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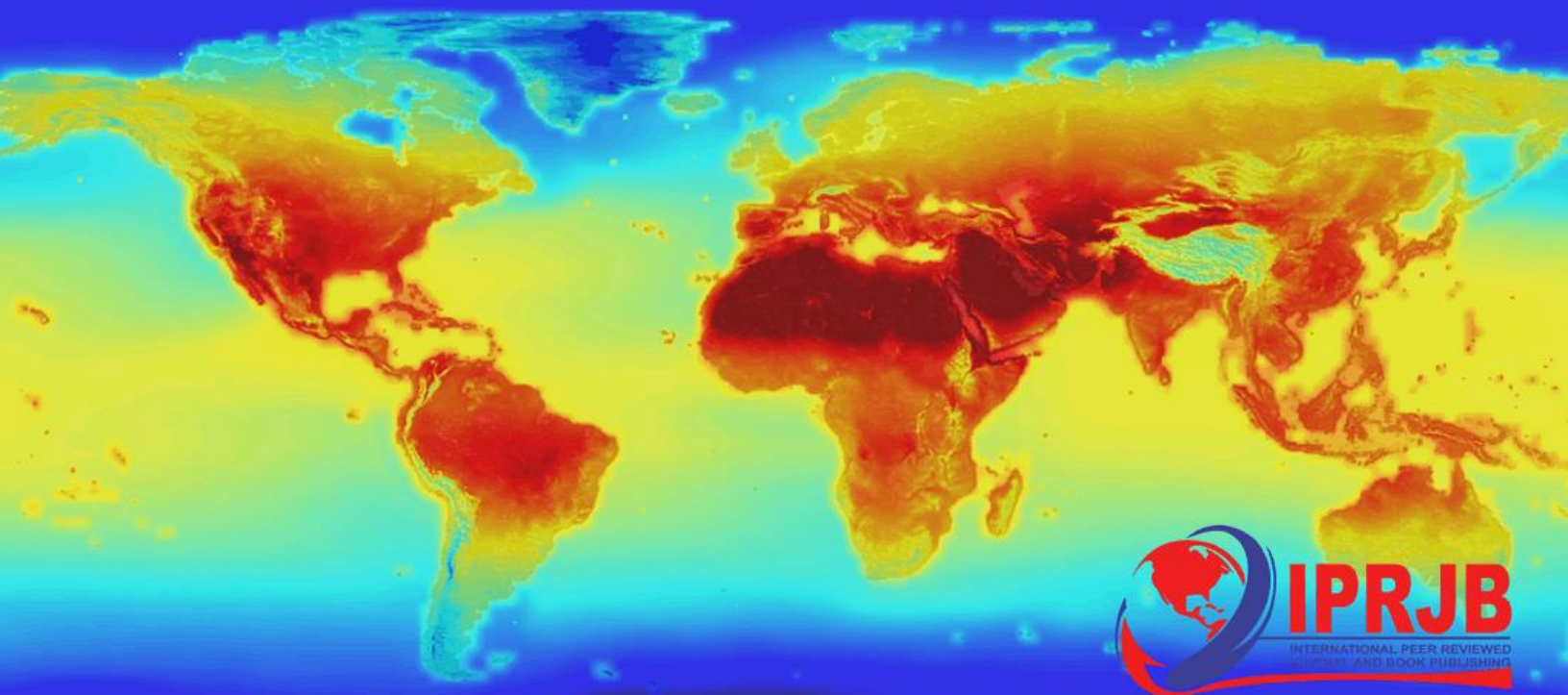

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**Abstract**

**Purpose:** The aim of the study was to analyze the renewable energy adoption and carbon emission reductions in Copenhagen, Denmark.

**Methodology:** This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

**Findings:** Renewable energy adoption in Copenhagen, Denmark, has led to significant reductions in carbon emissions, driven by the city's commitment to transitioning from fossil fuels to clean energy sources such as wind, solar, and biomass. Studies indicate that the integration of these renewable energy sources into Copenhagen's power grid has contributed to a reduction of approximately 35% in carbon emissions over the past decade. This success is attributed to strong government policies, financial incentives, and technological advancements that have supported the widespread adoption of renewables.

