

Analysis of the Impact of Energy Use on CO₂ Emissions: Before, During, and Post-Covid-19

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ABSTRACT

Since the beginning of the COVID-19 pandemic, social activity restrictions have influenced human energy usage patterns, thereby impacting CO₂ emissions. Therefore, this study analyzes the impact of changes in energy usage patterns during specific periods on CO₂ emissions. The research method involves analyzing data before, during, and after COVID-19. The analysis in this study discusses the impact of energy usage on CO₂ emissions, particularly the transition from fossil energy to renewable energy, as well as an analysis of energy consumption, the availability of energy sources, and the effects of fossil and renewable energy usage. The results of the study show a significant change in energy consumption patterns before, during, and after COVID-19. During COVID-19, CO₂ emissions experienced a significant decrease compared to before the pandemic. This reduction can catalyze energy transition, as reserves of oil and natural gas in Indonesia may be depleted in the coming years. Shifting to renewable energy can reduce CO₂ emissions and help slow down climate change. Additionally, the unlimited availability of renewable energy makes it a sustainable source.

ABSTRAK

Sejak dimulainya pandemi COVID-19, pembatasan aktivitas sosial telah mempengaruhi pola penggunaan energi manusia dimana mempengaruhi dampak pada emisi CO₂. Oleh karena itu, dalam penelitian ini dilakukan analisis dampak perubahan pola penggunaan energi selama periode tertentu terhadap emisi CO₂. Metode penelitian melibatkan analisis data sebelum, selama, dan pasca COVID-19. Analisis dalam penelitian ini membahas dampak penggunaan energi terhadap emisi CO₂, terutama transisi dari energi fosil ke energi terbarukan juga analisis terhadap konsumsi energi, ketersediaan sumber-sumber energi, dan dampak penggunaan energi fosil dan terbarukan. Hasil dari penelitian adalah bahwa faktanya terdapat perubahan signifikan dalam pola konsumsi energi sebelum, saat, dan sesudah COVID-19. Selama COVID-19, emisi CO₂ mengalami penurunan signifikan jika dibandingkan dengan sebelum pandemi. Penurunan ini dapat menjadi dorongan bagi transisi energi karena cadangan minyak dan gas alam di Indonesia dapat habis dalam beberapa tahun mendatang. Beralih ke energi terbarukan dapat mengurangi emisi CO₂, serta dapat membantu melambatkan perubahan iklim. Selain itu, ketersediaan energi terbarukan yang tidak terbatas membuatnya menjadi sumber yang berkelanjutan.

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INTRODUCTION

The industrial revolution transformed the way humans work, shifting from manual labor to machine-based processes (George & George, 2020). The existence of machines accelerated and simplified the production of goods or services, particularly addressing three basic human needs: clothing, food, and shelter. In the realm of clothing, the Industrial Revolution increased the efficiency of textile production, resulting in cheaper clothing and improved accessibility for the general population (Rouch, 2021). Moving to food production, technological advancements enhanced agricultural productivity, increasing food availability and addressing hunger (New York and Geneva, 2017). Finally, in the domain of shelter, technology expedited construction processes, enhancing housing availability. Consequently, the Industrial Revolution had a positive impact on improving access to food, clothing, and housing, thereby raising human living standards.

The ongoing development of the industrial revolution continues to yield new technologies that facilitate daily life. Currently, machines and technologies predominantly operate using electrical energy. The primary source of electrical energy is fossil energy due to its cost-effectiveness and ample reserves. However, the extensive use of fossil energy may deplete these reserves, posing a potential threat to its sustainability. Moreover, fossil energy combustion for electricity generation results in carbon dioxide (CO₂) emissions (Holechek et al., 2022; Pambudi et al., 2023; Sharvini et al., 2018). Numerous studies indicate that CO₂ emissions have been a significant contributor to climate change from 1750 to 2005 (Balogh & Jámor, 2017). Climate change leads to extreme weather events such as droughts, hurricanes, storms, and polar ice melting.

COVID-19 can spread through direct contact with infected individuals or by touching contaminated surfaces. Awareness of this transmission potential necessitates better preventive measures (Rinanda Saputri & Radithya, 2024; Saputri et al., 2022). Globally, the COVID-19 pandemic has led to significant changes in people's activities and lifestyles. To slow the virus's spread, social activities were restricted through measures like quarantine and lockdowns (Sugiyono et al., 2020). These restrictions led to reduced activities in industrial sectors, transportation, buildings, and power plants, consequently decreasing CO₂ emissions. Hence, social activity limitations across various countries contributed to a decrease in CO₂ emissions.

