**ANL488 PROJECT PROPOSAL**

**Are The Top Greenhouse Gas Producing Countries and Industries** **on track to achieve Net Zero Emissions by 2050?**



**Submitted by**

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# **Introduction**

Reduction in carbon emissions and the slowing of Greenhouse Gas (GHG thereinafter) effect has become the consensus throughout the world. This is evident as countries around the globe have signed several climate agreements to alleviate the greenhouse effect. As early as 1992 (Jacqueline Noga, 2013), the United Nations Conference on Environment Development formulated a convention to reconcile worldwide economic development with the protection of the environment. The year 2015 was a witness to the signing of the Paris Agreement with representatives from more than 200 countries. According to the agreement, the international community are to cooperate towards restricting the increase in global average temperature to well below 2 °C. The target is to limit to a temperature of 1.5 °C above pre-industrial levels from 1850-1990. The goal is to stave off severe climate disruptions that could exacerbate hunger, conflict, and drought worldwide. (Gao, 2016) To ensure that the temperature rise is not higher than 2 °C, developed countries collectively should reduce emissions by 25–40% below 1990 levels by 2020, while developing countries' emissions need to be reduced by 15–30%. (Michel Den Ezlen, 2010)

In this paper, the aim would be to identify: 1) the top 5 and bottom 5 countries and industries contributing to GHG emissions 2) the relationship between GHG emissions and financial impact towards the economy 3) forecast of GHG and the selected financial indicators to assess if the 2050 goal of Net Zero Emissions is truly on track based on historical trend.

The consequences of missing the Net Zero target are immense. There was plenty of tangible evidence recorded over the past centuries, revealing dramatic climate changes. The surge in air and ocean temperatures, rise in sea level, widespread melting of ice glaciers, increased happenstances, and intensification of extreme weather. (Hughes, 2000)

These are due to greenhouse effects, which is the trapping of the sun’s warmth of a planet by gases in the atmosphere. The causes of the greenhouse effect are as follows: in the process of the usage of combustible minerals in industries - coal, oil, natural gas, a huge amount of carbon dioxide and other harmful compounds are emitted into the atmosphere when burned; different modes of transportation – vehicles emit exhaust fumes that also pollute the air and enhance the greenhouse effect; deforestation and manmade forest fires, the removal of trees that converts carbon dioxide into oxygen, and with every tree that falls, the amount of CO2 in the air increases. The increase in population directly increases the demand for food, clothing, and housing. Correspondingly, to fulfil the ever-growing demand, industrial production is mounting, which in turn pollute the air with greenhouse gases. (Levin, 2012; Li, 2017; Lisin, 2020). All of the above contributes to the increase in greenhouse gas emissions.

Since the Earth already reacts violently to slight changes in the amount of CO₂, methane and other greenhouse gases in the atmosphere, emissions of these gases must be reduced until the whole system is back in balance again. Net-zero emission refers to the process of removing man-made greenhouse gas emissions to be carbon neutral to stabilize the global temperature. The U.N. climate science panel has announced man-made carbon dioxide emissions must fall by about 45% by 2030, from 2010 levels, and reach "net zero" by 2050 to give the world a good chance of limiting warming to 1.5C and avoiding the worst impacts of climate change.

This brings us to the question, are we on track to achieving net-zero emissions by 2050? What happens if we do not? The impact on the world will be catastrophic. At the present rate, global temperatures would have increased by 1.5°C around 2040. (IPCC, n.d.)   
Chart

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Credit: IPCC  
  
Going above 1.5 degrees of global warming puts millions more at risk of potentially life-threatening heatwaves and poverty. Examples of disasters previously unseen are happening all around the world. In 2019 in Pakistan, a heatwave took temperatures above 43.3 degrees Celsius and cost 65 lives in one city alone. Europe also experienced an unprecedented summer, with temperatures soaring above 46 degrees Celsius in Portugal. What is worrying is that the same heatwave went on and roasted countries across the continent, breaking records and costing yet more lives.