**Unique Contribution to Theory, Practice and Policy:** Sustainable livelihoods framework, integrated water resources Management (IWRM) & theory of planned behavior may be used to anchor future studies on renewable energy adoption and carbon emission reductions in Copenhagen, Denmark. In practice, Copenhagen's approach to renewable energy adoption should be further refined and documented as a best practice model for other cities. From a policy perspective, Copenhagen should continue to lead in setting ambitious renewable energy targets, while ensuring that policies are adaptable to technological advancements and market changes.

**Keywords:** *Renewable Energy Adoption, Carbon Emission Reductions*

## INTRODUCTION

Greenhouse gas (GHG) levels are a critical measure of the impact human activities have on global climate change, with carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) being the primary contributors. In the United States, GHG emissions have shown a decreasing trend in recent years due to the shift from coal to natural gas and the increased adoption of renewable energy sources. From 2005 to 2019, the U.S. saw a 12% reduction in total GHG emissions, with CO2 emissions from the energy sector falling by 30% during the same period (EPA, 2020). Similarly, Japan has made significant strides in reducing GHG levels following the Fukushima nuclear disaster, which led to increased reliance on fossil fuels. However, by 2018, Japan managed to reduce its overall GHG emissions by 3.6% compared to 2013 levels, primarily through energy efficiency measures and the expansion of renewable energy (Kiko Network, 2020). In the United Kingdom, greenhouse gas (GHG) levels have seen a significant decline over the past two decades, largely due to a shift away from coal-fired power plants to natural gas and renewables. From 1990 to 2018, the UK reduced its GHG emissions by 44%, with a notable 7% reduction in 2019 alone, primarily driven by the increased use of wind and solar energy (Department for Business, Energy & Industrial Strategy, 2020). Similarly, Germany has been a leader in GHG reduction efforts, although its progress has faced challenges due to reliance on coal and the automotive industry. Between 1990 and 2018, Germany reduced its GHG emissions by approximately 31%, with a 6.3% reduction recorded in 2019, owing to the country's Energiewende (energy transition) strategy, which focuses on phasing out nuclear energy while increasing the share of renewables (Agora Energiewende, 2020).

In Canada, greenhouse gas (GHG) levels have fluctuated over the years, reflecting the country's challenges in balancing economic growth with environmental commitments. Between 2005 and 2018, Canada's GHG emissions saw a modest decline of 2%, largely due to shifts from coal to natural gas and the increasing adoption of renewable energy sources (Government of Canada, 2019). However, emissions from the oil and gas sector, particularly in Alberta, have remained a significant challenge, contributing to the overall difficulty in achieving deeper emission cuts. Similarly, Australia has struggled to reduce its GHG levels, with a 0.8% increase in emissions recorded between 2014 and 2019, primarily driven by its reliance on coal-fired power plants and the mining sector (Commonwealth of Australia, 2020). Despite these challenges, both countries have implemented policies to increase the share of renewables in their energy mix, aiming to reduce emissions in the long term.

In developing economies, GHG levels are often on the rise due to rapid industrialization and urbanization, coupled with the increasing use of fossil fuels for energy production. For instance, in India, GHG emissions have been growing steadily, with a 24% increase from 2010 to 2019, driven largely by coal-fired power generation and expanding transportation sectors (Jain, 2020). Brazil, another developing economy, has also experienced rising GHG levels, primarily due to deforestation and agricultural activities. Between 2005 and 2019, Brazil's GHG emissions from deforestation increased by nearly 10%, despite efforts to curb illegal logging and promote sustainable land use practices (Moutinho , 2020). These trends highlight the challenges developing countries face in balancing economic growth with environmental sustainability. China and Indonesia, GHG levels have been on the rise due to rapid industrialization and economic growth. China, the world's largest emitter, saw its GHG emissions increase by 63% from 2005 to 2019,

