

A MULTICRITERIA ASSESSMENT APPROACH TO THE ENERGY TRILEMMA

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Overview

The development of sustainable energy systems plays a key role for addressing climate change, but it is a complex and multifaceted task that should take into consideration a wide range of technological and socio-economic (Kuzemko et al. 2016) issues. Recognizing this fact, the energy trilemma concept has been introduced, emphasizing the need to achieve a balance among three main dimensions: energy security, energy equity, and environmental sustainability. Country benchmarks based on such dimensions have been introduced by several organizations (e.g., the World Energy Council, World Economic Forum) and researchers (Grigoroudis, Kouikoglou, and Phillis 2015), to facilitate the identification of the strengths and weaknesses of the countries, as well as the global trends in the effectiveness of energy and environmental policies.

In this study we provide a systematic treatment of the energy trilemma at the country level. A novel multicriteria assessment framework is employed to evaluate the performance of countries and identify trends over time. Such an evaluation provides useful results for policy making, as it enables the examination of the status of each country and the challenges that it should face towards achieving energy sustainability. The obtained empirical results are analyzed over time as well as taking into account the characteristics of the countries.

Methods

The proposed benchmarking approach is based on concepts from the field of efficiency analysis, namely the “benefit-of-the-doubt” (BoD) framework (Cherchye et al. 2007). BoD is a variant of data envelopment analysis (DEA), for constructing composite performance indicators to assess the relative performance of a set of comparable units (e.g., countries) in a benchmarking context. DEA has been a popular tool for assessing energy efficiency at the country level (Makridou et al. 2015; Zhou, Ang, and Poh 2007) in an input/output context. The BoD approach extends the framework of DEA in a setting without inputs, where the outputs represent performance indicators describing the performance of the units. Performance assessments in BoD are derived in a data-driven context that requires minimum input from analysts and/or decision-makers. For the purposes of the analysis, we introduce a variant of the standard BoD approach, which enables the consideration of negative data in a straightforward manner, without relying on data transformations.

The period under examination is between 2005 and 2015 and 34 OECD countries are considered in the analysis. This extended time period encompasses both the financial crisis of the 2007-2009 as well as the oil price rally and falldown. We use a total of 20 indicators using data collected from the databases of World Bank and OECD. The selected indicators are categorized in four main dimensions, covering energy security, sustainability, and equity, as well as the contextual environment that characterizes the policy status and framework in each country in terms of its environmental and energy related policies.

Results

A ranking of the OECD countries is provided relative to each dimension of Security, Sustainability, Equity and Policy and overall. According to the obtained results, Scandinavian countries like Sweden, Denmark and Norway achieve the best performance. The worst overall performers are Poland, Turkey and Mexico, exhibiting weaknesses on all dimensions considered in the analysis. It is evident that the aggregate performance of the countries shows some improvement, particularly during the period after 2010. This improvement has been mainly driven by improvements in sustainability and the contextual environment. The former increased almost steadily throughout the period of the analysis, whereas the component score regarding the contextual environment improved after 2009. The security dimension improved up to 2011, followed by a decline in the later years due to an increase in energy imports. On the other hand, equity appears to raise the most notable challenges, following a decreasing trend due to increasing

energy and fuel costs. Moreover, based on the obtained estimates about the performance of the countries, we derive clusters of countries exhibiting similar performance patterns.

Conclusions

The results of the proposed benchmarking and evaluation methodology 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 with the less fossil intense energy mix and with improvements in energy efficiency. However there is still work to be done in the equity of energy purchase especially from households. Policy needs to set a clear path to be followed. Countries that invest and regulate towards a decarbonization policy don't always see the results immediately translated into better results in the other dimensions and especially in energy equity. A future research should look for the links that affect one dimension with another and determine if there is some sort of causality between them.

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