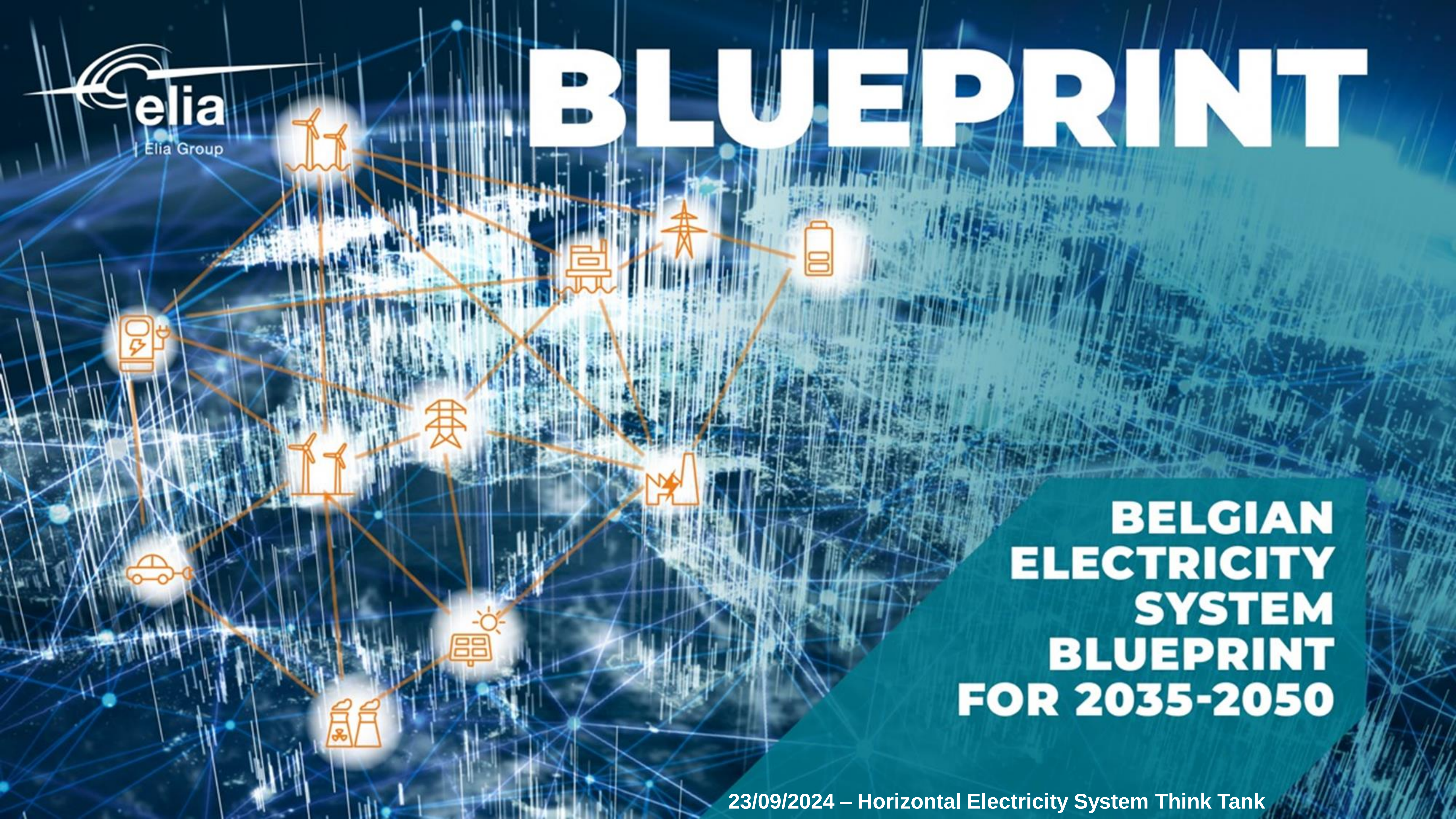

BLUEPRINT

BELGIAN ELECTRICITY SYSTEM BLUEPRINT FOR 2035-2050

23/09/2024 – Horizontal Electricity System Think Tank

BLUEPRINT

AGENDA

(and indicative timings)

Introduction	[15h00-15h10]
Process & stakeholder interactions	[15h10-15h15]
Methodology	[15h15-15h40]
European multi-energy findings	[15h40-16h15]
Belgian findings	[16h15-17h15]
EnergyVille reasoned opinion	[17h15-17h20]
Main messages	[17h20-17h30]

BELGIAN
ELECTRICITY
SYSTEM
BLUEPRINT
FOR 2035-2050

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BELGIAN ELECTRICITY SYSTEM BLUEPRINT FOR 2035-2050

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BELGIAN ELECTRICITY SYSTEM BLUEPRINT FOR 2035-2050

| SEPT. 2024 |

1\. INTRODUCTION

1.1. OBJECTIVES

AN ENERGY COMPASS FOR BELGIUM

Achieving the commitment to reach a net-zero energy mix by 2050 requires a clear vision that should be implemented via decisive measures. Given the recent European, federal and regional elections in Belgium, and clear signs that additional measures are required at different political levels, the time is ripe to take important decisions about the future of our energy system. As Belgium's electricity transmission system operator (TSO) Elia has applied its modelling expertise in this study by quantifying different possible energy pathways that Belgium could adopt in the lead-up to 2050 and assessing the challenges associated with each of these.

This study aims to illustrate the different electricity supply options that are still open to Belgium whilst considering the influence of other energy vectors on its power system. The study evaluates a wide array of scenarios for Belgium and Europe, reflecting the broad spectrum of potential futures that both face.

Instead of prescribing one single solution or setting out one clear direction for Belgium and Europe to follow, this study outlines the choices that policymakers face regarding our energy mix, the effects of these choices on several crucial indicators such as costs or imports, and the time frames related to these choices, to ensure that sufficient time can be allocated to considering each of them. It should be noted that the impacts of some choices cannot be quantified, and certain pathways entail more uncertainties than others. Policymakers should take this into consideration when making decisions about the future of our energy mix and what it will resemble in (the transition to) 2050.

Decisions about the period 2035-2050 must be taken soon, given how critical it will be for Belgium's future energy supply.

- 15 European scenarios and sensitivities
- 300 Belgian sensitivities
- A large set of quantified and qualitative indicators calculated

PREPARING THE ELECTRICITY INFRASTRUCTURE OF THE FUTURE

Elia is required to evaluate and identify future electricity grid requirements to ensure that these can be met in an efficient manner that is aligned with the interests of society. This is crucial, since infrastructure projects often take several years to complete, and decisions taken today influence how the grid will be developed years down the line. With Elia's next federal development plan as a reference point in mind (see BOX 1-1 on Elia's other studies for more information), Elia is keen to outline the potential trajectories that Belgium could adopt in the lead-up to 2050.

BELGIAN ELECTRICITY SYSTEM BLUEPRINT FOR 2035-2050
PROVIDING A COMPASS FOR POLICYMAKERS WHEN TAKING DECISIONS ABOUT THE ENERGY MIX

As an electricity TSO we...

...carry expertise and tools for scenario building
- Divergent scenarios BE/EU based on different visions
- Focus on power system
- Specific strengths/characteristics: hourly granularity, EU scope, physical grid constraints, ...

...need sufficient time to prepare an electricity grid which is 'fit for purpose'
- Grid infrastructure projects >10 years to build
- Need to define grid infrastructure corridors
- Highlight necessary steps and decisions in the forthcoming legislation period

- Further inform the general public and policymakers about the impact of different visions relating to Belgium's electricity landscape
- First step for future federal network development plan post 2035

- This presentation is given as a primeur to our stakeholders
- We therefore kindly ask you **to not share any information regarding the study until it is published on our website**
- A printed version of the report (version from a few days ago) will be provided to all of you at the end of this presentation
- The final report **will be published Tuesday evening**

Our goal: Providing a compass for the policymakers when taking decisions about the 2050 electricity mix

As an electricity TSO, we ...

…carry expertise and tools for scenarios building

- Divergent scenarios BE/EU based on different visions
- Focus on power system
- Specific strengths/characteristics: hourly granularity, EU scope, physical grid constraints, …

…need sufficient time to prepare an electricity grid which is ‘fit for purpose’

- Grid infrastructure projects >10 years to build
- Need to require grid infrastructure corridors
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BLUEPRINT

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BELGIAN
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BLUEPRINT
FOR 2035-2050

This study takes into account the input of many stakeholders

Elia Think Tank

Belgian stakeholders from across the energy sector

Academic research & advisory board

entsoe

entsog
european network of transmission system operators for gas

EnergyVille

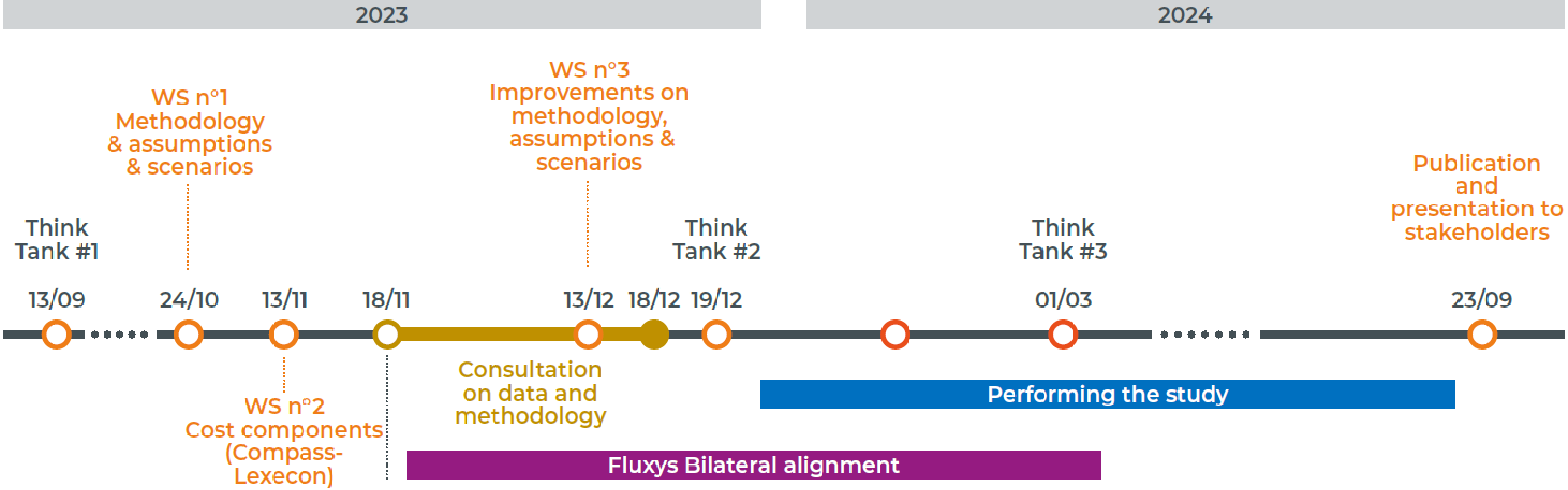
fluxys

Belgium's electricity distribution system operators (DSOs)

External interactions

- **3** dedicated **workshops**
- **4** presentations to the **Elia think Tank**
- **Consultation** with 10 replies and more than **50 comments**
- **2 external consulting** firms
- Reasoned opinion with **academic partners**
- **Numerous bilateral discussions** with our stakeholders.

