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Tackling CO_2 Emissions from Electricity Use in Kuwait

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About the author:

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Highlights:

- *Kuwait is facing a critical challenge in balancing economic growth with environmental sustainability.*
- *With one of the highest per capita CO_2 emissions in the world and a strong dependence on fossil fuels for electricity, immediate action is needed.*
- *This policy brief shows that electricity consumption in Kuwait has an asymmetric impact on emissions—suggesting that policy solutions must be carefully tailored to these dynamics.*
- *By reforming electricity pricing, modernizing infrastructure, investing in renewable energy, and raising public awareness, Kuwait can begin to curb its emissions and move toward a more sustainable future.*
- *These steps are not only environmentally responsible but also essential for long-term economic stability in an increasingly carbon-constrained global economy.*

Keywords:

pollution, electricity consumption, Kuwait

SDGs:

7, 13

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Introduction

Global warming has emerged as one of the most pressing environmental issues since the late 1980s. In response to mounting evidence on the harmful effects of rising greenhouse gas emissions, the Kyoto Protocol was introduced in 1997. Its primary objective was to push countries toward reducing and managing their greenhouse gas outputs, especially carbon dioxide (CO_2), which is widely recognized as the main contributor to the greenhouse effect. CO_2 emissions account for more than half of all global greenhouse gas emissions, underlining its dominant role in climate change.

One major driver of CO_2 emissions is electricity generation. Electricity is essential to modern life, powering homes, industries, and businesses. However, the production of electricity—especially from fossil fuels—contributes heavily to environmental degradation. Between 1971 and 2009, global per capita electricity consumption increased by more than 130%. According to the World Resources Institute (2010), over 25% of global greenhouse gas emissions originate from electricity generation and use.

Although many studies have examined pollution and its economic links, most have concentrated on the Environmental Kuznets Curve (EKC) hypothesis. The EKC suggests that pollution increases with economic growth (measured by GDP) up to a point, after which it declines. While this model has been tested extensively, few studies have looked at how energy consumption itself—especially in developing nations—directly influences CO_2 emissions. Moreover, existing research often assumes a linear relationship between energy use and emissions, implying that increases and decreases in consumption have symmetric effects. This is a simplification that does not reflect real-world dynamics.

To fill this gap, Kisswani (2024) investigates the asymmetric relationship between electricity consumption and CO_2 emissions in Kuwait using the Nonlinear Autoregressive Distributed Lag (NARDL) model introduced by Shin et al. (2014). This model can distinguish the effects of increases in electricity use from decreases, providing a more accurate understanding of how electricity consumption affects emissions over both the short and long term.

Kuwait is a relevant case study. In 2016, it ranked third globally in per capita CO_2 emissions, following Qatar and Montenegro. Per capita CO_2 emissions in that year were 37.29 metric tons in Qatar, 25.90 in Montenegro, and 25.65 in Kuwait (International Energy Agency, IEA, 2019). Despite these alarming figures, no research has yet examined the energy consumption–CO_2 emissions nexus in Kuwait, either in a linear or nonlinear framework. Kisswani (2024) addresses that void.

Key Facts About Kuwait's Energy Sector

Kuwait's economy is heavily dependent on oil. The country holds approximately 101.5 billion barrels in crude oil reserves, accounting for 7% of the global total. Oil and gas generate about 92% of Kuwait's GDP, making the country highly vulnerable to fluctuations in the international energy market. This oil dependency also directly affects the country's electricity sector.

In Kuwait, electricity is generated almost entirely from fossil fuels, especially natural gas and liquid petroleum. The production process includes several stages within power stations, where these energy sources are converted into electricity and distributed across the national grid to reach households, businesses, and industrial facilities.

Over the past six decades, electricity demand in Kuwait has grown sharply. This increase is linked to population growth, urbanization, economic expansion, and subsidized electricity prices. Government data highlights a consistent upward trend in electricity consumption:

- In the 1950s, electricity demand increased by around 32% annually.
- In the 1960s, the rate was 26%.
- In the 1970s, it dropped to 15%, and further to 8% in the 1980s.
- A modest rebound to 11% occurred in the 1990s.

