

Fossil Fuel Dependency and Economic Growth Report.ⁱ

An Empirical Assessment of Decoupling Patterns Across Countries.

1. Introduction

Decoupling economic growth from fossil fuel consumption is a key goal of global climate policy. International frameworks, such as the Paris Agreement, implicitly presume that economic growth may continue while greenhouse gas emissions fall, essentially through increased energy efficiency, structural economic transformation, and the deployment of low-carbon energy sources. However, empirical evidence calls into question whether such dissociation occurs automatically as income levels rise. While some high-income countries have stabilized or significantly reduced their use of fossil fuels, global fossil energy consumption continues to rise, driven mostly by industrialization, population expansion, and a persistent structural reliance and path dependencies on fossil fuels.

This report uses harmonized worldwide energy data to investigate the relationship between economic growth, population size, and fossil fuel consumption. By integrating cross-sectional and dynamic visual analysis, the study determines if greater income levels are systematically related with lesser fossil fuel dependence, or if structural and policy factors are more important. Recent literature suggests that relative decoupling is insufficient to achieve climate targets (Papież et al.) and that absolute reductions in fossil energy usage are equally unusual (Abbas).

The concept of decoupling refers to reducing the relationship between economic expansion and environmental pressure. Before delving further into the analysis, it is important to distinguish between two forms of decoupling commonly discussed in the energy and climate literature. *Relative decoupling* occurs when energy use or emissions continue to increase, but at a slower rate than economic output (GDP). *Absolute decoupling*, by contrast, refers to a situation in which energy use or emissions decline in absolute terms while GDP continues to grow.

Another sharp differentiation on these concepts is that while relative decoupling is frequently observed in high-income economies, absolute decoupling remains rare and often limited to specific sectors or periods.

According to Papież et al.'s ("Decoupling is not enough") analysis of fossil fuel consumption in over 130 nations, most occurrences of decoupling are due to efficiency improvements rather than structural transformation. Absolute independence from fossil fuels is rare and regionally concentrated. Similarly, Abbas' examination of worldwide trends underlines how apparent reductions in energy intensity frequently do not translate into absolute declines due to rebound effects, consumption growth, and carbon-intensive industrial structures.

2. Data and Methodology

3.1 Data Source

The research draws on harmonized national energy and economic statistics from the Our World in statistics Energy dataset (2025 edition), which is based on the Energy Institute's Statistical Review of World Energy. The key variables include:

- The percentage of primary energy derived from fossil fuels
- Fossil fuel consumption (total and per capita).
- GDP per capita (constant USD).
- Population.

2.2 Temporal scope

For cross-sectional analysis, 2022 is chosen as the reference year since it is the most full and consistent year across nations in the 2025 dataset. This decision ensures comparability, especially for large economies and energy exporters, which are highlighted in the analysis. Annual data from 1990 to the most recent available year are used to trace long-term patterns of economic development and fossil fuel consumption.

2.3 Visualization Strategy

Two complementing visualizations are used:

- Figure 1 investigates scale impacts and structural dependencies based on population, fossil fuel proportion, and total fossil use.
- Figure 2 plots dynamic growth-energy paths to see if rising incomes lead to lower fossil fuel consumption per capita.

3. Empirical Results.

4.1 Population, Energy Mix, and Scale Effects (Figure 1).

Figure 1 argues and demonstrates that population size alone does not predict fossil fuel dependence. Countries with radically varied population sizes cluster around similar fossil fuel proportions, demonstrating that energy mix composition is not a function of population alone.

However, the interplay of population size and fossil fuel share has a significant impact on total fossil fuel use. Large countries with moderately high fossil fuel dependence account for the majority of global fossil energy consumption, which explains why a limited number of economies account for a disproportionate percentage of total emissions. This finding supports a major understanding from the energy and society literature: structural scale factors, rather than national efficiency or per-capita performance, influence climate outcomes.

3.2 Economic Growth and Fossil Fuel Trajectory (Figure 2).

Figure 2 investigates whether economic growth is linked to reducing fossil fuel consumption per capita over time. The animation trajectories show three main patterns:

- Industrialization Phase: Economic growth is intimately linked to increased fossil fuel use per capita, especially in emerging economies like China and India. This indicates industrial expansion, infrastructure development, and improved energy access.
- High-income plateau: At greater income levels, fossil fuel usage per capita stabilizes rather than declines. This plateau indicates efficiency gains but offers little indication of absolute decoupling.
- Structured outliers: Norway achieves a high income with relatively low fossil fuel consumption per capita, thanks to hydro-dominant electricity, solid institutions, and long-term energy planning.

Overall, income growth alone does not forecast a decrease in fossil fuel dependence. Instead, energy system structure, resource endowment, and policy decisions have a significant impact on results.