The study started one year ago with the first interactions with our Think Tank and dedicated workshops and consultation on the methodology and scenarios



2023

2024

Think Tank #1 — 13/09

WS n°1 Methodology & assumptions & scenarios — 24/10

WS n°2 Cost components (Compass-Lexecon) — 13/11

18/11

WS n°3 Improvements on methodology, assumptions & scenarios — 13/12

18/12

Think Tank #2 — 19/12

Think Tank #3 — 01/03

Publication and presentation to stakeholders — 23/09

Consultation on data and methodology

Performing the study

Fluxys Bilateral alignment

Several methodological evolutions were implemented thanks to stakeholders' feedback

Based on the feedback received during the workshops and consultation:

- **Alignment on costs** with Fluxys and usage of the **TYNDP scenarios** as starting point
- **All energy vectors are modelled** (initially planned to only model electricity) and demands
- **Addition of CCU/S** estimation of non-CO2/non-modelled emissions
- **Expanded our scenarios** to cover **more sensitivities** at European and Belgian level (initially 4)

The main changes compared with previous Elia studies:

- Expansion of **European multi-energy scenarios** to feedstock, international aviation and shipping;
- Use of a **capacity expansion model** which optimises the location and the amount of selected technologies;
- Adoption of **hourly/daily multi-energy modelling** across the whole of **Europe**;
- Use of **a flow-based zonal modelling** for the electricity system to also reflect electric bottlenecks within countries;
- Consideration of **all GhG emissions** (processes, non-CO_2, LULUCF, energy…) and **options for capturing or using it.**

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BELGIAN
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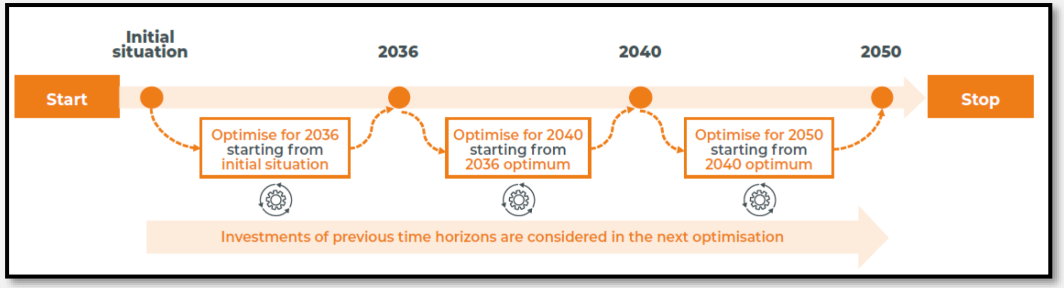
The methodology used incorporates expertise of previous Elia studies as well as a whole host of new features.

Chronological optimisation of 3 target years



Initial situation

2036

2040

2050

Start

Stop

Optimise for 2036 starting from initial situation

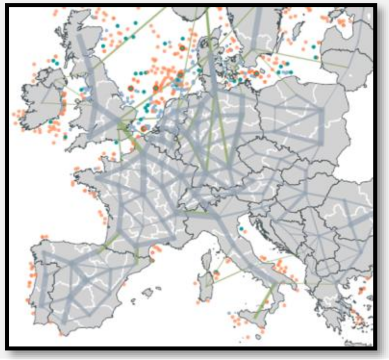
Optimise for 2040 starting from 2036 optimum

Optimise for 2050 starting from 2040 optimum

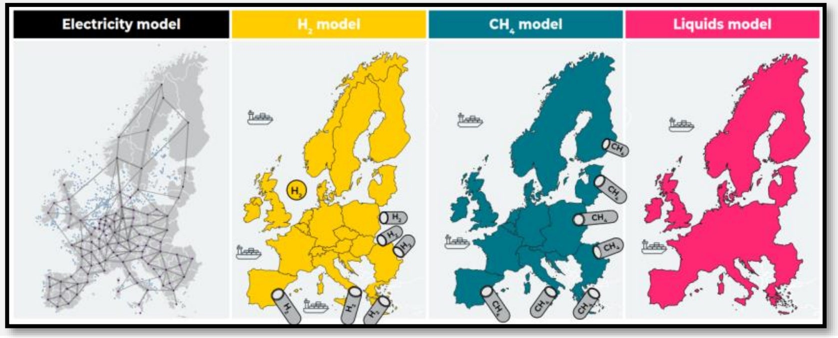
Investments of previous time horizons are considered in the next optimisation

Detailed Electricity model:

- Flow-based
- Hourly economic dispatch
- Smaller than bidding zone split
- Zonal demand flexibility and storage modelling for EV's, industry, heating, …

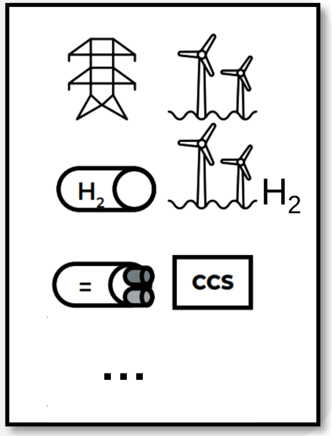


Multi-Energy modelling of Europe and imports from other continents

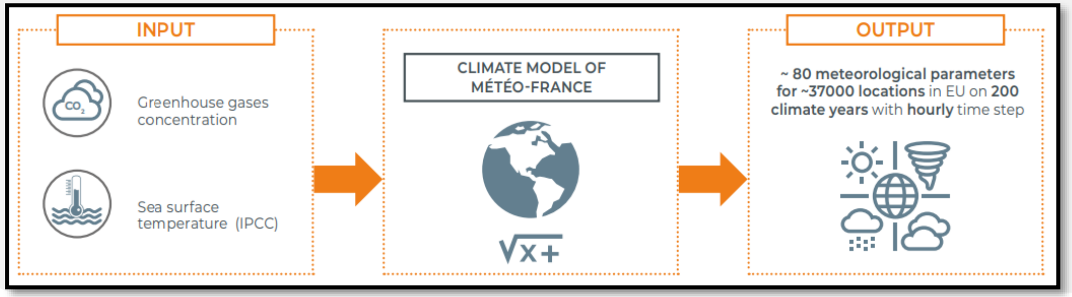


Endogenous optimisation taking into account GhG target:

- Infrastructure
- Thermal generation
- Electrolysers
- Offshore wind (radial, hybrid, multi-terminal, …)
- CCS
- …



Multi climate-year with forward looking database



INPUT

Greenhouse gases concentration

Sea surface temperature (IPCC)

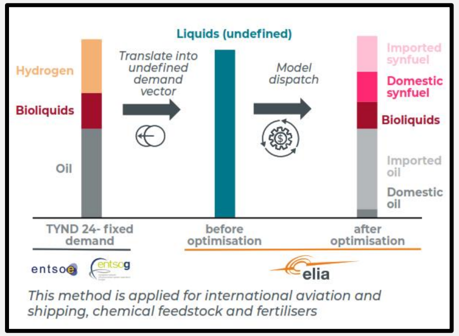
CLIMATE MODEL OF MÉTÉO-FRANCE

OUTPUT

~ 80 meteorological parameters for ~37000 locations in EU on 200 climate years with hourly time step