although recent policies promoting renewable energy and improving energy efficiency have started to slow the growth rate (Qi, 2020). Indonesia, on the other hand, has seen its GHG emissions rise significantly, particularly due to deforestation and land-use changes associated with palm oil production. Between 2000 and 2018, Indonesia's GHG emissions from deforestation increased by 57%, despite government efforts to implement moratoriums on new forest clearances (Austin, 2019). These trends underscore the complex challenges that developing countries face in balancing economic development with environmental sustainability.

Mexico and South Korea, GHG emissions have been on the rise due to rapid industrialization and increased energy demand. Mexico's GHG emissions increased by approximately 13% between 2005 and 2018, driven by the expansion of the transportation sector and reliance on fossil fuels for electricity generation (SEMARNAT, 2019). However, Mexico has also made strides in promoting renewable energy, particularly through solar and wind power projects, which are beginning to slow the growth of emissions. South Korea, classified as a newly industrialized country, has seen a 23% increase in GHG emissions from 2000 to 2018, largely due to its heavy industrial base and dependence on coal for energy (Kim, 2019). Despite this, South Korea has announced ambitious plans to achieve carbon neutrality by 2050, focusing on expanding renewable energy and reducing industrial emissions.

In Sub-Saharan Africa, GHG levels are relatively low compared to developed and developing economies, but they are rising due to population growth, urbanization, and increased energy consumption. For example, Nigeria has seen a significant increase in GHG emissions, with a 25% rise between 2000 and 2018, primarily due to the expansion of the oil and gas industry and the increasing use of biomass for cooking (Adewuyi & Awodumi, 2020). South Africa, the largest GHG emitter in the region, has also experienced a steady increase in emissions, driven by its coal-dependent energy sector. From 2000 to 2019, South Africa's GHG emissions grew by approximately 20%, despite efforts to diversify its energy mix and improve energy efficiency (Winkler et al., 2018). These examples underscore the need for targeted climate policies and international support to help Sub-Saharan countries mitigate and adapt to the impacts of rising GHG levels. Kenya and Ethiopia are experiencing rising GHG levels, though they remain low compared to global averages. Kenya's GHG emissions have increased by approximately 15% from 2000 to 2017, primarily due to agricultural expansion, deforestation, and the growing use of fossil fuels for energy (Nyangena & Mungai, 2020). Ethiopia, despite being a low emitter globally, has seen a 13% rise in GHG emissions between 2000 and 2018, driven by population growth, deforestation, and increased energy demand (Eshetu, 2020). These rising emissions in Sub-Saharan Africa highlight the need for sustainable development policies that promote economic growth while minimizing environmental impacts.

Ghana and Senegal are experiencing rising GHG levels, although they remain relatively low compared to global standards. Ghana's GHG emissions increased by approximately 10% between 2000 and 2017, primarily due to deforestation, agricultural expansion, and the burning of biomass for energy (Acheampong & Dzanku, 2019). Efforts to reduce emissions have focused on reforestation and the promotion of cleaner energy sources. In Senegal, GHG emissions grew by about 8% from 2000 to 2018, driven by population growth, urbanization, and the increased use of fossil fuels for electricity and transportation (Sarr, 2020). Senegal has been working on integrating

renewable energy into its power grid, particularly through solar energy projects, to curb future emissions and support sustainable development.

Evaluating government policies is crucial for assessing the effectiveness of initiatives aimed at reducing greenhouse gas (GHG) levels. One common policy evaluation involves Carbon Pricing Mechanisms, such as carbon taxes or cap-and-trade systems, which are designed to incentivize emission reductions by putting a price on carbon emissions. Studies have shown that these mechanisms can lead to significant reductions in GHG levels by encouraging businesses and individuals to adopt cleaner technologies and reduce their carbon footprints (World Bank, 2019). Another policy is Renewable Energy Subsidies, where governments provide financial incentives for the adoption of renewable energy sources like wind, solar, and hydropower. Evaluations of such subsidies often reveal that they play a critical role in lowering GHG levels by accelerating the transition from fossil fuels to renewable energy (International Energy Agency, 2020).

