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Issue Article

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GREENHOUSE EFFECT AND GLOBAL WARMING

Abstract: *Global climate has been changing as a cycle for millions of years already; however, industrialization, vast urbanization of cities, technological progress, and other similar factors have caused a rapid increase in global temperature. Global warming is strongly related to industrialization, vehicle usage, power plants' functioning, and generally, consumption of fossil fuels. As a result of the congestion of these fuels, vast amounts of carbon dioxide and other gasses, also called greenhouse gasses, are released into the air. The greenhouse effect is what's responsible for the global temperature rise. Scientists claim that increased temperature will result in changes in sea levels. Hurricanes, droughts, storms, and floods will become more and more frequent, draughts will become harsher and more common, and many species will fail to adopt these changes, which will cause their extinction. Although we will not be able to halt global warming immediately, we can decrease the intensity and limit the amount of global warming by minimizing social emissions of heat-trapping pollutants and soot. This can be achieved by promoting renewable energy, increasing the usage of electric vehicles, and familiarizing with leg lighting and a plant-based diet.*

Key words: *Greenhouse Effect, Urbanization, Sustainable Mobility, Climate Change, Electric Vehicle, Renewable Energy, Led Lighting, Plant-Based Diet.*

Language: *English*

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Introduction

Global climate has been changing as a cycle for millions of years; however, industrialization, vast urbanization of cities, technological progress, and other factors of the same nature have caused unexpected and rapid global temperature increases. The process of human activity affecting the global climate and causing temperature increases is known as global warming. Global warming is strongly related to industrialization, vehicle usage, power plants' functioning, and generally, consumption of fossil fuels which are, to this day, the primary energy source we use. As a result of the congestion of these fuels, huge amounts of carbon dioxide and other gasses, also called greenhouse gasses, are released into the air. The greenhouse effect [6], trapping the heat beneath the

atmosphere, is what's responsible for the global temperature rise. If we follow the statistical data, we will see a distinctive temperature increase and an ever-growing concentration of carbon dioxide and methane alongside other greenhouse gasses. In 2020, the earth's surface temperature was 0.98 degrees Celsius, higher than the standard for the previous century. Global temperatures have regularly been among the hottest on earth in recent years [15, Revised 2022, February 15]. Another indicator of increased temperature is the effects we see on arctic sea ice, which is shrinking more and more as time goes by. According to NASA studies, arctic sea ice has declined by 10% in the past 30 years or so.

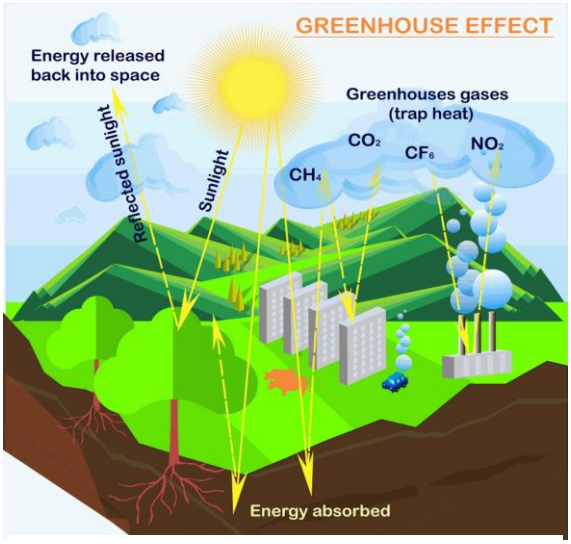

Figure 1. Greenhouse Effect Cycle

Increased temperature will have a significant impact on our living environment and ecosystem. Scientists claim that it will result in sea-level changes that flood many places. Hurricanes, droughts, storms, and floods will become more and more frequent, draughts will become harsher and more common, and many species will fail to adopt these changes, which will cause their extinction, earthquakes, and diseases will also become more common. Mosquitos that carry malaria, dengue fever, zika, and chikungunya will spread. Climate change has direct and indirect impacts on our environment. In some ways, we are directly affected by increased temperature; in other ways, we see chain reactions of negative and uncontrollable changes in different ecosystems and biological units that will impact our lives, our world, and its biodiversity. The melting of the arctic ice will cause an increase in sea levels, flood many coasts, destroy the habitats of many different species, and change the ecosystem in significant ways.

Figure 2. This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution

Meanwhile warmer weather will also cause the water temperature to rise; water acidification and coral bleaching will also affect sea ecosystems; Between 2000 and 2011, floods in the European Region infected 3.4 million inhabitants and killed over 1000 people. By 2085, the number of people affected by floods is estimated to be from 775 000 to 5.5 million yearly. Frequent hurricanes, earthquakes, floods, and global catastrophes of that sort will cause huge economic damage as well as result in the death of many people and cause misery that cannot be easily measured. Costs of these changes will be extremely hard, if not impossible, to recover from.