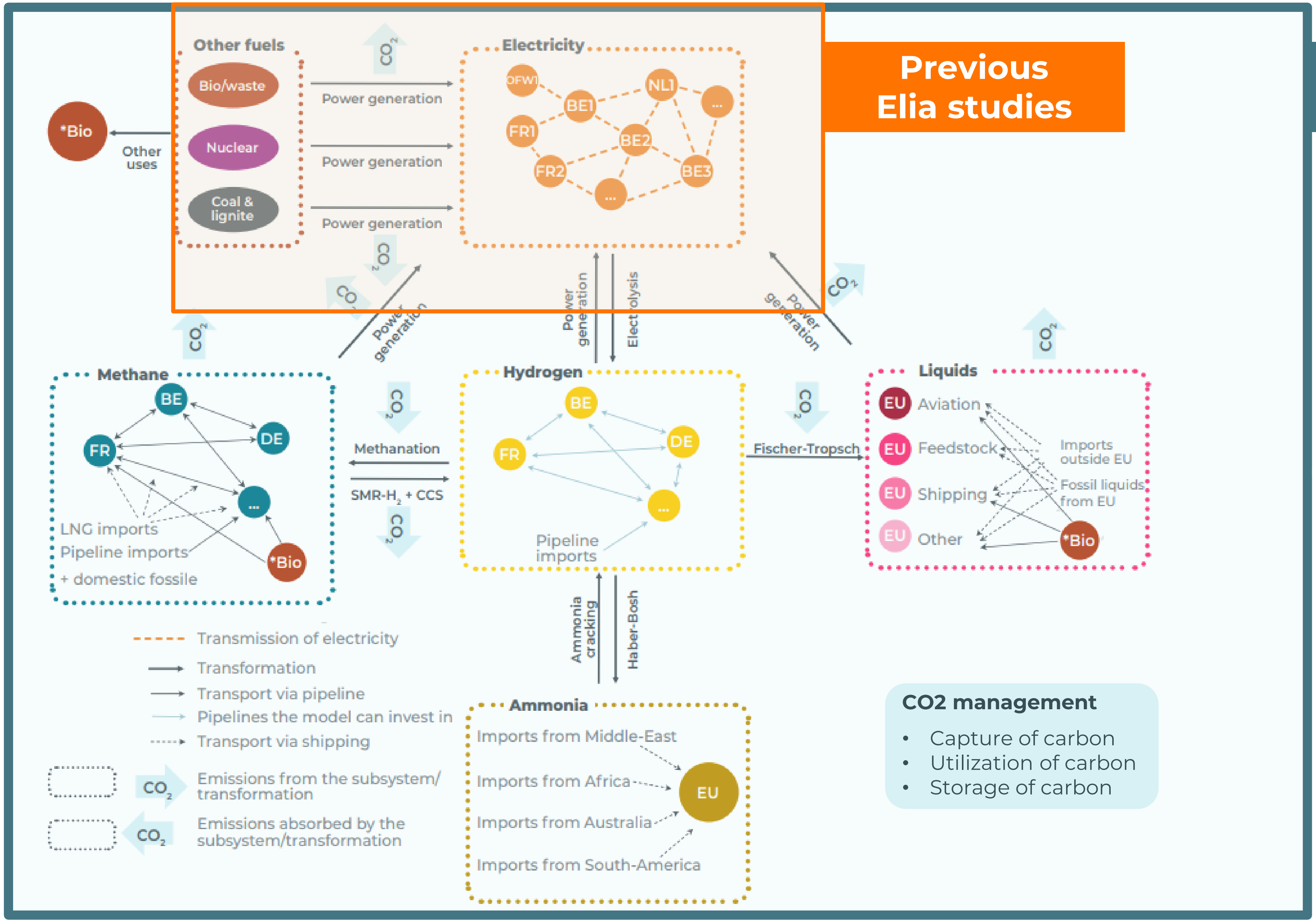
Explicit derivatives Modelling

Molecule models dispatch optimises what molecule and what transformation path it takes



This method is applied for international aviation and shipping, chemical feedstock and fertilisers

All key energy vectors as well as their interactions were explicitly modelled



Previous Elia studies

BluePrint Study 2024

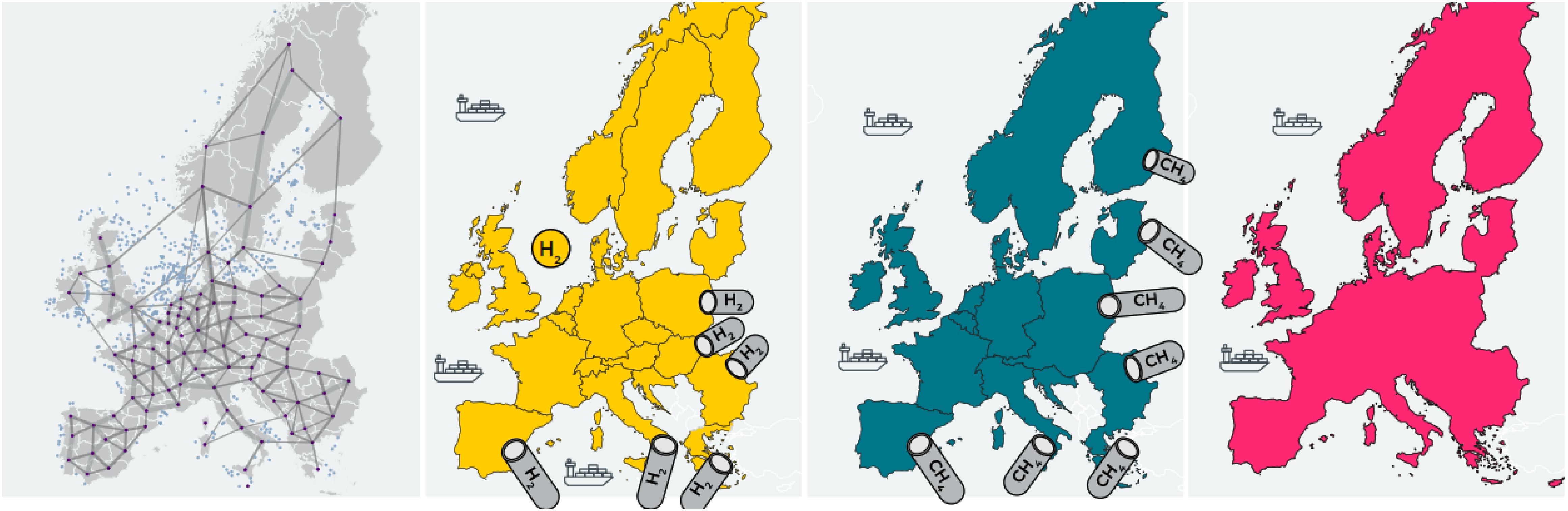
Multi-energy and CO_2 modeling is needed

- To assess **carbon-neutrality**
- To study the **interactions of other energy vectors on the electricity** system

- **However** other **simplifications** are made (less climate/Monte Carlo years, clustered units...) compared to other Elia studies

Modelling granularity (geographical and temporal) depends on the energy vector

	Electricity model	H_2 model	CH_4 model	Liquids model
⏱ ▶	Hourly	Daily		
🌐 ▶	500 zones	21 zones	10 zones	1 zone



The electricity model features a zonal flow-based hourly market dispatch for the entire European perimeter

INPUTS

EU-SCALE ZONAL ELECTRICITY MODEL (KARI)

OUTPUTS

Hourly electricity demand, PV, wind... including flexibility options

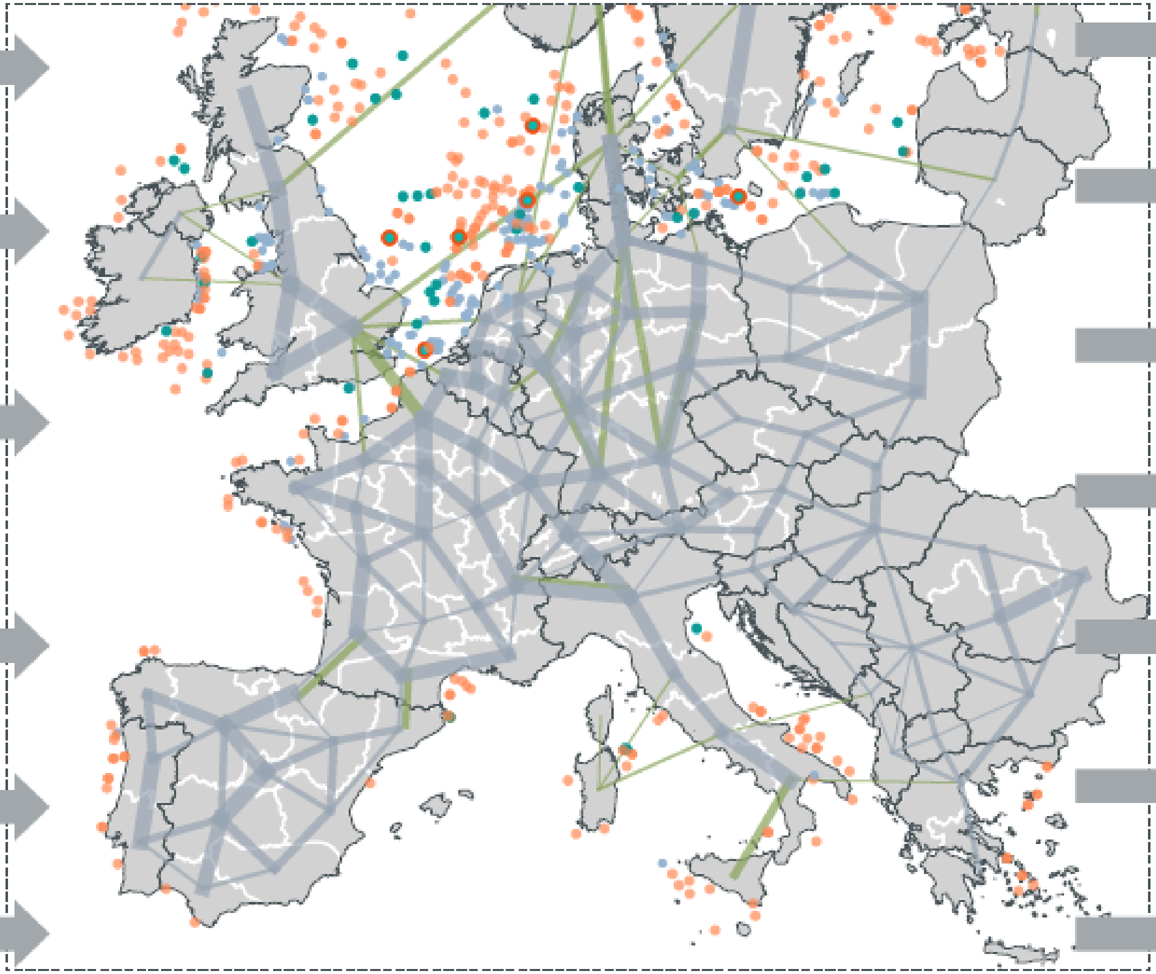
Thermal capacities, constraints, fuel and CO_2 prices

Physical constraints on the European HV grid

Investment candidates (offshore, grid, electrolysers, thermal...)

Hourly molecule prices

...



Electricity mix

CO_2 emissions

System Costs *(CAPEX + OPEX)*

Onshore & offshore transmission grid

Cross-vector capacities and location (thermal, P2X)

Marginal prices

...