4. Discussion

Why Decoupling Isn't Automatic?

The findings significantly support the literature's critique of growth-centric decarbonization narratives. Relative decoupling in high-income nations frequently reflects:

- Outsourcing energy-intensive production.
- Saturation effects instead of transformation. Continued reliance on fossil fuels for transportation, industry, and heating. This confirms Papież et al.'s conclusion that climatic stabilization requires absolute reductions in fossil fuel use, not only decoupling.

Policy Implications

The empirical patterns identified in this analysis add to a growing body of literature challenging the premise that economic expansion will automatically lead to decreased fossil fuel consumption. While advancements in energy efficiency and structural shifts toward service-based economies have reduced energy intensity in several high-income countries, fossil energy use rarely decreases in absolute terms. Instead, fossil fuel use rises during industrialization periods and plateaus at higher income levels, implying that growth-led decoupling is only partial and heavily reliant on structural and regulatory factors. This finding is consistent with Papież et al., who found that while relative decoupling is prevalent, absolute decreases in fossil fuel consumption are unusual and geographically concentrated.

Figure 2 clearly shows that even when per capita fossil fuel use stabilizes, it does not diminish. This plateau reflects long-term structural constraints, such as the use of fossil fuels in transportation, heavy industries, and heating, as well as the inertia of existing energy infrastructures.

Income alone is a poor predictor of fossil fuel dependence. Countries with comparable GDP per capita have dramatically diverse fossil fuel consumption histories, demonstrating that energy system structure, resource endowment, and policy frameworks are significantly more influential. This is especially true in Norway, which constantly ranks as an outlier in the analysis. Despite its high GDP, Norway's unusually low per capita fossil fuel usage is the result of decades of strategic planning, strong

institutions, and a hydroelectric-dominated renewable electricity system. In contrast, fossil fuel-exporting Gulf states, with comparable or higher per capita income, have exceptionally high per capita fossil fuel consumption, indicating how production patterns and resource dependency can outweigh income effects.

The Norwegian situation is highlighted in this report for several reasons. First, it shows a high-income economy that has used structural and policy decisions to reduce domestic fossil fuel dependence, demonstrating effective decoupling measures in action. Second, Norway offers a unique junction of domestic low-carbon energy capability and global fossil fuel export duties, posing fundamental concerns about how national energy policies influence global emissions outcomes. Highlighting Norway enables for a more nuanced understanding of the complexity inherent in energy transition pathways, especially for nations who are both leaders in renewables and key players in global fossil energy markets.

From an energy policy standpoint, these findings highlight the limitations of using economic growth as a decarbonization method. Efficiency increases and technical substitutes, while vital, are insufficient on their own. Significant reductions necessitate purposeful structural reforms, strong governance, and focused policy instruments that address both domestic energy consumption and the global elements of fossil fuel production.

5. Conclusion

This paper indicates that economic expansion alone does not automatically result in lower fossil fuel consumption. While per capita fossil fuel consumption may stabilize at higher income levels, absolute drops are uncommon and heavily reliant on structural and policy variables. The layout of energy infrastructure, industrial structures, and governmental choices has a greater impact on fossil fuel dependence than wealth.

Norway is highlighted throughout this analysis because it exemplifies a high-income, renewable-dominated energy system that has managed to reduce domestic fossil fuel consumption while preserving economic growth. Norway's trajectory demonstrates how purposeful policy interventions and structural choices, particularly hydropower investment, long-term energy planning, and institutional cooperation, can help to bridge the gap between economic progress and fossil fuel dependence.

Simultaneously, Norway emphasizes the global dimension of energy transitions: domestic decarbonization can coexist with significant fossil fuel exports, stressing the importance of considering both internal and exterior repercussions when assessing a country's energy policy performance.

Recent research (Papież et al., Abbas) suggests that relative decoupling is insufficient for achieving climate goals, and that absolute reductions in fossil fuel consumption require deliberate, politically mediated solutions. For the EU and nations like Norway, this emphasizes the significance of integrating domestic energy policy with international climate duty, targeting both production and consumption, and addressing structural restrictions across industries. In conclusion, this analysis demonstrates that decoupling is not automatic nor uniform. Income increase can open up prospects for transition, but it does not guarantee it. Achieving real reductions in fossil fuel consumption necessitates a combination of purposeful governmental action, structural reform, and careful assessment of the global energy context, as demonstrated by the Norwegian example. Norway is not simply an analytically intriguing country; it is also a practical policy laboratory that demonstrates the possibilities and limitations of growth-compatible energy transitions.

6. References

- Papież, M., Śmiech, S., Frodyma, K., & Borowiec, J. (2022). Decoupling is not enough: Evidence from fossil fuel use in over 130 countries. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2022.134552>
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