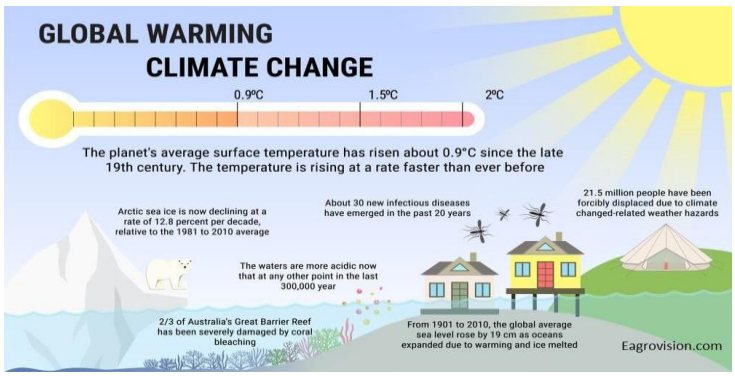

Figure 3. Challenges Caused by Global Warming

According to a NASA study [16, Revised 2022, 9 June], since the late 1800s, the planet's average surface temperature has risen by around 2.12 degrees Fahrenheit (1.18 degrees Celsius). A significant proportion of the temperature increase occurred in the last 40 years, with the last seven years being the warmest. The hottest years on record are 2016 and 2020. Global climate change is a highly complicated issue for many different reasons. To start with, we still don't have complete knowledge of the world's climate and related issues; besides, the impact of global warming is not always distinctively obvious and measurable, which is a significant issue. How do we expect to solve problems that are not only really hard to understand but also to measure and quantify? Finding adequate solutions for these issues is the next challenging step, even when we understand aspects of it. Solving this issue demands global attention and effort. Governments of developed countries that are heavily industrialized, as well as developing countries that use huge amounts of fossil fuels, have to carry out some measures to restrict the temperature from rising. Global poverty and, low socioeconomic background, political and economic interests of leading countries push the global warming issues [6] out of the agenda. The Paris Agreement, which imposes different obligations on 196 countries to keep the climate balanced, was signed in 2015 to keep global climate changes below 2 degrees. The green agreement was signed in 2019 to make Europe climate neutral by 2050; however, only political effort is not enough if individuals don't recognize the significance of the problem and start actively changing their lifestyles and behavioral patterns [5] to benefit global society.

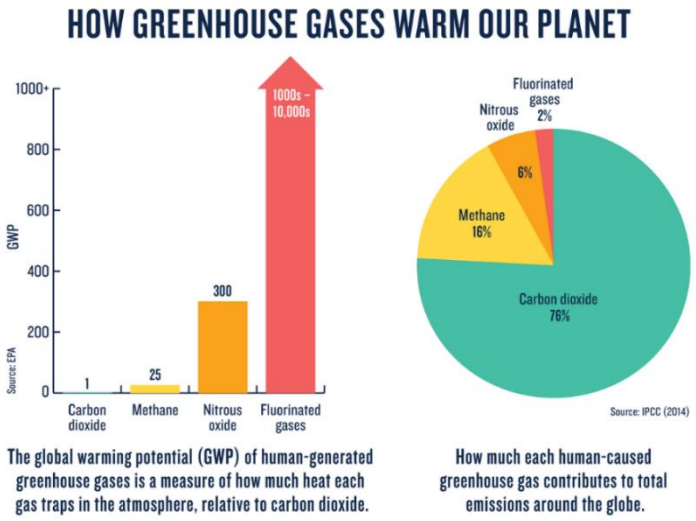

Figure 4. How Greenhouse Gases Warm Our Planet

Getting people to acknowledge first unanimously the existence of the issue, secondly, the significance of it, and then finding a way to solve it is borderline difficult, leaving us skeptical and pessimistic. Regardless of enormous efforts and attempts to implement innovative technologies and strategies to restrict global temperature rise, many have failed for the same reason – the unpredictability and complexity of processes in our ecosystems. Measuring the consequences of fuel consumption on a global scale is already a considerable difficulty, let alone measuring the impact over the years. As time goes by, the errors in these measurements accumulate, and it becomes almost impossible to say what our actions will result after 50 years adequately. Regardless, even though it is hard to gather empirical, scientifically quantified data, everyone with common sense would agree that the consequences will be brutal and dangerous. The data's inability is one reason people fail to participate in climate issues actively. Besides that, avoiding global warming catastrophe is related to giving up many of the conveniences of modern life, technology, and culture. People are hesitant to sacrifice the comfort of today to focus on an unclear and uncertain future.

1 Solutions

Solving the problem, which has been growing during the last decades, and taking rapid actions to cut greenhouse gas emissions significantly is a daunting challenge. Although we will not be able to halt global warming immediately or even for the next few decades, we can decrease the intensity and limit the amount of global warming by minimizing social emissions of heat-trapping pollutants and soot ("black carbon"). There is no one-size-fits-all approach to slow down the intensity or even stop global warming; using various strategies and possible solutions together extensively is needed to mitigate climate change. Each person, company, municipality, country, tribal, or federal agency should weigh their priorities considering effective climate action.

