

ML Based Solutions for Greenhouse Gas Emission and Impacts on Leading Countries: A Preliminary Work

Saif Al Faied*, Mahin Islam, Raini Hassan

Department of Computer Science, Kulliyah of ICT, International Islamic University, Kuala Lumpur, Malaysia.

*Corresponding author: sfaied99@gmail.com

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Abstract—This literature review will serve as the basis for a preliminary work that is part of the project on the analysis of greenhouse gas emission and its impact on leading countries. The research's main tasks include taking accurate measurements, understanding how the greenhouse Effect works, identifying instances of it, and interpreting the results while taking into consideration all natural and artificial factors that have an impact on the climate and the earth's environment. It will provide an effort to address the core concern of greenhouse impacts. It also discusses SDG objectives and how it connects to this work, as well as providing a brief overview of climate action and its effects. A brief introduction describes the economic scale, economic structure, and technical level, impact categories on energy use and greenhouse gas emissions, application of machine learning approaches, contradictory results, the environmental cost of algorithms, and the impact of AI in literature reviews. The goal of the literature review is to provide an overview of the methodology and describe the important variables that list the major factors that influence how greenhouse gas emissions are reduced in the environment.

Keywords—Global-warming, Greenhouse Gas, Machine-learning, Algorithm, Time-series, SDG goals, climate action, renewable energy

I. INTRODUCTION

Each and every gaseous substance in the atmosphere has the capacity to take in infrared radiation and hence trapping and keeping heat in the atmosphere is referred to as a greenhouse gas. This causes the greenhouse effect, which contributes to global warming by raising the amount of heat in the atmosphere. For the last century, the temperature has been rising at an alarming rate. Moreover, people are responsible for more than 70% of the greenhouse gas discharge.

From figure 1, it is clear that more than seventy percent of the GHG emission comes from the energy sector [1]. Where transportation and industry sector leaks huge amount of GHG. Every nation on every continent is being impacted by climate change. It is harming people's lives and upsetting national economies. Weather patterns are shifting, sea levels are increasing, and weather events are becoming more extreme. It aligns with the SDG goal thirteen Climate action. This paper will work on theoretical analysis of greenhouse gas (GHG) emission for different countries. It is to analyse the data of GHG emission and bring light to the mass effect of greenhouse gas in our environment.

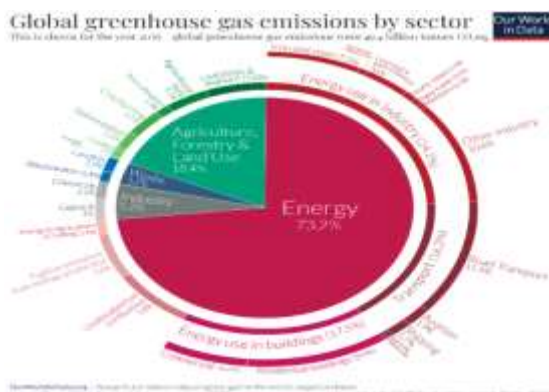


Figure 1: greenhouse gas emission by sector [1]

A. Problem Statement

This research paper attempts to address the fundamental issue of greenhouse effects. Wherein "greenhouse gases" confine heat at the Earth's atmosphere. It may be thought of as a layer of energy confining gases making the Planet warmer than it would otherwise be. Greenhouse gases generate major environmental and health issues, as well as climate change, by trapping heat and affecting many species in arid sectors. Climate disruption brought on by emissions of greenhouse gases exacerbates extreme climatic conditions, wildfires, droughts, and food shortages. As the world continues to generate large amounts of

greenhouse gases, weather patterns may shift, and certain animal species may become extinct. Greenhouse gases can also contribute to particulate air pollution, as well as respiratory and lung ailments.

