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# Carbon Dioxide Emission Accounting of Grid-powered Streetlights

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***Abstract**: This study aimed to determine the total carbon dioxide emission of the grid-powered streetlights in a barangay. This study uses both Qualitative and Quantitative Research, following the case study and computational techniques. Based on the collated responses from the semi-structured interview guide sheet and face to face interview, the barangay council have put these grid-powered streetlights for the safety of everyone. Moreover, they knew about the Carbon dioxide emission but not much about it but still they would pursue setting up solar-powered streetlights as their action to mitigate the situation. Results of the computation presents that there were 7.44 Kwh and 223.2 Kwh of electricity consumed for a day and month respectively. From this, the breakdown on the composition of each power source was also identified. Moreover, a total of 297.7 lbs of $CO_2$ was emitted from the total consumed electricity of the grid-powered streetlights for a month. Furthermore, it is recommended that the barangay officials would have to follow the environmental management plan for a sounder community and environment for it prevents from extra wastes and pollution. Most importantly, this study would help the community and environmental sector to track their emissions of carbon dioxide from the different grid-powered inputs.***

***Keywords: $CO_2$ Emission by Power Source, $CO_2$ Emission of Grid-Powered Streetlights, Energy Consumption, Energy Consumption of Grid-Powered Electricity, Grid-Powered Streetlights***

## 1. INTRODUCTION

Greening community was always associated with green chemistry for it includes lowering industrial carbon footprints and relying less on non-renewable energy sources [1] and be a part of the growing number of communities where they involved in investing more on solar panels and energy-efficient devices [2]. In relation to the concept of carbon footprints or the entire amount of greenhouse gas (GHG) emissions contributed by an individual, situation, or

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technology, both directly and indirectly [3]. Carbon Dioxide Emission which is one of the major concerns of the world nowadays. People in every corner of the world tend to create solutions just to lessen or mitigate the detrimental effects of it. As part of the greening community's campaign, simple practice like putting up street lights are no exceptions because of the fact that they were connected and powered by the grid that contributes on the emission of carbon dioxide for it started from the transmission to distribution of electricity until the usage of this transported and distributed electrical energy. S to this date, residential outdoor lighting alone emits 15 million tons of carbon dioxide per year [4]. Thus, street lighting accounts for a sizable component of a community's carbon footprint, particularly in densely populated areas with a high density of lamps and with patronizing the usage of LED lighting in lieu of the usual fluorescent bulbs, not only makes economic sense, but it also considerably reduces the carbon footprint of street lighting [5].

Grid or popularly known as the electricity that runs through the cable wires were generated through different sources wherein most of it emits carbon dioxide as its by-product. And as beneficiaries, we certainly and unnoticeably contributors of carbon dioxide for we enjoyed the purpose and reason why these streetlights are put up in every community, that is the reason why we are indirectly the culprits for the emission of it in the atmosphere. Moreover, streetlights are grid powered, and technically, grid power or the so-called electricity generated through different raw materials, the allocation of electricity production [6] can be seen in the table below:

Table1: Power Generation by source as of 2014

| Source | Percentage |
|---|---|
| Coal | 42.8% |
| Oil-Based | 7.4% |
| Natural Gas | 24.2% |
| Hydro | 11.8% |
| Geothermal | 13.3% |
| Other Renewable Sources (Wind, Solar, Biomass) | 0.5% |

What we barely don't know is that upon the simple lighting of streetlights to the usage of any appliances and devices that are connected to the grid, we greatly help in the emission of greenhouse gasses especially Carbon Dioxide where its negative effect causes unimaginable things to the environment, like its inevitable nature of trapping the heat of the sun inside the earth which will eventually result to the heightening of global warming and its synergistic effects. The amount of carbon dioxide (CO2) produced per kilowatt-hour (kWh) for specific fuels and specific types of generators [7] could be calculated and is presented below:

Table2: Emission Factor for Different sources of Electricity

| Sources | Pounds of CO2 per kWh |
|---|---|
| Coal | 2.23 |
| Oil | 2.13 |
| Natural Gas | 0.91 |

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People in the community were very please for barangay council have managed to put up streetlights. Members of the community have stated that, "for the safety of the people at night" and "brighter streets for the people to walk on".