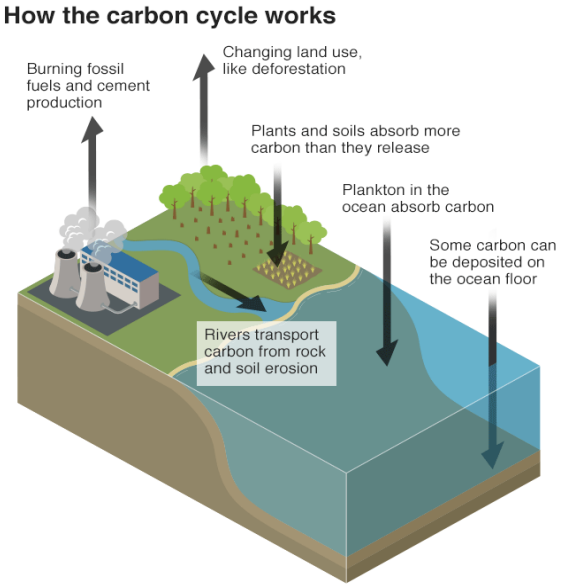

Figure 5. How the Carbon Cycle Works

1.1 Renewable Energy

As set out in the Paris Agreement, energy decarbonization is critical to keeping global temperature rises far below 2°C. This entails the share of renewable energy in the world's primary energy consumption to 65 percent by 2050, up from 15 percent today. Power output and usage account for about two-thirds of GHG emissions, putting the energy market at the heart of climate change efforts. Electricity generation and industry are the two leading CO_2-emitting industries [11], accounting for about 65 percent of all energy-related CO_2 emissions today. The remaining 35% comes from transportation, homes, and district heating. The electricity grid requires a complete redesign, including a shift from fossil-based to zero-carbon energy generation by the second half of this century. Today, fossil fuels account for 84% of energy consumption, with renewables accounting for 16% [14, Revised 2017, September].

According to an International Renewable Energy Agency (IRENA) study, rapid uptake could result in renewables accounting for 65 percent of energy demand by 2050 [14]. This will be sufficient for countries to achieve the Paris Agreement's climate targets. According to IRENA's global energy roadmap, identified as "REmap," renewable energy currently accounts for around 25% of global electricity production, with the remainder produced by fossil fuels. Renewable energy will produce approximately 80% of all electricity in 2050 [14, Revised 2017, September]. Accelerated solar energy implementation and energy conservation programs

are critical components of the energy transformation. According to recent research, the planet will achieve roughly 90% of the decarbonization needed to keep within the Paris Agreement borders by rapidly implementing clean energies and energy conservation, with the remaining 10% being fulfilled by other low-carbon approaches.

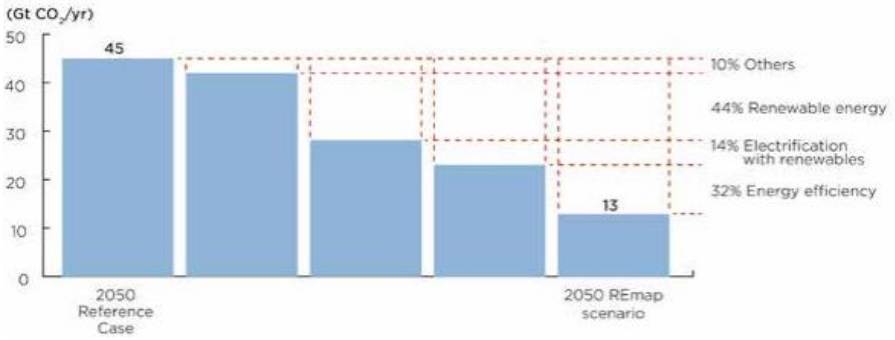

Figure 2. Future CO_2 emissions reductions from all industries under existing plans and policies vs. increased renewables adoption in 2050

Renewables could provide four-fifths of the world's energy by 2050 [14], significantly reducing pollution and aiding climate change mitigation. However, solar and wind power must be combined entirely, with renewable bioenergy playing a vital role in the mix. In 2017, bioenergy accounted for nearly three-quarters of renewable energy use, and the use of advanced bioenergy technology is expected to quadruple by the middle of the century. Clean, renewable, and new bioenergy is an essential component of the energy mix for meeting global warming targets [14, Revised 2017, September].