The reduction in carbon emissions has prompted changes in the energy sector. Governments are transitioning from fossil energy to renewable energy. Renewable energy is chosen for its lower emissions, decreasing costs over time, and Indonesia's substantial potential in renewable energy. According to IESR in 2021, Indonesia has a total renewable energy potential of 443 GW (Bagaskara, 2022). Consequently, renewable energy has become a preferable energy source to replace fossil energy. This article presents a critical analysis of relevant issues in the energy world, focusing on the impact of energy use on CO₂ emissions during the COVID-19 pandemic, both before and after. The article discusses energy consumption patterns, the availability of energy sources, the advantages and disadvantages of fossil and renewable energy use, and the impacts of energy use. Finally, the article concludes with the author's perspectives on these issues.

RESEARCH METHODS

This research employs a literature review methodology to examine the impact of energy use on CO₂ emissions before, during, and after the Covid-19 pandemic. The literature review method involves the collection of data through the exploration of various documents. The sources of literature utilized in this study are credible materials sourced from journals, official government reports, and international organizations. By conducting a thorough literature review, the author identifies and analyzes the trends in energy consumption and CO₂ emissions in the periods preceding, during, and following the COVID-19 pandemic.

The literature review process enables the researcher to synthesize information from diverse and reputable sources, offering a comprehensive understanding of how energy usage and carbon

dioxide emissions have evolved over time. By relying on scholarly journals, official government publications, and international organizations, the study ensures a robust foundation for the analysis. This methodology allows for a systematic exploration of the existing knowledge and insights related to energy use and CO₂ emissions, contributing to a well-informed discussion on the subject matter.

RESULTS AND DISCUSSION

The research method employed in this study is a literature review. The literature review method involves collecting data by seeking information from various documents. Credible literature sources utilized include journals, official government reports, and international organizations. Through a review of the literature, the author identifies and analyzes the developments in energy use and CO₂ emissions before, during, and after the COVID-19 pandemic.

From various literature discussing relevant issues, it is found that energy use before, during, and after COVID-19 affects CO₂ emissions. In more detail, the impact is observed in (1) energy consumption patterns, (2) the availability of energy sources, (3) the effects of energy use, and (4) the impact of using energy sources.

Energy Consumption

From the first industrial revolution to the current fourth industrial revolution, fossil energy remains the primary energy source (Yang et al., 2021; Zou et al., 2016). Figure 1 illustrates a gradual increase in energy use before the 1950s, followed by a drastic surge after 1950, coinciding with the post-war period and the Second Industrial Revolution. This period witnessed significant inventions like electricity, telephones, cars, and airplanes, leading to widespread adoption and increased energy usage.

