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Abstract

The objective of this study is to determine if the implementation of management measures decreases the Carbon Footprint of a Concentrate Store of a company in Lima, Peru. In order to do so, we made use of the Data Registry and Field Sheet, which are fundamental for the calculation of the Carbon Footprint. The results show a decrease from 7.65 tCO\textsubscript{2}eq in October to 7.03 tCO\textsubscript{2}eq in November of fuel consumption (Scope 1) and from 10.04 tCO\textsubscript{2}eq in October to 8.91 tCO\textsubscript{2}eq in November of electricity consumption (Scope 2). With the results obtained it was determined that the Implementation of management measures decreases the Carbon Footprint of a store of Concentrates of a company.

Keywords: Fuel, Electricity, Carbon Footprint.

1. Introduction

Lima owns industrial zones that use great amount of chemicals which generate the Greenhouse Gas emissions (GGE) that are discharged to the environment affecting public health and the environment.

The calculation of the Carbon Footprint is important, since it helps to reduce the Greenhouse Gas emissions (GGE). Although the Carbon Footprint is the total measure of the direct and indirect GGE released to the environment produced by human activity and the sea by the activities or processes (Viglizzo, 2010) and that is calculated through the elaboration of an inventory, which
details the source of pollution and its proportion over a given period of time (Reed and Ehrhart, 2007).

The carbon footprint is used to measure the emission of gasoline by the number of vehicles and by the consumption of fuel, and that to reduce its emissions must implement vehicular combustion systems based on natural gas in order to have greater efficiency energy for the operational development of an institution (Barragan, 2013). It is also used to measure emissions from the calcination furnace, cooling and burning wood for the manufacture of colored glass containers from the recycled glass (Mena, 2015).

2. Materials and Methods

The procedure carried out in the investigation was as follows:

i) Determination of boundaries:
The first action done, was to determine the limit of the organization, but for this purpose the approach was recognized, either that of shareholding or that of control, the last being the limit of the organization of the Concentrated Warehouse. The approach already defined, later it was determined what type of emission it is, without forgetting the definition of the scopes 1 and 2.

ii) Choice of base year:
A base year must be chosen and reported so that emissions can be tracked over time. In this case it is the year 2016.

Identification of GGE emission sources:
The sources of GGE emissions of each area must be identified. A route was made to the Concentrated Warehouse. All areas were noted and an inventory of equipment was made.

iii) Request and data collection:
We proceeded to request the activity data necessary for the respective calculation, which is why Scope 1 emissions were calculated based on the quantities of commercial fuel consumed, those of Scope 2 from electricity consumption.

iv) Calculation of GHG emissions:
For the respective calculation of the emissions of each scope, use is made of the documented emission factors multiplied by the activity data (Bermejo, 2015; Brito, 2011; Guzman, 2010; NIECC, 2005). With the results obtained, a report is made which will be presented to the Manager of the Company Concentrates Warehouse.

In the case of the calculation of:
- Scope 1:
To obtain the tCO2eq generated by the consumption of each fuel per month, the first thing that must be done is to have the energy consumption in TJ for it multiplies the amount of fuel (gal) by the conversion factor (TJ/gal). Then the result of each fuel energy consumption must be multiplied by each emission factor and in this way will have the emissions expressed in tCO2, tCH4 and tN2O. Once the emissions have been calculated, each one is multiplied by its global warming potential and they are added to obtain the results expressed in tCO2eq.

- Range 2:
These data are obtained by multiplying the consumption data (kWh) by the emission factor (KgCO2eq/kWh). But in order to obtain the consumption data, the following must be done:
- In the case of luminaires, lighting poles, panels, among others, the number of luminaires was multiplied by the power of the lamps (kW) per operation (Hours/Days) per month (number of days on) and as a result the total energy consumption (kWh) was obtained.
- The same process should be applied to air conditioning, office equipment, other equipment.

v) Implementation of management measures:

Finally, the management measures for the reduction of the Carbon Footprint were implemented and a final calculation was made to determine if there has been an increase or a decrease.

3. Results and discussion

Results before the implementation of management measures:

In Fuel Consumption (Scope 1) the result is as follows:

Table 1. Results of fuel consumption of Scope 1 (January – August 2016).