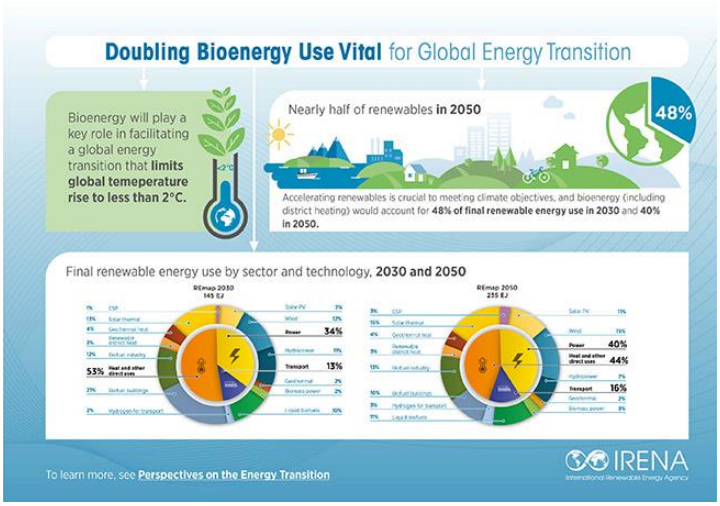

Figure 7. Doubling Bioenergy Use Vital for Global Energy Transition

1.2 Electric Vehicles

Electric vehicles (E.V.s) are essential in achieving global climate change targets. They play an important role in mitigation mechanisms that restrict warming to well-below two °C or 1.5°C, which is consistent with the Paris Agreement's goals. Nevertheless, although E.V.s emit no direct greenhouse gas emissions, they are powered by energy that is still primarily derived from fossil fuels in many parts of the world. Energy is also used in manufacturing the car – specifically, the battery. Carbon Brief offers a closer look at the climate impacts of E.V.s in response to recent inaccurate media coverage on the subject. According to Carbon Brief's study [12, Revised 2021, October 8]:

- E.V.s emit far less pollution over their lifespan than traditional (internal combustion engine) vehicles in Europe.
- In countries where coal is used to generate power, the advantages of E.V.s are lower, and they may have comparable lifetime emissions to the most powerful traditional cars – such as hybrid-electric models.

- Conversely, as countries decarbonize energy generation to meet their climate commitments, pollution for current E.V.s will decrease, as will processing emissions for new E.V.s.
- In the United Kingdom in 2019, the lifetime emissions per kilometer of a Nissan Leaf E.V. is roughly three times lower than those of the typical traditional vehicle, even before accounting for the decreasing carbon intensity of electricity production over the car's lifetime.
- Correlations between electric cars and conventional vehicles are difficult. They are affected by the vehicle's scale, the precision of the fuel-economy calculations, how energy emissions are measured, what traffic habits are inferred, and the conditions in the regions where the cars are used. There is no single calculation that extends to all situations.

The figure provided [12], adapted from an International Council for Clean Transportation (ICCT) study, indicates an approximation of lifecycle emissions for a traditional European conventional (internal combustion engine) car, the conventional hybrid car with the highest possible fuel economy (a 2019 Toyota Prius Eco), and a Nissan Leaf electric vehicle for different countries, as well as the E.U. average. The study includes tailpipe emissions (grey), emissions from the fuel cycle (orange) – which encompasses oil extraction, transportation, refining, and power generation – emissions from producing the vehicle's non-battery components (dark blue), and a conservative assessment of emissions from battery production (light blue).

