SHORT ARTICLE

CARBONE FOOTPRINT OF INDUSTRY IN A TERRITORY: IMPACT OF ENERGY

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ABSTRACT

Background: The inventory of greenhouse gas (GHG) emissions generated by different activities at the level of the territory makes it possible to evaluate their impact on the environment and their effect on the global climate. It constitutes a primary scientific tool for the development of a sustainable development local plan for energy and climate. Transportation and industry are essential positions in the development of territory's quantified GHG emissions balances. **Objective**: In this work, the first assessment of GHG emissions generated by the energy consumption of four industrial units is carried out at the scale of the Ait Melloul territory. The objective is the prioritization of the impacting factors and the orientation of the targeted actions to reduce the impact of these sectors on the environment. **Method:** Calculation of CO_2 emissions is based on activity data and emission factors. Activity data used to calculate emissions are collected directly from the industrialists concerned. They are grouped into three categories: fossil energies used in the industrial process (fuel oil and diesel), electricity consumption and the annual quantity of fuel used for professional transport. **Results:** The result of this study shows the predominance of emissions from fossil energies (fuel oil and diesel) used in industrial processes, followed by emissions from electricity consumption. Those due to professional transport represent the lowest values in the sample studied. **Conclusion:** This first result highlights the need to carry out Energy Audits to identify potential energy savings and to set up a priority action plan for the improvement of the energy performance of industrial equipment. This would generate gains while implementing actions to reduce GHG emissions.
Keywords: *Inventory of greenhouse gas emissions, Emission Factor.*

1. INTRODUCTION

On a global scale, people are increasingly sensitive to environmental problems and climate change phenomena. Citizens are directly aware of the consequences of this phenomenon and consequently are putting increasing pressure on the territories to improve their local environment and to protect the environment.

Faced with the global phenomenon of global warming, the role of the territories is fundamental for the implementation of actions in favor of the climate. The estimation of the local contribution to the emission of greenhouse gases makes it possible to determine the carbon impact of the territory and its contribution to global warming and also indicates its carbon vulnerability. It is also a basis for identifying actions to reduce greenhouse gases (GHGs) and for adaptation to climate change.

In Morocco, energy is a significant component of GHG emissions [1,2]. Transportation and industry are essential positions in the development of quantified GHG emissions assessments for a community. In this work, the first assessment of GHG emissions generated by energy consumption in four industrial units is carried out in the city of Ait Melloul. The objective is to prioritize the weight of these emissions according to activities and sources of emissions to identify priority actions to reduce GHG emissions [3].

2. MATERIALS AND METHODS

Carbon accounting is a quantification of environmental impacts focusing on the issue of greenhouse gas emissions [4]. Greenhouse gases (GHGs) are gaseous components that absorb infrared radiation emitted by the earth's surface and contribute to the greenhouse effect.

The IPCC (Intergovernmental Panel on Climate Change) Reference Approach provides a methodology for producing a first-order estimate of national greenhouse gas emissions based on the energy provided [2].
In this work, a sample of four industrial units is studied in the territorial area of the city of Ait Melloul (Morocco). This city bordering the city of Agadir is a part of the "Grand Agadir" agglomeration.

Table 1: The table presents the studied industrial units.

Industrial Unit	Ind 1	Ind 2	Ind 3	Ind 4
Activity	Dairy Industry	Semi-canning and packaging	vegetable packaging and export	citrus packaging

The reference year used for the assessment of greenhouse gases is 2013 to be homogeneous with the inventory of emissions carried out on the city of Agadir for the same period [5].

Calculation of CO_2 emissions is based on activity data and emission factors [2-4] according to the following formula (1):

GHG Emissions = Activity Data X Emission Factor (EF) **(1)**

Where GHG emissions = emissions expressed in t eq CO_2 [4] (t eq: tonne equivalent)
The positions considered for the GHG estimation of the industrial units studied are as follows:

- Fossil energies: consumption of fuel oil and diesel.
- Direct emissions of fuel from professional transport (service cars, trucks, bus)
- Indirect emissions related to electricity consumption

The activity data needed to calculate emissions for each item are collected directly from the industrialists concerned. They are grouped into three categories: fossil energies used in the industrial process (fuel oil and diesel in m^3 / year), electricity consumption (electricity bill in KWh / year), and the annual quantity of fuel used for professional transport (diesel in m^3 / year).

GHG emissions are calculated from the adjusted emission factors for the case of Morocco [5]:

- The emission factor for diesel: 2.66 kg eq CO_2 / liter
- The emission factor for electricity: 0.705 t eq CO_2 / MWh.
- The emission factor for fuel oil: 0.279 t eq CO_2 / MWh.

3. RESULTS AND DISCUSSION

The result of the calculation of emissions for each item is given in Tables 2 to 5 below.

Table 2: Table presents the emissions from Fuel oil used in industrial processes.

Industrial Unit	Ind1	Ind2	Ind3	Ind4
Fuel oil Consumption (m^3/year)	205	286		2 400
Emission factor (t eq CO_2/MWh)	0,279			
Total GHG emissions (t eq CO_2/year)	571	800		6700

Table 3: Table presents the emissions from diesel used in industrial processes.

Industrial Unit	Ind1	Ind2	Ind3	Ind4
Diesel consumption (m^3/year)	653		284	6036
Emission factor (Kg eq CO_2/l)	2,66			
Total GHG emissions (t eq CO_2/year)	1737		755	16056

The total GHG emissions from fossil energies used in industrial processes of the four industrial units corresponds to a total value of 26619 t eq CO_2 / year.

