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ASSESSMENT OF CARBON FOOTPRINTS IN TERMS OF CO_2 OF DIESEL GENERATOR

Waqas Ali[1*], Muhammad Salman Nasir[1], Abdul Nasir[1], Haroon Rashid[1], Iqra Ayub[2], Syed Hamza Gillani[1], Muhammad Jawad Latif[1]

[1]Department of Structures and Environmental Engineering, University of Agriculture Faisalabad, Pakistan
[2]Department of Energy Systems Engineering, University of Agriculture Faisalabad, Pakistan
****Corresponding author's e-mail: waqasali4733@gmail.com***

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ABSTRACT

The purpose of this paper is to evaluate the measure of carbon footprint transmitted from diesel generators to the extent carbon dioxide. One of the diesel generator was selected for this study that are available in the University of Agriculture Faisalabad. A reliable load demand of 180 ampere, 100 ampere, and 90 ampere with six hours of operation of a diesel generator for consistently was decided for this examination. The fuel usage rate is 550 liters per week and carbon foot prints to the extent carbon dioxide (CO_2) were settled. It was found that transmission of carbon foot prints as release part was 2.7kgCO_2/liters (consistent component) of diesel fuel used. It was observed that the enlargement of the kilowatts extends the fuel usage and surge of the carbon dioxide. It is revealed that the efficiency of diesel generator is inversely proportional to its rated power, fuel consumption rate and CO_2 emissions. Therefore, the rated power of selected diesel generator should be close to the required load demand.

KEYWORDS

Foot Prints, Emission, Efficiency, Carbon dioxide, Fuel.

1. INTRODUCTION

Emissions can be defined as the exiting of the flue gases into the atmosphere. The emission can be depicted as the exhaust of the gases into the air. These gases are passed on in perspective of the fuming of the fossil powers. These transmissions intertwine the CO, CO_2, NO_X, sulfur and methane. These gases are known as the greenhouse gases. There are both trademark and human wellsprings of carbon dioxide emanations. Normal sources join disintegrating, sea discharge and breath. Furthermore, the impact of fossil energizes like coal, oil and trademark gas. Other than this, agrarian waste likewise makes the methane which is the part of the greenhouse gases spreads. These spreads are making the air contaminations. A carbon impression is certainly depicted as "the aggregate arrangement of greenhouse gas discharges by an individual, occasion, alliance, and product granted as CO_2e [1].

The term "carbon footprint" has grown in popularity over the past ten years in response to the increasing public awareness of environmental issues and climate change. This phrase is now widely used throughout the media, government and commercial world. The popularity of this concept is intrinsically linked to concern about increasing levels of CO_2 in the earth's atmosphere and the belief that increasing concentrations of CO_2 have and will continue to alter the earth's climate along with other greenhouse gases [2]. These gases are causing air pollution. According to the environmental protection agency which works for the sustainable and rehabilitation of the environment, air pollution can be defined as: Air pollution means the contamination of air by emission of effluent or air pollutants or noise or other matter which either directly or indirectly or in combination with other discharges or substances alters unfavorably the chemical, physical, biological, radiational, thermal or radiological or aesthetic properties of the air, which may, or is likely to make the air, unclean, noxious or impure or injurious, disagreeable or detrimental to the health, safety, welfare or property of persons or harmful to biodiversity [3].

As the standards of the living are increased from previous four decades, the consumption of the electricity also increased due to increase in the living standards. As a result of this high electricity generation, some countries like Pakistan meeting electricity demands by using fossil fuels. These fossil fuels are emitting CO_2 in large amount.

With an increase in Pakistan's population growth, the rate of urbanization and industrialization will also increase substantially with a need for higher energy and resource consumption. This increase in urbanization and industrialization would also generate higher demand for infrastructure development and associated work. The Intergovernmental Panel for Climate Change (IPCC) estimates that the transportation sector annually produces 13%of the total greenhouse gas (GHG) emissions at the global level [4].

