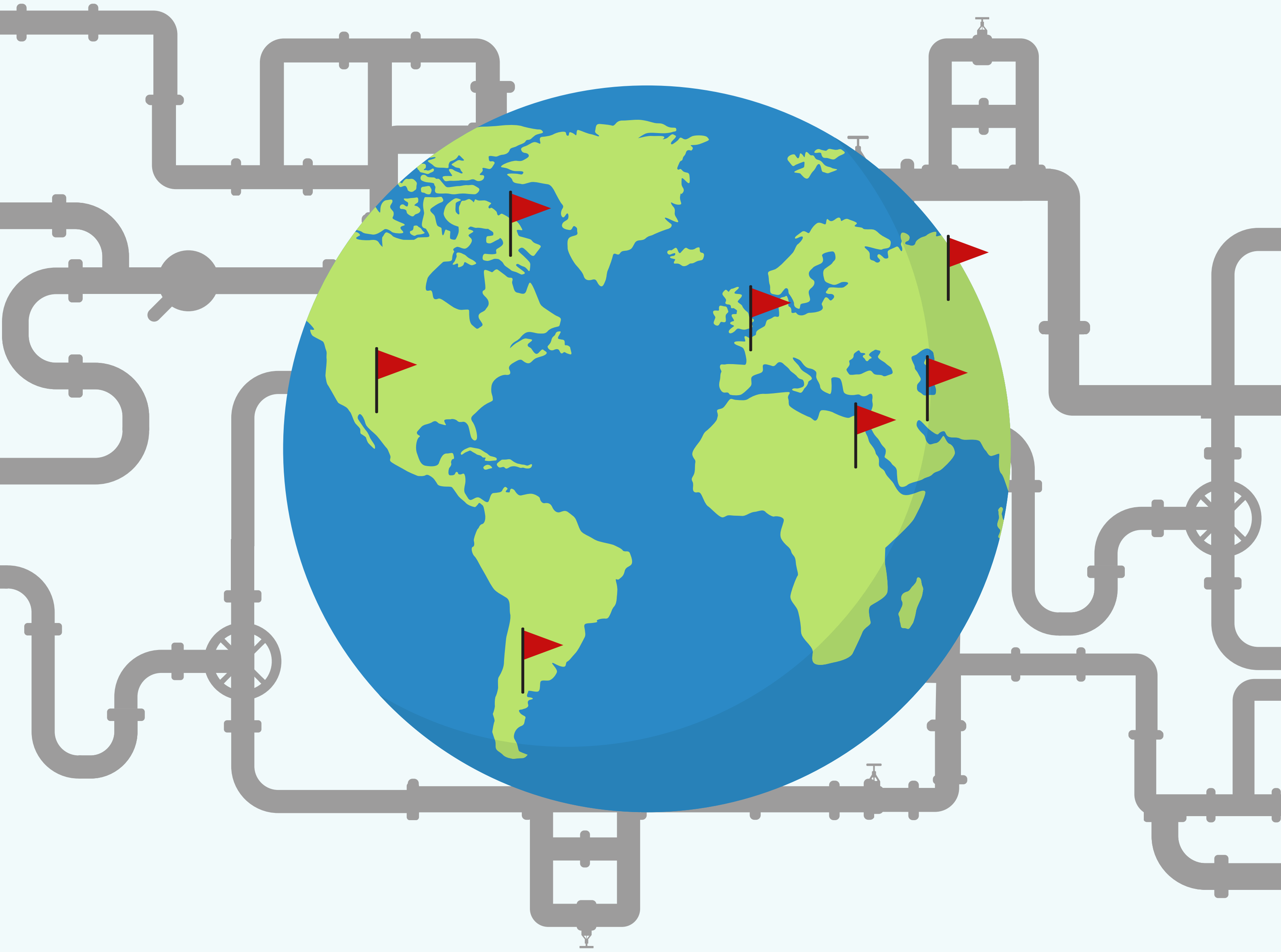
Multiple Impacts Calculation Tool

Empirical Basis of Economic Impacts Aggregated energy security (supply diversity)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

Frederic Berger, Fraunhofer ISI

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Executive summary

- Multiple Impact Supplier Diversity is an indicator of energy security, assessing supplier variety.
- Quantification uses the Herfindahl-Hirschman-Index and a reliability coefficient.
- Saved energy from the largest supplier is subtracted in the calculation.
- Attribution of saved energy to partner countries is complex and error-prone.
- The indicator is meaningful when combined with import dependency impact.
- Monetisation is unlikely due to difficulties in obtaining future import data.

