CO_2 EMISSIONS INVENTORY OF ONE OF THE MAJOR BRAZILIAN STEEL MAKERS

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1. Abstract

This paper aims to present the fossil fuel-related CO_2 emissions, for the energy use item, of one of the major Brazilian steel makers, according to the IPCC[34] methodology, and to assess the feasibility of replacing the currently imported raw materials coke and coal by charcoal, which may be domestically produced on a sustainable basis.

Keywords: CO_2 emissions, Certified Emissions Reductions (CER), steel maker

2. Approach

The CO_2 emissions inventory was calculated based on the 1998, 1999 and 2000 energy data, available in the company's Environmental Annual Reports at the Internet. After that, emissions forecasts were defined and plotted, considering the baseline scenario - with no changing in the thermal-reductor. Another scenario - substitution of imported coke by charcoal produced on a sustainable basis - provided the amount of emissions expected in that mitigation alternative, and the difference between the two scenarios represented the magnitude of emissions to be avoided. In both scenarios, it was applied the methodology presented in the "2000 Rio de Janeiro GHG[35] Inventory" for energy consumption, as well as the "1999 National Energy Balance", encompassing the following steps:

(i) analysis of all energy sources within the steel maker operation framework, from 1998 up to 2000;
(ii) calculation of the baseline scenario;
(iii) analysis of the alternative to mitigate the CO_2 emissions and their costs;
(iv) feasibility analysis to implement the mitigation alternative, considering the prices at which carbon is being trade in the global market.

The following assumptions were made during the course of this study:
(i) No other GHG was considered but the CO_2;
(ii) Coke and coal related emissions were taken without any differentiation, based on coal emission coefficients;

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[34] IPCC: International Panel of Climate Change
[35] GHG - greenhouse gas

(iii) Each energy carrier participation in the steel maker energy balance was held constant over the forecasting horizon, either in the baseline, as well as in the mitigation scenario.

(iv) Estimative on capital expenses needed to convert the steel making plant from coke into charcoal were calculated based on a proxy. Such proxy is the historical depreciation per ton of steel. Therefore, no major expenses would be required in such conversion.

(v) The net possible carbon sink derived from the reforestation activity to produce charcoal was not taken into consideration as long as such carbon absorption would be properly accountable to the agricultural activity solely.

3. Scientific innovation and relevance

Due to its energy-intensive nature, the steel making sector is one of the major responsible for some environmental damages on Vale do Paraíba region, Rio de Janeiro state, Brazil, with relevant air (CO_2, particles) and water (phenol, ammonia, sulphates) pollution. Further, some of its wastes post high risks of accidents. The 1996 Energy Balance of Rio de Janeiro state (Rosa, et al., s.d) highlights the high level of CO_2 emissions attributed to the manufacturing sector, out of which 29.7% from the steel making plants in the State. According to Berna (s.d.), the highest emissions per capita in Rio de Janeiro state are those at Vale do Paraíba (4,0 tC/capita). The largest source of emissions is a steel making company, one of the biggest in the country, with an output of 4,000 t of basic steel in 2001 (IBS, 2000).

Because of the quantitative importance of its emissions and the ballooning investment which is being made in environment conservation, it is important to make the company's emissions inventory analysis related to its energy use, as presented on this paper.

4. Results

With the input of energy consumption by source (natural gas, fuel oil, electricity, coal and coke) from 1998 up to 2000, CO_2 emissions were calculated, as it is shown on Figure 1 and Figure 2.