A five-step process was followed to identify key trends in the energy system for Belgium and Europe under a diverse set of assumptions

Key outputs

1 EU scenario definition

- **Quantified scenario storylines** for generation capacity, import potential of fuels, domestic fuel production, and demand for each of the multi-E vectors

2 Multi-E economic dispatch and capacity expansion

- **Multi-E market dispatch** optimisation
- **EU optimised infrastructure** (electricity grid, H2 grid, CCS/U, offshore wind, …)
- **Objective**: lowest costs while meeting carbon target

3 Adequacy check

- **Thermal capacity** needed to meet SoS criteria in the electricity system

EU optimal model → Rerun EU multi-E dispatch

4 BE sensitivities with full multi-E economic dispatch

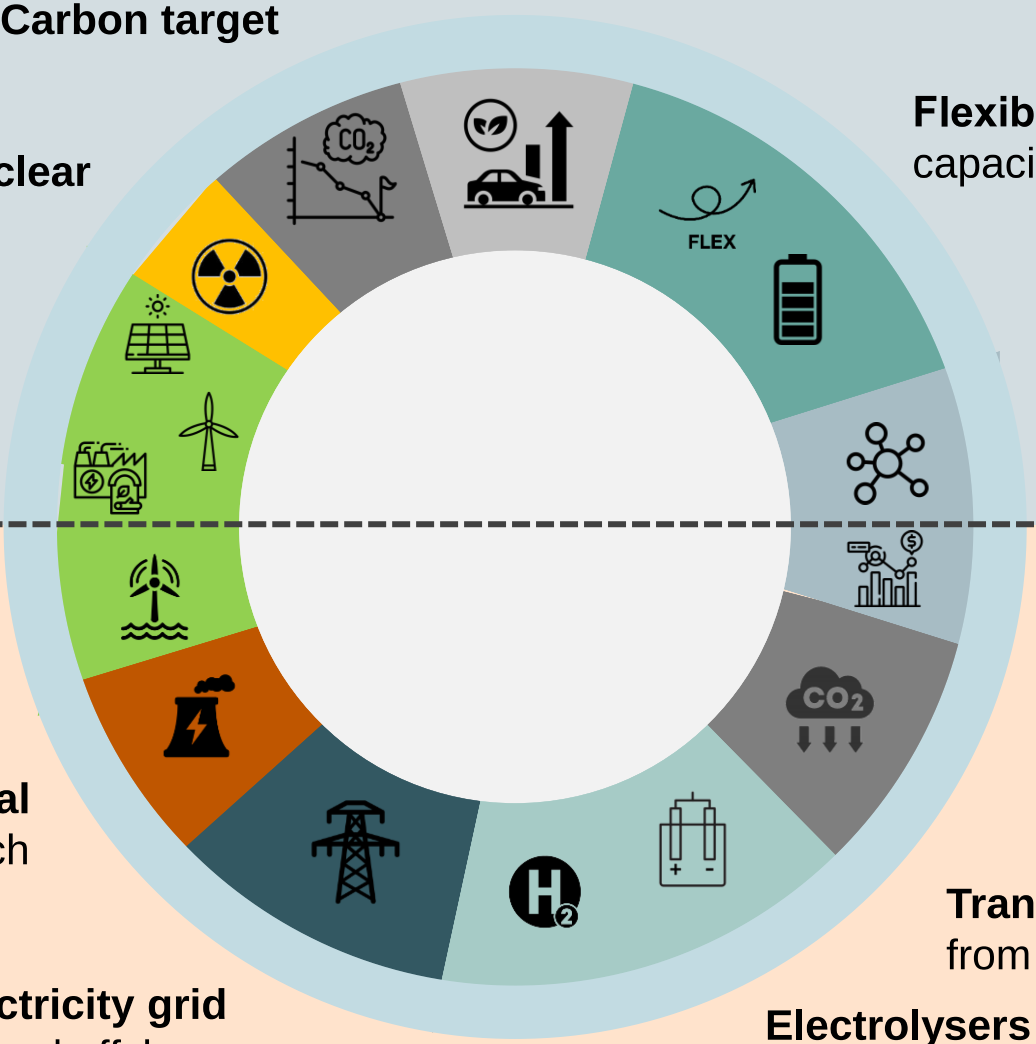
- **Apply sensitivity for Belgium**

BE sensitivity for EU optimum → Rerun EU multi-E dispatch

5 Assessment of indicators

- Dispatch
- Sustainability
- Economic
- …

The final models result from a combination of scenarios and optimisations



FIXED
PER SCENARIO

Carbon target

Final demand per sector & vector

Flexibility (EV/HP/batteries…) capacities

Nuclear

Solar

Onshore Wind

Biomass

Imported fuel merit order & potential per vector

Offshore wind location & amount

Thermal capacities & dispatch

Electricity grid onshore and offshore

Hydrogen storage & grid

Hourly/daily Multi-E dispatch (flex, thermal, imported fuels)

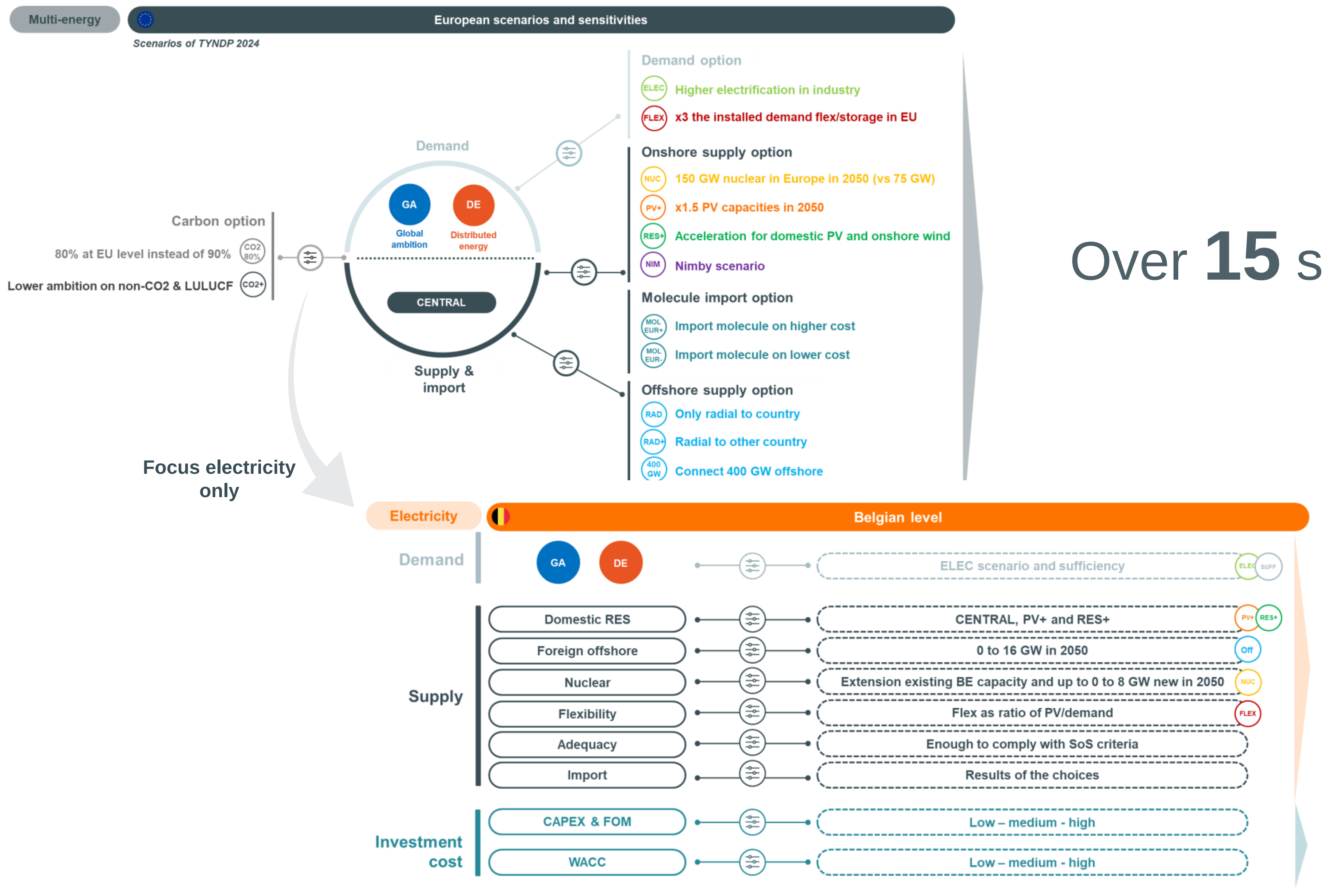
CCS/U amount & usage

Transformations from one vector to another

Electrolysers capacities and location (onshore and dedicated offshore)

OPTIMISED

Quantifying the most diverse set of futures for the Belgian Energy System



Multi-energy | **European scenarios and sensitivities**

Scenarios of TYNDP 2024

Demand

- GA – Global ambition
- DE – Distributed energy
- CENTRAL

Supply & import

Carbon option

- CO2 80% – 80% at EU level instead of 90%
- CO2+ – Lower ambition on non-CO2 & LULUCF

Demand option

- ELEC – Higher electrification in industry
- FLEX – x3 the installed demand flex/storage in EU

Onshore supply option

- NUC – 150 GW nuclear in Europe in 2050 (vs 75 GW)
- PV+ – x1.5 PV capacities in 2050
- RES+ – Acceleration for domestic PV and onshore wind
- NIM – Nimby scenario

Molecule import option

- MOL EUR+ – Import molecule on higher cost
- MOL EUR- – Import molecule on lower cost

Offshore supply option

- RAD – Only radial to country
- RAD+ – Radial to other country
- 400 GW – Connect 400 GW offshore

Focus electricity only

Electricity | **Belgian level**

Demand	GA, DE	ELEC scenario and sufficiency (ELEC, SUFF)
Supply	Domestic RES	CENTRAL, PV+ and RES+ (PV+, RES+)
	Foreign offshore	0 to 16 GW in 2050 (Off)
	Nuclear	Extension existing BE capacity and up to 0 to 8 GW new in 2050 (NUC)
	Flexibility	Flex as ratio of PV/demand (FLEX)
	Adequacy	Enough to comply with SoS criteria
	Import	Results of the choices
Investment cost	CAPEX & FOM	Low – medium - high
	WACC	Low – medium - high

Over **15** scenarios

Over **300** sensitivities for the demand/supply

Over **9** cost combinations for each technology

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Stakeholder interaction and literature review resulted in a diverse set of scenarios and sensitivities for Europe

