Lehrstuhl für Erneuerbare und Nachhaltige Energiesysteme
Fakultät für Elektrotechnik und Informationstechnik
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Meta-analysis of country-specific energy scenario studies for neighboring countries of Germany

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Agenda

1. Why an analysis of country-specific studies?

2. Overview & key figures of the meta-analysis

3. Insights from the studies
   a) Country profiles
   b) Analysis charts

4. Lessons learned

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In the scope of the project 

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Goal:

“Determine the future picture of a cost-optimal, reliable German energy system,
*taking into account the **European** electricity market coupling,*
*under various **extreme** technological, regulatory and social developments”*

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"Determine the future picture of a cost-optimal, reliable German energy system,
*taking into account the **European** electricity market coupling,*
*under various **extreme** technological, regulatory and social developments"*

Necessity:
An analysis of the **country-specific studies** to better understand **possible extreme outcomes** in all concerned countries, related to:

„Is nuclear phase-out discussed?"	„Is deep decarbonization targeted?"	„Efficiency vs. growth? Energy demand?"	Does the country seek self-sufficiency?

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2. Overview & key figures of the meta-analysis

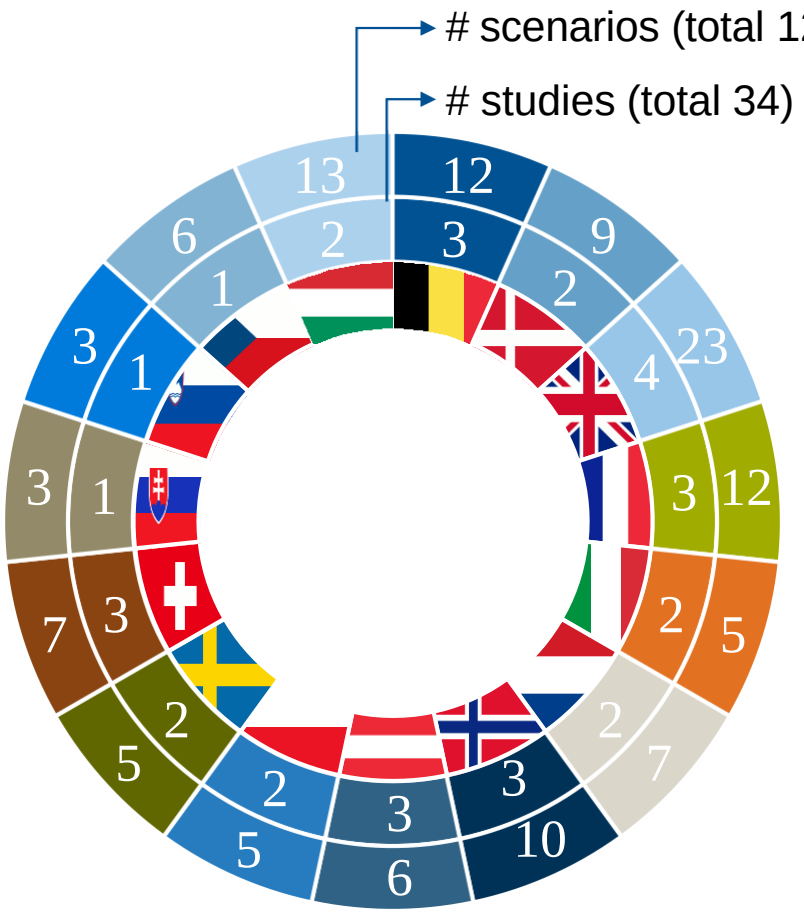
Overview on the scenario database

Final energy consumption, installed capacities…

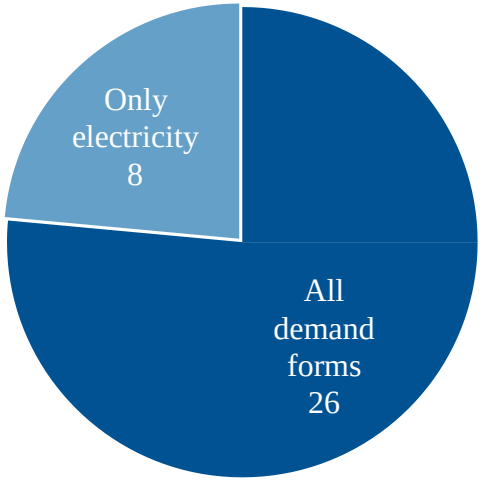
Country	Title	Institution	Contractor	Contractee	Year of study	# Scenarios	Starting year	End year
Belgium	Electricity Scenarios for Belgium Towards 2050	ELIA	Grid operator		2017	6	2016	2050
Belgium	The Belgian energy landscape by 2050: an outlook assuming no changes in policy	Federal Planning Bureau	Public agency		2017	1	2015	2050
Belgium	Energy Transition in Belgium	Energyville	Research institute	Business association	2017	5	2016	2030
Denmark	IDA's Energy Vision 2050	Aalborg Universitet	University	Trade union	2015	1	2015	2050
Denmark	Energiscenarier frem mod 2020, 2035 og 2050 (Energy scenarios from 2020, 2035 and 2050)	Energistyrelsen (Danish Energy Agency)	Public agency		2014	8	2035	2050
Great Britain	Future energy scenarios	National Grid	Grid operator		2018	4	2017	2050
Great Britain	2050 Energy Scenarios	KPMG	Service company	Trade association	2016	4	2014	2050
Great Britain	Whole-system cost of variable renewables in future GB electricity system	Imperial College London	University		2016	7	2015	2030
United Kingdom	The UK energy system in 2050	UKERC	Research institute		2013	8	2015	2050
France	ADEME energy transition scenarios 2030/2050	ADEME	Public agency		2014	2	2030	2050
France	Scénario négaWatt 2017-2050	Association négaWatt	Think-tank	Policymakers	2017	2	2015	2050