Generally, the main problem the study was to determine the total carbon dioxide emission of the grid-powered streetlights in a barangay Specifically, it answered the following questions:

1. What is the reason why the barangay council have put up streetlights in all over the barangay?
2. How familiar are they to the emission capability of Grid-powered streetlights?
3. What is their stand on the situation and what is their future plans to at least mitigate the situation?
4. What is the total energy consumption of the grid-powered streetlights for a day and for the month?
5. What is the breakdown of the electricity generated for each fuel source?
6. How much carbon dioxide are emitted by the grid powered streetlights with regards to (a) Coal, (b) Natural Gas, and (c) Oil?

Significance of this research was primarily on the dissemination of information to the barangay councils and the members of the community regarding the amount of carbon dioxide emitted from the streetlights. It also provides mitigating solution on how carbon dioxide will be reduced. The Study was conducted at Poblacion Sur, Santa Maria, Ilocos Sur for the whole month of June 2019.

**Research Elaborations**

The research used a mixed approach of Qualitative and Quantitative Research. The qualitative approach flows the case study design getting solid, contextual, in-depth information about a specific real-world subject by allowing you to investigate the major traits, meanings, and implications [8] and the collected of data in in-depth interviews were analysed using thematic analysis [9]. On the other hand, the quantitative research approach focuses on the process of collecting and analysing numerical data [10] using computational techniques [11] [1]. The use of semi-structured interview guide was the primary tool used in gathering raw data. The researchers asked the views and opinions of the members of the barangay council with regards to the situation of the putting up streetlights and its environmental impact. Moreover, the questions asked during the interview were developed based on the identified priori codes crafted from the defined human experience. The data gathered were analyzed through coding and theming, then afterwards interpreted and corroborated with articles and researches. In addition, the data on the total number of streetlights, specification of the light source and the time of usage were the quantitative data gathered that were subjected for computation, specifically on the total energy consumption of the grid-powered streetlight, the percentage on the composition of fuel source in the generated electricity and total CO2 emission from the fuel source. The following will be the different computational methodologies that were used in the conduct of the study:

a. Energy Consumption
   EC = t*P

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Where: **EC** is energy consumed from the light source
**t** is the time usage of the light source for a day
**P** is the specified power for the light source

b. Carbon Dioxide Emission per Source

$$CO_2e\left(\frac{\text{EF of source in lbs}}{1\ \text{kWh}}\right)$$

Where: $CO_2e$ or the Carbon Dioxide emission of the fuel source
EF of source in lbs is the emission factor of a specific fuel source in lbs

## 2. RESULTS AND DISCUSSION

**Lighted path for the Safety of the People.**

Participants' responses clearly depict what had been themed, participant 1 said that "Streetlights are provided to keep the people safe from harm and to keep the barangay well lighted to promote brighter path for everyone who will pass through". The said statement was also in connection to the statements of Participants 2 and 3 stating that "This provides safe passage and brighter path for people." and "The well-lighted path by the streetlights ensures safety for every people.". Their statements were unanimously directed to the idea that barangay officials have clearly put up streetlight surrounding the barangay to provide a well-lighted path for the community and for the passers-by. Wherein, it can be used to boost security and quality of life of the communities by artificially prolonging the hours when it is bright so that activities can take place. Lighting also the streets increases the safety of vehicles, cyclists, and pedestrians [12].

**Knew but Insufficient!**

With regards to the technicalities on the capacity of these grid-powered streetlights in its emission of carbon dioxide, the barangay council have known about this but not much. When asked about the question, Participant 1 mentioned "I have heard and read about it but not on the in-depth technicality of the concept." The said statement was then second by the other participants saying "I knew but not much." and "I also knew about it but little on the idea on it.". Upon continuous casual talk about this matter, the barangay council was aware of the concept of greenhouse effect and global warming but the sources and technicalities about it was vague to them. Furthermore, their statements are in unison when it comes to their familiarity of the said situation.

**We talked and we will!**

Moreover, the barangay council have already decided and planned that they will put up solar powered streetlights surrounding the barangay as their mitigating measure towards the growing problem on climate change. Their statements towards this matter was "We will stand against it for it is really environmentally threatening and we will address it by putting up Solar-powered streetlights.", "The council have talked about it and we know about the bad effects and we will go with the solar one.", and We talked about it during meetings and want to at least reduce the problem by putting the solar." With their statements, it clearly shows that they saw this measure as achievable and easily put up. In addition, as according to one of the participants, the cost

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would be disregarded as part of their thinking for they will still put up this Solar-powered Streetlight for them to promote safety not just with the community but with the environment.