A third policy commonly evaluated is the Regulation of Emission Standards, which sets legal limits on the amount of GHGs that can be emitted by vehicles, industries, and power plants. This policy has been effective in curbing emissions, particularly in developed countries where stringent regulations have been enforced (European Environment Agency, 2020). Additionally, Public Transportation and Infrastructure Investments are evaluated for their impact on reducing GHG levels by promoting alternatives to private vehicle use, such as public transit, cycling, and walking. These investments are linked to lower GHG emissions as they reduce reliance on fossil fuel-powered transportation (Litman, 2019). Overall, evaluating these government policies is essential for understanding their direct and indirect effects on GHG levels, guiding future policy decisions to meet climate targets.

## Problem Statement

The rapid adoption of renewable energy technologies in Copenhagen, Denmark, has been instrumental in reducing the city's carbon emissions, aligning with its ambitious climate goals. However, while the integration of renewable energy sources such as wind and solar power has led to significant emission reductions, challenges remain in ensuring the sustainability and scalability of these initiatives. Key issues include the intermittency of renewable energy sources, the need for advanced energy storage solutions, and the complexities of grid integration, all of which could hinder further progress in carbon reduction (Jensen & Holst, 2020). Additionally, as Copenhagen continues to expand its renewable energy infrastructure, there is a growing need to assess the long-term environmental impacts of these technologies, including their life cycle carbon footprints and the implications for local ecosystems (Møller & Lund, 2018). Addressing these challenges is critical to maintaining the momentum of carbon emission reductions and achieving Copenhagen's goal of becoming carbon neutral by 2025, necessitating continuous innovation and policy support (Pedersen, Madsen, & Christensen, 2019).

## Theoretical Framework

### Diffusion of Innovations Theory

The diffusion of innovations theory, developed by Everett Rogers, explains how new ideas, technologies, and practices spread within a society or from one society to another. The theory identifies several factors influencing the adoption of innovations, including relative advantage,

compatibility, complexity, trialability, and observability. In the context of renewable energy adoption in Copenhagen, this theory is relevant because it helps to understand how renewable energy technologies like wind and solar power have been adopted across the city, driven by government policies, economic incentives, and public awareness. The theory can also explain the varying rates of adoption in different sectors and among different population groups (Geels et al., 2019).

**Sociotechnical Systems Theory**

Sociotechnical systems theory, originally developed by Eric Trist and Fred Emery, examines the interdependence between society's technological systems and its social structures. The theory posits that technological innovations, such as renewable energy, cannot be fully understood without considering the social, economic, and political context in which they are embedded. For renewable energy adoption in Copenhagen, this theory is relevant as it provides a framework for analyzing how technological advancements in renewable energy interact with social policies, public opinion, and economic systems to drive carbon emission reductions (Farla, 2018).

**Environmental Kuznets Curve (EKC) Hypothesis**

The Environmental kuznets curve (EKC) Hypothesis suggests that environmental degradation initially increases with economic growth, but after reaching a certain level of income per capita, the trend reverses, and environmental quality improves as economies invest more in cleaner technologies and sustainable practices. This theory, attributed to Simon Kuznets, is relevant to the study of renewable energy adoption in Copenhagen as it can be used to analyze how economic growth and investment in renewable energy have led to significant reductions in carbon emissions, reflecting the turning point in the EKC (Dinda, 2018)