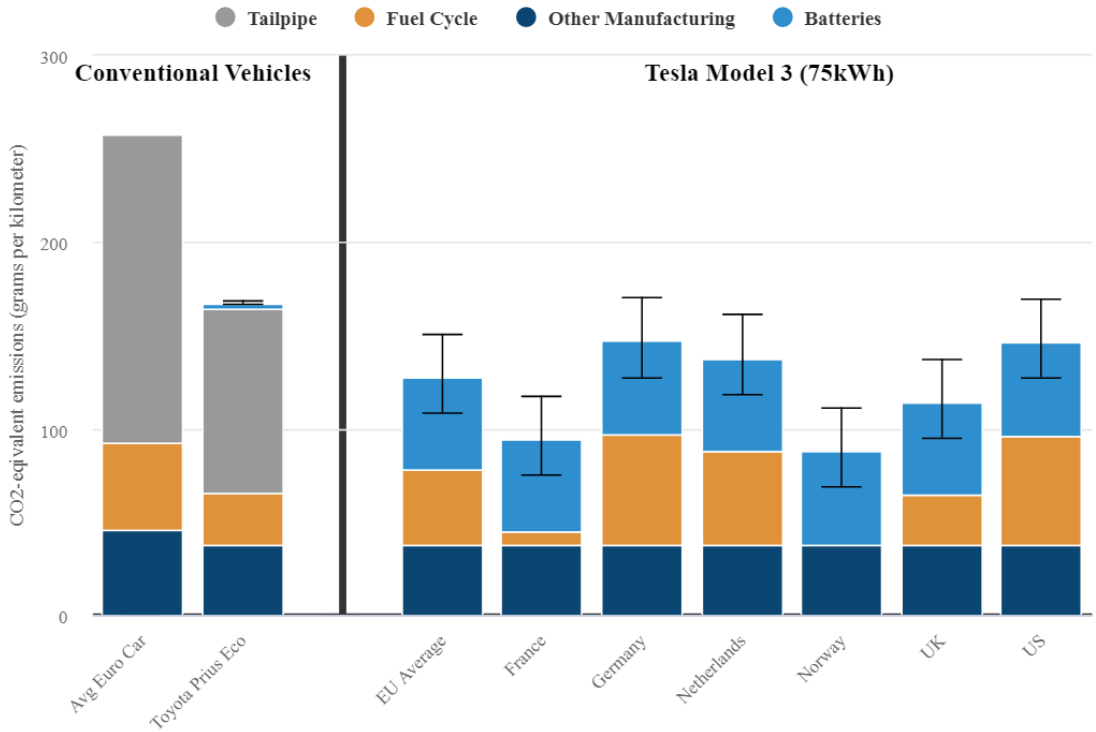

Figure 3. Lifecycle greenhouse gas emissions for traditional and electric vehicles (by country) in grams CO_2-equivalent per kilometer, estimating 150,000 kilometers driven over the vehicle's lifespan, for using a 75kWh battery

E.V.s mark a significant decrease in lifecycle greenhouse gas emissions as a comparison to the typical traditional vehicle in both the United States and Europe. This has been a consistent assumption in most studies reviewed by Carbon Brief [12, Revised 2021, October 8]. As Prof Jeremy Michalek, director of the Vehicle Electrification Group at Carnegie Mellon University, says that E.V.s is not a cure-all for climate change right now. Lifecycle GHG emissions from electric cars can be comparable to, if not higher than, those of the most potent gasoline or diesel vehicles [in the United States]. Electric cars would be superior to all traditional vehicles in almost all situations when energy generation becomes less carbon dependent – especially at the margins. There are inherent limits on how effective gasoline and diesel cars can become. At the same time, low-carbon energy and improved battery production performance can eliminate most manufacturing pollution and almost all electricity consumption emissions from E.V.s.

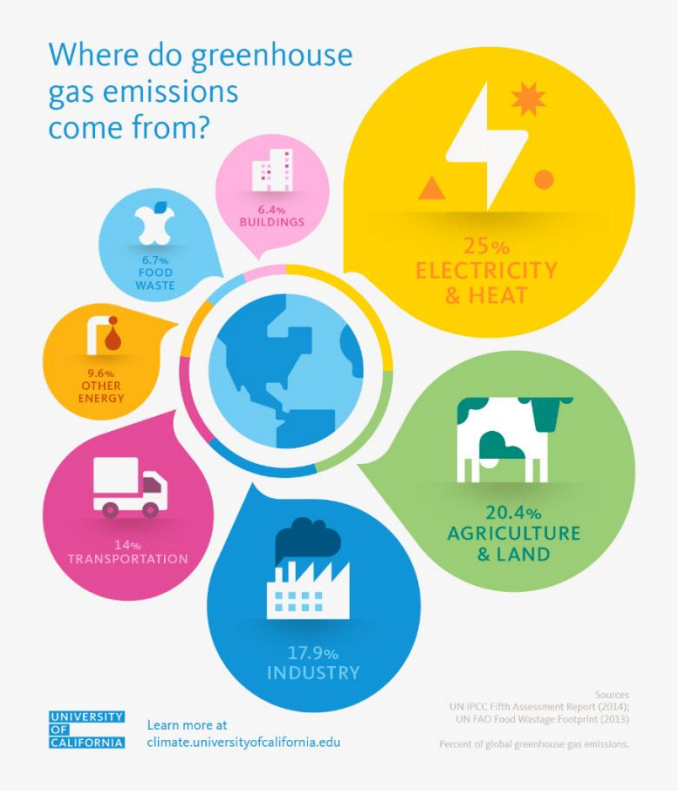

Figure 9. Where Do Greenhouse Gas Emissions Come From?

1.3 Led Lighting

Reduced greenhouse gas emissions (GHG) [23] have been a common global target in relation to various environmental effects of climate change. This has resulted in initiatives and programs that have had little impact on GHG reduction goals at the national level. As a result, assessing the impact of energy is critical for promoting public policy at the local level that can contribute to GHG reduction behavior. The average electricity used worldwide in 2007 was 600 EJ (1018 Joules), which is forecasted to triple by 2060; 30 percent of the total was used for electric generation activities, equal to 1.67x1014 kWh, resulting in greenhouse gases (GHG) that cause climate change. The overall global GHG emissions in 2011 were 42 billion metric tons, with electric generation accounting for 24 percent of total global emissions. Because the global economy relies on fossil fuels and public concern about climate change (CC), many governments have established public policies that encourage the use of clean energy resources and energy conservation. Fuel efficiency in street lighting is a critical technique that helps local councils to accomplish significant GHG reductions, particularly carbon dioxide ($C0_2$), at lower costs and faster payback periods. The goals of real street lighting construction include concerns for pedestrian and driver safety at night, as well as reducing violent incidents. New requirements for energy conservation and environmental effects are needed. Street lighting alone is estimated to surge 20% of overall electric energy emitted [10, Revised 2022, February 25].

