Applied Science & Engineering Journal for Advanced Research
ISSN (Online): 2583-2468
Volume-1 Issue-4 || July 2022 || PP. 1-7 DOI: 10.54741/asejar.1.4.1

A Hybrid Environment Friendly Energy System with Solar Photovoltaic and Diesel Generator

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Received: 11-06-2022	Revised: 30-06-2022	Accepted: 12-07-2022

ABSTRACT
We will examine the advantages of solar photovoltaic modules over diesel generators in this paper. To demonstrate this, we compared the emissions of greenhouse gases and the global warming potential (GWP) of solar photovoltaic modules and diesel generators. Because carbon dioxide, nitrous oxide, and methane have such a large impact on the environment, we looked at these three GHGs together. We've assumed a 100kw load for the sake of ease of calculation.

Keywords: *energy system, solar, photovoltaic*

I. INTRODUCTION

As a gas in the atmosphere, a greenhouse gas (sometimes abbreviated GHG) is capable of absorbing and emitting thermal infrared radiation. The greenhouse effect is primarily due to this process. In the absence of greenhouse gases, the Earth's surface would be 33°C colder, or 59°F lower than the current average of 14 °C (57°F).

In accordance with Kyoto protocol (The Kyoto Protocol is an agreement under which industrialised countries will reduce their collective emissions of greenhouse gases by 5.2% from 1990). Six greenhouse gases (carbon dioxide, methane, nitrous oxide and sulphur hexafluoride) are to be reduced in order to reduce the overall greenhouse gas emissions. According to the Kyoto Protocol, there are six types of Greenhouse Gases. Hydrofluorocarbons (HFCs), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), carbon dioxide (CO_2), sulphur hexafluoride (SF_6), and nitrous oxide (N_2O) (SF_6).

Methane accounts for about 15% of the human-induced greenhouse effect. When organic compounds decay (through putrefaction or fermentation) in an absence of air (actually in an absence of oxygen), they produce methane, which is the primary component of "natural gas" (and also the cooking gas of most people, and...the firedamp so feared by coalminers). Nitrous oxide (N_2O), which generates roughly 5% of the human-induced greenhouse effect, also produces methane, which is the primary component of "natural gas." Microbes in the soil produce this gas as a byproduct of their activity (and it is obviously linked to the nitrogen cycle), so it can be found in humid areas.

Approximately 55% of the human-induced greenhouse effect is attributed to CO_2 emissions. For the most part, this comes from the use of fossil fuels (coal, oil, and natural gas), with a small portion coming from industrial processes (such as cement production), which do not include combustion.

All Green House Gases should be measured in mass units of Carbon dioxide equivalents, regardless of their source or method of calculation. CO_2 equivalent form can be achieved by multiplying a gas other than CO_2 with its Global Warming Potentials (GWP). Because different GHGs have different abilities to trap heat, the GWP (global warming potential) concept was developed.

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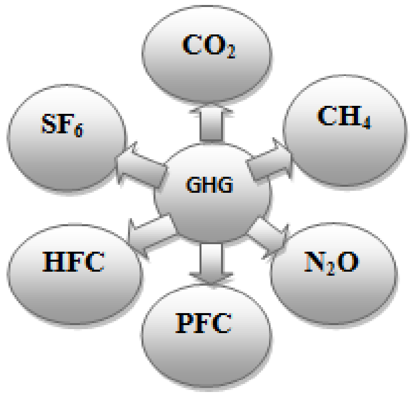

Figure1: Different types of green house gases.

II. ENVIRONMENTAL ISSUE

To put it another way, if co2 emissions were 100 kilogrammes in 2009, they would be 125 kilogrammes by 2019 and, by the end of the decade, they would be 50 percent higher than they were in 2009, i.e. 200 kilogrammes. The graph below shows the annual increase in carbon dioxide emissions. It shows an estimate of the percentage increase in CO2 over time, based on historical data.

