

THE INCOMPLETENESS OF ENERGY SECURITY INDICATORS: THE CASE OF HIDDEN ENERGY CONSUMPTION

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Overview

Energy security ranks high on the policy agenda of many countries. Governments use the notion of energy security as a rationale for justifying massive intervention into energy markets. Accordingly, to provide policy guidance, a large and growing body of literature proposes metrics to measure security of (primary) energy supply. These metrics are then frequently applied in cross-country energy security assessments that rank countries according to the applied metrics at certain points in time.

Since these studies in general are based on data coming from production-oriented accounting frameworks for regional primary energy consumption – i.e. direct energy consumption based on the territory principle – they neglect that energy is not only used directly in any given production and final demand sector but also indirectly – i.e. in the production of imported goods and services for use in that sector (Battjes, Noorman, and Biesiot 1998). Since in a highly globalized world countries are heavily and increasingly involved in international trade, trade in non-energy goods and services can substitute for trade and consumption of primary energy which in the end masks energy security issues (Andrew, Davis, and Peters 2013). To put it more pointedly: If trading partners providing imports of non-energy goods and services cannot secure their energy supply, how can energy security being provided without disconnecting from global trade of non-energy goods and services (Tang, Snowden, and Höök 2013).

Because Europe is one of the most dominant trading centers in terms of embodied energy (Chen and Chen 2011), commonly applied energy security assessments for European countries are based on only an incomplete picture of the European energy situation. This implies that cross-country energy security assessments for European countries might be inaccurate – i.e. indicator-specific country rankings for European countries might change once embodied energy in traded goods is acknowledged for. Acknowledging indirect energy consumption would require a switchover from production-oriented energy accounting to more consumption-oriented approaches for energy accounting. This switchover in energy accounting would provide a novel perspective on the European energy security problem. In the end, it would allow a better-informed energy security debate.

So far only some rare studies address the implications of this hidden energy use for perceived security of European energy supply. Bordigoni, Hita, and Le Blanc (2012) examine the role of these additional energy flows with a special focus on the European manufacturing industry. They find that in 2005 embodied energy in imported manufactured products used in European production and final consumption comes close to energy consumed directly by the European industry and, therefore, has to be considered as a significant aspect of the European energy situation. In a similar way, Tang, Snowden, and Höök (2013) quantify energy embodied in international trade of the UK. They find that UK is a net-importer of embodied fossil energy for every year within the time period 1997 to 2011. Accordingly, since the gap between fossil energy consumption and domestic fossil energy production is larger than commonly believed, they argue that if net-imports are taken into consideration, the energy security problem is greater than generally accepted. Therefore, they conclude that energy embodied in traded goods is another variable which should be considered in the complex equation of energy security.

Hence, to motivate future research, the principal objective of this paper is to further highlight the implications of the consideration of embodied energy in traded goods for commonly conducted cross-country energy security assessments. First, it extends a set of conventionally used energy security indicators in such a way that they also include indirect energy consumption. Second, it provides a methodology that enables the quantification of indirect energy consumption. Third, to quantify the impact of the switchover in the energy accounting framework on indicator values and indicator-specific country rankings, it applies the methodology and the indicators for 27 European countries for the years 1995 to 2007.

Methods

To quantify energy security from a production-oriented and a consumption-oriented perspective, the following three indicators are used: energy intensity of GDP, net-import dependency, and primary energy carrier dependency. Hereby, consumption-oriented indicator values account for primary energy embodied in imports and exports of goods and services.

The calculation of primary energy embodied in imports and exports of goods and services is based on a complete multi-regional input-output model (MRIO) extended by sector- and carrier-specific primary energy consumption – i.e. crude oil, natural gas, coal, nuclear energy, and renewables. The parameters required to solve the model are taken from the World Input-Output Database (WIOD). Furthermore, satellite data coming from the Eurostat statistical database is used to calculate direct consumption of imported energy for European countries.

In the application, annual values for the three energy security indicators are calculated for each EU member state based on production-oriented as well as on the consumption oriented accounting framework for regional primary energy consumption. The production oriented indicator values are then taken as reference against which changes in indicator values and that occur due to the switchover in the energy accounting framework are quantified. To compare differences in the country rankings, a non-parametric correlation measure is applied for each year and each indicator.

Results

The application shows that in many cases the incorporation of primary energy embodied in traded goods has a quite substantial impact on the values of the applied energy security indicators. Hereby, direction and magnitude of these changes depend on the indicator as well as on the total amount of regional net-imports of embodied energy, its composition as well as its size relative to direct primary energy consumption. Hence, since total and carrier-specific net-imports vary across countries, changes in the indicator values are quite heterogeneous across countries for each indicator. As it comes to indicator-specific country rankings, this heterogeneity is large enough to cause substantial changes in the countries' positions in the rankings. This is particularly the case for primary energy carrier dependency.

Conclusions

The findings of this research suggest that the question whether indirect energy consumption should be taken into consideration is of particular relevance for comparing security of primary energy supply across countries. Furthermore, they imply that if indirect energy consumption is included, the goal of lowering dependency on (foreign) primary energy is more difficult to achieve. This is because it is no more possible to simply substitute direct energy consumption for indirect energy consumption. On the other hand, achieving the goal of lowering dependency on primary energy carriers becomes easier.

References

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