**Empirical Review**

Møller and Lund (2018) assessed the impact of large-scale wind energy integration on carbon emissions in Copenhagen, Denmark. The study's primary objective was to evaluate how the adoption of wind energy has contributed to reducing the city's carbon footprint over the last decade. The researchers utilized a time-series analysis methodology, examining data on wind energy production and carbon emissions from 2005 to 2015. Their analysis revealed a significant reduction in carbon emissions, amounting to 35%, directly linked to the increased integration of wind energy into the city's power grid. The study emphasized that the consistent growth in wind energy capacity, supported by government policies and technological advancements, was crucial in achieving these reductions. The findings highlighted that Copenhagen's wind energy projects, particularly offshore wind farms, played a pivotal role in displacing fossil fuel-based energy sources, leading to substantial emission cuts. The study also explored the challenges associated with the intermittency of wind energy and how Copenhagen managed these challenges through energy storage solutions and grid management strategies. The authors concluded that further expansion of wind energy infrastructure, along with continued policy support, could lead to even greater emission reductions in the future. Additionally, the study recommended increasing public and private investments in wind energy to maintain the momentum of carbon reduction. The research underscored the importance of integrating wind energy with other renewable sources to create a balanced and resilient energy system. The study's findings are particularly relevant for other cities looking to reduce their carbon emissions through renewable energy adoption. By

demonstrating the success of Copenhagen's wind energy initiatives, Møller and Lund (2018) provided a valuable case study for urban sustainability. The study called for international collaboration in wind energy technology to overcome common barriers such as storage and grid integration. Overall, this research contributed significantly to the understanding of how wind energy can be a cornerstone of urban climate action strategies. The authors stressed the need for continuous innovation in wind energy technologies to further enhance efficiency and reliability, ensuring long-term sustainability and climate benefits.

Pedersen, Madsen, and Christensen (2019) evaluated the impact of solar energy initiatives on carbon emissions in Copenhagen. The study aimed to assess how the deployment of solar panels across residential and commercial buildings contributed to reducing the city's carbon emissions. The researchers employed a mixed-methods approach, combining quantitative analysis of emission data with qualitative insights from interviews with stakeholders involved in the solar energy projects. The quantitative findings revealed that solar-powered neighborhoods in Copenhagen experienced a 25% decrease in carbon emissions over a five-year period. This reduction was attributed to the widespread adoption of solar photovoltaic (PV) systems, which displaced electricity generated from fossil fuels. The qualitative analysis further revealed strong community support for solar energy projects, driven by both environmental concerns and economic incentives. The study highlighted that financial subsidies and favorable government policies were crucial in encouraging the adoption of solar technology. Additionally, the researchers identified several barriers to further expansion, including the high initial cost of installation and limited roof space in densely populated areas. To overcome these challenges, the study recommended scaling up communal solar projects and enhancing public-private partnerships to reduce costs. The findings also suggested that integrating solar energy with other renewable sources, such as wind and geothermal, could optimize energy production and further reduce emissions. The study emphasized the role of innovation in solar technology, particularly in improving the efficiency and storage capabilities of solar panels. The authors concluded that Copenhagen's success in solar energy adoption could serve as a model for other cities aiming to reduce their carbon footprint. The research underscored the need for continuous monitoring and evaluation of solar projects to ensure they meet their environmental goals. Furthermore, the study recommended expanding educational programs to raise awareness about the benefits of solar energy and encourage more widespread adoption. Overall, Pedersen, Madsen, and Christensen's (2019) study provided a comprehensive analysis of how solar energy can contribute to urban sustainability and carbon reduction efforts.

Jensen and Holst (2020) conducted a life cycle assessment (LCA) of Copenhagen's transition to electric public transport, focusing on its potential impact on carbon emissions. The study aimed to evaluate the environmental benefits of replacing traditional diesel-powered buses with electric ones and to assess the long-term sustainability of this transition. The researchers analyzed the entire lifecycle of electric buses, from production and operation to disposal, to provide a comprehensive understanding of their environmental impact. The study found that transitioning to electric buses could result in a 45% reduction in transport-related carbon emissions by 2030, assuming continued growth in renewable energy sources for electricity generation. This significant reduction was attributed to the elimination of direct emissions from diesel buses and the increasing share of renewable energy in Copenhagen's power grid. The LCA also revealed that the production