Besides this, industrial revolution in Pakistan and all over the world has increased and as a consequence of this revolution, the emissions of CO_2 also increased. This is creating an alarming situation. As mentioned above, the electricity production is also increased due to increase in the living standards and mechanical work. The countries like Pakistan are meeting electricity demands by using fossil fuels. This use of the fossil fuels is resulting in the depletion of the natural resources and emissions of CO_2.

Environment challenges and issues of Pakistan areas associated primarily with an imbalanced social and economic development in recent decades. This challenge is further compounded with rapid urbanization due to a shift of population from rural to urban areas. Thus, all major cities of Pakistan face haphazard, unplanned expansion leading to increase in pollution. The aggregate total of greenhouse gases (GHGs) discharged by any framework to bolster human exercises unmistakably and roundabout is named as carbon foot prints [5]. It is hard to get each required information for each specific greenhouse gas discharges because of particular and checking issues. In like way, for straightforwardness, it is as often as possible passed on like the measure of carbon dioxide (CO_2) transmitted [6]. The most ideal route is to take in the carbon dioxide discharges, depends upon the measure of fuel use by diesel generator [7]. Carbon substance of fills to some degree fluctuates, yet conventionally the run of the mill carbon content qualities to gage CO_2 discharges could be adjusted [8]. The utilization of one-liter diesel discharges around 2.7kg of CO_2 [9]. Notwithstanding, the measure of kg of CO_2 passed on per liter of fuel ate up by the diesel generator relies on upon the properties of the diesel generator and of the qualities of the fuel, and it is generally falls in the degree of 2.4–2.8 kg/l [7]. Carbon foot prints can in like way be passed on in kg carbon as opposed to kg carbon dioxide [10]. It can be changed over from kg carbon to kg carbon dioxide by extending with a variable 0.27 (i.e. 1000 kg CO_2 levels with 270 kg carbon) [7].

2. MATERIALS AND METHODS

For diesel we estimated the carbon intensity that gave the amount of

emissions. We used this factor to capture the direct emissions from combustion of fuel. These emissions are the same throughout the world as they are determined by the physical properties of the fuel. Combining the direct factors gives an emission factor for the full life-cycle of the fuel. Natural gas is roughly 6.6 kg CO2e/therm or 0.22 kg CO2e/kWh, more than 85% of which arises directly from combustion. Heating oil is around 11.6 kg CO2e/US gallon or 3.1 kg CO2e/litre. LPG is 6.8 kg CO2e/US gallon or 1.8 kg CO2e/ litre. The rated capacity of the different generators varies according to their applied loads [8]. The working hours of the generator is different in summer and winter due to the factor of the load shedding hours. On an average, the working hours of the generator are six hours. The data about the brand, model number and specifications of the generator was collected. Every gallon of diesel fuel contains 2,778 grams of pure carbon. Every gram of atomic carbon, when oxidized with oxygen, forms 3.666 grams of carbon dioxide [9]. (This is another way of saying that each molecule of CO_2 weighs 3.66 times more than an atom of carbon alone). In an average liquid hydrocarbon-burning engine, it can be assumed that about 99 percent of the fuel will oxidize. (It is assumed that somewhat less than 1 percent will fail to fully oxidize and will be emitted as particulates or unburned hydrocarbons instead of CO_2). Therefore, we multiplied the amount of carbon per gallon of diesel by the ratio of carbon weight to CO_2 weight by 99 percent i.e. 2,778 g x 3.66 x 0.99 = 10,084 g. Each gallon of diesel fuel produces, on an average 10,084g of CO_2 or about 22.2 lb. So, if our diesel generator uses, for example, 15 gallons of diesel fuel per hour, it'll be producing: 15 gallons/hour x 22.2 lb. /gallon = 333 lb.

By inserted the fuel burning rate for our diesel generator, we got the amount of CO_2 that it produces Diesel generators normally come with constant 1500 or 3000 rpm. Consumption, liters/hour, largely depends on power load demand. They are normally designed to get the best efficiency at approximately 75% of maximum-nominal power rating, i.e. if it is 100 kVA, at ~75 kVA loads it has the best efficiency, so you would need a "demand/consumption" diagram for the specific engine. Also, by the time engine reaches its working temperature, emissions are different for pollutants other than CO_2, and outside temperature is also relevant for NOx. If you could determine the demand, then you can get the generator "size" to minimize emissions. Carbon emissions are to be calculated exclusively by the content of C in the fuel, and liters consumed. The testo 310 is a handheld measuring instrument for the professional flue gas analysis is used.