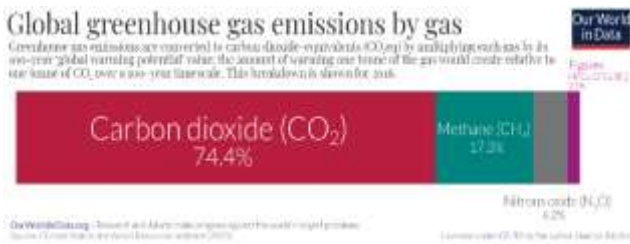


Figure 2: contribution of greenhouse gas [1]

Carbon dioxide, Methane, Nitrous oxide, fluorinated gases etc. are greenhouse gases (GHG) [1]. It is seen that climate change is caused by both natural and human factors. The first and most crucial point is that researchers have not "accused" the last century's worth of human actions as being the causes of climate change. After carefully examining the phenomenon, gathering data through precise measurements, analysing the data, and accounting for all the natural and human-made factors that affect the climate and global temperature, scientists have concluded that greenhouse gas emissions from humans are mostly to blame for the current warming.

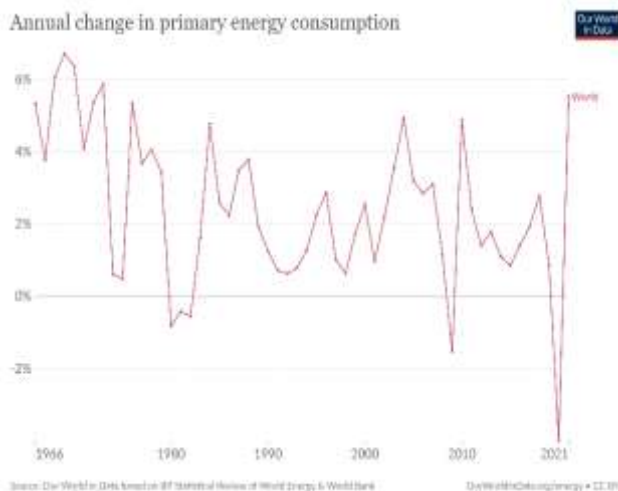


Figure 3: Annual change in energy consumption [24]

According to figure 3, the rate of energy consumption has been fluctuating. In recent years the use of energy has been gradually rising. Which is considered the main cause of GHG emission (73.2%) (figure 1) [1]. Furthermore, in the past few decades the emission rate of these gases has been increasing at an alarming rate.

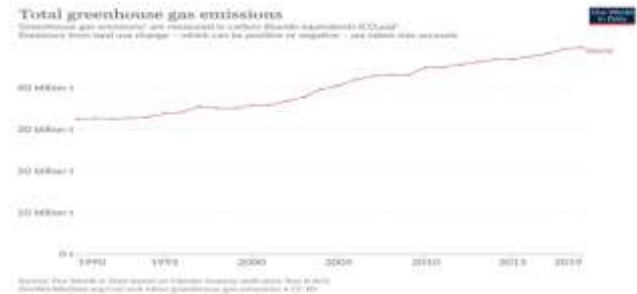


Figure 4: change in total greenhouse gas emission [1]

Greenhouse gas has reached its peak during this decade which accounts to more than 49 billion tons (figure 4). These gases have become out of balance, threatening to significantly alter which living creatures can live on this planet and where they can survive. The current world walks on the edge of the cliff. Without a proper estimation of the problem, it will be too late to turn around. Moreover, climate change is a long and versatile process, and these gases directly impact climate change. Not only stopping climate change is a time-consuming practice but also proper plans and placement is an absolute requirement. Without proper time and geographical prediction, it is difficult to plan for reduction of GHG emission.

B. Scope of review

The overall goal of the literature review is to analyse the current approaches of machine learning methods, variables, countries capabilities or limitations while researching machine learning, estimates, and results regarding energy consumption, ecological pollution, and greenhouse gas emissions.

The main objective is to combine the key findings from research on the project's analysis of greenhouse gas emissions and their impact on different nations using visualizations and to describe what they have done and the studies' limitations.

C. Significance of Project

This project involves one of the greatest threats for humanity: climate change. With the help of this research, the effect of climate change can be visualized. Which will be a great assistance for scientists, researchers, environmentalists and many more. Most importantly it will draw the attention of the country-specific Governments and many NGOs. Which may hopefully change the current down grading trend of the environment.