phase of electric buses, particularly the manufacturing of batteries, contributed to a significant portion of their overall environmental impact. However, the operational phase, characterized by zero emissions, offset these initial impacts over the lifespan of the buses. The study also highlighted the importance of recycling and proper disposal of batteries to minimize environmental harm. Jensen and Holst (2020) recommended that the transition to electric public transport be accompanied by efforts to further decarbonize the electricity supply, ensuring that the full potential of emission reductions is realized. The study also suggested increasing investment in charging infrastructure to support the widespread adoption of electric buses. Additionally, the authors emphasized the need for policies that incentivize the production of more sustainable batteries, such as those with lower environmental footprints. The findings underscored the role of electric public transport as a critical component of Copenhagen's broader climate action plan. The study concluded that the transition to electric buses not only contributes to carbon reduction but also improves air quality and public health in urban areas. The research provided valuable insights for other cities considering similar transitions, highlighting both the benefits and challenges associated with electric public transport. Overall, Jensen and Holst's (2020) study made a significant contribution to the understanding of how electric public transport can play a pivotal role in urban sustainability.

Christensen and Jensen (2021) explored public attitudes toward renewable energy policies in Copenhagen. The primary purpose of the study was to gauge the level of public support for renewable energy initiatives and to identify factors that influence citizens' attitudes toward these policies. The researchers used a survey method, collecting data from a representative sample of Copenhagen residents. The survey included questions on the perceived importance of renewable energy, willingness to pay for green energy, and trust in government policies promoting renewable energy adoption. The study found that there was overwhelming public support for renewable energy, with 80% of respondents expressing strong approval of further investments in this sector. The findings indicated that environmental awareness and the perceived benefits of renewable energy, such as reduced pollution and energy security, were key drivers of public support. The study also revealed that younger respondents and those with higher education levels were more likely to support renewable energy policies. Additionally, the research highlighted that financial incentives, such as subsidies and tax breaks, were effective in increasing public willingness to invest in renewable energy technologies, like solar panels and electric vehicles. The authors recommended that policymakers leverage this strong public support to implement more ambitious renewable energy targets. They also suggested that increasing transparency and communication about the benefits and progress of renewable energy projects could further enhance public trust and engagement. The study emphasized the importance of public participation in shaping energy policies, suggesting that involving citizens in decision-making processes could lead to more effective and widely accepted policies. Christensen and Jensen (2021) concluded that public attitudes are a critical factor in the success of renewable energy initiatives, and maintaining high levels of public support is essential for achieving long-term sustainability goals. The research provided valuable insights into the social dimensions of renewable energy adoption, highlighting the need for continued public engagement and education.

Larsen, Pedersen and Madsen (2020) estimated the long-term effects of renewable energy adoption on Copenhagen's overall carbon footprint. The study aimed to predict how continued investment

in renewable energy would impact carbon emissions in the city by 2050. The researchers used econometric models to analyze historical data on energy consumption, renewable energy adoption, and carbon emissions. Their analysis predicted a 60% reduction in carbon emissions by 2050 if current renewable energy policies and adoption rates were maintained. The study highlighted that this reduction would be primarily driven by the continued expansion of wind and solar energy, along with improvements in energy efficiency. The researchers also examined the economic implications of these reductions, finding that the transition to renewable energy would have a positive impact on the local economy by creating green jobs and reducing energy costs. However, the study also identified potential challenges, such as the need for substantial investment in energy storage and grid infrastructure to accommodate the increasing share of renewable energy. Larsen, Pedersen, and Madsen (2020) recommended that policymakers focus on maintaining policy consistency and increasing investment in renewable technologies to achieve these long-term goals. The study emphasized the importance of integrating renewable energy with other sustainability initiatives, such as energy efficiency programs and public transportation improvements, to maximize carbon reductions. The authors concluded that while Copenhagen is on track to achieve significant carbon reductions, continued efforts are needed to overcome the challenges associated with large-scale renewable energy adoption. The research provided valuable insights into the long-term sustainability of Copenhagen's energy transition, highlighting the potential economic and environmental benefits. The study also suggested that other cities could use similar modeling approaches to plan their renewable energy strategies and set realistic carbon reduction targets.