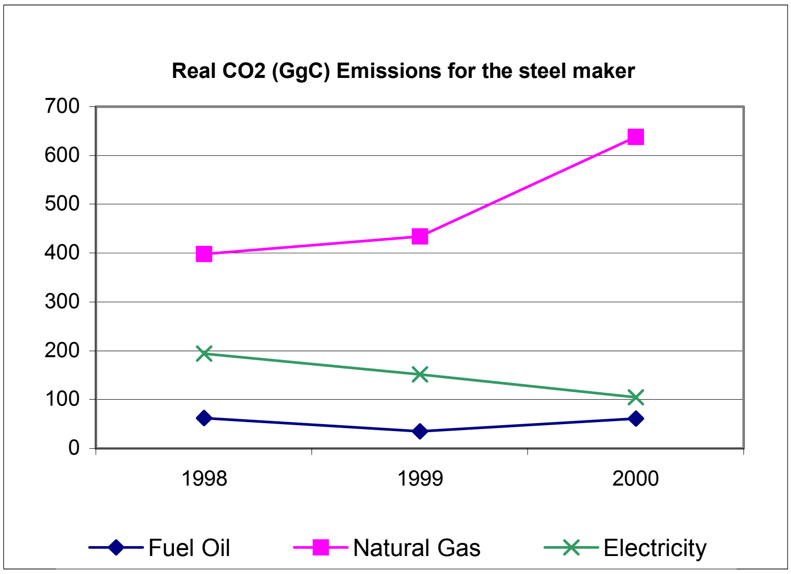

Figure 1: Real CO_2 emissions related to fuel oil, natural gas and electricity

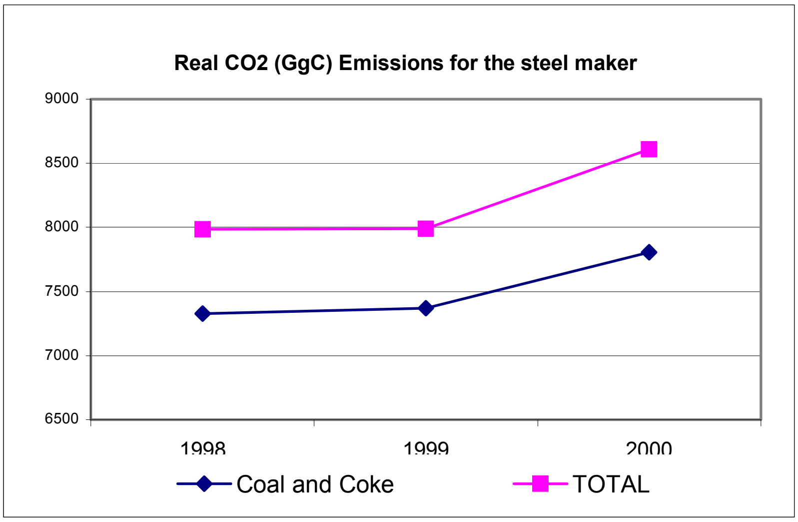

Figure 2: Real CO_2 emissions related to coal and coke, and total for the steel maker

Based on ongoing trends, the production evolution and the energy intensity were forecasted for the next 10 years, in order to plot a CO_2 emission baseline scenario of the company, as shown on the Figure 3. To forecast the production, it was considered a growing percentage of capacity utilization (from 77% to 95% on 2010), and a shift of the installed capacity from 5,000,000 t steel/year in 2000 to 5,400,000 t in 2001 and 5,800,000 t in 2002. This hypothesis reflects one of the main goals of the steel maker – maximize the pay-back by the maximization of the installed capacity. The ongoing trend of reduction on the energy intensity was kept, down to the national average of the steel sector – 16.28 GJ/t steel (Henriques, M., 1995). The percentage of energy consumption by source were held constant until 2010, according to the observed trends.

Afterwards, the mitigation scenario, a significant shift from 100% coke to 100% charcoal, was assumed. The main reason for this shift is the high percentage of coke CO_2 emissions (above 90% on 1998, 1999 and 2000) on the total steel maker emissions. All other variables, like production growth and energy intensity reduction over time, were held the same as the baseline scenario, and the emissions for the mitigation scenario were calculated, as shown at the Figure 3.

When comparing the results shown on the Figure 3, it is interesting to note that the total CO_2 emissions on the mitigation scenario would be higher than the baseline scenario if the charcoal used by the steel maker was not produced on a sustainable basis (renewable forests), mainly because the emission factor of the charcoal (29.9 tC/TJ) is higher than the coke's (25.8 tC/TJ). The Figure 4 shows the total CO_2 emissions avoided on the steel production when charcoal from renewable forests is used as raw material. In this case the contribution of charcoal to total emissions is zero due to the absorption of the CO_2 by the planted forest. The Figure 5 compares a general steel making process using coke as raw material versus the process using charcoal as raw material.

Finally, mitigation costs were calculated based on estimates on the plant conversion from coke into charcoal (Capital Expenses) and the use of this sustainable produced thermo-reductor (Operational Expenses). The results show that costs would be negative at R$25.49 per ton of carbon, i.e., a no-regret cost of a local currency denominated raw material, domestically produced. This negative cost holds valid for an exchange rate around R$3/US$

and coal/coke trading at US$50 per ton in the international market. The Figure 6 shows the variation of mitigation costs (or CER) for different exchange rates.