3. RESULTS AND DISCUSSIONS

It is revealed from the analysis that the efficiency of the diesel generators is changed with the change in the rated capacity and the load respectively. Furthermore, it has the relation with the fuel usage as the fuel consumption by the generators changes the rated capacity and load also changes. The diesel generators on which the analysis is done, has three loads which were 2250KW, 2500KW and 4500KW for 90A, 100A and 180A currents respectively and the total associated load is 9250KW. For 9250kW, the fuel usage was 500 liters/week [10]. The evaluated furthest reaches of the generator is 15000KW. The working hours of the generator is different in summer and winter in view of the component of the load shedding hours. On an ordinary, the working hours of the generator are 6 hours in a day.

Table 1: Estimation of Fuel Consumption and Efficiency of the Diesel Generator

Rated Power of Diesel Generator (KW)	Efficiency of Diesel Generator (%)	Fuel consumption	
		Liter/day	Liter/kwh
9250	87.26	78.57	13.09
2250	46.00	42.00	7.00
2500	50.00	45.78	7.85
4500	67.46	60.72	10.12

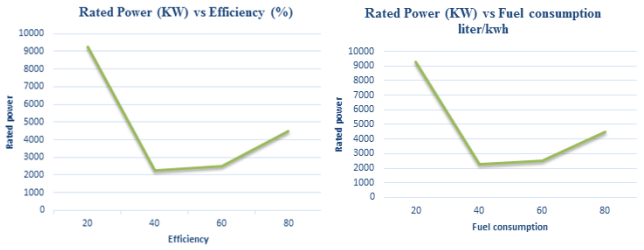

Figure 1: Relationship between efficiency, fuel consumption, and rated power.

It can be seen from table (1) that efficiencies are 46%, 50% and 67.46% for 2250KW, 2500KW and 4500KW independently. If the associated load is joined as 9250KW then profitability efficiency of the generator will be 87.26%. From these results, it can be induced that fuel use is inversely proportional with respect to the applied load and the efficiencies of the generators is inversely proportional to the rated power. That is the reason for the selection of the generator should be close to the load demand for or applied load. However, power factor must be taken into account.

Release of CO_2 can be represented as consumption of one-liter diesel releases 2.7 kg/CO_2. The usage of one-liter diesel transmits 2.7 normally in the extent of 2.4-2.7 kgCO_2. Along these lines, the carbon footprint in terms of kgCO_2 emissions can be found out as we know the fuel usage values.

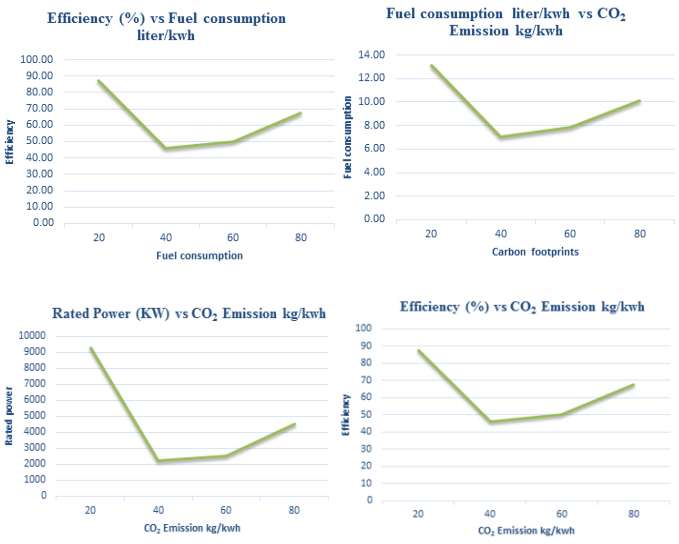

Figure 2: Relationship between Rated power, Fuel consumption, Carbon footprints, and Efficiency