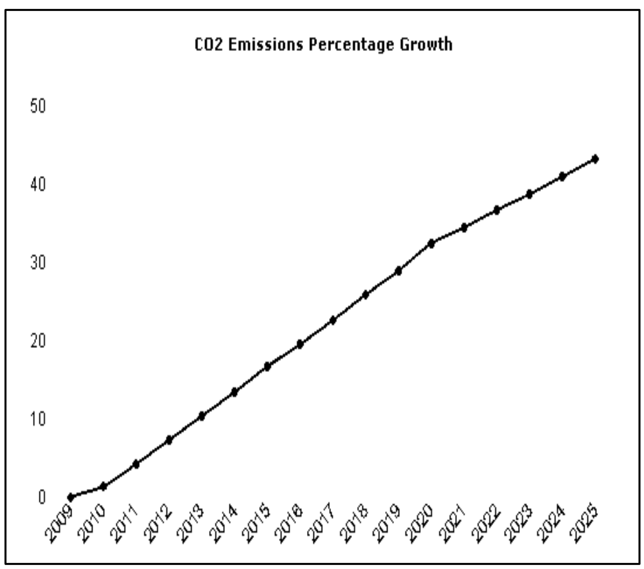

Figure 2: Graph showing emission percentage growth of CO2 for different years

III. CALCULATIONS

Calculation of CO2 emission from diesel generators:-

CO_2 emission = Fossil fuel consumption in volume unit **x**
CO_2 emission factor
We have assumed 100kw load and 100kw diesel generator consumes
2.6 gallon /hour for ¼ load of generator.
4.1 gallon /hour for ½ load of generator.
5.8 gallon /hour for ¾ load of generator.
7.4 gallon /hour for full load of generator.
But, 1gallon= 4.5 lit.
CO_2 emission for ¼ load = 11.7 X 2.65= 31.005

CO_2 emission for ½ load = 18.45 X 2.65= 48.8925
CO_2 emission for ¾ load = 26.1 X 2.65= 69.165
CO_2 emission for full load = 33.3 X 2.65= 88.245
For SPV we have taken CO2 emission amount from the reference papers.
CO_2 emission for SPV 32g /kWh. So 100kw load will produced
= 3.2kg of CO2.

Calculation of CH_4 emission from diesel generators:-
CH_4 emission for ¼ load = 11.7 X 0.00036 = 0.004212
CH_4 emission for ½ load = 18.45 X 0.00036 = 0.006642
CH_4emission for ¾ load = 26.1 X 0.00036 = 0.009396
CH_4emission for full load =33.3 X 0.00036 = 0.011988

Calculation of N_2O emission from diesel generators:-
N_2O emission for ¼ load = 11.7 X 0.000021 = 0.0002457
N_2O emission for ½ load = 18.45 X 0.000021 = 0.00038745
N_2O emission for ¾ load = 26.1 X 0.000021 = 0.0005481
N_2O emission for full load =33.3 X 0.000021 = 0.000699

IV. GLOBAL WARMING POTENTIAL

The global warming potential (GWP) is influenced by both the molecule's greenhouse gas efficiency and the time it takes for it to accumulate in the atmosphere. Measured in terms of CO2 equivalent mass, the GWP is evaluated over a specific time frame. This means that in terms of global warming potential, a gas with high (positive) radiative forcing but a short life expectancy will have a high GWP over the next 20 years, but a low GWP over the next 100. When considering GWP, the longer the molecule's life span in the atmosphere, the greater the GWP. It is universally accepted that carbon dioxide has a GWP of 1.

In terms of global warming potential (GWP), a greenhouse gas' ability to trap heat in the atmosphere is measured as a percentage of that gas's GWP. Similar mass of carbon dioxide can be used to measure the amount of heat trapped by a given mass of gas in question. In order to calculate a GWP, you must use a specific time horizon, usually 20, 100, or 500 years in the future. The global warming potential (GWP) is measured as a percentage of CO2 emissions (whose GWP is standardised to 1). If the same mass of methane and carbon dioxide were released into our atmosphere over the next two decades with no mitigation, methane's long-term global warming potential (GWP) would be 86 times greater than carbon dioxide's.
There is a 12 3-year atmospheric lifetime for methane, and it has a GWP over 20 years of 72; 100 years of 25; and 500 years of 7.6 for methane. Chemical reactions in the atmosphere break down methane into water and carbon dioxide, which lowers the GWP over time.

Table 1: GWP of green house gases

	Formula	GWP For 20 years	GWP For 100 years	GWP For 500 years
Carbon dioxide	CO_2	1	1	1
Methane	CH_4	72	25	7.6
Nitrous Oxide	N_2O	289	298	153

Total GHG emission (in CO2 equivalent) =(CO2 emission) +
(CH4 emission X GWP) + (N20 emission X GWP)

For 20 years time scale
For ¼ load
Total GHG Emission (IN CO2 equivalent)=31.005x1 + 0.004212x72 + 0.0002457x289

= 31.3792713
For ½ load
Total GHG Emission (in CO2 equivalent) = 48.8925x1 + 0.006642x72 + 0.00038745x289
= 49.4827
For 3/4 load
Total GHG Emission (in CO2 equivalent) = 69.165x1 + 0.009396x72 + 0.0005481x289
= 69.9999
For full load.
Total GHG Emission (in CO2 equivalent) = 88.245x1 + 0.011988x72 + 0.6006993x289
= 262.71