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	Base scenario		Options
	Global ambition	**Distributed energy**	
Demand & flexibility *Electrification level of the final demand*	GA 52%	DE 64%	ELEC 72% FLEX
Onshore RES supply	CENTRAL		NUC PV+ RES+ NIM
Offshore & electricity grid	All options for offshore/onshore		RAD RAD+ 400 GW
Molecule import	CENTRAL		MOL EUR+ MOL EUR-
Greenhouse gases			CO2 80% non CO2+
GHG target	-90% in 2040 and net zero 2050		
non-CO2 & LULUCF	S3 EC scenario		

Some key references

entsoe

Rte

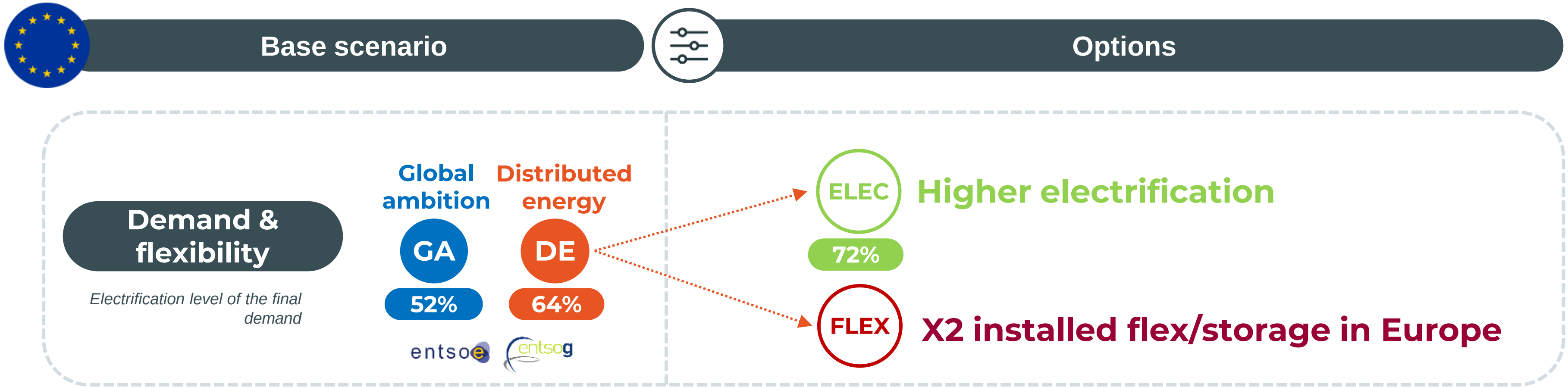
nationalgrid

European Commission

EnergyVille

…

The demand scenarios are based on TYNDP 2024 and enriched by a scenario with higher electrification and one with higher flexibility



Base scenario

Options

Demand & flexibility

Electrification level of the final demand

Higher electrification

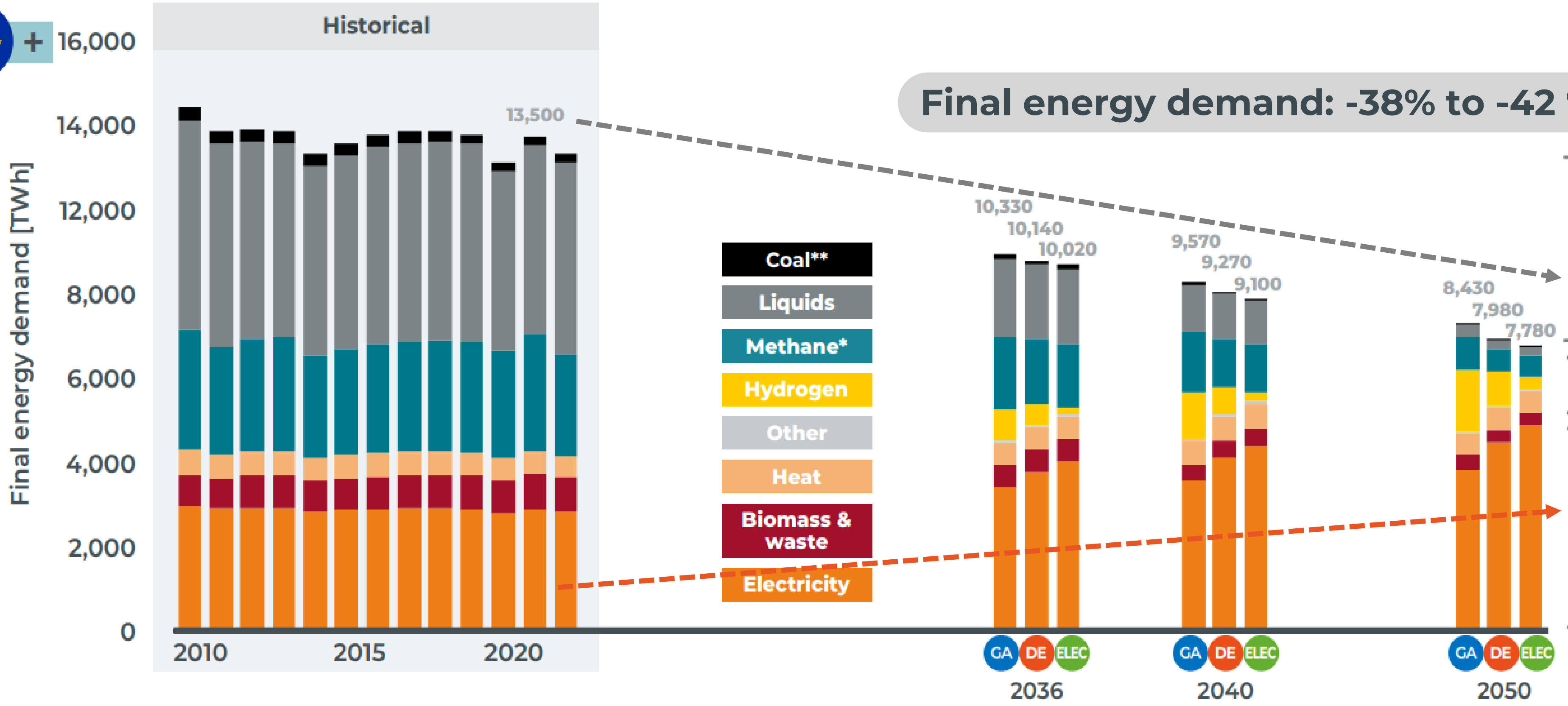
X2 installed flex/storage in Europe

H2 → Elec

	GA	DE	ELEC
Energy Intensity	Energy efficiency +	Energy efficiency ++	Energy efficiency ++
Buildings	Heat pumps, hybrid heat pumps, hydrogen heat….	Focus on Heat pumps, some gaseous heating remains	Maximised focus on heat pumps
Road transport	Electricity, H2 and liquid fuels used in all transport.	Electrification of light, some H2 and liquids for heavy-duty	Near full electrification
Industry	Only low temp and some medium temp electrified. Molecule-based heating remains key	Electrification of low temp, important share of medium and high temp	Near full electrification, including all types of heat

Final energy demand in Europe can be reduced by 40% towards 2050, while electricity consumption is set to increase significantly

FINAL ENERGY DEMAND – EUROPE (in TWh, excl. feedstock & int. transport)



Final energy demand: -38% to -42 %

Final energy demand reduction (electrification, sufficiency and energy efficiency)
-38% to -42% reduction of final energy demand

Gaseous Molecules
10% to 30% share of final energy demand

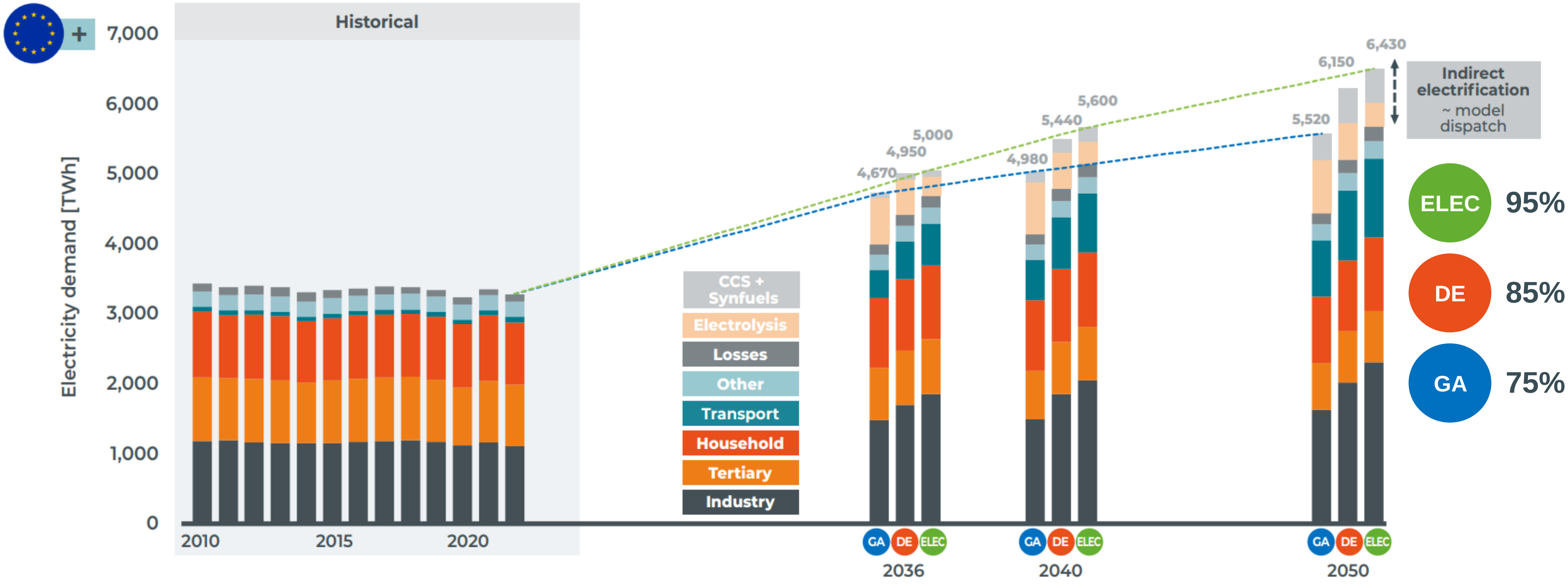
Electricity
52% to 72% share of final energy demand
Compared to 24% in 2021