Table 2: Estimation of Fuel Consumption, Carbon emission and efficiency of the Diesel Generator

Rated Power of Diesel Generator (KW)	Efficiency of Diesel Generator (%)	Fuel consumption of Diesel Generator		Carbon footprint in terms of CO_2 Emission	
		Liter/day	Liter/kwh	Kg/day	Kg/kwh
9250	87.26	78.57	13.09	57.24	9.54
2250	46.00	42.00	7.00	30.61	5.10
2500	50.00	45.78	7.85	34.33	5.72
4500	67.46	60.72	10.12	44.25	7.37

The figure 2 show that for the rated power of 9250 KW the efficiency is 87.26% and the carbon foot print in terms of co_2e is 9.54kg/kwh and fuel consumption 13.09lt/kwh. Similarly, For the rated power of 2250 KW the efficiency is 46% and the carbon foot print in terms of co_2e is 5.103kg/kwh and fuel consumption 7lt/kwh. For the rated power of 2500 KW, the efficiency is 50% and the carbon foot print in terms of co_2e is 5.72 kg/kwh and fuel consumption 7.85lt/kwh. For the rated power of 4500 KW the efficiency is 67.46 and the carbon foot print in terms of co_2e is 7.37 kg/kwh and fuel consumption 10.12lt/kwh.

The selection of diesel generator should be based on peak power demand to maintain load. If the difference between peak power demand and average energy demand is high. In that situation, the efficiency of diesel generator will drop and ultimately emit more greenhouse gases and will consume large amount of fuel.

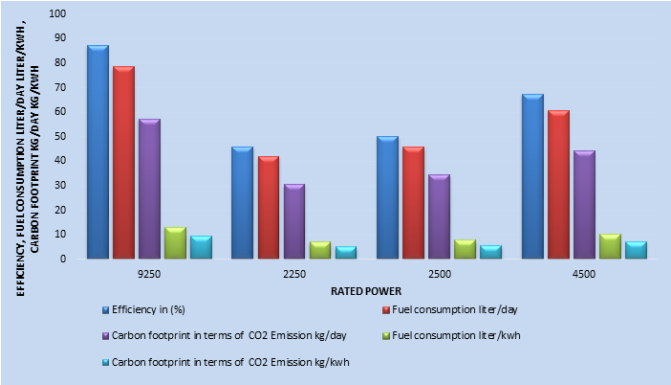

Figure 3: Rated power vs Efficiency, Fuel consumption liter/day liter/kwh, Carbon footprint kg/day kg/kwh

The emissions are high as a result of fuel combustion when the associated load is 20-40% o as shown in figure 3. The release of carbon is 57 kg when the associated load is 9250 KW. Likewise, when the store is associated from one side and other two sides are off then emission is 30.61kg, 34.33kg and 44.25kg from 2250 KW, 2500KW and 4500 KW separately. It can be seen that surge from 4500KW is 44.25kg and 57kg from 9250KW.4500KW is about half of the 9250KW so emission of the carbon should be half. Regardless, in useful result it is 77% of the total spreads. That is to state, there exist an inverse association between the associated load and emission of carbon. Right when the associated load is 20-40% of as far as possible the emissions of the carbon augments exceptionally in sum.

4. CONCLUSION

The conclusion is that air pollution is coming to fruition in view of the remission of greenhouse gases, especially CO_2 emission is in far reaching aggregate. As UAF is using non-renewable resources for dealing with the power demands. This is getting on depleting the non-renewable resources which can't be energized in a brief time allotment. On the other hand, they are realizing a natural pollution along these lines of CO_2 emission. We should use renewable resources which are pollution free. Considering, other suggestion is that we should use the generator near the load demand. If we are applying the load at 70%-80% of the evaluated furthest reaches of generator, the emission will not be in generous entirety. Of course, if we are applying are the loads at 20%-40% of the evaluated furthest reaches of the generator, then efficiency of the generator will be low, and emission will be high. The fuel usage will in like manner be high and it has arranged negative impact on the economy.

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