

A Multicriteria Assessment Approach to the Energy Trilemma

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Executive summary

The concept of the energy trilemma provides a framework for supporting energy policy decisions based on three main dimensions, namely energy security, environmental sustainability, and energy equity. Contrary to models that focus on providing policy guidelines solely based on normative grounds, energy trilemma adopts a descriptive perspective that emphasizes the need to monitor and assess the observed results of energies policies and of all externalities that affect the status of a country and the challenges that it faces regarding energy planning.

Building on the grounds of the energy trilemma concept, the objective of this study is to introduce a comprehensive framework and an evaluation process for operationalizing the assessment of the countries' performance from the energy trilemma point of view. To this end, first we describe the context of each of the main energy trilemma dimensions and suggest relevant indicators for each of them. We view energy security focusing on energy dependence and resilience, energy sustainability is considered in the context of energy use, energy efficiency, and environmental impacts, whereas energy equity is analyzed from the perspective of income availability and energy poverty. Moreover, we enhance the trilemma concept with a fourth dimension to account for the contextual environment of the countries, which is described in terms of their economic development, policy regulations, and innovations in energy and environmental technologies.

This framework is operationalized through the consideration of 20 indicators using data from the World Bank and the OECD. The selected indicators provide a “bottom line” view for the context of each dimension regarding the current status of the countries, their existing strengths and weaknesses, as well as the challenges that they face, incorporating information for both the outcomes of policy decisions as well as external (uncontrollable) factors.

The aggregation of the indicators provides composite indicators for each one of the four dimensions describe above, as well as an overall assessment. The construction of these composite evaluations is performed using a multicriteria approach, which is based on principles from efficiency measurement.

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More specifically, a variant of the envelopment analysis is introduced to evaluate the countries in a data-driven context. Under this scheme, the performance of a country is measured in terms of its distance from a best practice frontier that is defined by the observed data of a set of countries. The assessment combines an optimistic perspective, which emphasizes the dimensions where a country performs best, as well as a pessimistic point of view that focuses on the weaknesses of each country. This data-driven approach overcomes difficulties associated with the specification of specific (subjective) weights for the indicators, while providing flexibility in the evaluation process, by allowing the consideration of country-specific trade-offs among the trilemma dimensions, based on the characteristics that best describe the observed data of each country compared to its peers.

To illustrate the proposed methodological framework and the multicriteria approach for the construction of composite indicators for measuring the performance countries in accordance with the energy trilemma concept, empirical results are presented for OECD countries over the period 2005-2015. A rolling window approach is used to explore the dynamics of the countries' performance and the identification of time trends.

The results show that Scandinavian countries tend to utilize a relatively balanced and more independent energy mix compared to other OECD countries. Energy sustainability has improved steadily during the period of the analysis, driven by the increasing use of clean energy technologies and the improvements in energy efficiency. However, there is still work to be done in energy equity, as this dimension remains challenging. Overall there is improvement over time.

Keywords: climate change; energy policy; energy trilemma; multicriteria decision making.