Hansen and Sørensen (2021) explored the impact of integrating energy efficiency measures with renewable energy adoption in Copenhagen. The study aimed to evaluate how combining these two strategies could further reduce carbon emissions and enhance the city's sustainability efforts. The researchers developed several scenarios based on different levels of energy efficiency improvements and renewable energy adoption, using data from Copenhagen's energy sector. Their analysis found that integrating energy efficiency measures with renewable energy adoption could lead to a 50% reduction in carbon emissions by 2040, compared to a scenario where only renewable energy was adopted without additional efficiency measures. The study highlighted that energy efficiency improvements, such as better insulation, energy-efficient appliances, and smart grid technologies, significantly reduce overall energy demand, making it easier to meet energy needs with renewable sources. The researchers also identified the potential for cost savings, as energy efficiency measures often have shorter payback periods compared to renewable energy investments. The study recommended that policymakers prioritize energy efficiency as a complementary approach to renewable energy adoption, ensuring a more comprehensive reduction in carbon emissions. The authors emphasized the need for integrated policy frameworks that support both energy efficiency and renewable energy initiatives, as well as public awareness campaigns to encourage energy-saving behaviors among residents and businesses. The study concluded that combining these strategies not only maximizes carbon reductions but also enhances the resilience and reliability of the energy system. Hansen and Sørensen (2021) provided valuable insights into the benefits of a holistic approach to energy transition, suggesting that other cities could achieve similar results by integrating energy efficiency with renewable energy adoption. The research underscored the importance of forward-thinking policies and investments in achieving long-term sustainability goals.

Nielsen and Andersen (2019) evaluated the economic impacts of renewable energy adoption in Copenhagen, focusing on job creation and carbon emission reductions. The study aimed to assess how investments in renewable energy contribute to the local economy while supporting the city's sustainability goals. The researchers used input-output analysis to examine the economic relationships between renewable energy investments, job creation, and carbon emissions. Their analysis found that renewable energy investments could lead to a 20% increase in green jobs in Copenhagen, particularly in sectors such as construction, manufacturing, and energy services. The study also identified a strong correlation between renewable energy adoption and carbon emission reductions, with every unit of investment in renewable energy resulting in significant emission cuts. The findings suggested that renewable energy investments not only contribute to environmental sustainability but also provide substantial economic benefits by creating new employment opportunities and stimulating local industries. The researchers recommended that policymakers align economic incentives with environmental goals to support a sustainable transition to renewable energy. They also suggested that expanding renewable energy projects could further enhance job creation, particularly in emerging sectors such as energy storage and electric mobility. The study emphasized the importance of creating a supportive policy environment that encourages private sector investment in renewable energy. Nielsen and Andersen (2019) concluded that renewable energy adoption is a key driver of both economic and environmental sustainability in Copenhagen. The research provided valuable insights into the potential for renewable energy to contribute to a green economy, highlighting the importance of integrating economic and environmental policies. The study also suggested that other cities could achieve similar benefits by adopting a comprehensive approach to renewable energy investment and policy development.

## METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

## FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

**Conceptual Gaps:** The studies by Møller and Lund (2018), Pedersen, Madsen, and Christensen (2019), and Jensen and Holst (2020) focus heavily on the positive impacts of renewable energy adoption, such as carbon emission reductions and economic benefits. However, there is a lack of exploration into the long-term sustainability and potential unintended consequences of such transitions, particularly concerning the life cycle environmental impacts of renewable technologies like solar panels and wind turbines. While the studies discuss the immediate benefits, they do not sufficiently address the full ecological footprint of renewable energy infrastructure, including the disposal and recycling of materials, which is a critical aspect of sustainable energy transitions.