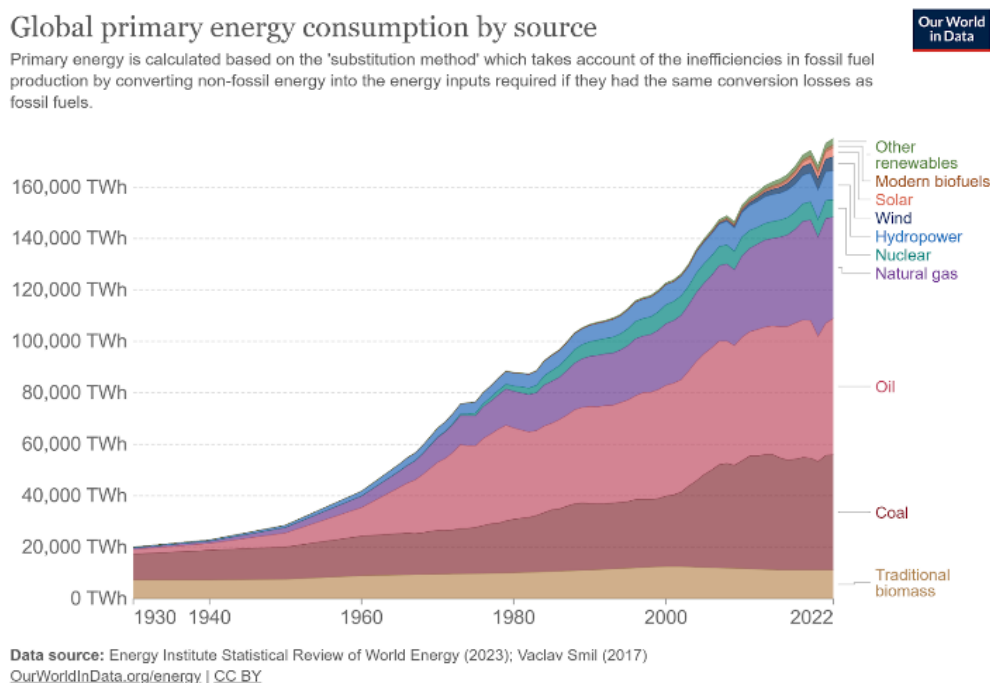


Figure 1. Energy Usage Based on its Source (Data, 2023) (School, 2020)

The escalating use of energy results in increased CO₂ emissions. The combustion of fossil energy for electricity generation, industrial activities, and transportation sectors contributes to CO₂ emissions. Figure 2 shows that the rise in CO₂ emissions correlates with increased fossil energy use, emphasizing the influence of energy consumption on CO₂ emissions. The increase in CO₂ emissions prompts a transition from fossil to renewable energy due to its lower emissions and decreasing costs over time.

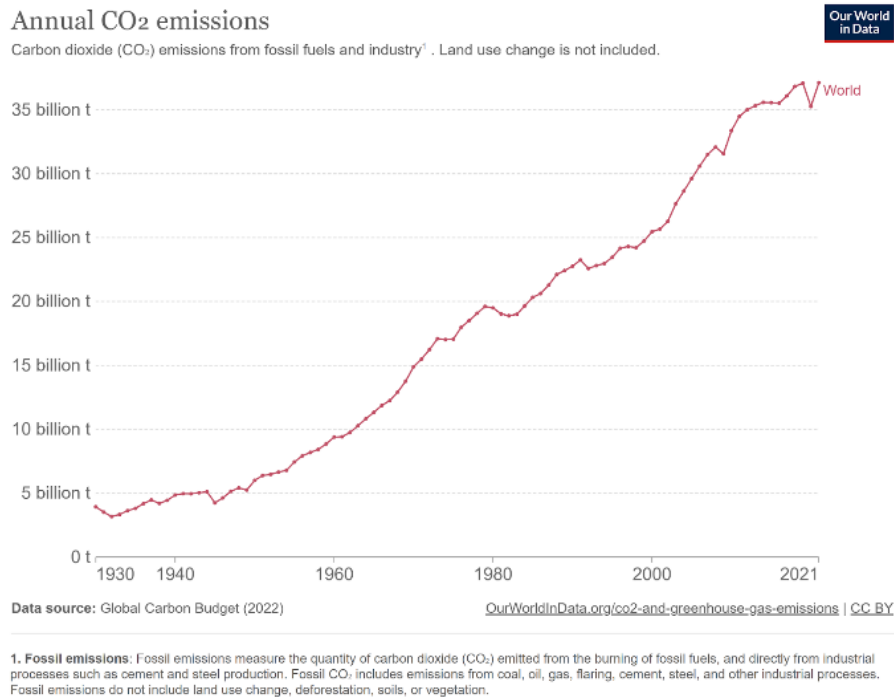


Figure 2. CO₂ Emission (Ritchie et al., 2020)

The COVID-19 pandemic, spanning 2019 to 2021, caused a drastic reduction in energy use and CO₂ emissions, as depicted in Figures 1 and 2. Widespread social activity restrictions, limiting people's movements, led to decreased transportation, industrial activities, and building-related energy use. Consequently, COVID-19 altered energy consumption and CO₂ emissions, with a visible decrease during the pandemic and subsequent increases post-pandemic. Notably, COVID-19 also spurred an increase in the use of renewable energy sources, as shown in Figure 3, indicating a rise in renewable energy utilization in the world. The graph below shows that from 2019 to 2020-2021, there was an increase of EBT by 1.2%, from the previous 12.25% to 13.45%.