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Scope of MI indicator

Definition

The multiple impact indicator supplier diversity describes the composition of countries energy carriers are imported from. It also takes the respective share of imports into account. A limited supplier diversity can lead to higher energy prices and a dependent relationship. However, the indicator is insensitive to the geopolitical relation to the supplier countries.

Relevance on EU, national and/or local level

The low supplier diversity for some energy carriers was a driver of the EU Commission's 2014 Energy Security Strategy, emphasising the central role of energy efficiency in reducing the import shares of major supplying countries and associated dependent relationships (European Commission, 2014).

Given the more severe situation of some member states in this regard, supplier diversity is of major relevance to several countries on a national level. It is not expedient to determine supplier diversity on a local level, since energy contracts are generally entered nationally and energy markets operate on larger scales. Nevertheless, it can make sense for local authorities to foster adaptation measures in case of a low national supplier diversity in order to be prepared in case of energy price spikes or even shortages.

Impact pathway figure

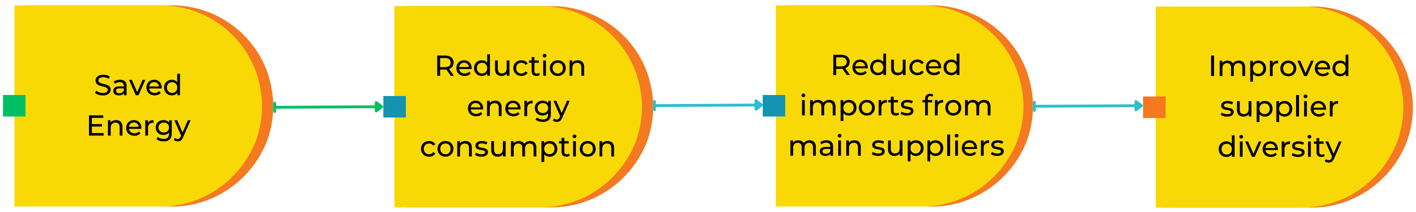

Figure 1 : Impact pathway for the indicator aggregated energy security (supply diversity)

Overlaps with other MI indicators and potential risk of double-counting

This indicator is connected to the MI import dependency, since it can exacerbate the latter's severity. Particularly when it comes to energy price surges and shortages, the two indicators are strongly intertwined. However, since both are not recommended for monetisation, the risk of double-counting is averted. No overlap with any other indicator is found.

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Quantification method

Description

In order to quantify the supplier diversity for energy carrier *e*, a modified version of the Herfindahl-Hirschman-Index (HHI) is used:

$$HHI_{c,e} = \sum_{p=1}^{N_p} \left(\frac{k_p \cdot IE_{c,e,p}}{IE_{c,e}} \right)^2$$

In this equation, $IE_{c,e}$ represents the amount of caloric value of imported energy carrier *e* originating from country *p*, while $IE_{e,tot}$ stands for the total caloric value of the imported energy carrier *e*. A problem of the HHI is that it does not differentiate between reliable and unreliable partner countries. Therefore, the risk-coefficient k_c is introduced, quantifying the risk of supply disruptions. Since a high HHI is bad, a value of 0.5 is assigned for EU countries, 0.7 for EFTA countries and the UK, and 1 for the rest of the world. At a later stage, a consideration of figures from the World Energy Council's Energy Trilemma, taking particularly the energy security dimension into account. The adapted HHI is normalised to values between 0 (exclusive) and 1, the latter describing a monopoly held by a country that is neither part of the EU nor of the EFTA and the UK. This method can also be used for all energy carriers combined by adding the relevant energy carriers' caloric value for each country:

$$HHI_c = \sum_{p=1}^{N_p} \left(\frac{k_p \cdot \sum_{e=1}^{N_e} IE_{c,e,p}}{IE_c} \right)^2$$

However, an aggregation obfuscates strong dependent relationships for single energy carriers by averaging. A top-down approach is most expedient for this quantification, the data being available from Eurostat.