For 100 years
For ¼ load
Total GHG Emission (IN CO2 equivalent)=31.005x1 + 0.004212x25 + 0.0002457x298
= 31.18
For ½ load
Total GHG Emission (in CO2 equivalent) = 48.8925x1 + 0.006642x25 + 0.00038745x298
= 49.17
For 3/4 load
Total GHG Emission (in CO2 equivalent) = 69.165x1 + 0.009396x25 + 0.0005481x298
= 69.5632
For full load.
Total GHG Emission (in CO2 equivalent) = 88.245x1 + 0.011988x25 + 0.6006993x298
= 267.54

For 500 years
For ¼ load
Total GHG Emission (IN CO2 equivalent)=31.005x1 + 0.004212x7.6 + 0.0002457x153
= 31
For ½ load
Total GHG Emission (in CO2 equivalent) = 48.8925x1 + 0.006642x7.6 + 0.00038745x153
= 49
For 3/4 load
Total GHG Emission (in CO2 equivalent) = 69.165x1 + 0.009396x7.6 + 0.0005481x153
= 69.3
For full load.
Total GHG Emission (in CO2 equivalent) = 88.245x1 + 0.011988x7.6 + 0.6006993x153
= 180.243

Loads/yrs.	GWP for diff. load & time scale		
	For 20 yrs.	For 100yrs	For 500 yrs.
¼ load	31.3792713	31.18	31
½ load	49.4827	49.17	49
¾ load	69.9999	69.5632	69.3
Full load	262.71	267.54	180.243

V. HARMFUL EFFECTS OF GREEN HOUSE GASES

1. Carbon dioxide harmful effects

Exposure limits (% in air)	Health Effects
2-3	Unnoticed at rest, but on exertion there may be marked shortness of breath
3	Breathing becomes noticeably deeper and more frequent at rest
3-5	Breathing rhythm accelerates. Repeated exposure provokes headaches
5	Breathing becomes extremely laboured, headaches, sweating and bounding pulse
7.5	Rapid breathing, increased heart rate, headaches, sweating, dizziness, shortness of breath, muscular weakness, loss of mental abilities, drowsiness, and ringing in the ears
8-15	Headache, vertigo, vomiting, loss of consciousness and possibly death if the patient is not immediately given oxygen
10	Respiratory distress develops rapidly with loss of consciousness in 10-15 minutes
15	Lethal concentration, exposure to levels above this are intolerable
25+	Convulsions occur and rapid loss of consciousness ensues after a few breaths. Death will occur if level is maintained.

2. Methane harmful effects

S.NO	Disease
1.	Cough
2.	Rapid breathing
3.	Rapid heart rate
4.	CNS depression
5.	Blurred vision

3. Nitrous oxide harmful effects

S.NO.	Disease
1.	Hypoxia
2.	Sinus

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VI. GREENHOUSE GASES COMPARISON CHARTS

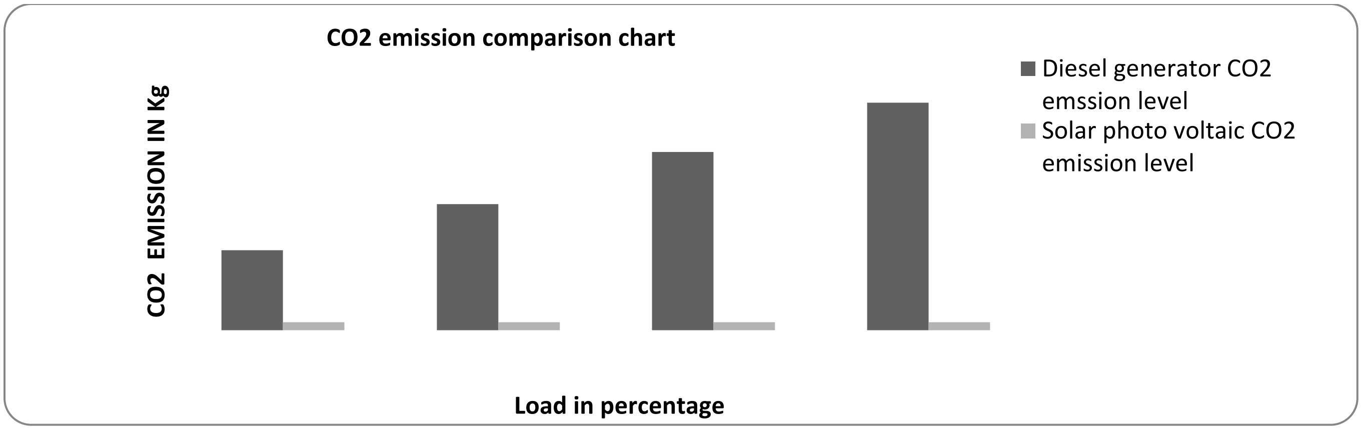

Figure 3: CO2 emission level Comparison chart between Diesel generator & Solar photo voltaic