France	Bilan prévisionnel - de l'équilibre offre-demande d'électricité en France	Réseau de Transport d'Électricité	Grid operator		2017	8	2016	2035
Italy	Strategia Energetica Nazionale (National energy strategy)	Ministerio dello Sviluppo Economico	Ministry		2017	3	2010	2030
Italy	Una strategia energetica per L'italia	Associazione Italiana Economisti dell'Energia	Business association	Business association	2017	2	2015	2030
Netherlands	Nationale energieverkenning 2017	Energy Research Center for Netherlands (ECN)	Research institute	Ministry	2017	2	2016	2035
Netherlands	Energy scenarios for 2030	CE Delft	Research institute		2014	5	2012	2030
Norway	CenSES Energy demand projections towards 2050	Centre for Sustainable Energy Studies (CenSES)	Research institute		2014	5	2010	2050
Norway	The Norwegian scenario and action plan presented by NITO Future Climate	The Norwegian Society of Engineers and Technologists	Union in engineering		2009	2	2000	2050
Norway	Det norske energisystemet mot 2030 (The Norwegian energy system in 2030)	UiO:Energi	University		2014	3	2011	2030
Austria	Energie wirtschaftliche Szenarien im Hinblick auf die Klimaziele 2030 und 2050	Umweltbundesamt (Österreich)	Government agency	Ministry	2015	2	2010	2035
Austria	Szenario erneuerbare Energie 2030 und 2050	Umweltbundesamt (Österreich)	Government agency	Business association	2016	1	2010	2050
Austria	Stromzukunft Österreich 2030	Technische Universität Wien	University	Advocacy group	2017	3		2030
Poland	Polish energy sector 2050 - 4 scenarios	Forum Energii	Think-tank		2017	4	2016	2050
Poland	Energy sector in Poland	Polish Information and Foreign Investment Agency	Public agency	Ministry	2013	1	2015	2030
Sweden	Energy Scenario for Sweden 2050	Swedish Environmental Research Institute (IVL)	Research institute	NGO	2011	1	2005	2050
Sweden	Four Futures: The Swedish energy system beyond 2020	Swedish Energy Agency	Public agency		2016	4	2014	2050
Switzerland	Die Energieperspektiven für die Schweiz bis 2050	Prognos AG	Research institute	Government agency	2012	3	2000	2050
Switzerland	Energiestrategie 2050	Bundesamt für Energie	Government agency		2017	1		2050
Switzerland	Switzerland Energy Transition Scenarios – Development and Application of the Swiss TIMES Energy System Model	Paul Scherrer Institut	Research institute		2014	3	2010	2050
Slovakia	Energy policy of the Slovak Republic	Ministry of Economy of the Slovak Republic	Ministry		2014	3	2010	2035
Slovenia	Energetski koncept Slovenije (Energy concept of Slovenia)	Slovenian Ministry of Infrastructure	Ministry		2018	3	2015	2050
Czech Republic	Státní energetická koncepce České republiky (State energy concept of Czech Republic)	Czech Ministry of Industry and Trade	Ministry		2014	6	2010	2045
Hungary	Zöld Magyarország - Energia Útiterv (Green Hungary - Energy Roadmap)	Wuppertal Institute	Research institute	Environmental organization	2016	4	2010	2040
Hungary	National energy strategy 2030	Hungarian Ministry of National Development	Ministry	-	2012	9	2008	2030