II. LITERATURE REVIEW

A. Theoretical background

This Literature Review is subdivided into six topics: Describes the ways of economic scale and economic

structure and technical level, Impact categories on energy use and greenhouse gas emissions, Use of Machine Learning (ML) approaches, Contradictory results, Environmental cost of algorithms, the influence of AI.

1. This section briefly explains the approaches of economic scale, economic structure, and technical level.
2. Here, effect categories establish a connection between the use of renewable energy and environmental degradation, serving as a link between the literature on the rise in energy usage and the Environmental
3. This section on the effect of ML techniques on literature on energy and environmental issues is a very recent addition.
4. The section on impact research applied a variety of methodologies and generated results that were contradictory.
5. Section on impact discusses how much an algorithm costs the environment.
6. Section on impact shortly describes the influence of AI.

B. Problem case related with SDG

The Sustainable Development Goals (SDGs), commonly referred to as the Global Goals, are a collection of 17 interrelated global goals that are intended to act as a blueprint for peace and progress for all people and the environment in the future. Among them goal 13 represents climate actions. It identifies the impacts of climate change and introduces crucial steps to prevent it.

According to scientists, the strength of this warming impact depends on the concentration of carbon dioxide and other climate gases. The impact increases with the amount of greenhouse gases. Environmental systems generate the majority of carbon dioxide. Furthermore, the unprecedented and rapid rise in carbon dioxide over the last few decades has coincided with an increased use of fossil fuels for energy, which also produces carbon dioxide. Due to this, human activities are the explanation for the increases in greenhouse gases and subsequent increase in atmospheric temperatures. According to the well-established concept of climate change, human activities like burning fossil fuels, deforestation, and the production of the artificial greenhouse gas emissions are to blame for the increase in carbon dioxide and other greenhouse gasses. Since there is a high proportion of carbon dioxide, the heat produced by the greenhouse effect cannot escape the atmosphere as quickly, resulting in an increase in global temperature.

C. Description of Literature Review

The three key elements harming the climate are economic scale, economic structure, and technical level.

Overall performance of the economy is evaluated on the economic scale; stronger employment output means increased pollution. Because economic expansion necessitates increased resource investment and energy use, this is the case. The structure of the economy is the structure of the industries. Emissions would be reduced as the industry structure changes. As the economy develops, the proportion of secondary industries, particularly energy-intensive industries, will decrease, while energy usage rises, reducing pollution. As technology advances, adaptive reuse will become a reality, and power consumption will be reduced. The first set of research looked at the relationship between CO₂ emissions, economic growth, and energy use. An Environmental Kuznets Curve (EKC) is a popular tool for discussing the relationship between pollution and economic growth, which is also the most used way of analysing the relationship between CO₂ emissions and economic growth [2]. Environmental Kuznets Researchers have noted growth in the economy in developed nations and the tilted U-shaped relationship between environmental damage, knowingly or unknowingly, as advanced countries adjust economic structure and energy usage structure to achieve a quick speed of the inverted U-shaped path, the overall environment protection deteriorated prior to improving as economic expansion build-up [2]. Power consumption has a negative influence on economic growth, income growth has a negative impact on CO₂ emissions, and CO₂ emissions have a significant effect on economic growth [3]. Economic expansion in Asia does not result in CO₂ emissions. However, there is a loop causation between economic expansion and carbon pollution in the Caribbean and Latin America. Given limited resources, technological advancement is the most key factor for long-term economic success. Changes in technology have a beneficial impact on energy efficiency and a negative impact on energy intensity [2, 5 & 6]. Ang used the framework to conceptually combine modern growth to assess the function of R&D activities and technological progress in pollution reduction [4]. Technology advancement is the product of R&D expenditure, which helps to reduce energy intensity [7]. In the paper [8, 9] utilized Antweiler's framework to analyse the factors that affect CO₂ emissions. GDP, industrialization, and free trade all have a favourable impact on CO₂ emissions, according to the study, but autonomous research and innovation and technology import also help to reduce CO₂ emissions.

