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Economic-energy Model Integration for Optimizing Transition Pathways

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Introduction

The global transition from fossil-fuel-based energy systems to more sustainable, low-carbon alternatives is one of the most pressing challenges of our time. This transformation involves not only technological innovation but also significant economic and policy shifts that require comprehensive and informed planning. As countries aim to meet ambitious climate goals while maintaining economic growth and social equity, it becomes essential to understand the complex interdependencies between energy systems and the broader economy. Economic-energy model integration addresses this need by combining the strengths of energy system models often focused on technology, resource constraints and emissions with economic models that capture market dynamics, policy impacts and behavioral responses. The resulting integrated framework offers a more holistic approach to decision-making, enabling policymakers to evaluate the feasibility, cost-effectiveness and social implications of various transition pathways. By bridging the gap between technical feasibility and economic viability, this integrated modeling approach provides critical insights into how societies can transition efficiently and equitably toward a sustainable energy future [1].

Description

Economic-energy model integration is the process of linking or combining two distinct yet complementary types of models: energy system models and economic models. Energy system models typically focus on the technological side of energy production, distribution and consumption. They simulate scenarios based on inputs such as available resources, technology costs, infrastructure constraints and carbon emissions, helping identify the optimal mix of energy technologies to meet future demand under various policy constraints. These models such as MARKAL, TIMES, or MESSAGE provide detailed representations of energy flows but often lack the capacity to assess broader macroeconomic impacts. On the other hand, economic models like Computable General Equilibrium (CGE) models or macro-econometric models evaluate how changes in the energy system affect the economy, including GDP, employment, income distribution and sectoral output. By integrating these models, analysts can capture both the technical feasibility and economic consequences of transition strategies, offering more balanced and realistic guidance for long-term policy development.

There are several approaches to achieving this integration, ranging from soft-linking and hard-linking to fully hybridized models. In a soft-linked approach, outputs from one model are used as inputs for the other in a sequential manner, allowing for iterative feedback without tightly coupling the models. For instance, the results of an energy system model regarding technology deployment and emissions can be input into an economic model to assess cost impacts or welfare changes. Hard-linked models involve tighter coupling, where models are run simultaneously and exchange data dynamically at each time step, capturing feedback loops between energy and economic systems in real time. Fully hybrid models are those that combine energy and economic modeling frameworks into a single integrated system from the ground up, though these are often more complex and resource-intensive to develop. Regardless of the approach, integrated models provide policymakers with richer insights, such as identifying cost-effective carbon mitigation options, evaluating the impact of subsidies or carbon taxes and forecasting long-term investment needs. They also allow for a nuanced understanding of trade-offs between environmental goals and economic stability, thus aiding in the design of policies that are both effective and politically viable [2].

Conclusion

In the pursuit of sustainable development and climate resilience, economic-energy model integration stands out as a crucial tool for optimizing energy transition pathways. By bringing together the technical precision of energy system models and the broader socio-economic analysis of economic models, this approach offers a comprehensive lens through which to evaluate complex policy decisions. Integrated modeling not only identifies efficient and feasible technological solutions but also assesses their economic impacts, equity considerations and implementation challenges. As energy systems become more decentralized, diversified and digitally interconnected, the need for sophisticated, integrative tools to guide policy and investment decisions will only grow. Economic-energy model integration, therefore, represents a vital advancement in strategic planning, enabling governments, industries and stakeholders to navigate the path to a low-carbon future with greater confidence, efficiency and inclusiveness.

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Conflict of Interest

None.

References

1. Del Granado, Pedro Crespo, Renger H. Van Nieuwkoop and Evangelos G. Kardakos, et al. "Modelling the energy transition: A nexus of energy system and economic models." *Energy Strategy Rev* 20 (2018): 229-235.

2. Mardani, Abbas, Dalia Streimikiene, Tomas Balezentis and Muhamad Zameri Mat Saman, et al. "Data envelopment analysis in energy and environmental economics: An overview of the state-of-the-art and recent development trends." *Energies* 11 (2018): 2002.

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