Table 3. Data for Total Energy Consumption

| Quantity | Time Duration (h) | Total Power (kW) | Daily Energy Consumption (kWh) | 30 Days Energy Consumption (kWh) |
|---|---|---|---|---|
| 31 | 12 | .62 | 7.44 | 223.2 |

Furthermore, using the Energy Consumption computation methodology, in 30 days, the streetlights of the barangay have consumed a total 223.2 kWh of electricity. This computed consumption of energy was considered to be large in quantity for a small community. But for a grid-powered street light, it is expected to be true for public street lighting consumes a lot of electrical energy [13] but the willingness of many communities to use environment friendly energy sources depends on the rightness of the project presented [14].

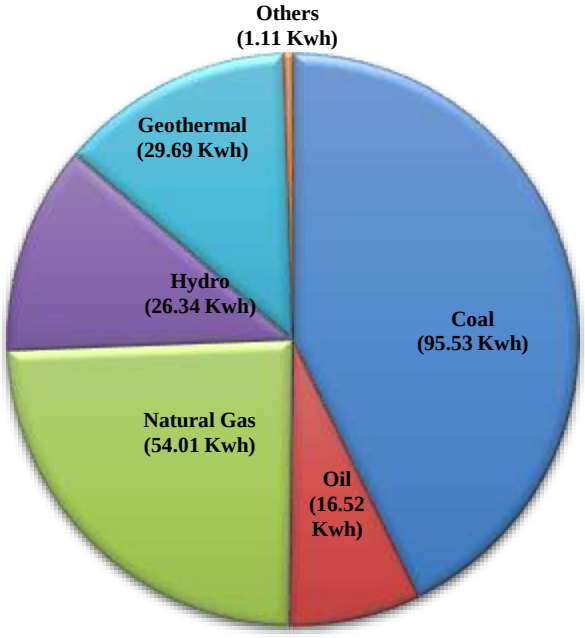


Figure 1. Breakdown of 223.2 kWh Based on the Power Generation Source

Furthermore, the above figure shows the composition of the breakdown each fuel source in the electricity consumption of the grid-powered streetlights of the said barangay. The figure then emphasizes that electricity generated from non-renewable fuel sources plays a big part in our supplies of electricity from the grid for it occupies almost three fourths (3/4) of the total electricity consumed and the rest was generated from the renewable sources.

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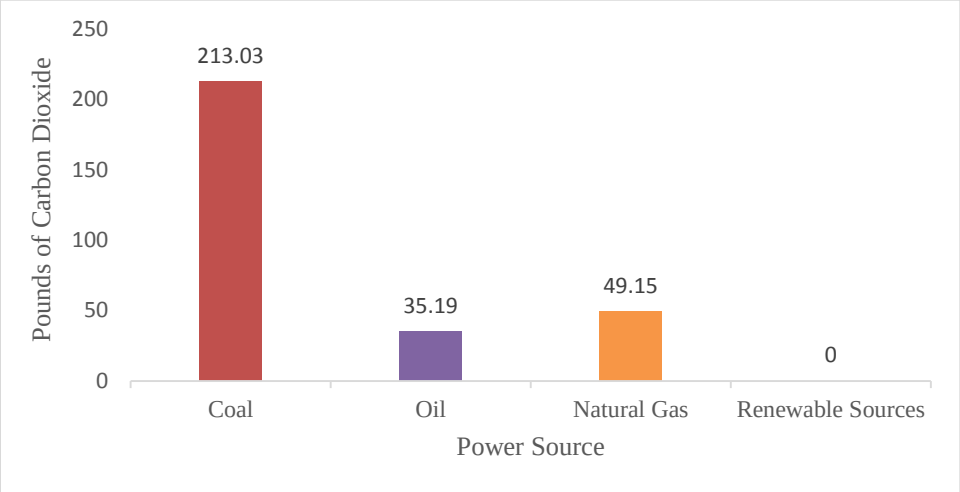


Figure 2. Breakdown of 297.37 lbs of Carbon Dioxide Emission per Power Source

Anent to the data in the figure, the barangay has emitted a total of 297.37 lbs. of CO2 in just a month and presented on Figure 2 was the emission of carbon dioxide in pounds per power source in terms of the composition for each power source upon the generated electricity for a month. These data then were the unnoticeable and indirect negative effects we brought to the environment upon the benefits we enjoyed from the street lights. Relative to the prior data was a study in Nigeria where total emissions of grid-powered devices were also identified [15]. Moreover, it was presented that there was a 0 lbs. of CO2 emitted for renewable sources do not emit carbon dioxide hence these sequester this gas and therefore reduces its amount on the atmosphere. In addition, renewable energy sources do not produce carbon dioxide or other greenhouse gases [16], which contribute to global warming.