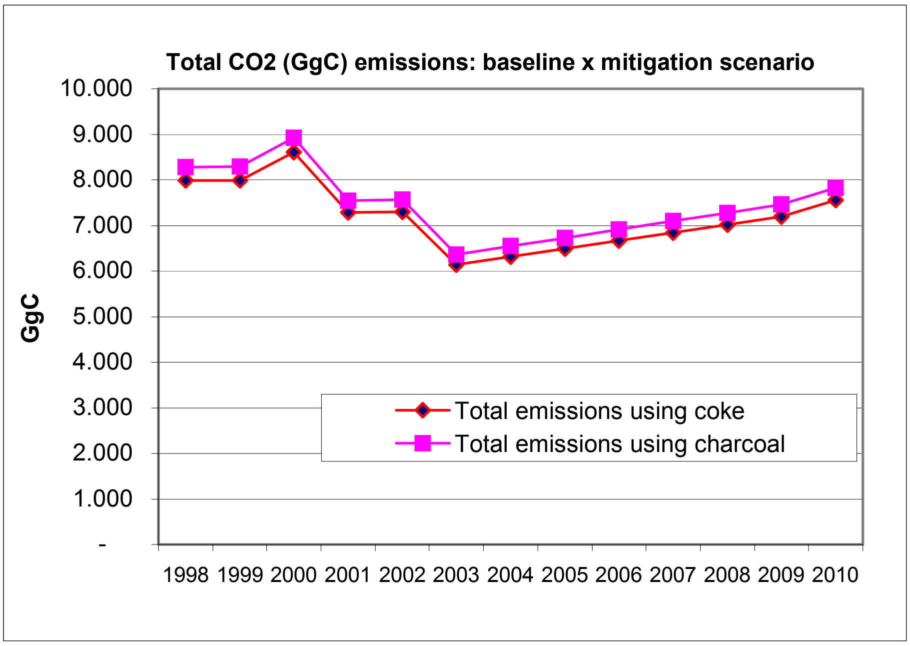

Figure 3: Total CO_2 emissions for the steel maker on the baseline x mitigation scenario (not on a sustainable basis)

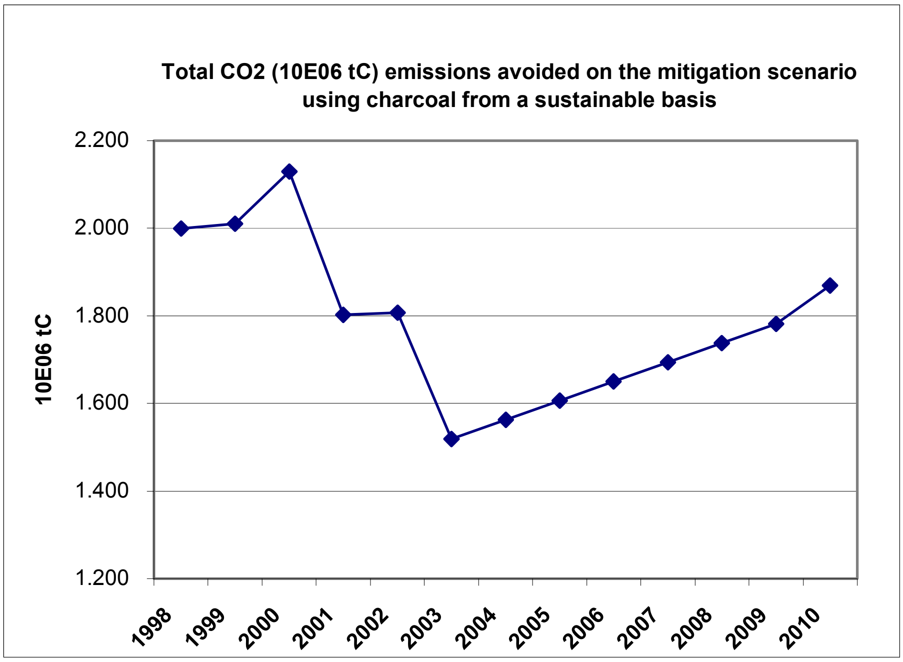

Figure 4: Total CO_2 emissions avoided on the mitigation scenario, using charcoal produced on a sustainable basis