To achieve the total energy usage for street lighting, the consumption recorded by CFE and Biogas de Juarez S.A de C.V. must be included, as shown in Figure [9]. The municipality collected and studied many LED street light plans from manufacturers. Among the considerations considered was its output in a field-measured circuit to check its electrical usage, independent laboratory experiments, financially and dependent on the consumption of electricity, the pollution of carbon dioxide equivalent ($C0_2$ e) to the environment, remote management system (which includes a range of computer and telecommunication technologies that enable remote control, energy metering, and GPS mapping of street lighting) [9, Revised 2014, October].

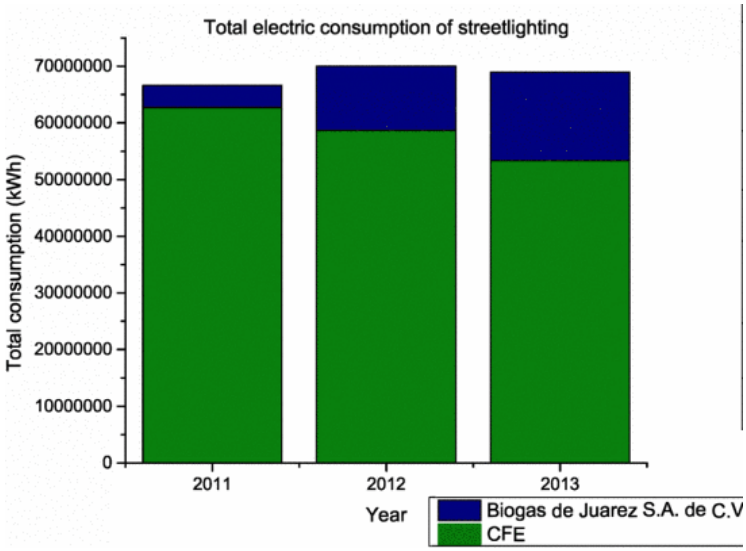

Figure 4. Total electricity consumption for street lighting in Ciudad Juarez, Chihuahua

Figure 11. Opportunities to Reduce Carbon Emissions in the Power Sector

LED bulbs [2] are the most environment-conscious for CFLs, incandescent, and LED bulbs, according to the Office of Energy Efficiency and Renewable Energy. They are eco-sustainable not only during use but also during packaging, transportation, and disposal. Because of the byproducts generated by the aluminum heat sink on the end of the bulb, CFLs pose a danger to the atmosphere when disposed of in a landfill. Sulfuric acid is emitted by the heat sink and cannot be disposed of in a typical landfill. LEDs are much cleaner for the ecosystem than CFLs when adequately disposed of. LED bulbs are often more energy efficient and last longer than other bulbs, with the average LED bulb lasting nearly 50,000 hours when using just 6-8 watts.

On the other hand, incandescent lamps have a lifespan of 1,200 hours and use 60 watts. CFLs outperform incandescent bulbs, lasting 8,000 hours and absorbing 13-15 watts. Fewer light bulbs would end up in the trash due to the transition to LEDs, resulting in less pollution. LEDs will also save money in the long term, and you will have to buy fewer bulbs in the longer term [7, Revised 2017, October 27]

1.4 Plant-Based Diet

We have mentioned several ways to confront climate change. Surprisingly, according to U.N. experts,' a plant-rich diet is one of the successful strategies to fight global warming. An international scientific group recently assessed, mapped, and

modeled responses to global warmings, such as handling refrigerants, constructing onshore wind turbines, eliminating food waste, and transitioning to plant-rich diets. Animal foods demand more energy, such as water, fuel, and soil, and lead to deforestation and habitat destruction than plant-based foods. Beef, for example, has a carbon cost of about 20 times higher per gram of protein than beans. More sustainable land-use activities, an emphasis on habitat restoration, and a move away from resource-intensive diets could all assist reduce pollution from industrial agriculture. For instance, planting plant-based foods such as dry peas and lentils in crop rotations allows the channeling of resources such as water, space, and fuel to increase food production, minimize agricultural pollution, and improve soil quality [11, Revised 2019, August 8].