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Fuel oil</th>
<th>Amount of Fuel oil (gal)</th>
<th>Conversion factor (TJ/gal)*</th>
<th>Energy consumption (TJ)</th>
<th>EF CO₂ (TJ/TJ)**</th>
<th>Emission tCO₂</th>
<th>EF CH₄ (tCH₄/TJ)**</th>
<th>Emission tCH₄</th>
<th>EF N₂O (tN₂O/TJ)**</th>
<th>Emission tN₂O</th>
<th>Efficiency Factor</th>
<th>Partial emission (TJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>January</td>
<td>DIESEL B5 S-50 UU</td>
<td>566.41</td>
<td>1.39E-04</td>
<td>0.079</td>
<td>70.395</td>
<td>5.4228761</td>
<td>0.0037</td>
<td>0.000029131</td>
<td>0.00371</td>
<td>0.000292095</td>
<td>5.9236</td>
<td></td>
</tr>
<tr>
<td></td>
<td>February</td>
<td>GASOLINA 90 OCT</td>
<td>34.39</td>
<td>1.21E-04</td>
<td>0.004</td>
<td>69.3</td>
<td>0.28837047</td>
<td>0.0033</td>
<td>0.000137321</td>
<td>0.00324</td>
<td>1.3316E-052</td>
<td>4.0600</td>
<td></td>
</tr>
<tr>
<td></td>
<td>March</td>
<td>DIESEL B5 S-50 UU</td>
<td>408.62</td>
<td>1.39E-04</td>
<td>0.057</td>
<td>70.395</td>
<td>3.99830788</td>
<td>0.0037</td>
<td>0.00021015</td>
<td>0.00371</td>
<td>0.000210722</td>
<td>3.6584</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>April</td>
<td>DIESEL B5 S-50 UU</td>
<td>368.20</td>
<td>1.39E-04</td>
<td>0.051</td>
<td>70.395</td>
<td>3.60280202</td>
<td>0.0037</td>
<td>0.00018937</td>
<td>0.00371</td>
<td>0.00018988</td>
<td>8.9523</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>July</td>
<td>DIESEL B5 S-50 UU</td>
<td>901.00</td>
<td>1.39E-04</td>
<td>0.125</td>
<td>70.395</td>
<td>8.16119941</td>
<td>0.0037</td>
<td>0.00046338</td>
<td>0.00371</td>
<td>0.00046464</td>
<td>13.5169</td>
<td></td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>DIESEL B5 S-50 UU</td>
<td>1360.40</td>
<td>1.39E-04</td>
<td>0.189</td>
<td>70.395</td>
<td>13.3113848</td>
<td>0.0037</td>
<td>0.00069966</td>
<td>0.00371</td>
<td>0.00070154</td>
<td>13.5169</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>964.00</td>
<td>1.39E-04</td>
<td>0.134</td>
<td>70.395</td>
<td>9.43264842</td>
<td>0.0037</td>
<td>0.00049579</td>
<td>0.00371</td>
<td>0.00049713</td>
<td>6.9949</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>704.00</td>
<td>1.39E-04</td>
<td>0.098</td>
<td>70.395</td>
<td>6.8865312</td>
<td>0.0037</td>
<td>0.00036027</td>
<td>0.00371</td>
<td>0.00036305</td>
<td>9.1213</td>
<td></td>
</tr>
</tbody>
</table>

Total emission 66.2013

* Conversion factor obtained from intocarbon.

The emissions generated before the implementation of management measures in the Concentrated Warehouse was 66,2013063 tCO₂eq, being the months of May and June the largest generators of GHG emissions with 13,51688441 tCO₂eq. And the month of lowest emissions generation was March with a consumption of 368.20 gallons of Diesel B5 S-50.

In the Consumption of electricity (Scope 2) the result is as follows

Table 2. Results of electricity consumption of Scope 2 (January – August 2016).

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Operating area (kWh)</th>
<th>Administrative area (kWh)</th>
<th>Detail (kWh)*</th>
<th>Emission factor (Kg CO₂eq/kWh)**</th>
<th>Partial emission (KgCO₂eq)</th>
<th>Partial emission (tCO₂eq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>January</td>
<td>12,114.61</td>
<td>3,307.79</td>
<td>15,422.40</td>
<td>0.569</td>
<td>8,775.35</td>
<td>8.78</td>
</tr>
<tr>
<td></td>
<td>February</td>
<td>9,626.49</td>
<td>2,682.51</td>
<td>12,309.00</td>
<td>0.569</td>
<td>7,003.82</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>March</td>
<td>14,510.41</td>
<td>4,180.79</td>
<td>18,691.20</td>
<td>0.569</td>
<td>10,635.29</td>
<td>10.64</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>13,867.60</td>
<td>5,701.00</td>
<td>19,548.60</td>
<td>0.569</td>
<td>11,123.15</td>
<td>11.12</td>
</tr>
</tbody>
</table>

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<th>Operating area (kWh)</th>
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<th>Detail (kWh)*</th>
<th>Emission factor (Kg CO₂eq/kWh)**</th>
<th>Partial emission (KgCO₂eq)</th>
<th>Partial emission (tCO₂eq)</th>
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</thead>
<tbody>
<tr>
<td>2016</td>
<td>January</td>
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<td></td>
<td>March</td>
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<td>4,180.79</td>
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<td>0.569</td>
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<td>10.64</td>
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<td></td>
<td>April</td>
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<td>5,701.00</td>
<td>19,548.60</td>
<td>0.569</td>
<td>11,123.15</td>
<td>11.12</td>
</tr>
</tbody>
</table>
The total emissions before the implementation of Scope 2 measures is 87.84 tCO₂eq, showing an increase in energy use from March and therefore an increase in emissions, with July being the highest emission generation of 13.99 tCO₂eq and January the lowest with 8.78 tCO₂eq.