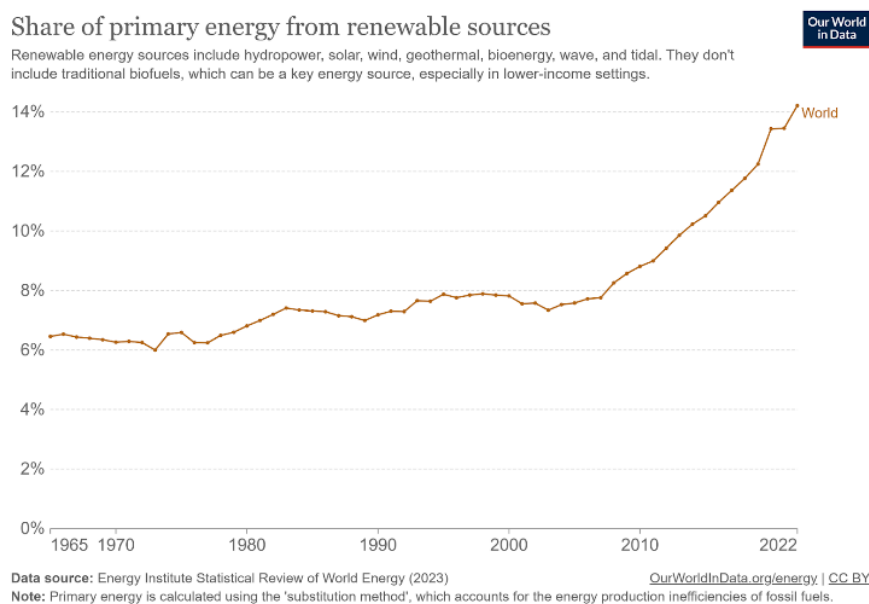


Figure 3. Renewable Energy Utilization in the World (Data, 2023) (School, 2020)

Specifically, in Indonesia, there was an increase in EBT by 3.07%. The graph below illustrates that in the year 2019, the usage of EBT in Indonesia was only 8.37%. Then, in the year 2021, during the Covid-19 pandemic, the utilization of EBT increased to 11.14%.

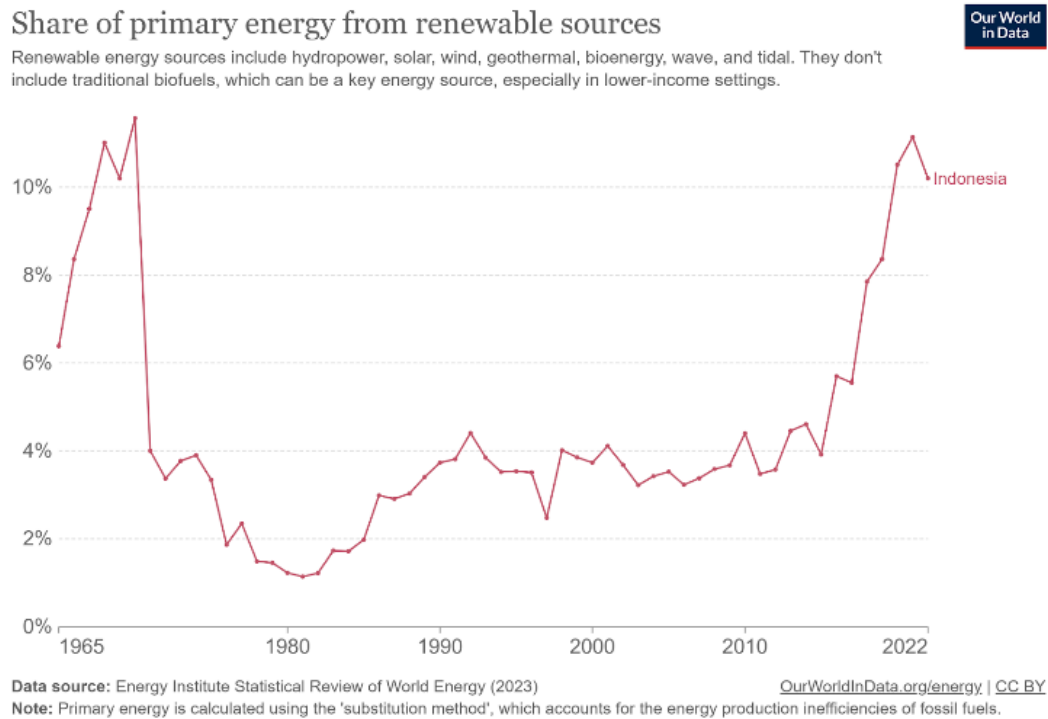


Figure 4. Renewable Energy Utilization in Indonesia (Ritchie et al., 2022)

Energy Availability

COVID-19 accelerated the energy transition, driven by reduced CO₂ emissions during the pandemic. Additionally, Indonesia faces the potential depletion of oil and natural gas reserves in the coming years. Currently, Indonesia has estimated oil reserves of 4.17 billion barrels, with proven reserves at 2.44 billion barrels. Natural gas reserves are estimated at 62.4 trillion cubic feet, with proven reserves at 43.6 trillion cubic feet.