Table 4: Table presents the emissions due to Electricity consumption.

Industrial Unit	Ind1	Ind2	Ind3	Ind4
Electricity consumption (MWh / year)	1586	24	635	6345
Emission factor (t eq CO_2/MWh)	0,705			
Total GHG emissions (t eq CO_2/ year)	1118	17	448	4473

The total GHG emissions relating to the electricity consumption of the four industrial units corresponds to a total value of 6056 t eq CO_2/year.

Table 5: Table presents the emissions due to professional transport.

Industrial Unit	Ind1	Ind2	Ind3	Ind4
Diesel consumption (l/year)	646415	592760	219365	316820
Emission factor (Kg eq CO_2/l)	2,66			
Total GHG emissions (t eq CO_2 /year)	1719	1577	584	843

The total GHG emissions related to professional transport for the four industrial units corresponds to a total value of 4723 t eq CO_2/ year.

The total GHG emissions generated by energy consumption in the units studied correspond to a total value of 37398 t eq CO_2/ year.

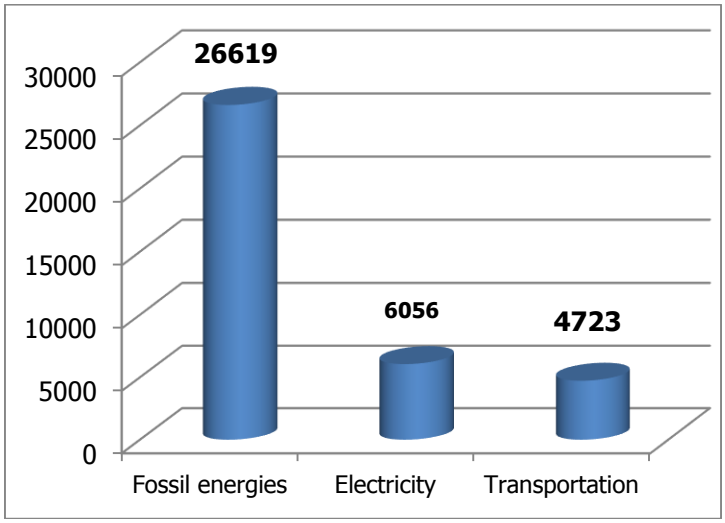

Figure 1: The figure shows the total emissions per item in t eq CO_2 per year.

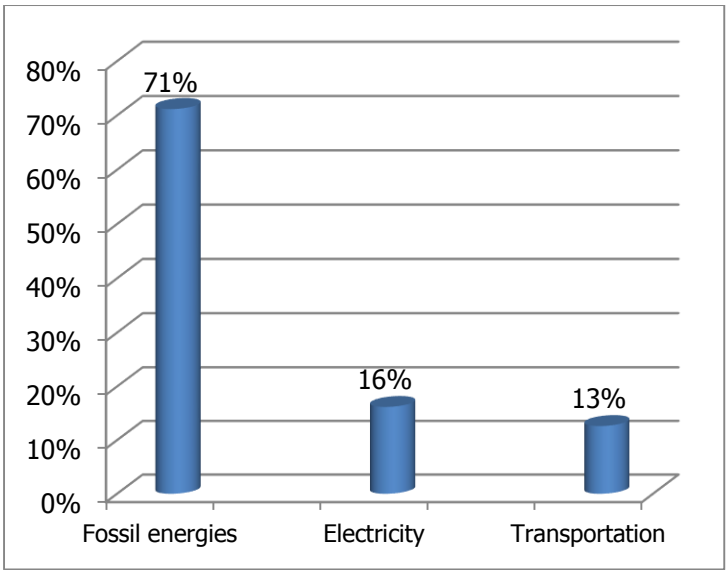

Figure 2: The figure shows percentage of emissions by item.

The sample studied shows that fossil energies generate a very high rate of GHG emissions. It's about 26619 t eq.CO_2 per year for the four units studied in the Ait Melloul industrial zone. This value represents a percentage of 71% of the total GHG emissions generated by energy use in these four units. The share of emissions from the electricity item is 6056 t eq.CO_2per year, which represents 16% of total emissions. Emissions from professional transportations account for approximately 13% of the total GHG emissions in these units. It's about 4723 t eq.CO_2 per year.

4. CONCLUSION

In this work, evaluation and prioritization of the total GHG emissions generated by energy consumption in four industrial units studied were carried out. The study shows the predominance of emissions from fossil energies (fuel oil and diesel) used in industrial processes with a percentage of around 71%, followed by emissions from electricity consumption (16%). Those due to professional transport represent the lowest values (13%).

This first result allows the companies concerned to become aware of the main emitting GHG emitters. It highlights the need to sensitize the industrialists to carry out Energy Audits to identify potential energy savings and to set up a priority action plan for the improvement of the energy performance of industrial equipment. This would generate gains while implementing actions to reduce GHG emissions.
The essential purpose of this type of study is not so much quantification but rather to give awareness of the environmental impacts that industrial operations generate. Indeed, the measurement of the carbon footprint achieved gives information that may be sufficient for decision making for the implementation of tools to reduce the impact on the climate.

This study constitutes a first exercise in evaluating the carbon impact on the city of Ait Melloul. A complete diagnosis of the territory (Global Inventory of GHG) would be necessary for a sustainable urban development planning of the city.

5. REFERENCES

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