

## **Green Transitions in Coal-Dependent Economies: A Hybrid Computable General Equilibrium Analysis of the Czech National Energy and Climate Plan**

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Environmental policies play a crucial role in mitigating climate change and improving air quality, yet their macroeconomic and sectoral implications remain a subject of debate, particularly in coal-dependent economies such as the Czech Republic. This paper evaluates the long-term economic and environmental impacts of key climate policies outlined in the updated Czech National Energy and Climate Plan (NECP) within the framework of the EU's Fit-for-55 package. We employ a hybrid recursive-dynamic Computable General Equilibrium (CGE) model, integrating a bottom-up electricity module that disaggregates power generation by technology and a discrete choice module that endogenizes consumer preferences for vehicle technologies. The model is formulated as a mixed complementarity problem (MCP) in GAMS, ensuring the consistent integration of sector-specific technological dynamics within a macroeconomic framework. The electricity module follows a technology-specific zero-profit condition with capacity constraints, while the transport module links consumer choice probabilities to aggregate vehicle stock evolution. The recursive dynamic structure captures investment accumulation, capital stock evolution, and intertemporal adjustments to policy shocks. We assess two scenarios: With Existing Measures (WEM), reflecting the continuation of current climate policies, and With Additional Measures (WAM), incorporating enhanced decarbonization strategies, including coal phase-out, the expansion of renewables, and the introduction of a second Emissions Trading System (ETS2). Our results indicate that while WAM requires higher upfront investments, it leads to a 75% reduction in power sector CO<sub>2</sub> emissions by 2040 and an 80% market share for battery electric vehicles (BEVs) by 2050. GDP initially benefits from green investments but slows post-2041 due to sectoral shifts, particularly in fossil fuel-related industries. By combining top-down macroeconomic analysis with sector-specific bottom-up technological representation, this study provides a comprehensive framework for assessing the system-wide effects of climate policy. The findings offer empirical insights for Czech and EU policymakers in designing cost-effective and equitable decarbonization strategies.