As compared to a 1.5 °C world, 2°C would result in:

* 1.7 billion (13.8%) more people would experience severe heatwaves at least once every five years.
* Seas rise on average another 10 centimetres
* Up to several hundred million more people become exposed to climate-related risks and poverty.
* The coral reefs that support marine environments around the world could decline as much as 99 per cent.
* Global fishery catches could decline by another 1.5 million tonnes.

(IPCC, n.d.)

According to an IPCC report, “these emissions alone are unlikely to cause global warming of 1.5°C (medium confidence).” This means that the world still has a chance of maintaining at 1.5 degrees and keeping what is already a climate crisis affecting millions from becoming a climate catastrophe. Therefore, countries and industries must cut fossil fuel emissions in half by 2050 to achieve the goal of 1.5°C.

In this study, the time series Autoregressive Integrated Moving Average (ARIMA thereinafter) model will be used to analyse and forecast GHG emissions trends and financial trends in the next 50 years to identify if the top GHG producing countries and industries are achieving net-zero emissions target by 2050. (888 words)

# **Literature Review**

## **The misconception of sustainability objectives towards financial targets**

From a company’s perspective, the overarching goal would be to maximise shareholder value. In theory, this should require firms to take a long-term view to deliver the necessary results, but in actuality, most firms adopt a short-term perspective (Dominic Barton, 2014). There is extensive academic literature that shows how executives will act in a short-term manner when offered incentives that reward such behaviour (Marginson and McAulay, 2008; Marginson et al., 2010). Misaligned compensation systems result in executives making decisions that do not adhere to the vision of creating long-term shareholder value (John R. Graham, 2005) There is also a body of academic findings on investor pressure to generate fast, high returns (Bhojraj et al., 2009; Ernstberger et al., 2011), contributing to the short-term time horizon of public firms (Zellweger, 2007). In addition, businesses have this misconception that the more environment-friendly they become, the more their competitiveness gets undermined. They believe that it will add to costs and not produce immediate economic benefits. (Ram Nidumolu, 2009) shared the concerns from CEOs, particularly from the United States or Europe, that making operations sustainable and developing “green” products places the company at a disadvantage in comparison with rivals from developing countries that don’t face the same pressures. Suppliers are also unable to provide green inputs or transparency; sustainable manufacturing will require new equipment and processes, and customers will not pay more for eco-friendly products during a recession. These are why most executives treat the need to become sustainable as corporate social responsibility, instead of merging with the business objectives.

Executives feel that they must choose between social or financial benefits, but that’s just not true. Becoming environment-friendly reduces costs because companies end up lowering the inputs they use. Furthermore, the process generates additional revenues from better products (Ram Nidumolu, 2009) If a firm were to adopt the sustainable business model in the long run, it would reinforce resilience, reduce risk, boost sales, enhance brand value, and create a corporate culture that attracts investment. Having firms pioneer and take the lead with sustainable goals on their agenda sets benchmarks for competition. With customer appreciation of practices leading towards sustainability, the ‘green marketing’ effect can give a firm competitive edge which the competition cannot ignore over the long run (Dinuk Arseculeratne, 2014). This would shift the market in the right direction as the cost curve for sustainable technologies and strategies would become flattered. Examples of leaders in the field are diverse and aplenty: Google, Wal-Mart, Apple, Facebook are such examples that have committed to power their direct energy usage from 100 per cent renewable sources (Gade, 2017). In 2013, Microsoft was a pioneer in assigning an internal price on their carbon emissions which resulted in a reduction of 9.6 million tonnes of CO2 and has inspired 1,200 firms to follow suit (Microsoft, 2018).

Furthermore, there is existing empirical research on the relationship between environmental and financial performance. They have tested extensively on a wide range of environmental performance indicators against financial measures over the last decade and found that environmental performance is highly correlated with financial results. Specifically, empirical studies have found that companies that scored well according to independent environmental criteria have realized stronger stock price gains than the S&P 500 overall – and companies that scored poorly have had weaker returns. (Murphy, 2002)

## **Concept and Barriers of Sustainability**

The policy concept of sustainability first appeared in the Brundtland Report of 1987. The Brundtland Commission aimedto help direct the nations of the world towards the goal of sustainable development. That document was concerned with tensions between the aspirations of mankind towards a better life versus the constraints imposed by nature. Over time, the concept has been re-interpreted as encompassing three dimensions, namely social, economic, and environmental (Tom Kuhlman, 2010) The essential point, according to this broad concept, is that sustainability is about achieving results related to all three dimensions, and achievement in any one pillar should not be realized by sacrificing other aspects.