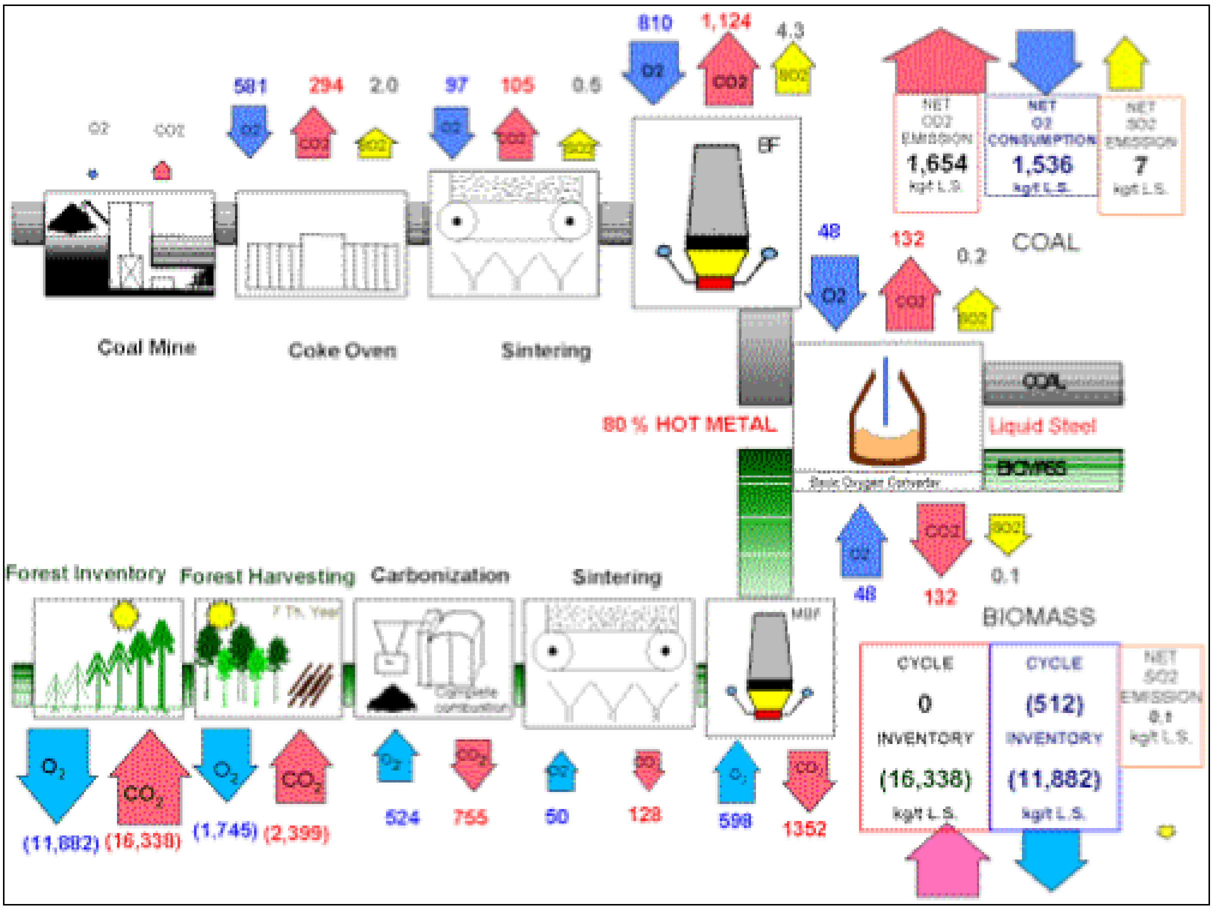

Figure 5: General steel making process – coal/coke x charcoal (Ferreira, 2000)

5. Conclusions

Based on the findings of this work, it is concluded that the complete shift to charcoal would eliminate 1.9 x 10^6 tC (year 2010) to be emitted in the future, at a negative cost of R$25.49 per ton of carbon avoided. Contrasting the values at which carbon avoided is traded in the international market, around US$5 per ton (R$15/t), the environmental rents to be obtained from any operation would increase even more the profitability of such proposed mitigation.

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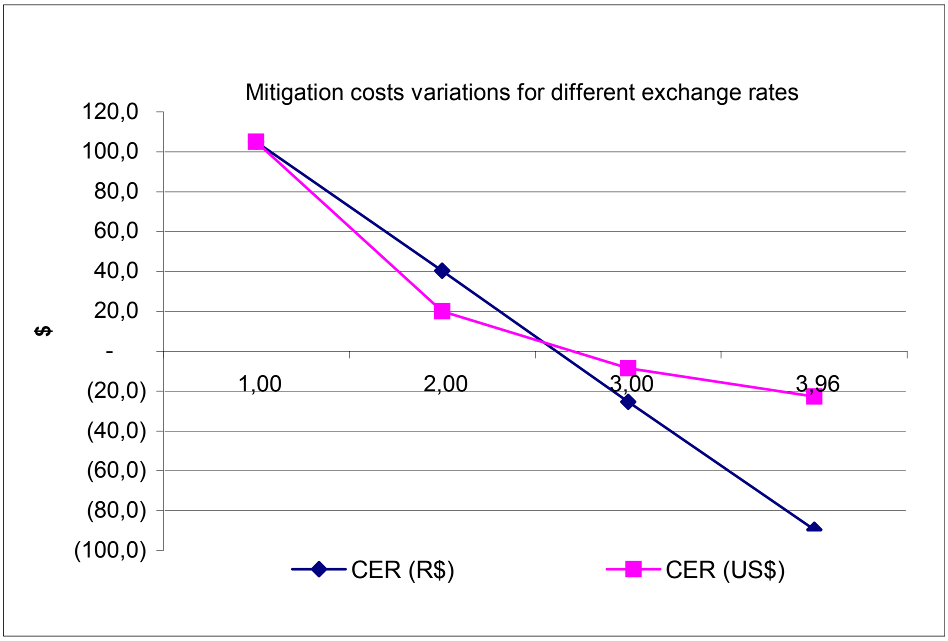

Figure 6: Mitigation costs ($/tonC) (or CER) for different exchange rates

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