2. Overview & key figures of the meta-analysis

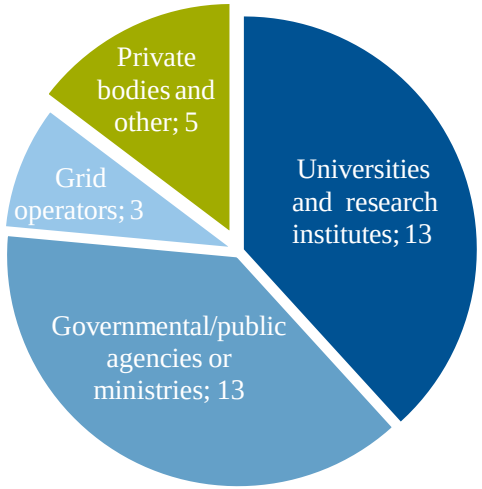
Key figures



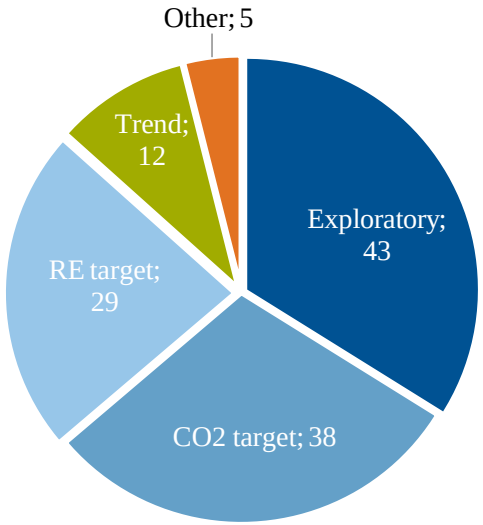
Sector coverage



Stakeholders



Context of scenarios



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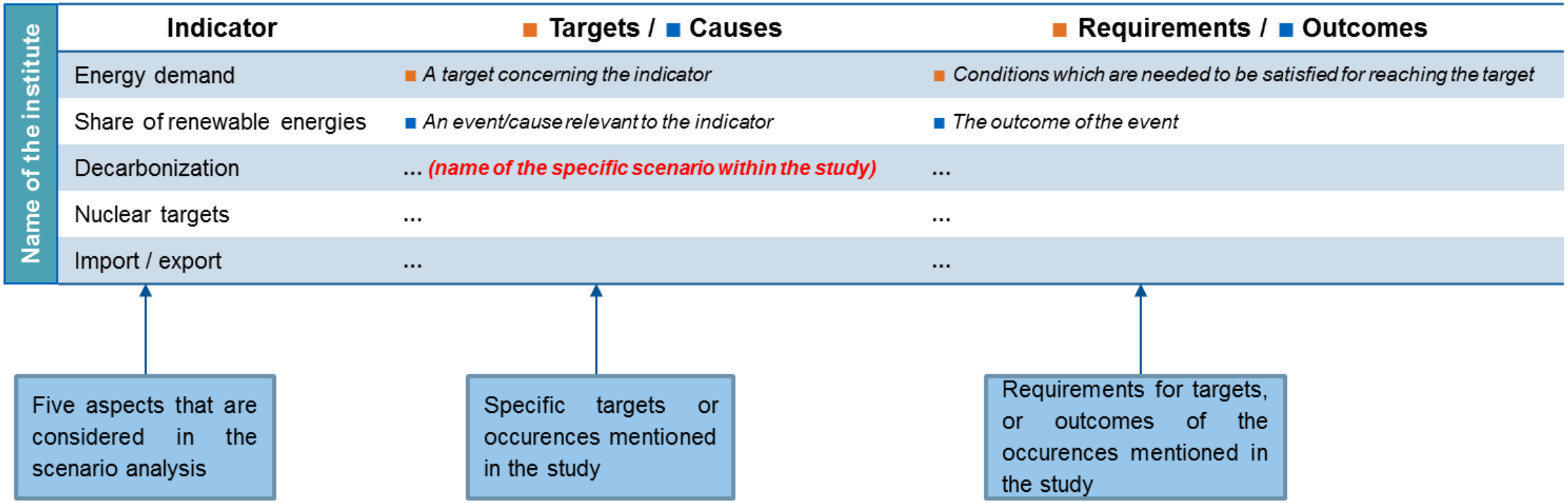
4. Wrap up

3. Insights from the studies

Country profiles

- Five **energy indicators** are identified
  (energy demand, share of renewables, decarbonization, nuclear power, import/export)

- Profiles for all countries are generated with statements regarding the indicators



3. Insights from the studies

Country profiles, example Belgium

Belgium – Insights from studies

	Indicator	Targets / Causes	Requirements / Outcomes
ELIA [5]	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

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Federal Planning Bureau [6]	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
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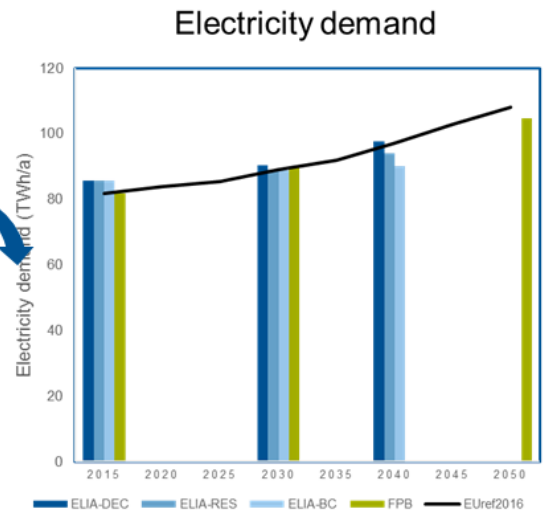
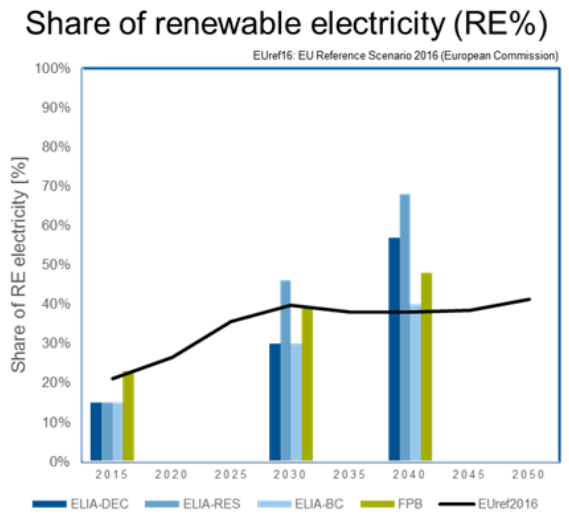
	Import / export	Unavailability of the nuclear fleet + high VRE	Rise in net imports between 2030–2050; up to 25 TWh/a