Several factors contributed to this sustained growth. Kuwait's harsh climate, particularly during long, hot summers, significantly increases air conditioning use. Additionally, the country experienced rapid infrastructure growth in both public and private sectors, creating a substantial increase in electricity use. Compounding the problem is Kuwait's electricity pricing structure, which offers extremely low rates to consumers. This encourages wasteful consumption and limits incentives for conservation.

The rise in electricity demand is also closely tied to population growth. In 1951, the number of electricity consumers was only 2,462. By 1960, it had grown to 47,060. In 1970, it reached 118,682, and by 1980, it had doubled to 217,232. Although growth slowed during the early 1990s due to the Gulf War and Iraq's invasion, the upward trend resumed soon after. By 2018, the number of consumers had reached 528,618 (Environment Public Authority, 2019).

Methodology and Results

To explore the relationship between electricity consumption and CO_2 emissions in Kuwait, Kisswani (2024) uses annual data from 1971 to 2018. The key variables include:

- CO_2 emissions: measured in metric tons per capita,
- Electricity consumption: measured in kilowatt-hours (KWh) per capita, and
- Real GDP: measured in 2010 constant US dollars to control for economic activity.

The analysis uses the NARDL approach, which allows to identify asymmetric effects—that is, whether increases and decreases in electricity consumption have different impacts on emissions. This method separates electricity use into positive and negative changes to determine their distinct long-term and short-term effects.

Key Findings

- In the long run, an increase in electricity consumption significantly increases CO_2 emissions. However, a decrease in consumption has no statistically significant impact. This asymmetry suggests that once emissions rise due to higher consumption, reversing that trend is difficult without structural changes.
- In the short run, the opposite is true. Decreases in electricity consumption significantly reduce CO_2 emissions, while increases have little to no immediate impact. This implies that short-term energy-saving efforts, such as seasonal conservation campaigns, can be effective.

Policy Recommendations

The results of Kisswani (2024)'s study contribute to the achievement of the UN Sustainable Development Goals (SDGs), particularly Goal 7: "Affordable and Clean Energy" and Goal 13: "Climate Action", by identifying key areas where policymakers in Kuwait can reduce CO_2 emissions and enhance environmental sustainability.

1. Revise Electricity Pricing Policies: Kuwait's flat-rate pricing model fails to encourage energy conservation. By charging a uniform, low price per kilowatt-hour, consumers have no financial incentive to reduce consumption. Introducing a tiered pricing system, where the rate increases with usage, can promote

more responsible energy use among households and businesses.

2. Modernize and Clean Up Power Plants: Most of Kuwait's electricity is generated by aging fossil-fuel power plants. These facilities are likely inefficient and contribute heavily to CO_2 emissions. Investment should be made in upgrading existing power plants and integrating cleaner technologies. Efficiency improvements can reduce waste and emissions simultaneously.

3. Shift to Renewable Energy Sources: Given Kuwait's strong financial position and technological capacity, the country is well-positioned to diversify its energy portfolio. Policymakers should develop and implement a long-term strategy to transition to renewable energy—particularly solar and wind, which are abundant in the region. Reducing reliance on fossil fuels will significantly cut greenhouse gas emissions over time.

4. Launch Public Awareness Campaigns: A large part of the electricity overconsumption problem is due to a lack of awareness. Public education campaigns should highlight the environmental consequences of high electricity use and promote energy-saving behaviors. These campaigns must target both residential and commercial consumers to be effective.

5. Encourage Energy Efficiency in the Residential Sector:
   In 2017, residential consumption made up about 21% of Kuwait's total energy use (IEA, 2019). Policymakers should introduce regulations and incentives for the use of energy-efficient appliances, better insulation in homes, and smart meters that allow users to track and reduce their energy use.

6. Implement Demand-Side Management Programs:
   Kuwait should invest in demand-side management (DSM) strategies to reduce peak electricity loads. These could include time-of-use pricing, rebates for reducing usage during peak hours, and integration of energy storage systems to balance supply and demand efficiently.

7. Strengthen Environmental Regulations:
   Enforcing stricter environmental standards for industries and new construction can limit unnecessary electricity use and improve overall energy efficiency. Building codes should mandate the use of energy-efficient materials and technologies.

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