Analysing the relevant literature can help us learn a lot. The link between renewable energy consumption and environmental deterioration serves as a link between the works of literature on energy usage growth and the Environmental Kuznets Curve (EKC). Moreover, a few articles looked at the causal relationship between coal,

economic activity, and pollution in China and India, but none of them included the United States. Individual renewable energy sources are still used in a small amount of research. For a selection of chosen countries analysed the causal connection between CO₂ emissions, nuclear energy use, alternative energy usage, and economic expansion [12]. Findings from a panel Error Correction Mechanism (ECM) utilizing data from 1984 to 2007 revealed a substantial positive relationship between CO₂ emissions and renewable energy consumption. Additionally, the panel's Granger causality test showed that using renewable energy did not help to reduce CO₂ emissions. On the other hand, the authors discovered evidence that supports nuclear energy as a fundamental driver of air pollution reduction.

The use of Machine Learning (ML) approaches in the literature devoted to energy and environmental issues is relatively new. It arose as a response to complicated situations. Demand algorithms capable of depicting strong causal relationships using data obscured by statistical procedures are standard. However, the number of ML procedures that can be used is vast. diversified. As a result, while certain models have been used to investigate causal relationships, others have not. It has been used to predict the outcome of a situation. In [13] used a tree-based methodology to solve their problem. determine the future trajectory of Indonesia's energy demand. In [14] it was predicted that improving the effectiveness of electricity consumption leads to faster increase in average per capita inclusive wealth for 104 nations using a boosted regression trees (BRT) technique. Mele and Magazzino used the Causal Direction from Dependency (D₂C) method to investigate the link between economic growth, pollution, and COVID-19 fatalities in India [15]. They used a Long Short-Term Memory (LSTM) approach to investigate the relationships between China's iron and steel industry, air pollution, and economic expansion [15]. Eventually, further cutting-edge machine learning processes have lately been deployed on a variety of challenges. Magazzino used Artificial Neural Networks (ANNs) studies to investigate the connections between nuclear energy usage and productivity expansion in Switzerland [16]. In addition, Cogoljevi used ANNs to predict GDP from an international standpoint depending on the mix of energy resources [17,21]. In France, Magazzino used the D₂C and ANNs frameworks to predict threshold air pollution levels linked to COVID-19-related mortality [16]. In a rather different way, Mardani used the Adaptive Neuro-Fuzzy Inference System (ANFIS) model to estimate carbon dioxide Journal Pre-proof emissions for 20 countries [18]. Such new techniques, on the other hand, were used to estimate radiation from the sun for the goal of maximizing the usage of solar Photovoltaic energy. For example, Karasu and Altan suggested a high-performance solar radiation identification

system based on random forest (RF) and a feature selection method to deal with highly nonlinear time series [22]. Liu and Ghoddusi provide an overview of the machine learning models used to create energy consumption prediction (2019) [10,11]. More specifically, a review on machine learning methods employed for the purpose of electricity forecasting can be found in [23]. Significant issues appear from this research review's overall conclusion.

First, research used a variety of approaches and produced contradictory results. Panel estimate methods (DOLS, FMOLS) were utilized in some studies, whereas time series cointegration and causality techniques were used in others (ARDL, VECM, GC, TY). Finally, to illustrate casualties across energy, economic, or environmental variables, a few significant articles used Machine Learning (ML) approaches. However, neither renewable energy nor coal research have used such novel methodologies to conduct their assessments in the past. This necessitates deeper investigation into that hotly debated topic utilizing a fresh approach. Second, studying the literature on coal, economic growth, and environmental contamination is instructive. Above all, just a handful of published research for both India and China investigated the causal association among coal usage, income, and CO₂ emissions. Meanwhile, they also included the United States in their analysis. Furthermore, some studies examined the correlation between renewable power use, income, and CO₂ emissions in China, India, and the United States, but they included one or more of these nations within large and varied samples (i.e., G-7, BRICS, and OECD countries) [20]. Third, while a few studies have looked at the connections between different renewable resources and economic growth, only a few have included greenhouse gas emissions data in their analysis. Additionally, hydropower and biomass energy were virtually always included, obviating the need for other fundamental renewable energy sources. We further noted that no study has looked at the causal link between solar and wind energy, economic growth, and Carbon intensity until recently [19]. As a result, research exploring the association between solar and wind energy, economic growth, and environmental pollution in China, India, and the United States are lacking. This paper applied an innovative estimating technique, the Causal Direction from Dependency (D₂C) algorithm, from a methodological standpoint (ML).