- Across all scenarios: nuclear phase-out set by 2025
- Additional thermal capacity and/or interconnectors necessary for base load
- Wind power is a major renewable electricity contributor

Belgium – Demand & RE share





- Studies agree on a prediction of consistently increasing electricity demand by 2050
- Electrification of other sectors (e.g. via EV's and heat pumps) outweighs energy efficiency
- Discrepancy in 2015 values, possibly stemming from different definitions for RE
- EUref16 predicts a stagnation of RE% around 40%
- The more ambition RE targets in ELIA scenarios lead to shares up to 70%

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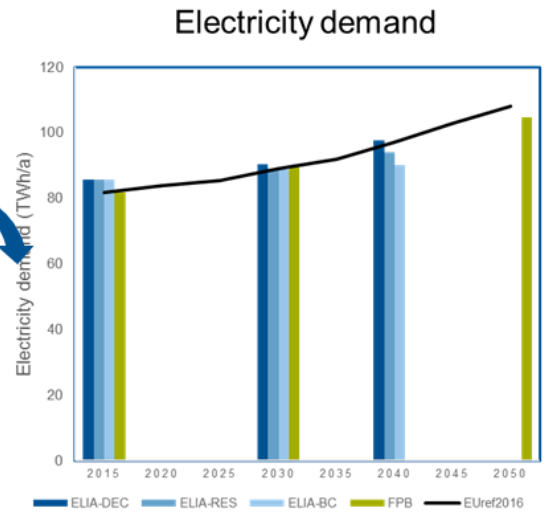

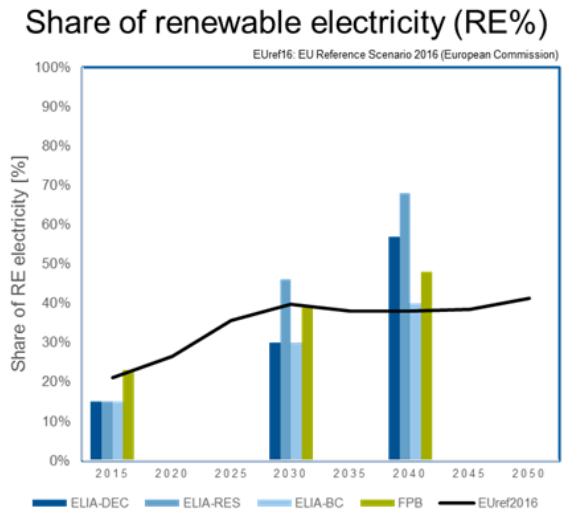

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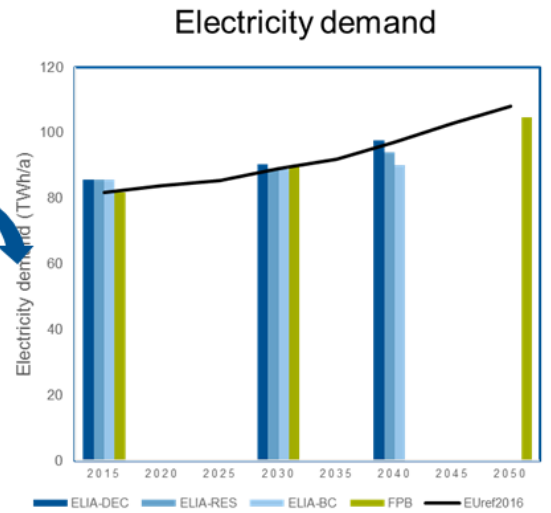