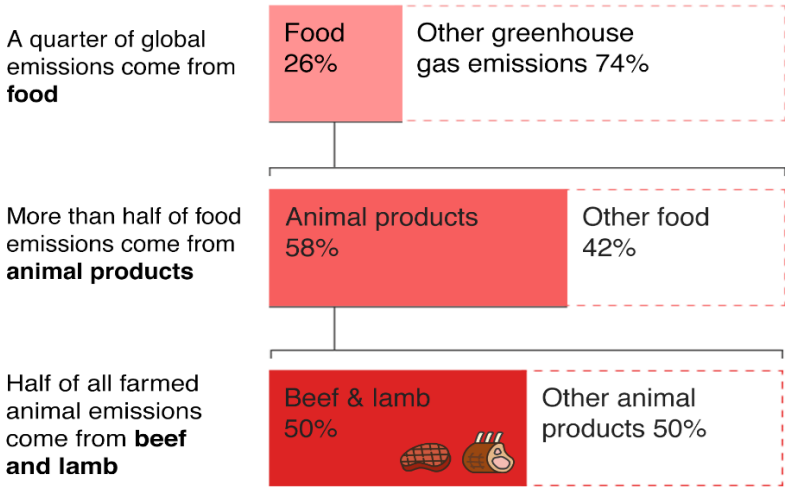

Figure 12. Proportion of Total Greenhouse gas Emission from Food

Climate change endangers the sustainability of our food supplies. Increasing temperatures, rising precipitation, and more severe weather conditions affect crops and livestock. However, food processing leads to global warming. Agriculture and forestry account for about one-quarter of greenhouse gas emissions. Livestock production leads to global warming not only through the greenhouse gas generated by the livestock but also by deforestation to increase pastures, for instance. The graph [11] presents the proportion of food's total greenhouse gas emissions.

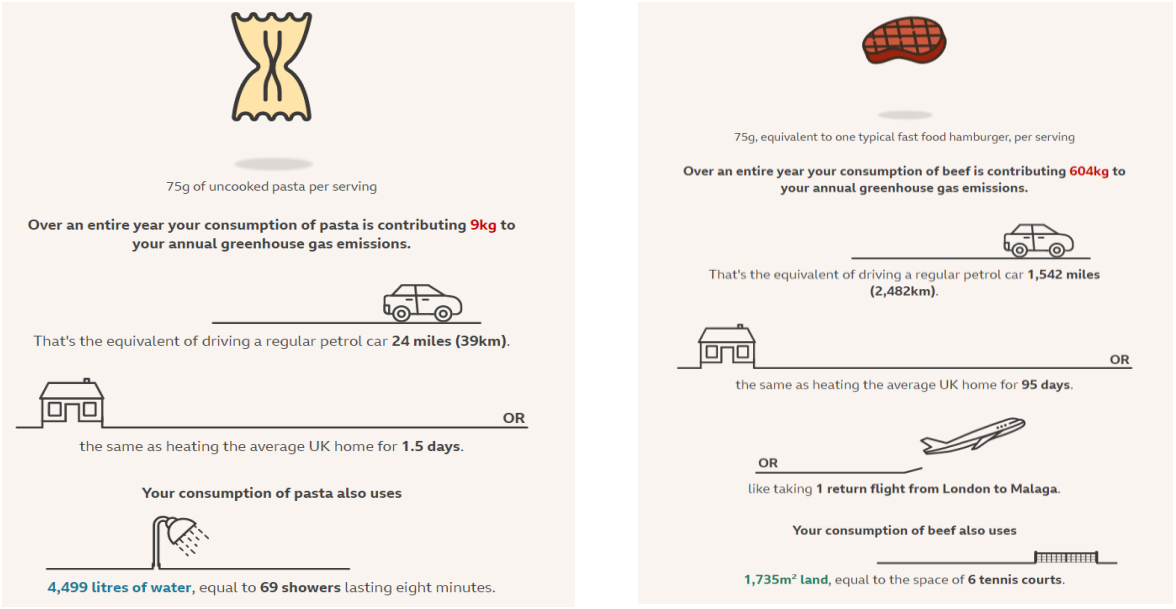

Figure 13. Relationship between food and Greenhouse Gas Emission

BBC [21, Revised 2019, August 9] enables readers to find out the climate impact of what we drink or eat. Users need to select food or drink and pick how often they have it. First-time "Pasta" and "1-2 time a week" was selected. To compare the results with meat, then "Beef" "1-2 times a week" was chosen. The results are shown below [21]:

