Meta-analysis of country-specific energy scenario studies for neighbouring countries of Germany

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Overview

This study consists of a meta-analysis from a collection of energy scenario studies that were conducted specifically for individual neighbouring countries of Germany. It provides an overview on recent energy-technical discussion taking place in these countries and derives generalized insights. It lays the focus on the fifteen electrically and geographically connected neighboring countries of Germany: Belgium, Denmark, United Kingdom, France, Italy, Netherlands, Norway, Austria, Poland, Sweden, Switzerland, Slovenia, Czech Republic, Slovakia and Hungary. The study excludes the whole European scenario studies such as the Ten Year Network Development Plan of ENTSO-e, World Energy Outlook, e-Highway or the EU Reference Scenarios. By focusing on the country-specific studies, we believe that the energy-technical discussion points within a country can be more closely identified, and the reconciliatory biases arising from a continental point of view–e.g. matching between import/export dependencies across countries–can be avoided. Within the scope of this work, only the studies which were conducted after 2010 are taken into account to ensure that the individual policies and targets that are considered in the studies are suffciently up-to-date. Figure 1 gives an overview on the key figures of the study.

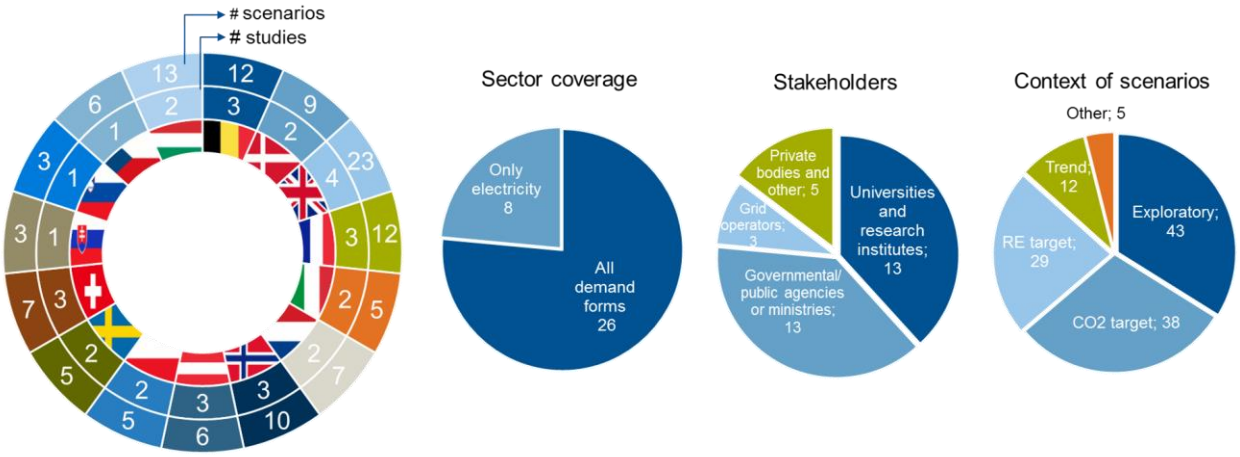
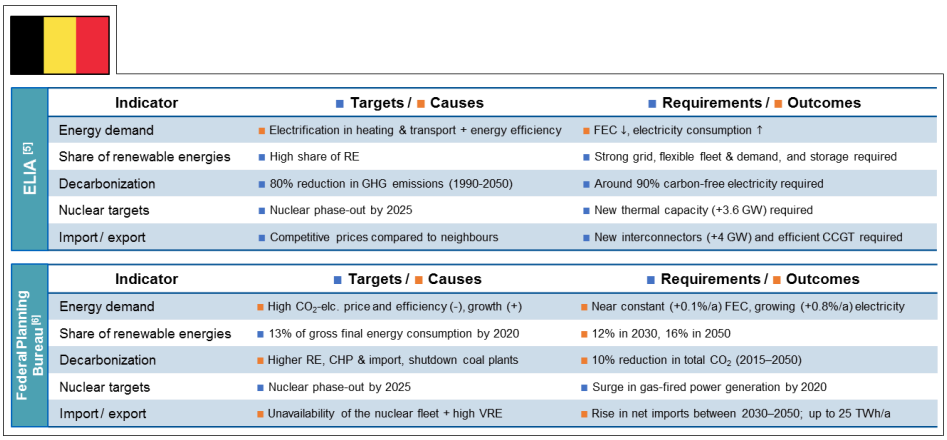


Figure 1. Key figures of the meta-analysis.