The absence of new fossil energy discoveries and the annual increase in fossil consumption expedite the depletion of fossil energy reserves. Indonesia's Minister of Energy and Mineral Resources, Arifin Tasrif, predicts that Indonesia's oil reserves will last for 9.5 years, while natural gas reserves will last for 19.9 years. The Indonesian government aims to meet the new renewable energy (RE) targets set for the national energy mix, which include reaching 23% by 2025 and 31% by 2050. Table 1 indicates that Indonesia possesses considerable energy potential from various types of renewable energy sources (RES). Notably, the solar energy potential is particularly promising, estimated at around 207,898 MWp, owing to the country's abundant solar resources.

Table 1 Renewable Energy Potency in Indonesia (Tambunan et al., 2021)

Renewable Energy Source	Potential in Giga Watt (GW)
Solar power ¹	5,374
Wind power	60.6
Biomass	30
Mini hydro	19.4
Geothermal ²	17.5
Hydro pump storage	4.3

¹ In Giga Watt peak (GWp)² Excluding the speculative and hypothetical potential

Currently, the Indonesian government is focusing on the development of solar power plants (PLTS). This aligns with the global trend as solar energy represents the fastest-growing renewable technology, especially in equatorial regions like Indonesia with prolonged and intense sunlight throughout the year.

Impact of Energy Use

During COVID-19, there was a reduction in fossil energy consumption and an increase in renewable energy, positively impacting the environment by reducing CO₂ emissions (Adebayo et al., 2022; Pancasari, 2023; Smith et al., 2021). However, reduced energy use also meant decreased activities in industrial sectors, commercial buildings, land transportation, shipping, and aviation, disrupting the economy. Many financial institutions predicted a global economic recession or negative growth in 2020.

Post-COVID-19, energy use rebounded, leading to increased CO₂ emissions, visible through worsened air pollution. However, increased energy use for economic activities contributed to economic recovery.

Impact of Energy Source Use

Fossil energy is currently dominant due to its availability, economic contributions, limited affordable energy options, infrastructure constraints, technological adoption, and substantial subsidies. The combustion of fossil energy generates CO₂ emissions, causing ocean acidification, extreme weather events, rising sea levels, and health issues.

Renewable energy has positive environmental and sustainability impacts, reducing CO₂ emissions and fostering long-term energy sources. However, renewable projects may affect landscapes, wildlife, and local ecosystems. Additionally, challenges in storing and providing stable electricity pose obstacles to renewable energy adoption.

In conclusion, this comprehensive review explores the multifaceted impact of energy use on CO₂ emissions before, during, and after the COVID-19 pandemic, emphasizing the importance of transitioning to renewable energy for a sustainable future.

CONCLUSION AND SUGGESTION

Conclusion

Covid-19 has altered human activities significantly. Social activity restrictions have led to a decrease in fossil fuel consumption and an increase in the use of renewable energy. Social activity restrictions have a positive impact on the environment by reducing CO₂ emissions. However, this hurts the economic condition as economic activities come to a halt.

Currently, fossil energy is still widely used due to its abundance and mature technology, making it accessible to the entire population. However, the CO₂ emissions produced have adverse effects on the environment, causing ocean acidification, extreme weather events, rising sea levels, and health issues.

During Covid-19, CO₂ emissions significantly decreased. This reduction in emissions became a driving force for energy transition. Additionally, the reserves of oil and natural gas in Indonesia could be depleted in the coming years. Transitioning to renewable energy can reduce CO₂ emissions, helping to slow down climate change. Furthermore, the unlimited availability of renewable energy makes it a sustainable source.

Suggestion

Based on the above conclusions, the author provides several recommendations that can be implemented by various parties. Firstly, it is hoped that the community can reduce the use of fossil energy by conserving electricity and utilizing public transportation. Secondly, the government is advised to reduce subsidies for fossil energy and redirect them towards the development of renewable energy, while strengthening regulations regarding carbon emissions and the environment. Thirdly, the private sector is encouraged to transition to more sustainable energy sources and invest in renewable energy technologies. Lastly, other researchers are suggested to use more reference sources to gain a deeper understanding of the impact of energy transition on the economy and the environment. By adopting these measures, it is expected to enhance collective efforts in achieving a more sustainable and environmentally friendly energy system.

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