Mandatory emission reduction may have higher significant effects on the economies of developing countries and regions. The macro-economic costs may be higher due to their economic development stage and energy-economy characteristics. The mining industry, oil industry, chemical industry, and metal smelting industry have a high potential to lessen their CO2 emissions. (Ying Fan, 2010)

Alvarez Jaramillo identified a total of 175 barriers to sustainability for SMEs in European countries. The barriers that appeared with most frequency in the studies were lack of resources, the high initial capital cost in implementing sustainability measures, and lack of expertise. (Alvarez Jaramillo, 2019)

Other barriers to sustainability to note could be the price of products being driven up due to paying a premium price for switching to using green materials. These increases in costs will either be passed along to customers in the means of higher prices or at the company’s expense by having a smaller profit margin. The financial payback period might also be longer than other projects that go with the traditional route rather than green.

To alter a corporate infrastructure can be a colossus and an expensive feat. The bigger and older a company is, the harder the task. If it’s a startup, sustainability can be introduced relatively easier considering the systems and infrastructure are still not fully established. If it’s an established corporation, it’s an overhaul that could take years.

(Elliott, 2013) noted that universities are ideally suited to sway prospective leaders about the lens and importance of sustainability. Unfortunately, while concepts on sustainability have been increasingly integrated into universities in recent years, it is questionable whether the change is happening fast enough. However, it is heartening to see an increasing number of Canadian universities getting involved towards the path of sustainability in Higher Education or international agreements such as the Talloires Declaration. The rate of integration of sustainability in universities is not as quick as expected due to several obstacles, such as misunderstandings, lack of shared vision, lack of rankings of activities and lack of financial resources.

(Brandli, 2015) also identified several obstacles to educating sustainability in Brazilian universities, with many barriers identical to the findings for the Canadian universities. To list a few not mentioned earlier is a lack of government policies to encourage the implementation of education for sustainability and sustainable practices on campus, lack of resources or funding available for sustainability projects and lack of staff that can implement and oversee these sustainability efforts.

For innovation and sustainability to be promoted, they must be rooted in social culture and university awareness (Segovia, 2002) Innovation, sustainability, and universities are closely related. The competitiveness and productivity of a nation depend on an educated workforce. A worker with little formal education can only perform simple manual tasks and finds it almost impossible to adapt to complex production processes and techniques. Consequently, the absence of adequate educational processes restricts the development of sustainable businesses, making an upheaval task to produce more sophisticated or value-added products (Lucas Veiga Ávila, 2019)

## **Earlier literature and research that uses ARIMA time series analysis to assess GHG emissions and projection of GDP**

Analysing time series data involves applying different statistical methods to identify trends, seasonal fluctuations, cyclical patterns, and irregular changes. Forecasting is the process of predicting future events based on historical data. When forecasting is performed on time series data, it is regarded as time series forecasting.

Previous studies from different countries employed ARIMA modelling to forecast GHG emission and energy consumption through time series.

To project energy-relevant CO2 emissions in the U.S., Silva (2013) uses multiple forecasting approaches such as Holt-Winters, ARIMA, and exponential smoothing.

Tudor (2016) employs seven Automated Forecasting Methods to forecast the evolution of CO2 emissions in Bahrain between 2012 and 2021, including Holt-Winters, ARIMA, the BATS/TBATS model, exponential smoothing state-space model (ETS), the naive model, the structural time series model (STS), and the neural network time series forecasting method (NNAR). Ang et al. (2013) project CO2 emissions in Malaysia with the use of ARIMA modelling. Lotfalipour et al. (2013) applied ARIMA to predict CO2 emissions in Iran. Likewise, Liu et al. (2014) did the same for emissions in China. Sen et al. used ARIMA to forecast the energy consumption of an Indian Pig Iron manufacturing company, the results appeared smoother and improved greatly compared to the seasonal random trend model. (Sen P., 2016) The ARIMA model could be adjusted to follow the characteristics of self-similarity, periodicity, suddenness, and trends, enabling improved performance in short-term forecasting (Cui Z., 2015). So, this model has been applied broadly throughout other critical industries, such as public transport, metal prices, and the assessment of health care structures (Onasanya O.K., 2014) (Ediger V.Ş., 2007)