Lastly, participants unanimously suggested from the interview that these grid-powered street light will be changed or replaced by a solar powered one as a possible mitigation measure because they saw the environmental mitigation capability of these solar technology and the environmental impact of these grid-powered streetlights. And for an environmental problem that needed a solution like this, it needed a careful analysis that needed planning for implementation and it encompasses the presentation of an Environmental Management Plan.

## 3. CONCLUSION

Upon the so many analyses and realizations encountered on the accomplishing of this paper, street lights are indeed a very important structure of a community for it brings the people in it to their safety. Furthermore, while maintaining the safety of everyone, keeping the environment safe is also a must and it is by switching into a solar powered one, because it is not a joke that solar powered streetlights means no harm to the environment upon its installation and operation because unlike the grid powered streetlights, solar powered streetlights doesn't emit greenhouse gasses upon the generation of electricity that will be used upon the lighting of the streetlights. And based on the results presented, the 31 grid-powered streetlights put up by the

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barangay consumed, 223. 2 Kwh of electricity per month and thus emits a total of 297.37 lbs of CO2. And with this, the barangay council have already decided to put up solar-powered streetlight to reduce their indirect emissions of carbon dioxide to the atmosphere.

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## 4. REFERENCES

1. Environmental Studies Part 3: Quantitative Research. (2018). Retrieved from Virginia Wesleyan University: https://online.vwu.edu/news/environmental-studies/quantitative-research/
2. Peterson, B. (2019). Green Home Guide. Retrieved from https://www.greenhomeguide.com/know-how/article/how-everyone-can-benefit-from-green-communities
3. Carbon Footprint Factsheet. (2017). Retrieved from Center for Sustainable Systems, University of Michigan: https://css.umich.edu/factsheets/carbon-footprint-factsheet
4. 15 Million Tons of Carbon Dioxide Emitted Each Year On Residential Outdoor Lighting in the U.S. (2016). Retrieved from International Dark-Sky Association: https://www.darksky.org/15-million-tons-of-carbon-dioxide-emitted-each-year-on-residential-outdoor-lighting-in-the-u-s/
5. Albert, B. (2019). Carbon accounting for the energy use of streetlighting. Retrieved from https://100percentrenewables.com.au/carbon-accounting-energy-streetlighting/
6. (2014). Power Situation. Department of Energy. Retrieved from https://www.doe.gov.ph/sites/default/files/pdf/electric_power/power_situationer/2014_power_situationer.pdf?withshield=1
7. How much carbon dioxide is produced per kilowatthour of U.S. electricity generation? (2019). Retrieved from Energy Information Administration: https://www.eia.gov/tools/faqs/faq.php?id=74&t=11
8. McCombes, S. (2019). Descriptive Research Design | Definition, Methods and Examples. Retrieved from Scribbr: https://www.scribbr.com/methodology/descriptive-research/
9. Mcleod, S. (2019). What's the difference between qualitative and quantitative research? Retrieved from Simply Psychology: https://www.simplypsychology.org/qualitative-quantitative.html
10. Daniel, E. (2016). The Usefulness of Qualitative and Quantitative Approaches and Methods in Researching Problem-Solving Ability in Science Education Curriculum. Journal of Education and Practice, 7(15), 91-100.
11. Quantitative Methods for Evaluating Business Profits. (2016). Retrieved from Simplilearn Solutions: https://www.simplilearn.com/quantitative-methods-rar199-article

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12. Sudarmono, P., Deendarlianto, & Widyaparaga, A. (2018). Energy efficiency effect on the public street lighting by using. Journal of Physics: Conference Series, 1022, 1-9. doi:10.1088/1742-6596/1022/1/012021
13. Five Reasons Why Solar Street Lighting Is A Smart Decision For Cities. (2017). Retrieved from Lightinus: https://www.lightinus.com/five-reasons-why-solar-street-lighting-is-a-smart-decision-for-cities/
14. 5 Actionable Tips To Use More Renewable Energy. (2019). Retrieved from METGROUP: https://group.met.com/en/mind-the-fyouture/mindthefyouture/5-actionable-tips-to-use-more-renewable-energy
15. Kumar, N. M., Singh, A. K., & Reddy, K. K. (2016). Fossil Fuel to Solar Power: A Sustainable Technical Design for Street Lighting in Fugar City, Nigeria. Elsevier, 93, 956-966. doi:https://doi.org/10.1016/j.procs.2016.07.284
16. Nunez, C. (2019). Renewable energy, explained. Retrieved from National Geographic Society: https://www.nationalgeographic.com/environment/article/renewable-energy