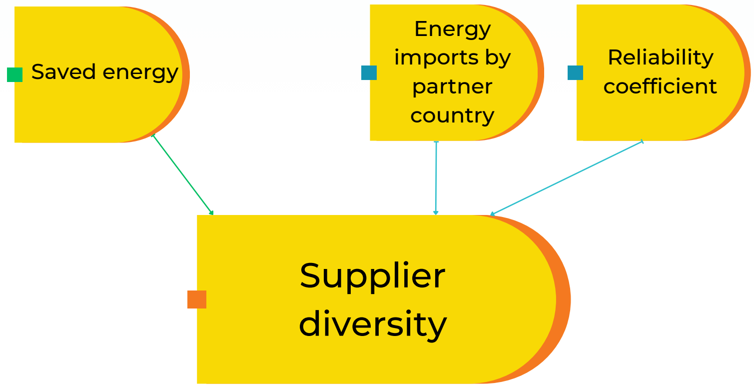

Figure 2: Quantification of the indicator aggregated energy security (supply diversity)

Methodological challenges

The calculation of energy savings' impact on the HHI is rather inaccurate. Firstly, subtracting energy savings from the largest supplier could lead to a change in the supplying order if the difference between the two leading countries is smaller than the saved energy. Secondly, a country could be keen on reducing the quota of a supplier deemed unreliable or with which the political relation is brittle, rather than just reducing the main supplier's share. In order to alleviate these issues, a more complicated equation striving to minimise the overall HHI could prioritise which country's imports to reduce. However, this would lead to a more complex determination process, contradicting the overarching idea of a simple easy-to-use tool.

Data requirements

Independent of sophistication or of whether the energy carriers are aggregated or broken down, the same data is required from Eurostat, namely the "Imports of [energy carrier] by partner country" for each examined energy carrier. The same data would be necessary for the future from PRIMES, which is likely going to be difficult to get.

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Impact factor/functional relationship

In order to assess the impact of energy savings of energy carrier *e* on the relevant supplier diversity, the status quo is compared to the expected scenario with the projected energy savings. In the latter, the largest non-EU/EFTA/UK supplier's quota (*p*=1) is reduced (or increased for ex-post) by the additional relevant energy savings *ΔE* (if there is no non-EU/EFTA/UK supplier, then the largest EFTA/UK supplier and then the largest EU supplier are selected instead). This leads to the following equation:

$$\Delta HHI_{c,e} = \sum_{p=1}^{N_p} \left(\frac{k_p \cdot IE_{c,e,p}}{IE_{c,e}} \right)^2 - \left[\left(\frac{k_1 \cdot (IE_{c,e,1} - \Delta E_{c,e})}{IE_{c,e} - \Delta E_{c,e}} \right)^2 + \sum_{p=2}^{N_p} \left(\frac{k_p \cdot IE_{c,e,p}}{IE_{c,e} - \Delta E_{c,e}} \right)^2 \right]$$

The nomenclature is equivalent to the formula in the Quantification method section.

Monetisation

As is the case for the MI import dependency, a monetisation of supplier diversity is not deemed expedient and therefore not recommended. The major economic factor linked to this indicator is the risk of energy price surges and shortages or even outages. The costs of internalisation of such risks are very difficult and inaccurate to determine, particularly since the energy price increases of 2021 point towards the fact that the chosen internalisation rate has been insufficient. Furthermore, it is difficult to determine a relationship between HHI and energy prices, since it can strongly depend on the geopolitical relation to the supplying country and their political agenda. However, if a monetisation is imperative, it should apply to the aggregated value of import dependency and supplier diversity, since this combination is most closely linked to the risk of supply shortages and price surges.

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Aggregation

An aggregation of this MI with the MI import dependency would be expedient, since a lack of supply diversity is a factor aggravating the latter. Therefore, a simple multiplication would suffice to determine the weighted import dependency *WID* for a given energy carrier *e*. Yet, this formula should only apply if the import dependency for an energy carrier is positive, since a potential HHI calculated for a small proportion of imported energy does not diminish the benefit of a net surplus of the examined energy carrier:

$$WID_{c,e} = \begin{cases} ID_{c,e} \cdot HHI_{c,e}, & ID_{c,e} > 0 \\ ID_{c,e}, & ID_{c,e} \leq 0 \end{cases}$$

It is to be noted that this reduces the overall range of values, leading to a lower perceived import dependency. Furthermore, the weighted import dependency is not normalised, as import dependency values can exceed the boundaries 0 (net exporter) and 1 (building up reserves).

Conclusion

The MI Supplier Diversity is an important indicator to assess a country's energy security, describing the variety and reliability of energy suppliers. While merely relevant at the EU and national level, the quantification of the indicator is quite complicated, as the saved energy has to be attributed to (ex-post) or subtracted from (ex-ante) partner countries. This allocation is not really straightforward and could turn out to be a major source of error. Besides, the indicator is not really meaningful unless combined with the MI import dependency. A monetisation of this indicator is probably not going to be possible in the framework of this project, getting data on imports by partner countries for the future could already become quite a struggle.

Reference

European Commission (2014). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL European Energy Security Strategy. *https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0330&qid=1407855611566*

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Author: Frederic Berger, Fraunhofer ISI

Design: Mara Oprea , IEECP

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