

Decarbonization and energy transition in Portugal: a panel data analysis in the EU context

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INTRODUCTION & AIM

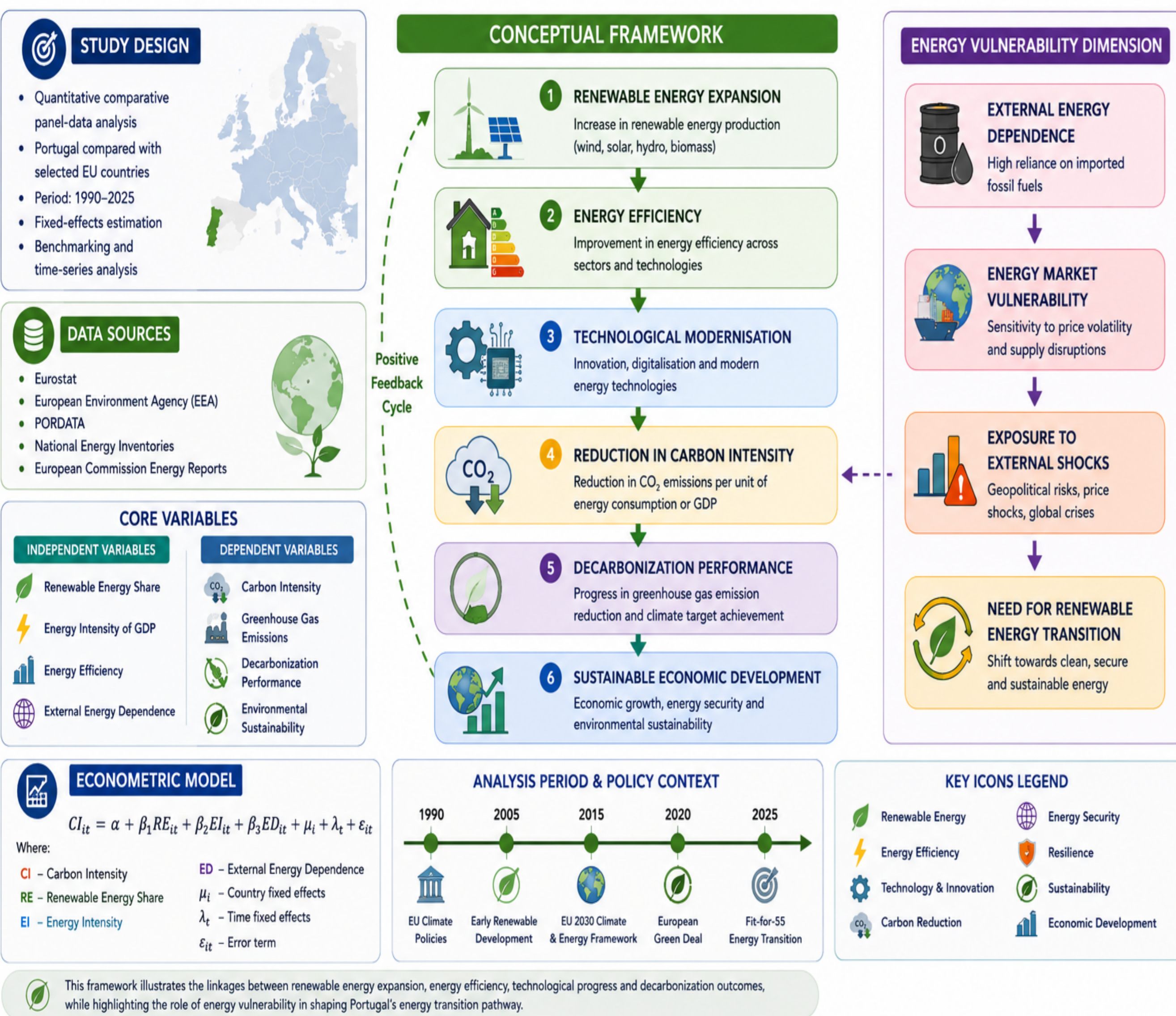
The transition toward low-carbon energy systems has become one of the main strategic priorities of the European Union. Policies such as the European Green Deal and the Fit-for-55 package aim to accelerate decarbonization, increase renewable energy integration, and improve energy efficiency across member states.

Portugal has demonstrated significant progress in renewable electricity generation and carbon emission reduction during the last decades. However, the country continues to face structural challenges related to external energy dependence, energy market vulnerability, and long-term sustainability.

This study aims to analyse the relationship between renewable energy expansion, energy efficiency, and carbon intensity reduction in Portugal within the European Union context. Using a comparative panel-data approach, the research evaluates the evolution of key energy and environmental indicators between 1990 and 2025 and examines the role of technological modernization and policy integration in supporting decarbonization performance.

METHOD

Quantitative Panel-Data Analysis of Energy Transition and Decarbonization in Portugal (1990–2025)



CONCLUSION

The study confirms that effective energy transition strategies require the combined interaction of renewable energy integration, technological modernisation, and efficiency improvements. However, external energy dependence remains an important structural challenge for long-term energy resilience and sustainability. Overall, the findings highlight the importance of integrated climate policies in supporting sustainable economic development and strengthening decarbonization pathways within the European Union context.