When an algorithm's environmental cost is reduced, increasing efficiency might have a variety of advantages. As a result, we highly urge it and regard techniques required as one of the most fruitful and immediately identifiable key activities of green computing. While speed is an evident efficiency benefit, storage conservation is also a component of algorithm improvement. The storage power draw is

mostly determined by the amount of storage accessible, not the amount of memory used and the amount of memory available is the maximum memory required for one stage of the algorithm, typically a merger or aggregation. It is simple to cut power usage by improving these stages. In Japan, the technology is already being used to predict catastrophe warnings, analyse tropical deforestation, and develop greener, smarter cities in China. AI applications could also contribute to the development of many more emission structures, the improvement of power storage, and the optimal integration of renewable power by injecting wind and solar power into the network as required. On a lesser scale, it might help homeowners save energy by turning off lights that aren't used or transferring power from powered mobility back into circulation to fulfill expected demand. Including a recent study conducted for Microsoft, which is developing machine learning products for the global warming sector, the innovation might help lower emissions of greenhouse gasses by 4% by 2030. The system is "pushing back frontiers" for climate modelling, according to Peter Clutton-Brock, co-founder of the Centre for Intelligence and Climate (CAIC), a British think tank. He told the Thomson Reuters Foundations that AI can handle large volumes of unstructured data such as photos, graphs, and maps, presenting "great opportunities for understanding the dynamics underlying sea level rise and ice sheets."

Finally, whether AI is controlled beyond borders may influence whether it is used to fight global warming. According to Dignum, who served on the European Commission's High-Level Expert Panel on AI Technology last year, privacy policies are "particularly peculiar to the sort of device that we are employing at this time. If we add other sorts of algorithms which are less sensitive to confidential information, the trade-off between power consumption and confidentiality becomes less of a problem," she explained. She noted that such algorithms would soon be "as efficient" as the ones currently in use.

III. METHODOLOGY

We followed the typical data-science lifecycle for our study. We used a variety of visualization packages, including matplotlib, Plotly and others. Basically, it is data collection, data-pre-processing, data modelling and data evaluation and finally result visualization.



Figure 4: diagram of the Methodology

For this experimentation we used the dataset of Greenhouse Gas emission of different countries around the world from 1990-2018. The data of GHG emission is collected from Climate watch. The dataset contains 196 rows and 35 columns. Containing 5460 data of Greenhouse gas emission for 195 countries around the world.

The datasets that will be used are first examined and, if necessary, cleaned. To ensure that the datasets were appropriate for testing, many data cleaning processes were performed. The data cleaning operations that were done using tools (Google collab) are depicted in the diagram below.



Figure 5: process of Data cleaning

At first, the dataset is loaded in Google collab. Then, it is checked for missing and duplicate values. For this project among 195 countries, we selected 6 countries data. This dataset does not have any missing values, however there are many redundant rows and columns. We deleted the rest of the data for better analysis. As we want an accurate result, we only want the completed version of the dataset with no missing information. Furthermore, the data are collected as an integer value so, we checked the data for accurate value resulting in more accurate dataset.

IV. CONCLUSION

Human population causes climate change and global averaged heat, according to climate prediction analysts. According to Richard, which can be assumed almost certain that it is going to continue getting warmer in the tropics, but it is unsure of the upper bounds on plausible rates of warming, while predicting for all other aspects of climate are strongly model-dependent [25]. This can be reduced by taking extensive measures to prevent an increase in global temperatures in terms decreasing GHG emission. Through the literature analysis it is found that various stages of greenhouse gas emission and their effects on leading countries and various types of information were analysed, it is challenging to compare objectively the findings from numerous research. While this research paper has finished the literature review, data collection, and data pre-processing for the current progress. The model will be finished for upcoming work completing the performance measurements, model validation, and data visualization which will provide a better visualization on GHG emission.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of Interest

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