Results after the implementation of management measures:

The results obtained after the implementation of management measures are detailed below:

Table 3. Results of fuel consumption of Scope 1 (September – November 2016).

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Fuel oil</th>
<th>Amount of Fuel oil (gal)</th>
<th>Conversion factor (TJ/gal)*</th>
<th>Energy consumption (TJ)</th>
<th>EF CO₂ (tCO₂/TJ)**</th>
<th>Emission tCO₂</th>
<th>EF CH₄ (tCH₄/TJ)**</th>
<th>Emission tCH₄</th>
<th>EF N₂O (tN₂O/TJ)**</th>
<th>Emission tN₂O</th>
<th>Partial emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>September</td>
<td>DIESEL BS-50 UU</td>
<td>918.00</td>
<td>1.39E-04</td>
<td>0.128</td>
<td>70.395</td>
<td>8.98254279</td>
<td>0.0037</td>
<td>0.00047213</td>
<td>0.00004734</td>
<td>9.121214264</td>
<td></td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>DIESEL BS-50 UU</td>
<td>770.40</td>
<td>1.39E-04</td>
<td>0.107</td>
<td>70.395</td>
<td>7.53829081</td>
<td>0.0037</td>
<td>0.00039622</td>
<td>0.0003973</td>
<td>7.654666088</td>
<td></td>
</tr>
<tr>
<td></td>
<td>November</td>
<td>DIESEL BS-50 UU</td>
<td>707.60</td>
<td>1.39E-04</td>
<td>0.098</td>
<td>70.395</td>
<td>6.92379878</td>
<td>0.0037</td>
<td>0.00036392</td>
<td>0.0003649</td>
<td>7.0308687596</td>
<td></td>
</tr>
</tbody>
</table>

Total emission 23.8085679

* Conversion factor obtained from infocarbon.
Therefore, it can be seen that after the change of filters there has been a reduction in emissions of scope 1 of 1.466548 tCO$_2$ eq with respect to the month of October and 0.62397849 tCO$_2$ eq in the month of November.

In electricity consumption (Scope 2) the result is as follows:

Table 4. Results of electricity consumption of Scope 2 (September – November 2016)

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Operating area (kWh)</th>
<th>Administrative area (kWh)</th>
<th>Detail (kWh)*</th>
<th>Emission factor (Kg CO$_2$eq/kWh)**</th>
<th>Partial emission (KgCO$_2$eq)</th>
<th>Partial emission (tCO$_2$eq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>September</td>
<td>16,092.69</td>
<td>3,551.31</td>
<td>19,644</td>
<td>0.569</td>
<td>11,177.44</td>
<td>11.18</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>14,745.71</td>
<td>2,906.29</td>
<td>17,652</td>
<td>0.569</td>
<td>10,043.99</td>
<td>10.04</td>
</tr>
<tr>
<td></td>
<td>November</td>
<td>12,944.90</td>
<td>2,709.10</td>
<td>15,654</td>
<td>0.569</td>
<td>8,907.13</td>
<td>8.91</td>
</tr>
</tbody>
</table>

Source: Adapted from of Carbon Footprint Calculator of an Organization of the Spain Government. Version 4.2015

* Company invoices.
** Emission factor in the Eco-efficiency Guide from MINAM.

Figure 2. Partial emissions from scope 2
4. Conclusions

It is concluded that the implementation of management measures has partially decreased the Carbon Footprint originating from a company's Concentrate Store.

- The fuel consumption is not higher after the implementation of management measures in the Concentrate Store. It occurs by changing filters and maintenance through the daily verification of the mini loaders, industrial sweepers and heavy machinery. These measures were reduced from 7.65 tCO2eq in October to 7.03 tCO2eq in November.
- The consumption of electricity is not greater because of the luminaires maintenance was with replacement of LED luminaires in the passageways, talks to raise awareness about good energy use, disconnection of equipment, among others has generating a decrease from 10.04 tCO2eq in October to 8.91 tCO2eq in November.
- It is concluded that due to lack of sufficient information for the respective calculation, Scope 3 (office supplies) is excluded.

References