- Felício, L., Henriques, S. T., Guevara, Z., & Sousa, T. (2024). From electrification to decarbonization: Insights from Portugal's experience (1960–2016). *Renewable and Sustainable Energy Reviews*, 198, 114419. <https://doi.org/10.1016/j.rser.2024.114419>
- Maia, F., Leitão, S., & Marques, M. C. (2024). Energy transition in Portugal: The harnessing of solar photovoltaics in electric mobility and its impact on the carbon footprint. *Journal of Cleaner Production*, 477, 143834. <https://doi.org/10.1016/j.jclepro.2024.143834>
- European Environment Agency (EEA). (2024). *Energy transition and greenhouse gas indicators*. <https://www.eea.europa.eu>

RESULTS & DISCUSSION

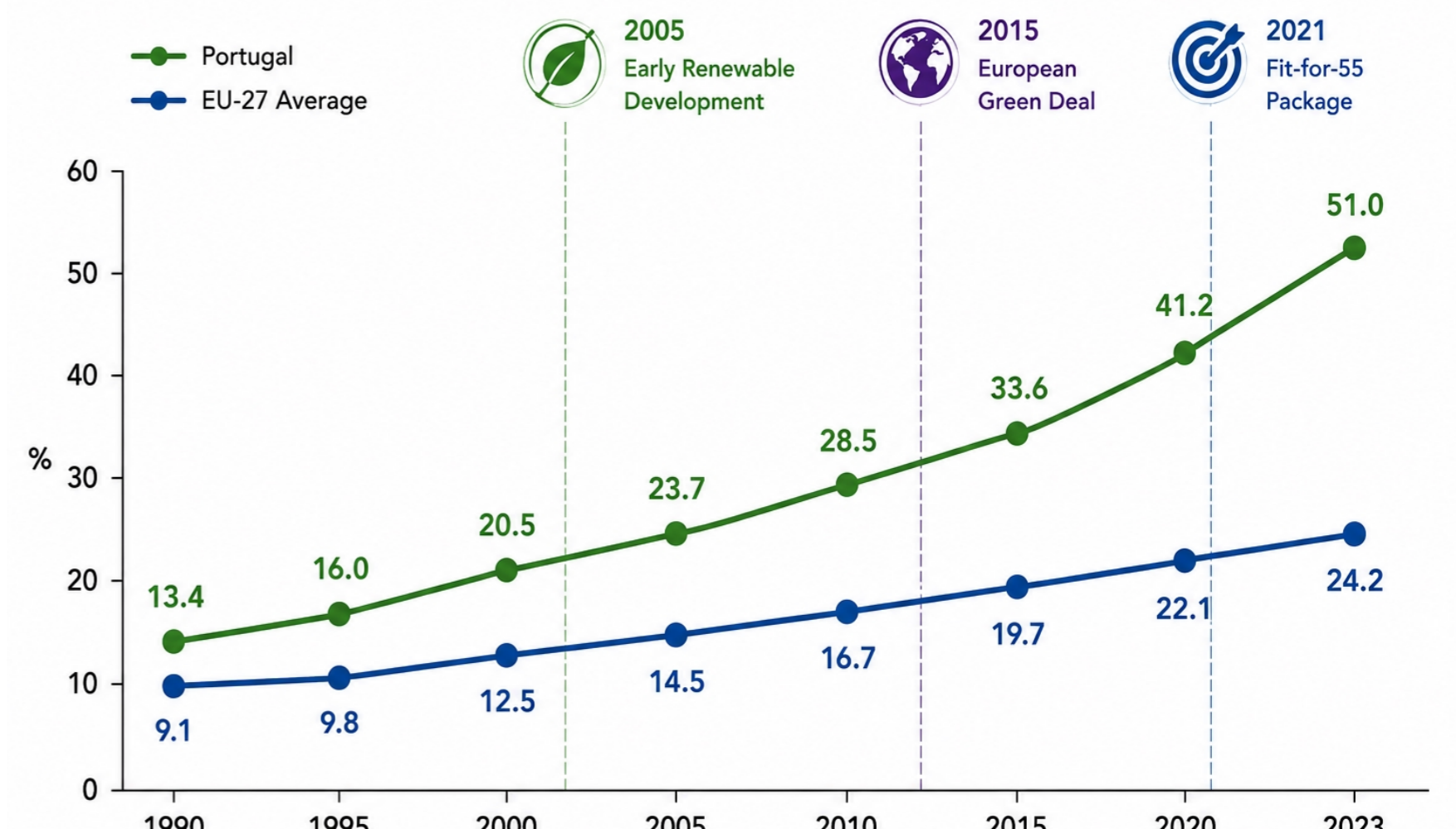


Figure 1. Renewable Energy Share in Portugal vs EU (1990–2023)

Key Insight

Portugal demonstrates a substantial increase in renewable energy integration during the analysed period, significantly outperforming the EU average after 2015 and strengthening its decarbonization trajectory.