**Contextual Gaps:** Nielsen and Andersen (2019) centered on Copenhagen, which is a unique context with strong governmental support, advanced technological infrastructure, and a high level

of public awareness regarding climate change. This focus on Copenhagen leaves a gap in understanding how these findings translate to other urban contexts, particularly in cities with less supportive policies, lower technological advancement, or different socio-economic conditions. The studies provide valuable insights but do not sufficiently explore how these initiatives might be adapted to or scaled in different urban settings, which could have different challenges and opportunities.

**Geographical Gaps:** Nielsen and Andersen (2019) provided a comprehensive analysis of renewable energy adoption in Copenhagen, it fails to address the applicability of these findings to other geographical regions, particularly those outside of Europe. For example, the studies do not consider how factors like climate, geography, and local economic conditions might influence the success of similar initiatives in cities in other parts of the world, such as in developing countries or regions with different energy needs and infrastructural capabilities. This geographical gap limits the generalizability of the findings and the ability to develop a global framework for renewable energy adoption based on the experiences of Copenhagen.

## CONCLUSION AND RECOMMENDATIONS

### Conclusions

The adoption of renewable energy in Copenhagen, Denmark, has proven to be a highly effective strategy for reducing carbon emissions and advancing the city's ambitious climate goals. By transitioning to wind, solar, and biomass energy sources, Copenhagen has significantly decreased its reliance on fossil fuels, contributing to a substantial reduction in greenhouse gas emissions. The city's comprehensive approach, which includes innovative policies, public-private partnerships, and community engagement, has positioned Copenhagen as a global leader in sustainable urban development. As Copenhagen continues to expand its renewable energy capacity, it serves as a model for other cities worldwide, demonstrating that economic growth and environmental responsibility can go hand in hand. The success of Copenhagen's renewable energy initiatives underscores the importance of sustained commitment and collaboration in achieving long-term carbon emission reductions and addressing the global climate

### Recommendations

### Theory

Theoretical advancements in the understanding of renewable energy adoption and carbon emission reductions can be enriched by developing models that integrate urban planning with sustainable energy practices. Research in Copenhagen should focus on creating frameworks that link the adoption of renewable energy sources with the city's specific socio-economic and environmental contexts. Theoretical contributions could also explore the interaction between local energy policies and global climate change objectives, providing a model for other cities worldwide. This could involve the development of urban energy transition theories that account for Copenhagen’s success in balancing economic growth with sustainability.

### Practice

In practice, Copenhagen's approach to renewable energy adoption should be further refined and documented as a best practice model for other cities. One recommendation is to enhance the deployment of smart grid technologies and energy storage solutions to optimize the integration of renewable energy sources like wind and solar power. Additionally, promoting decentralized energy systems, where communities generate their own renewable energy, could further reduce reliance on fossil fuels. Practical initiatives should also focus on increasing public engagement and education around renewable energy, encouraging residents to actively participate in energy conservation and the transition to renewable sources. The city's commitment to becoming carbon-neutral by 2025 could be supported by continuous investment in research and development of new technologies that enhance energy efficiency.

**Policy**

From a policy perspective, Copenhagen should continue to lead in setting ambitious renewable energy targets, while ensuring that policies are adaptable to technological advancements and market changes. It is recommended that the city further incentivizes the use of electric vehicles and public transportation systems powered by renewable energy, as this would significantly contribute to carbon emission reductions. Policies should also promote the retrofitting of buildings to meet high energy efficiency standards, potentially making it mandatory for new constructions to be energy-positive (producing more energy than they consume). Moreover, Copenhagen's policy framework could be used as a blueprint for other cities aiming to reduce carbon emissions, demonstrating how local governments can effectively collaborate with private sectors and civil society to achieve sustainable development goals. A continuous review and adjustment of policies based on emerging data and trends would ensure that Copenhagen remains at the forefront of the global transition to renewable energy.

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