Methods

In order to establish comparison points between these studies that have diverse contexts, five energy-technical indicators were identified as common themes recurring in almost every study: 1) *changes in the energy demand*: 2) *shares of renewable electricity*, 3) *nuclear targets*, 4) *decarbonization targets*, 5) *import/export dependencies*. Then, considering each of these indicators, causal relationships were derived for each individual country and compiled as *country profiles* (Figure 2).

Additional to the country profiles, generalized forms of representation are plotted for country-overarching insights using quantifiable metrics related to each of the indicators (except the fourth indicator). For example, for the indicator *"changes in the energy demand*", the general trend towards electrification of sectors is investigated by comparing the changes in the annual electricity demand and the total energy demand between the first and latest simulated years of the study. These forms of representation enable a unified comparison across these studies and thus constitute the added value of this meta-analysis.



ELIA [5]

Indicator	Targets / Causes	Requirements / Outcomes
Energy demand	Electrification in heating & transport + energy efficiency	FEC ↓, electricity consumption ↑
Share of renewable energies	High share of RE	Strong grid, flexible fleet & demand, and storage required
Decarbonization	80% reduction in GHG emissions (1990-2050)	Around 90% carbon-free electricity required
Nuclear targets	Nuclear phase-out by 2025	New thermal capacity (+3.6 GW) required
Import / export	Competitive prices compared to neighbours	New interconnectors (+4 GW) and efficient CCGT required

Federal Planning Bureau [6]

Indicator	Targets / Causes	Requirements / Outcomes
Energy demand	High CO_2-elc. price and efficiency (-), growth (+)	Near constant (+0.1%/a) FEC, growing (+0.8%/a) electricity
Share of renewable energies	13% of gross final energy consumption by 2020	12% in 2030, 16% in 2050
Decarbonization	Higher RE, CHP & import, shutdown coal plants	10% reduction in total CO_2 (2015–2050)
Nuclear targets	Nuclear phase-out by 2025	Surge in gas-fired power generation by 2020
Import / export	Unavailability of the nuclear fleet + high VRE	Rise in net imports between 2030–2050; up to 25 TWh/a

Figure 2. Country profiles – Example Belgium.

Results

Key results of the study for each of the indicators can be summarized as follows:

1. *Changes in the energy demand:* Common trend is a decrease in the final energy consumption, whereas the electricity demand increases through economic growth and electrification of end use sectors. Trend scenarios predict small changes in both final energy and electricity consumption. CO_2 target scenarios predict significant reductions in final energy consumption. In particular, electrification in transport sector was mentioned by the studies for 14 of the 15 countries, and in residential heating for 12 of the 15 countries .

2. *Shares of electricity from renewable energies (RE):* In terms of the RE technologies having the highest electricity production by the end of the simulated years, hydropower and wind energy are the dominating technologies. Across all scenarios, a wide range of RE shares between 10% and 100% of total electricity are predicted, whereas the 100% RE outcomes consist mainly of exploratory of RE target scenarios. When emerging RE technologies–e.g. the technologies for which the highest expansion takes place–are considered, wind and solar energy are leading for large number of countries (53% of all scenarios for wind, 20% for solar).

3. *Nuclear targets:* When it comes to the prospects on nuclear power, the studied countries have a wide variety of targets. For instance, four of the 15 countries (Austria, Denmark, Italy and Norway) already have no nuclear power, whereas Belgium and Switzerland target phase-out across each of the scenarios associated with them. On the other hand, countries such as UK, Czech Republic and Slovakia target nuclear expansion in the majority of their scenarios.

4. *Import/export dependencies:* As far as national import and export policies are concerned, Belgium, Italy and Poland stand out as the countries where each scenario predicts positive net import of electricity by the end of their simulation period. On the other hand, each scenario for Norway, Sweden and Slovakia predicts generation of surplus electricity (former two via hydropower, latter via new nuclear) which, in turn, creates export potential into neighboring countries. In general, the number of net export studies are higher than the number of net import studies; implying a general trend towards self-sufficiency

Conclusions

In this study, a meta-analysis of energy scenario studies has been conducted using simple forms of representations, which facilitate comparison despite high heterogeneity of these studies. Through these representations, scenarios depicting trend and extreme cases could be identified. All in all, the trend scenarios show no big changes in final demand, whereas there is a common progress towards electrification in transport and residential heating. Wind energy is identified as the most relevant expanding RE technology in the European market, whereas it competes with hydropower in terms of the installed capacities. Import/export considerations discussed in each country-specific study were found to be lopsided in the favour of export, implying insufficient coordination between national policies. For only a few countries, nuclear phase-out is not discussed. On the other hand, more than half of the countries have at least one nuclear scenario, hinting that there is there is no common, conclusive ground regarding nuclear targets.