Electricity: +30% to +70%

Final energy demand for Europe (incl. UK, NO, CH)
Excluding international aviation & shipping and non-energetic feedstock, including grid losses.
Energy demand for transformations such as power-to-hydrogen and carbon capture are not included. Values are normalised for historical climate while in the simulations, a forward-looking climate database is used, therefore the simulated demand can differ from these input values.
** Methane & liquids could be fossil, bio or synthetically sourced, which is defined in the model.*
*** Coal as defined as final energy demand per EUROSTAT (i.e. excluding coal consumed in blast furnaces).*
Historical values based on EUROSTAT

Total electricity demand is set to increase with 75%-95% by 2050

TOTAL ELECTRICITY DEMAND (in TWh) – EUROPE



ELEC 95% increase

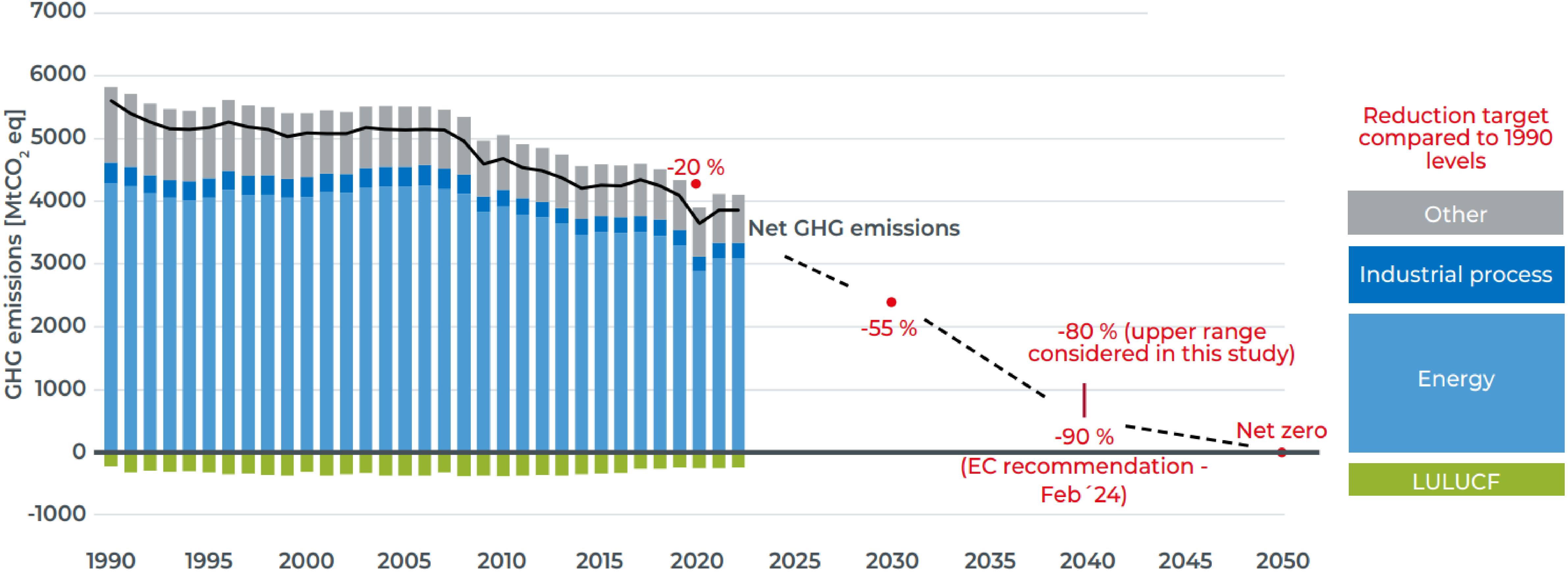
DE 85% increase

GA 75% increase

Electricity demand for Europe (incl. UK, NO, CH).
Values are normalised for historical climate while in the simulations, a forward looking climate database is used, therefore the simulated demand can differ from these input values.Electrolysis, CCS/U is optimised within the model and depends therefore on each potential scenario and sensitivity.
Historical values based on EUROSTAT

Greenhouse gas scenarios based on latest EU assessments

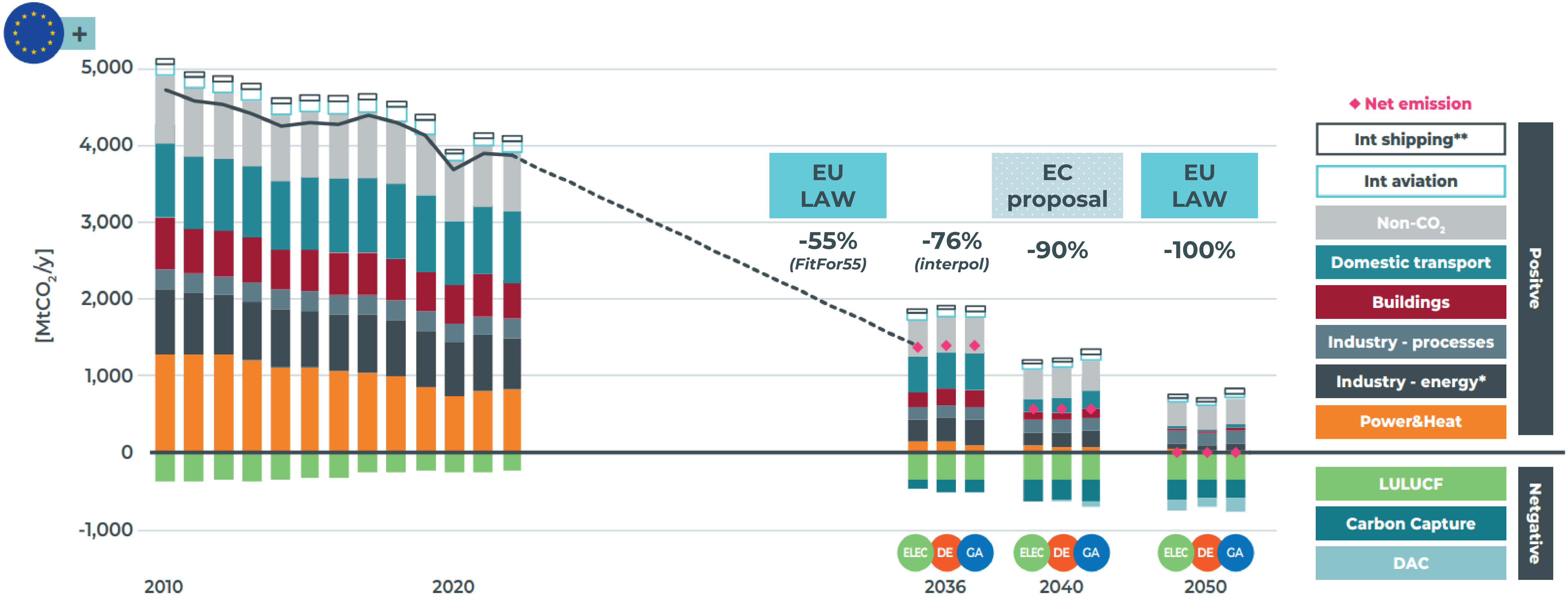
Assumed GHG emissions reductions targets for Europe (incl UK, CH a NO) – relative to 1990



Net GHG emissions for Europe including UK, NO, CH.
'Energy' category: includes international aviation and 50% of international shipping.
'Other' category includes agriculture, waste management and other sectors.
'LULUCF' category includes Land Use, Land-Use Change and Forestry.
Source: European Environment Agency.

Emission reductions vary per sector, with CO_2 abatement being required to compensate persisting emissions

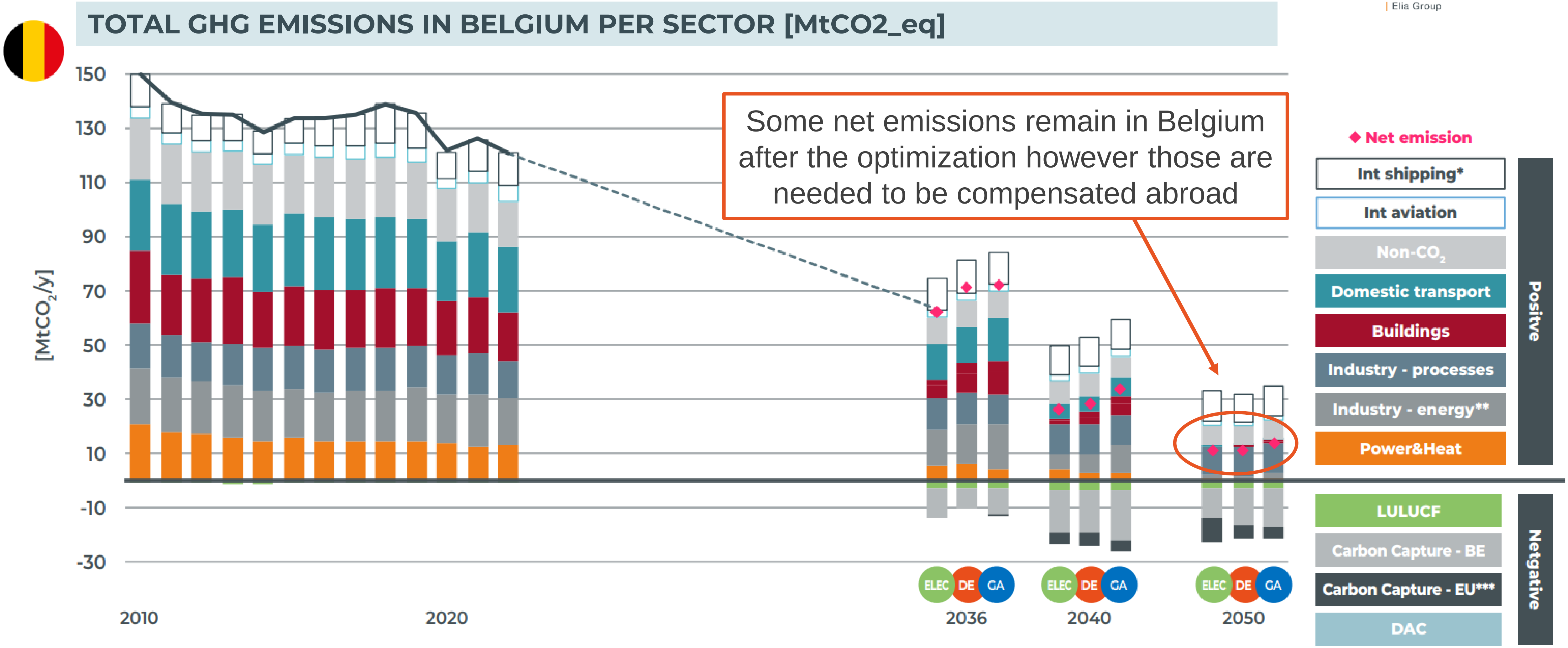
EUROPEAN GREENHOUSE GAS EMISSIONS [$MtCO_2$_eq]