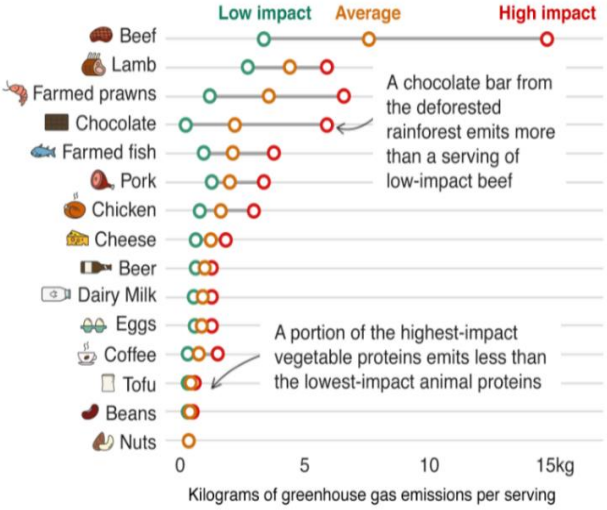

Figure 14. Kilograms of greenhouse gas emissions per serving

The equivalence numbers show a big difference in your environmental footprint based on plant-based and meat diets. Surprisingly, beef has the most extensive carbon footprint – but the same food can have various impacts. The graph shows kilograms of greenhouse gas emissions per saving [21]:

Consequently, Governments should implement policies and practices that promote more effective, ethical, and sustainable food production. Not only does this help mitigate pollution from food sources, but it would also ease some of the anxiety that many people are experiencing. Any states, businesses, and individuals have gathered together to promote greater development by imagining and articulating a Green New Deal for Canada. By implementing validated solutions to these pressing problems, we will collectively and personally heed the best of science while still pulling out the best of humanity.

2 Evaluations

2.1 LED Lighting

Implementation of Light emitting diode (LED) bulbs can significantly improve greenhouse gas emissions as such bulbs use less electricity. But they are not entirely safe for humans. According to Prakash [17, Revised 2017, August 31], LED lights are becoming widespread in India daily. Statistics show that light usage grew by 17.5 % in the Indian market between 2009 and 2016. But the negative impact of LED lights became distinct as well. The American Medical Association (2016) asserts that LED bulbs can negatively impact human health. In particular, such light is short-wave, which negatively affects our sleep cycle and circadian rhythm. Constant exposure or LED light can lead to itchiness and redness of the eye and cause damage to eyesight by increasing the chances of developing a cataract. 2014 in Environmental Health Perspective showed that rats' retina was injured due to the long-termed LED light exposure. Too much flickering and 100 percent dimming of LED bulbs is one of the primary causes factors headaches as they irritate the eyes and make the brain struggle.

That is why Light emitting diode (LED) is not the sole solution to the greenhouse problems and needs wise implementation to avoid possible harmful effects. They can significantly lessen electricity consumption but should be used in a limited way. Otherwise, by lessening the CO_2 emissions health of humans will be affected.

2.2 Electric Vehicles

Electric vehicles (E.V.) are one of the remarkable sources of improving climate challenges. However, according to the Norwegian University of Science and Technology Study, greenhouse gas emissions increased when coal provided E.V. with an electric supply. Because factories where electric cars are assembled also produce a lot of toxic waste and lead to an increase in CO_2 emissions.

The lifecycle impact of E.V.s is considerable while discussing this issue. Essentially, producing electric vehicles turned out to be more dangerous for the environment than conventional cars. The E.V.s involve numerous toxic minerals, among which aluminum, copper, and nickel are considerable. Their utilization increases the acidification effect and boosts the chances of ecosystem toxification. Another aspect

is the source of electricity used for charging the electric motors. In areas where fossil fuel is the leading source of electricity, electric vehicles are also provided with such energy. This causes the deterioration of the existing situation and increases greenhouse gas emissions.

However, electric cars are an excellent solution for Europe. They face a 10 % to 24 % reduction in global warming with the implementation of electric vehicles. The reason for that is the energy source used for charging electric cars. As Europe produces various environmentally friendly energy sources, it has significant benefits from E.V.s.

Besides manufacturing and charging, connected electric cars' lifetime challenges are also significant. If the electric car's longevity is around 100 000 km, the profits of E.V.s will be less in relation to petrol and diesel cars. It should have a lifespan of at least 200, 000 km to positively influence greenhouse gas emissions [1, Revised 2012, October 5].

Therefore, electric vehicles can have a massive positive impact on global warming if the source of energy, manufacturing, and longevity are evaluated adequately.

2.3 Renewable Energy

Renewable energy is a promising way of solving global warming issues. But it also includes some obstacles which limit the massive usage of renewable energy. First of all, the most challenging aspect is the cost. Even though renewable sources like solar and wind energy are low-priced to operate, their installation costs are too high. Typical price for solar system to install was nearly 2000$ / kilowatt (large-scale installations) and 3,700 $/ kilowatt (small-scale, housing systems). Another hurdle is the transmission infrastructure. Existing infrastructure was designed in the 20th century and was oriented toward fossil fuel energy; therefore, the transmission of energy produced by renewable sources demands extra effort. Moreover, barriers exist to entry market with renewable energy. As investors demand a huge amount of energy at the initial level, it is challenging to comply with their standards [18, Revised 2019, 26 June].

Therefore, renewable energy needs more attention and assistance from the government. The political influence can lead to positive results and increase the usage of renewable energy.

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