2005 the activities in bakery and food industries have improved and this yielded a net of 35352.2 tonnes of CO₂ emission between the years 2005 to 2006.

CO₂ emission in the construction industry throughout the past 6 years was almost negligible. The construction industries rely mainly on fuel engine for its activities. Hence, with the low consumption of fossil fuels, the amount of CO₂ emission was only 11417.7 tonnes of CO₂ in 2006.

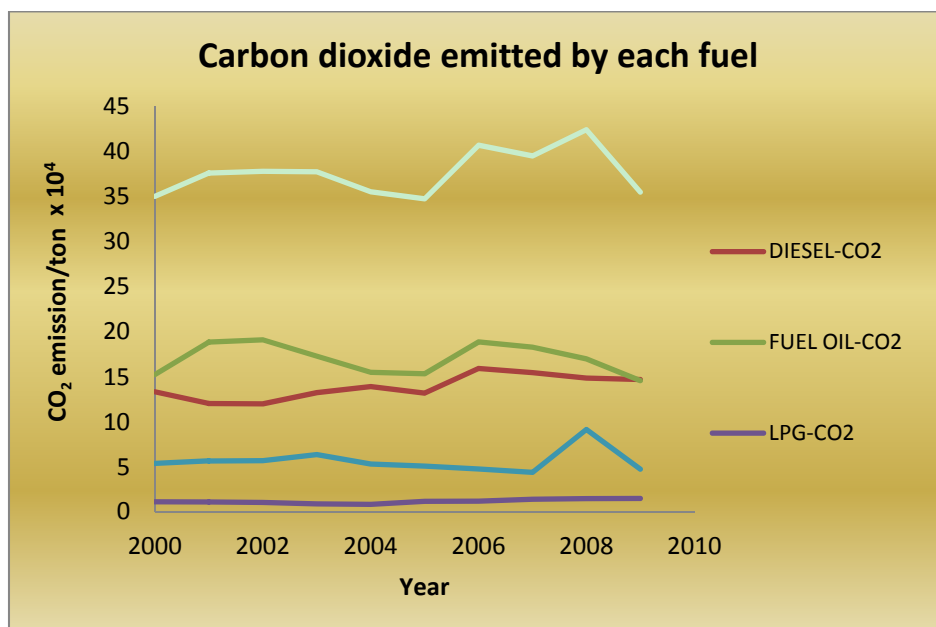


Fig. 3: Carbon dioxide emissions by fossil fuel

The manufacturing sector relied heavily on fuel oil. As shown in Figure 3 above, fuel oil remains the major polluting resource. In 2009, the CO₂ emission from fuel oil was 145757.8 tonnes followed by diesel oil which was 147025.9 tonnes. The two main factors was the growth in energy demand and productivity. LPG is the least polluting fossil fuels with negligible CO₂ emissions between years 2000 and 2009. In Mauritius coal consumption in the manufacturing sector is relatively low hence the quantify CO₂ emission from coal was 67.5% less than the CO₂ emitted from fuel oil.

A heat recovery system namely an economizer was studied to estimate the energy recovery and reduction in carbon dioxide emissions. As can be seen from Figure 5, the quantity of CO₂ emissions avoided from fuel oil was relatively higher than diesel oil and coal. From 2000 to 2006, the maximum CO₂ given off from fuel oil was recorded in 2002 with 453 tonnes while the CO₂ avoided from diesel oil and coal was almost negligible. From year 2004 to year 2005, the amount of CO₂ emissions avoided from fuel oil was decreased from 453 to 350 tonnes, as energy production using fuel oil was lower. This was because more diesel oil was used during that year to meet the energy demand. For coal, the amount of carbon dioxide emissions avoided throughout the past 6 years was more or less the same with not more than 67.7 tonnes of CO₂.

6. Conclusion

Mauritians in their quest for better standard of living have led to a rapid increase in manufacturing services over the recent years. Likewise, the use of fossil fuels namely coal, diesel oil, fuel oil and LPG in the EPZ industry is increasing and results showed that the amount of diesel oil has increased from 11954 ton in 2005 to 19200 ton in 2006. One of the major findings of this study was that, the amounts of carbon dioxide emissions increase proportionally to the amount of fossil fuel being consumed as it is the case in other sector like transportation [4] and power generation [5]. In this context, the EPZ industry and fuel oil were the two main anthropogenic sources of CO₂ emissions in terms of sub-industry and fossil fuels use. Out of 410,000 tCO_{2e} emitted in 2006, about 57.98% and 46.3% of CO₂ was emitted by the textile industry and

fuel oil respectively. Despite the limited availability of fossil fuels, manufacturing industries will continue to consume it for many years to come. Hence, efficient use of energy in manufacturing industries is the best alternative to reduce fossil fuels consumption and CO₂ emission. Going towards energy efficient projects is our priority even if the percentage reduction of CO₂ was 0.25 which look very low but it does make saving in energy reduction and CO₂ emissions.

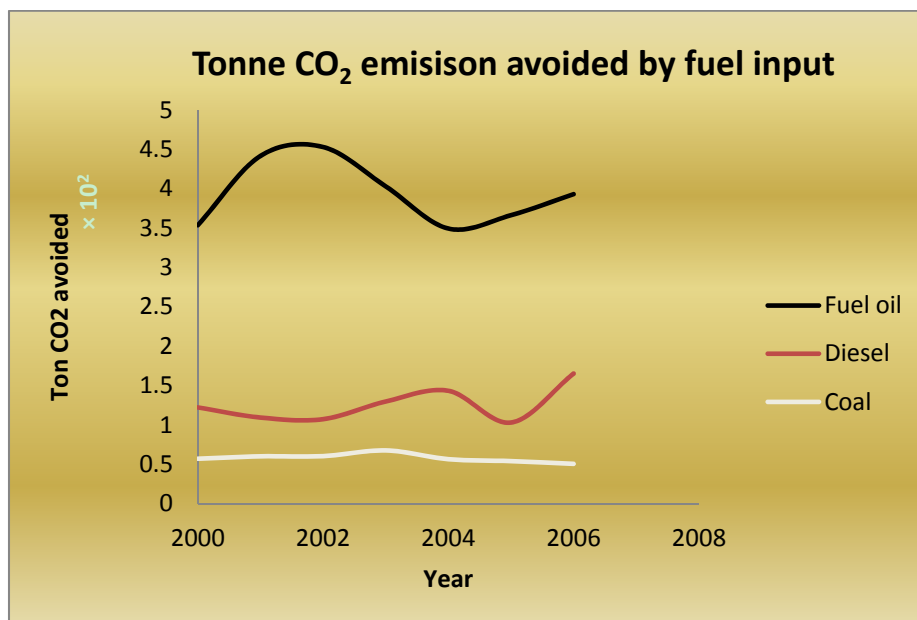


Fig. 5: CO₂ emission avoided by fossil fuel input in EPZ industry

7. References

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