Data for Europe (incl. UK, NO, CH)
For UK, because of incomplete data, 2022 emissions data are assumed the same as in 2021
The sectoral split concerns CO_2 emissisions, the non-CO_2 emissions are shown seperately in aggregate
** also includes refineries, agriculture and waste management*
*** includes 50% of the emissions*
Historical values based on European Environment Agency and Department for Energy Security & net-zero for the UK

Resulting emission for Belgium were optimized at EU level

TOTAL GHG EMISSIONS IN BELGIUM PER SECTOR [MtCO2_eq]



Some net emissions remain in Belgium after the optimization however those are needed to be compensated abroad

Figures presented under the electricity supply scenario assuming no new nuclear, central onshore RES and optimised offshore
The sectoral split concerns CO_2 emissions, the non-CO_2 emissions are shown separately in aggregate
The European weighted average CO_2 intensity is assumed for methane and liquids imported and consumed in Belgium
** Includes 50% of the emissions*
*** Also includes refineries, agriculture and waste management*
**** This includes the CO_2 which was captured within Europe to make synthetic fuels, combusted within Belgium. As such this would mean a net-zero emission for BE*
Historical values based on European Environment Agency

Several electricity supply scenarios are studied

	Base scenario	Options		
Onshore supply	**CENTRAL** **PV:** + 50GW/y **Wind onshore:** +15 GW/y **Nuclear:** known plans (new and phase out)	NUC	170 GW nuclear in Europe in 2050 (instead of 75 GW)	
		PV+	2,700 GW vs. 1,600 GW	+100 GW/y for PV
		RES+	Acceleration for domestic PV and onshore wind	+25 GW/y for wind onshore +75 GW/y for PV
		NIM	Nimby scenario (lower onshore & more expensive onshore grids)	+10 GW/y for wind onshore High costs for the electricity grid
Offshore & electricity grid	All options for offshore/onshore	RAD RAD+ 400 GW		Different offshore grid topologies (radially, 400 GW offshore)

Significant growth assumed for renewables.
Uncertainty on Nuclear volume captured in a sensitivity.

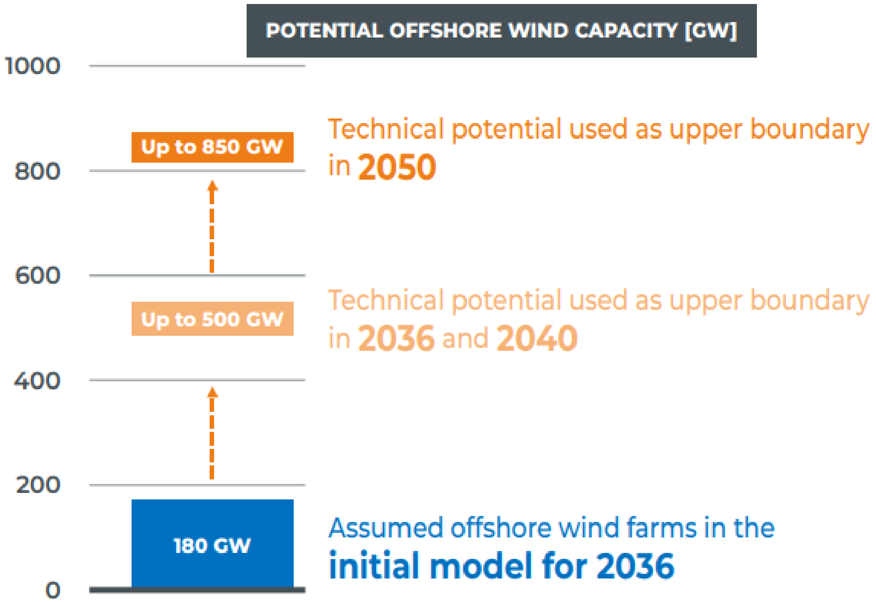
Installed Capacity [GW]

Installation rate to 2050 [GW/year]

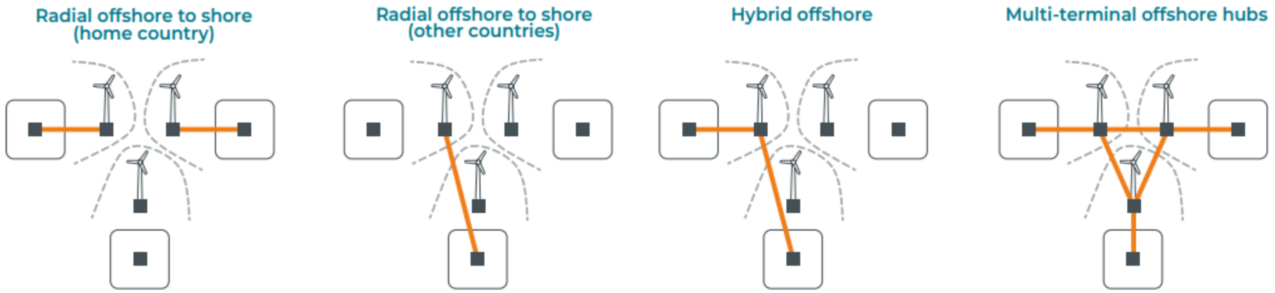
		Solar	Onshore wind	Nuclear
	Today…	≈ 275 GW	≈ 220 GW	≈ 110 GW
2050	CEN **CENTRAL**	**1600 GW** +50 GW/y	**620 GW** +15 GW/y	**75 GW**
	NIM **NIMBY**	1600 GW +50 GW/y	**490 GW** **+10 GW/y**	75 GW
	RES+ **High RES**	**2100 GW** **+75 GW/y**	**850 GW** **+25 GW/y**	75 GW
	PV+ **High RES +very high PV**	**2700 GW** **+100 GW/y**	**850 GW** **+25 GW/y**	75 GW
	NUC **High Nuclear**	1600 GW	620 GW	**170 GW**

The model was able to invest in up to 850 GW of offshore energy.

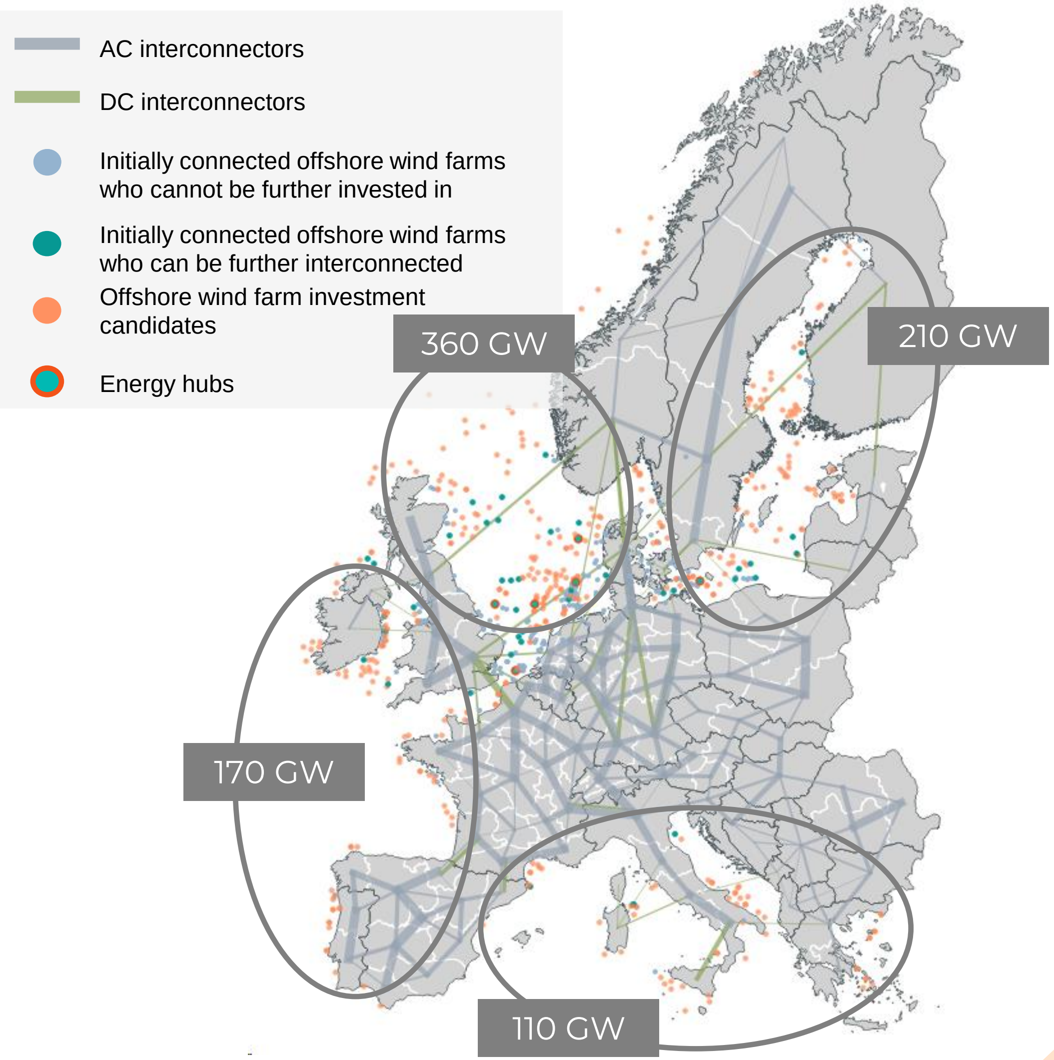
- **Up to 850 GW of individually modelled offshore wind farms can be invested in**