(Wabomba, 2016) applied ARIMA modelling on the data from the Kenya National Bureau of statistics with the period from 1960 to 2012 to forecast the Kenyan GDP. The results indicated that the predicted values were within 5% of the actual numbers. It proves that the forecasting strength of this model was sufficient and effective towards predicting the future values of the Kenyan GDP. (Annie Uwimana, 2018)used the ARIMA model on the top 20 of Africa's industries to forecast future GDP indicators. Judging from estimated results, there would be a steady increase in GDP, whereas the average rise of the economies of Africa will be at 5.52%. (Mohamed Reda Abonazel, 2019) found that the appropriate statistical model for forecasting the Egyptian GDP is ARIMA (1, 2, 1), and was used to forecast up to the year 2026. According to the forecast, GDP is expected to continue rising. After reviewing prior works of literature which achieved success towards generating estimates close to actual values with ARIMA, this study will continue to use the same ARIMA methodology but incorporating both GDP and GHG indicators for comparison to identify the relationship between the two factors.

As the time series forecasting method has been used extensively in different fields, it has been generally accepted in academia.  (1649 words)

# **Data Understanding and Preparation**

Data preparation consists of the following steps: Data extraction, cleaning of data, formatting of data and combination of data before any analysis can happen.

This study aims to compare the trend of GHG against the financial performance of countries and industries. Hence, in this report, two datasets are used for analysis.

One would be the greenhouse gas emissions dataset from Climate Watch, an online platform designed to empower people with the open climate data required to gather insights on national and global progress on climate change. (Climate Watch, 2022) It brings together dozens of datasets and compare the Nationally Determined Contributions (NDCs) under the Paris Agreement and allows individuals to access historical emissions data. The dataset extracted consists of all 195 countries in the world, the types of greenhouse gas emitted, the unit of measurement for the gases, the sectors producing the greenhouse gases and the amount of greenhouse gas generated. The period of the data is from 1990 to 2018.

As the raw data has every year split into a column on its own, it would be difficult to perform analysis with this. Hence, cleaning of the raw data would be required.   
Table

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For analysis, the data should have all the years as one column as per the example shown below.   
Table

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After which, there are some data transformations upon ingesting of the data, such as ensuring the data types of each column are correctly listed, e.g. Gas Emitted should be decimal data type instead of text.

The second dataset extracted would be from the World Economic Outlook database that is managed by the International Monetary Fund. They are “an organization of 190 countries, working to foster global monetary cooperation, secure financial stability, facilitate international trade, promote high employment and sustainable economic growth, and reduce poverty around the world.” (International Monetary Fund, 2022). The dataset consists of the same 195 countries in the world and 7 different indicators relevant to Gross Domestic Product (GDP). The period of the dataset would be from 1990 to 2026.

Since the datasets are available, the remaining steps would be to clean, format and lastly, combine the data.

As both datasets are at a country–year level, they can be joined by creating a unique id by concatenating the country and year for both datasets and joining by this particular column. (385 words)

# **Proposed Modelling and Evaluation**

The proposed modelling would be to use time series analysis with ARIMA modelling to perform forecasting from 2019 to 2050, with visualizations in either Python or Power BI to show the historical trends from 1990 to 2018. (37 words)

# **Proposed Schedule**

|  |  |
| --- | --- |
| **Dates** | **Activities** |
| 7th March | #3 Meeting with Supervisor - Data prepared for analysis and modelling  - Visualizations to be created for storytelling |
| 14th March | Completion of Chapter 4 and 5 (Discussion, Recommendations) |
| 21st March | Project Oral Presentation |
| 11th April | #4 Meeting with Supervisor - Revision on project final report |
| 4th May | 5th Meeting with Supervisor - Revision of project final report |
| 9th May | Project Final Report Submission |

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