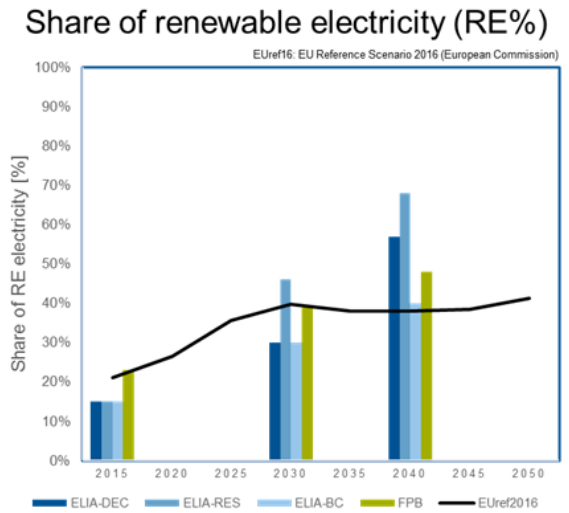

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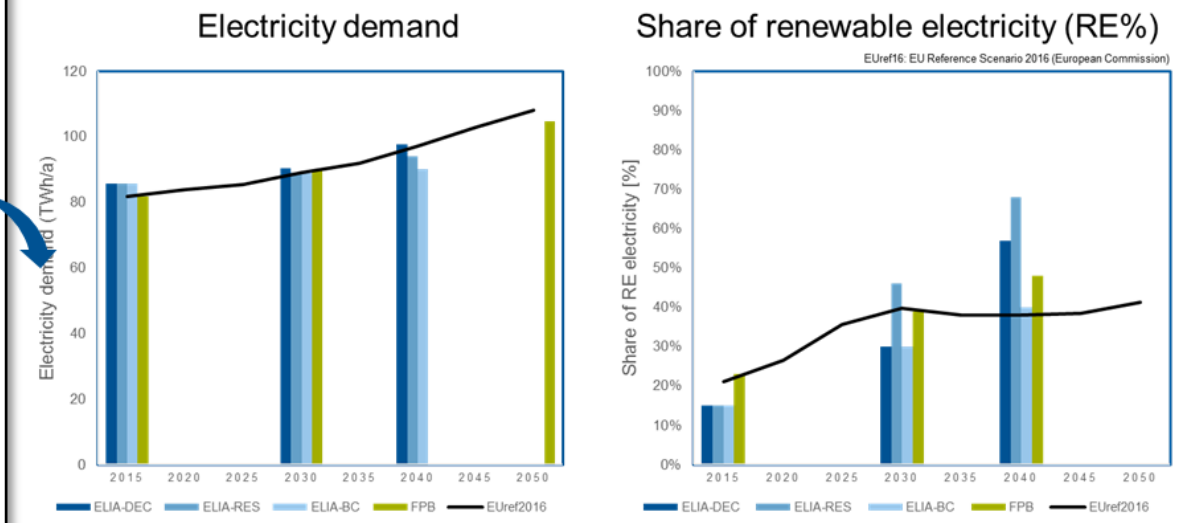

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E targets in ELIA scenarios lead

Available online:
https://github.com/sonercandas/energy_scenario_studies

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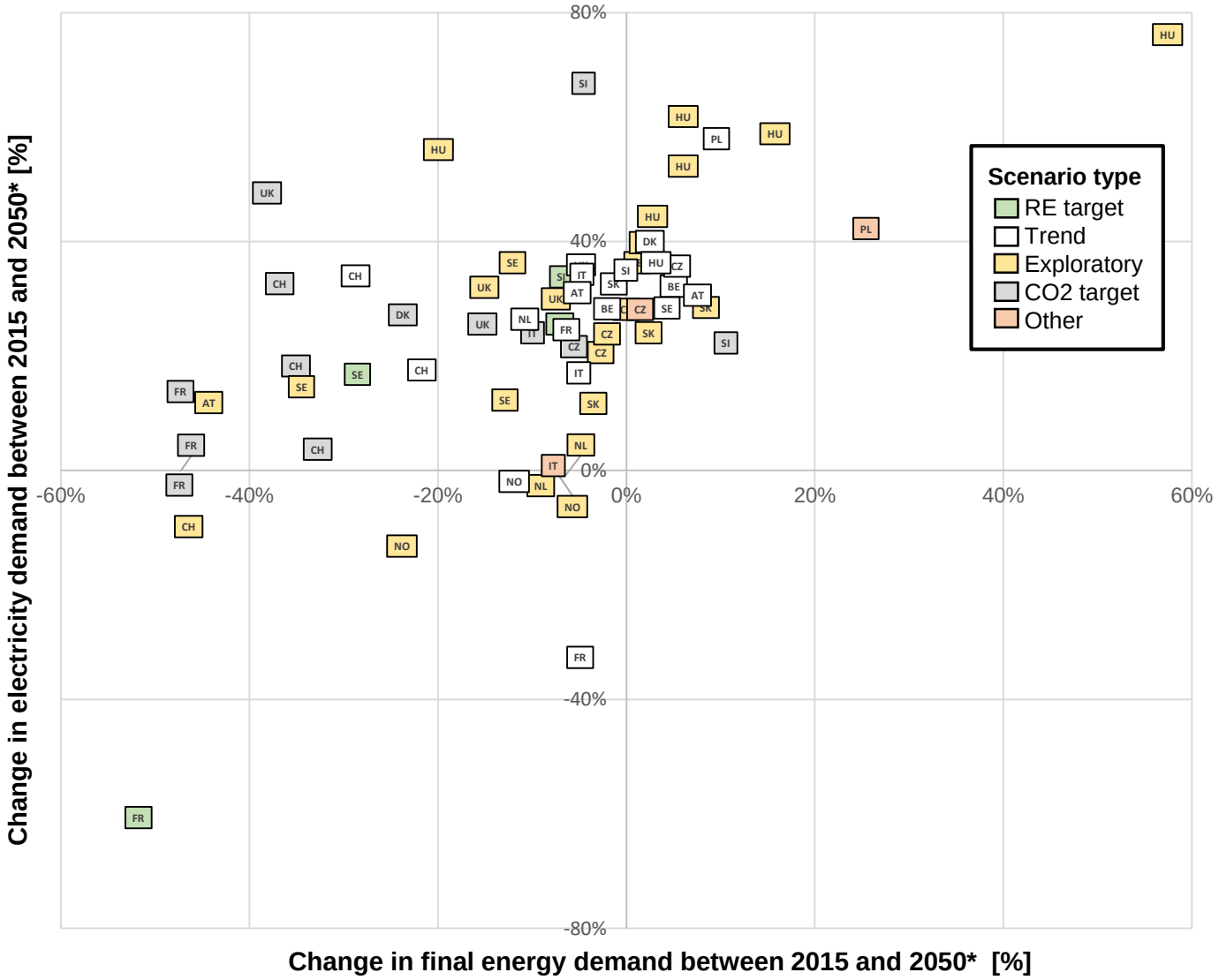
Analysis charts – Final energy consumption (electricity vs. total energy)