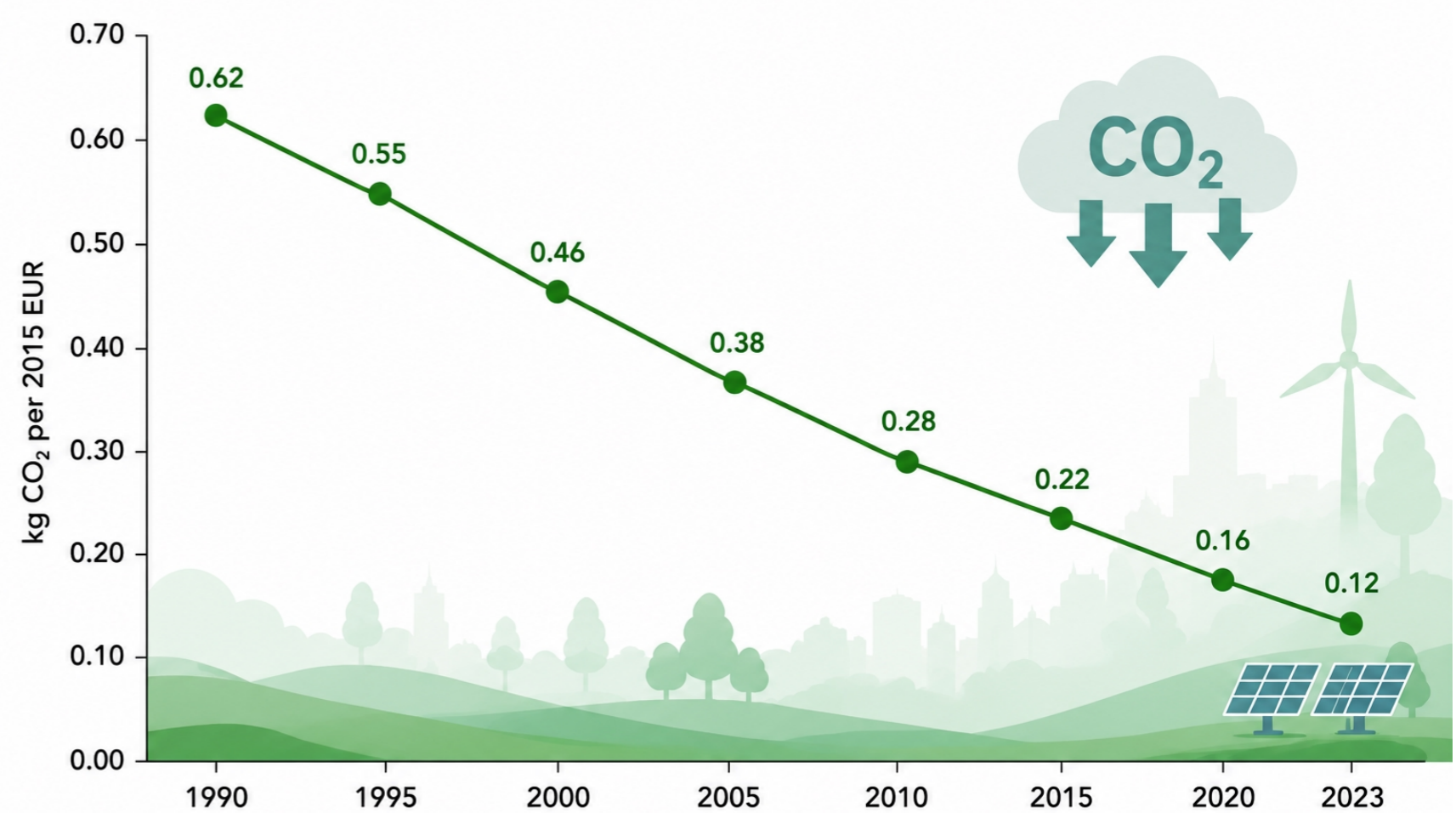


Figure 2. Carbon Intensity Reduction in Portugal (1990–2023)

Key Insight

Portugal demonstrates a substantial reduction in carbon intensity during the analysed period, reflecting the positive impact of renewable energy expansion and improvements in energy efficiency.

Table 1. Comparative Energy Transition Indicators

| Indicator | Portugal | EU Trend |
|--|---|-----------------------------------|
| Renewable Energy Share | ↑ Strong Growth (51.0% in 2023) | ↑ Moderate Growth (24.2% in 2023) |
| Carbon Intensity (CO ₂ per unit of GDP) | ↓ Significant Reduction (–81% since 1990) | ↓ Reduction (–59% since 1990) |
| External Energy Dependence | High (structural challenge) | Moderate (improving) |
| Energy Efficiency | ↑ Improving | ↔ Stable |
| Decarbonization Performance | ↑ Strong Progress | ↑ Moderate Progress |

FUTURE WORK / REFERENCES

Further research is recommended to evaluate causal relationships between renewable energy expansion and carbon intensity reduction using advanced econometric models.