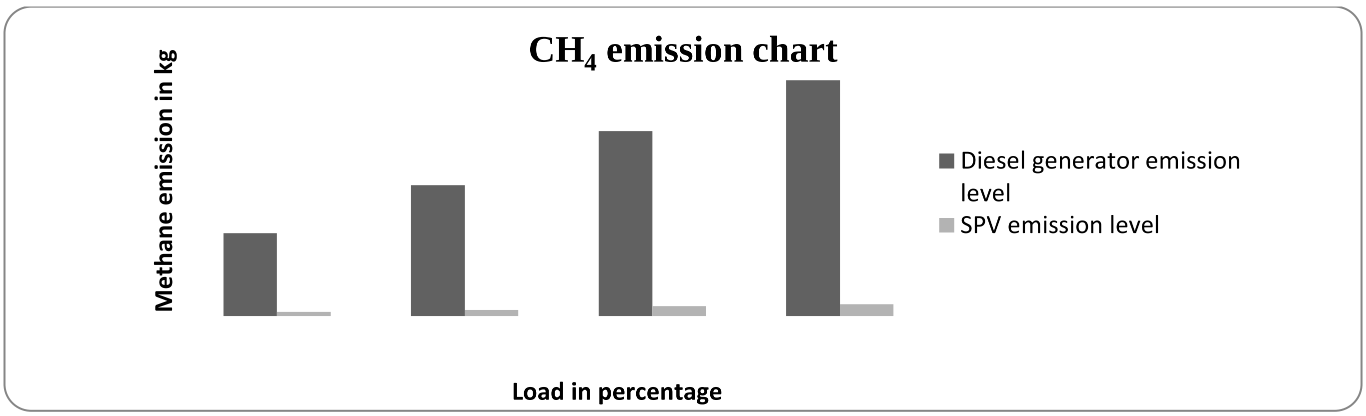

Figure 4: CH4 emission level Comparison chart between Diesel generator & Solar photo voltaic

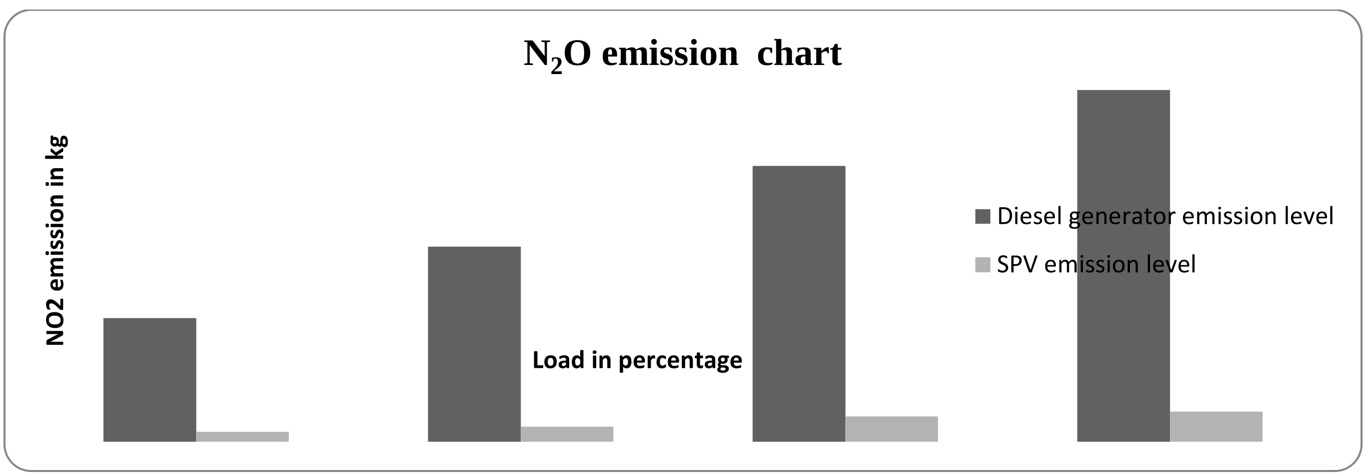

Figure 5: N_2O emission level Comparison chart between Diesel generator & Solar photo voltaic

Emission levels of diesel generators and SPV modules are shown in all of these comparison charts. Emission levels of the diesel generator and the solar power plant (SPV) are shown in dark grey and light grey, respectively. So, based on these graphs, we can conclude that diesel generators are the most harmful to our environment and health.

VII. CONCLUSION

Diesel generator and solar photovoltaic module emissions of greenhouse gases (GHG) were compared. Our calculations show that diesel generators emit significantly more greenhouse gases than solar photovoltaic modules, and we also found that the higher levels of emissions from diesel generators result in significant health issues for humans. Consequently, we can conclude that solar power is safer and healthier because it causes fewer health issues and has a lower environmental impact.

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