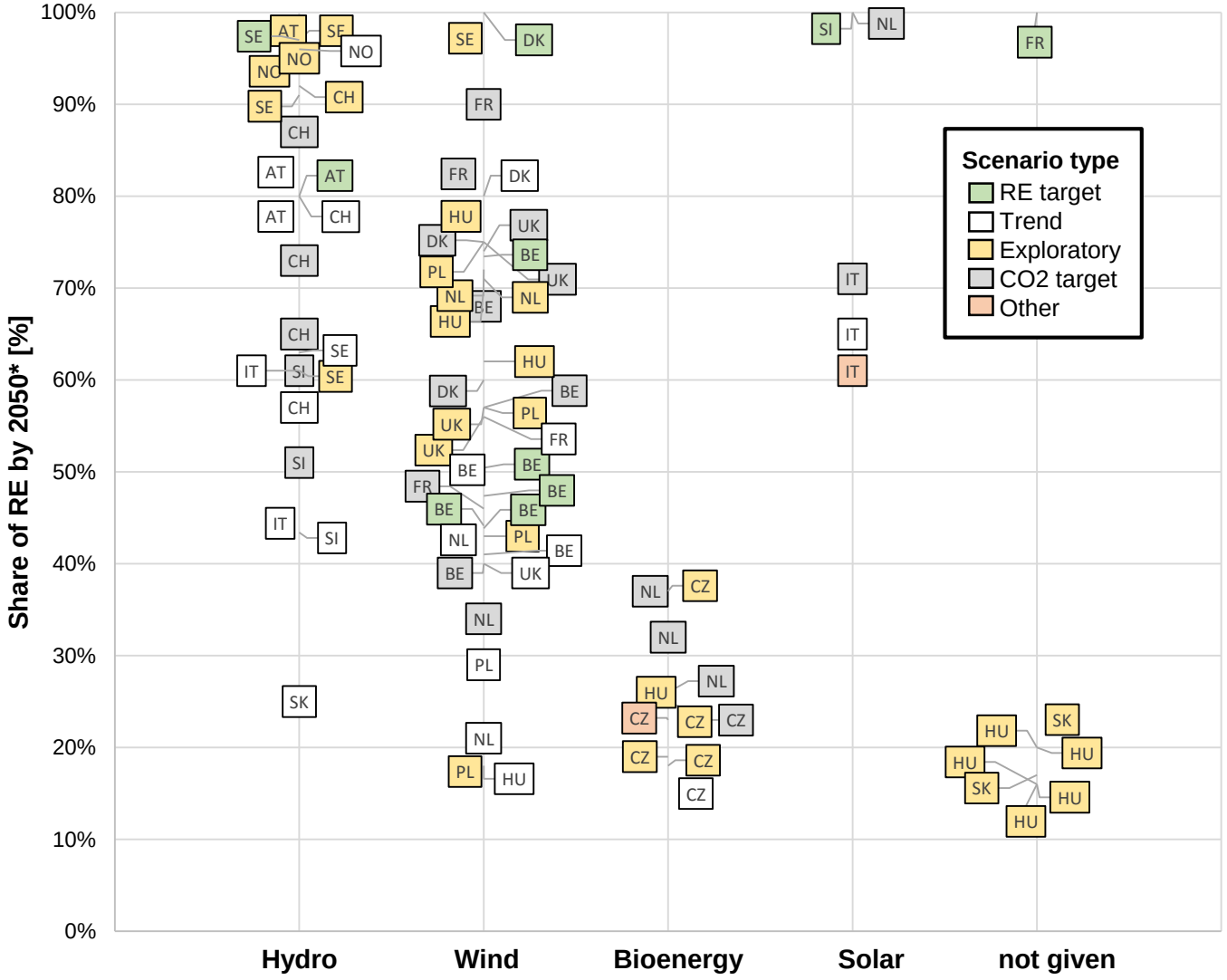


- Common trend: Decline in final energy consumption, while demand for electricity is rising due to **electrification** and **economic growth** (upper left quadrant)
- Trend scenarios **(white)** predict small changes in final energy consumption
- CO2 target scenarios **(grey)** necessitate significant reduction in final energy consumption

* For studies that do not simulate until 2050, the last simulated year was assumed.

3. Insights from the studies

Analysis charts – Dominating renewable electricity (RE) technologies



- Hydropower and wind energy are the dominant RE technologies in most countries (measured by the total electricity generation)
- Studies predict a wide range of RES shares between 10% and 100% of the total electricity
- 100% RE outcomes usually consist of explorative or RE target scenarios

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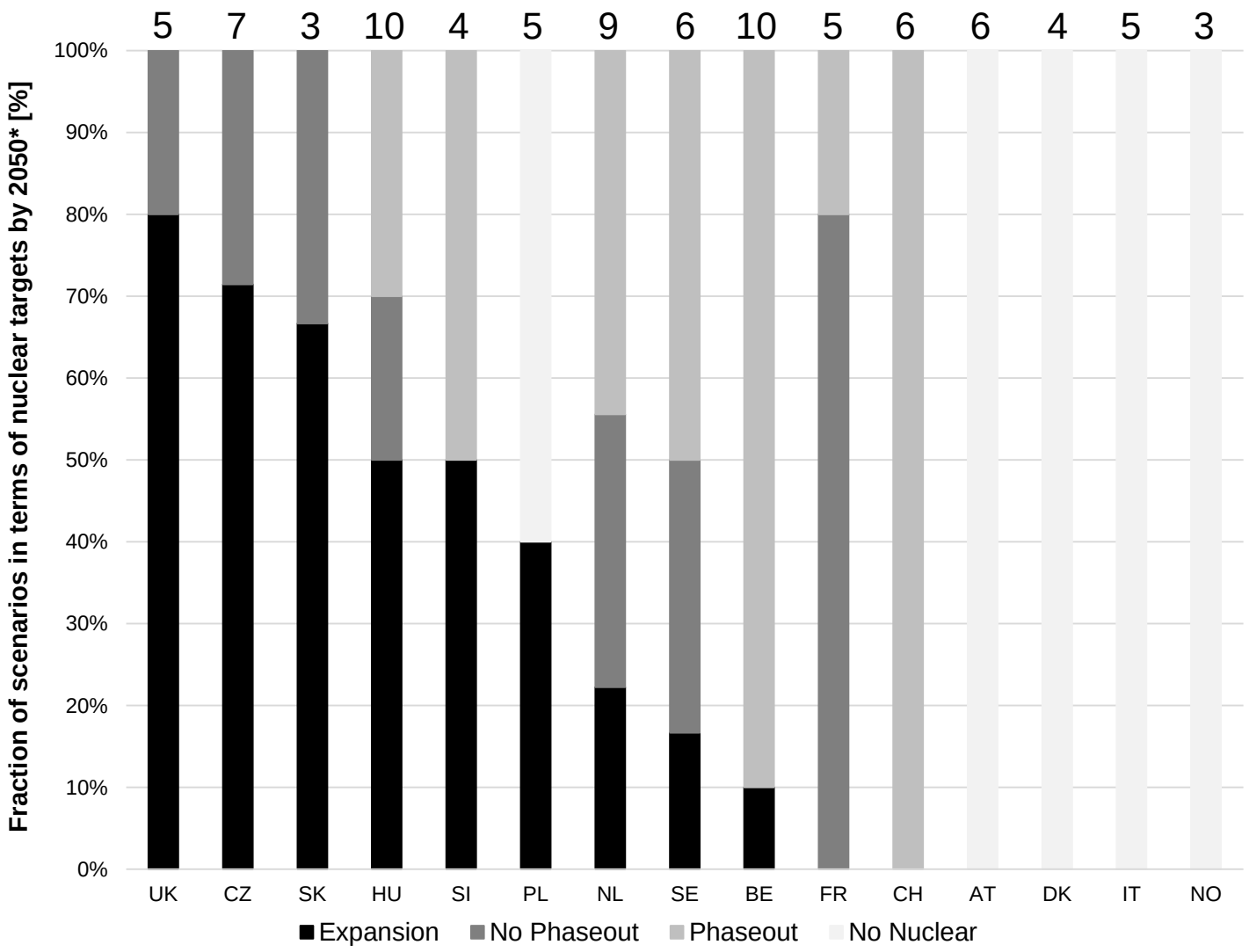
3. Insights from the studies

Analysis charts – Nuclear goals



- A wide variety of nuclear power targets present **(no consensus)**
- **4** of the **15** countries (Austria, Denmark, Italy and Norway) do not have nuclear energy, while Belgium and Switzerland target phase-out
- United Kingdom, the Czech Republic and Slovakia aim for nuclear expansion in most of their scenarios

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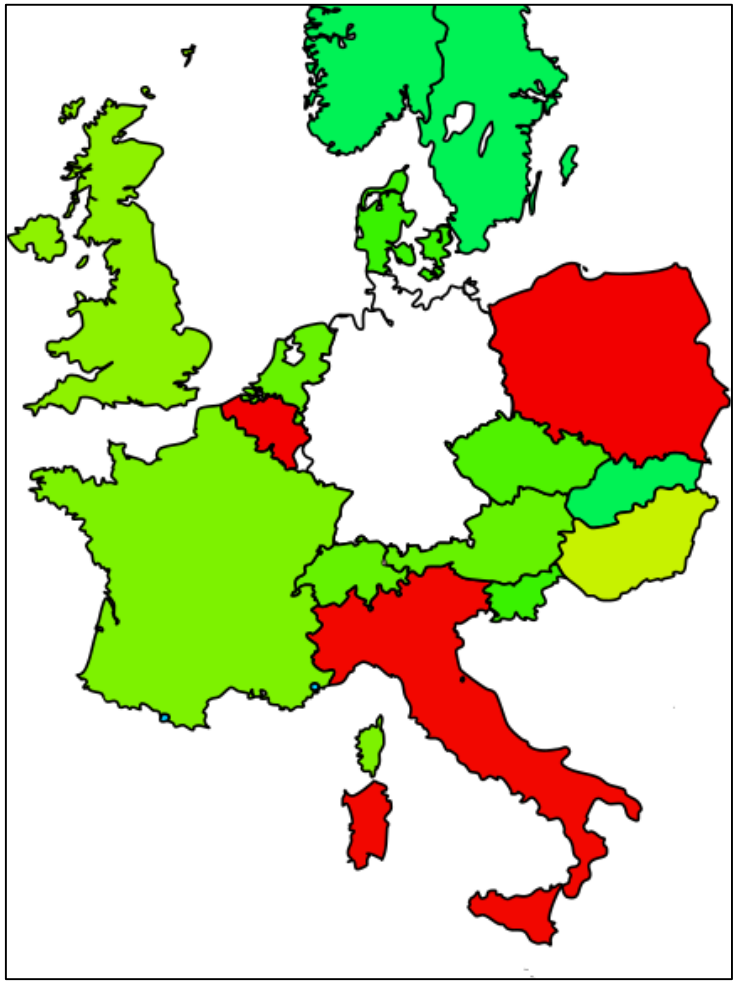
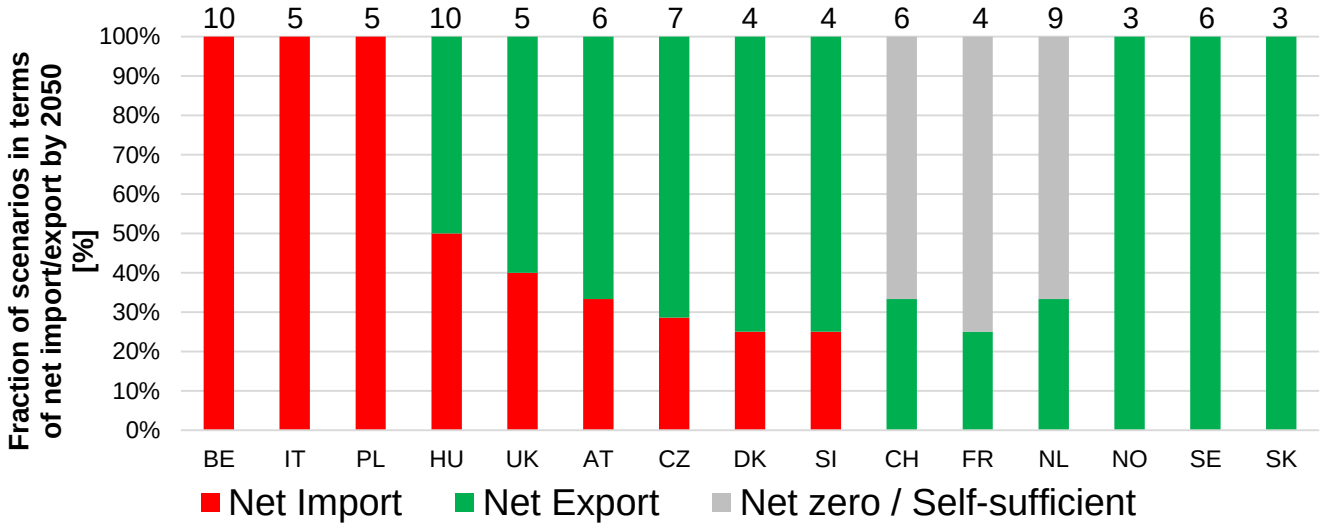
3. Insights from the studies

Analysis charts – Import/export



- Majority of their scenarios imply **net import** for Belgium, Italy and Poland
- All of their scenarios imply net export for Norway, Sweden and Slovakia (surplus in Norway and Sweden via **hydropower**, in Slovakia via **new nuclear power plants**)
- General trend is net export **(where does the electricity go?)**



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Europe-wide studies

+ easy comparability across studies since common metrics are involved in standardized forms (capacities, consumption, emissions…)

Country-specific studies

− outcomes of scenarios are very context-dependent (low comparability)

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- \+ there are plenty of them (World Energy Outlook, eHighway, EU reference scenario, TYNDP…)

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- ? assume (naively?) collaborative/consistent evolution of the energy system

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- − specific country has the focus, what happens in neighbors re. import/export dependencies often not considered

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- \+ there are plenty of them (World Energy Outlook, eHighway, EU reference scenario, TYNDP…)
- \+ high accessibility + data availability
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- \+ useful when data needed for modelling European energy systems with **low detail level**

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- \+ useful when data needed for modelling **country-level** energy systems, or high-detail European models with **many scenarios**

References - 1

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