- **Grid investment options include HVDC and AC**
A wide range of offshore investment configurations is allowed

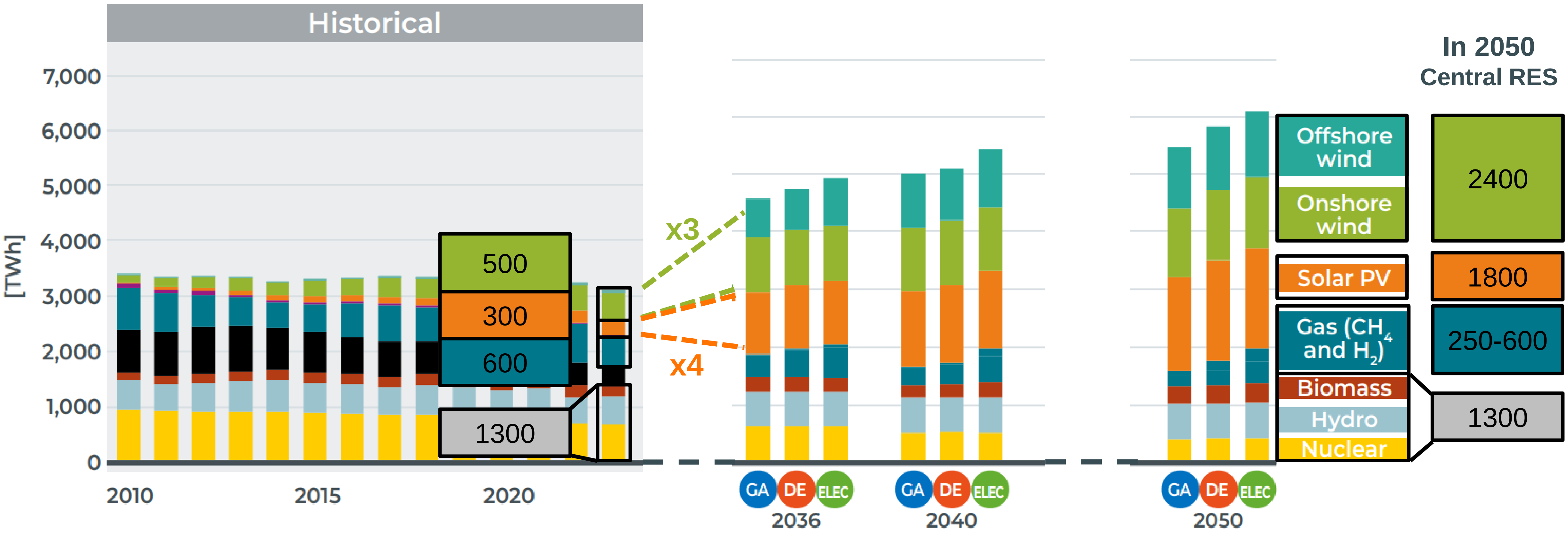


POTENTIAL PER SEA BASSIN



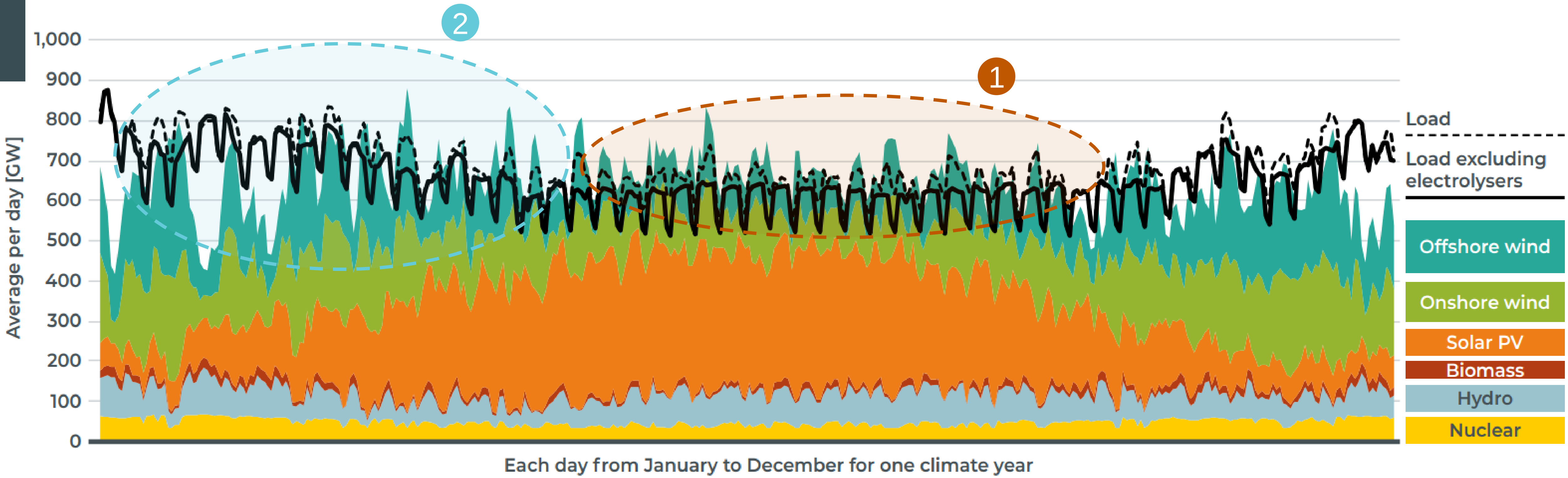
The assumed growth of electricity consumption is covered by additional renewables

ELECTRICITY GENERATION BY FUEL TYPE FOR EUROPE FOR CENTRAL RES [in TWH]



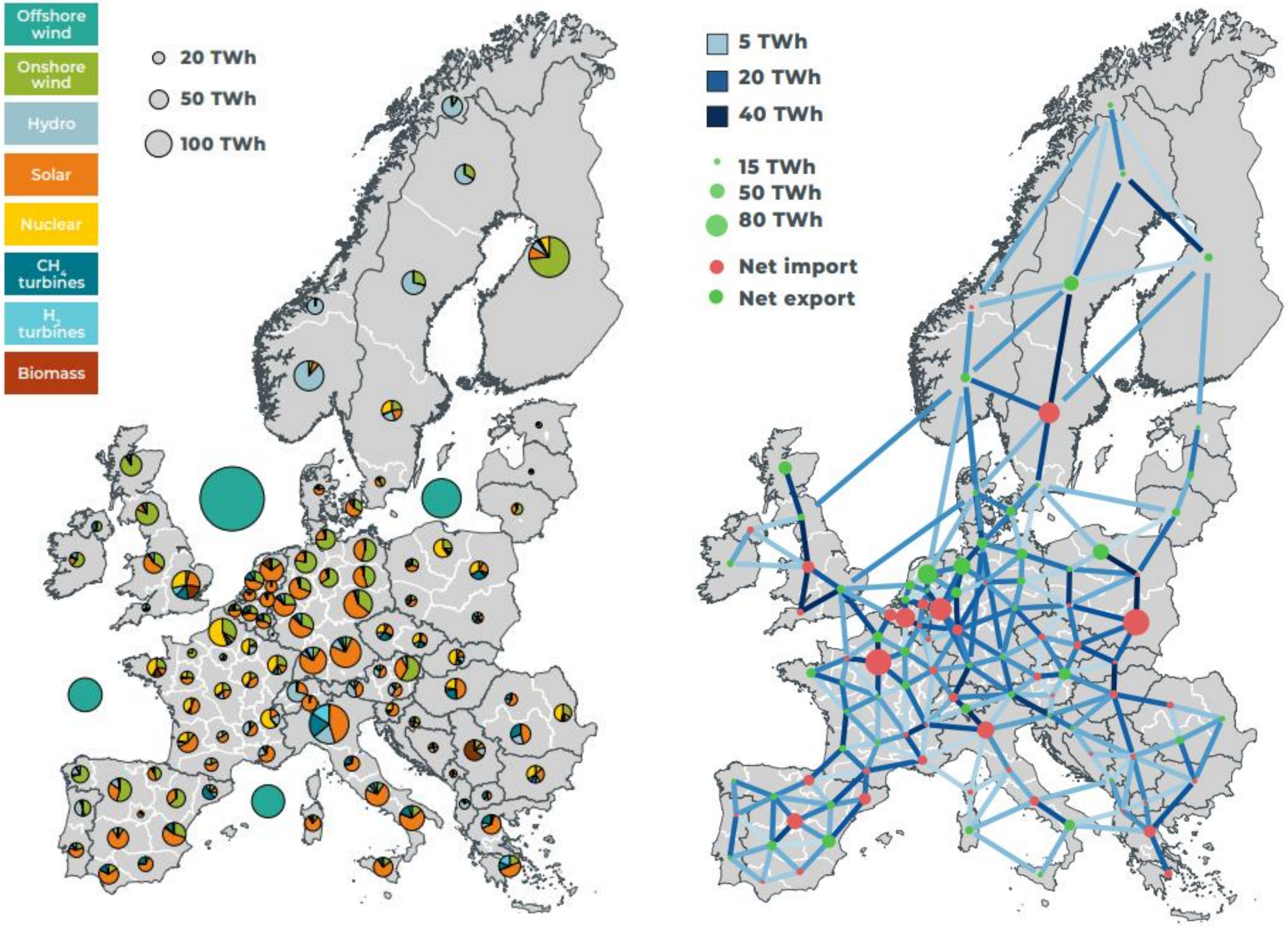
If EU would be a copper plate, low-carbon generation can cover the entire daily load in most days

Daily average carbon free power generated over the entire simulation perimeter in a copperplate setup



DE scenario, central RES, optimised offshore, 2050

Transmission capacity links areas with different generation and load characteristics



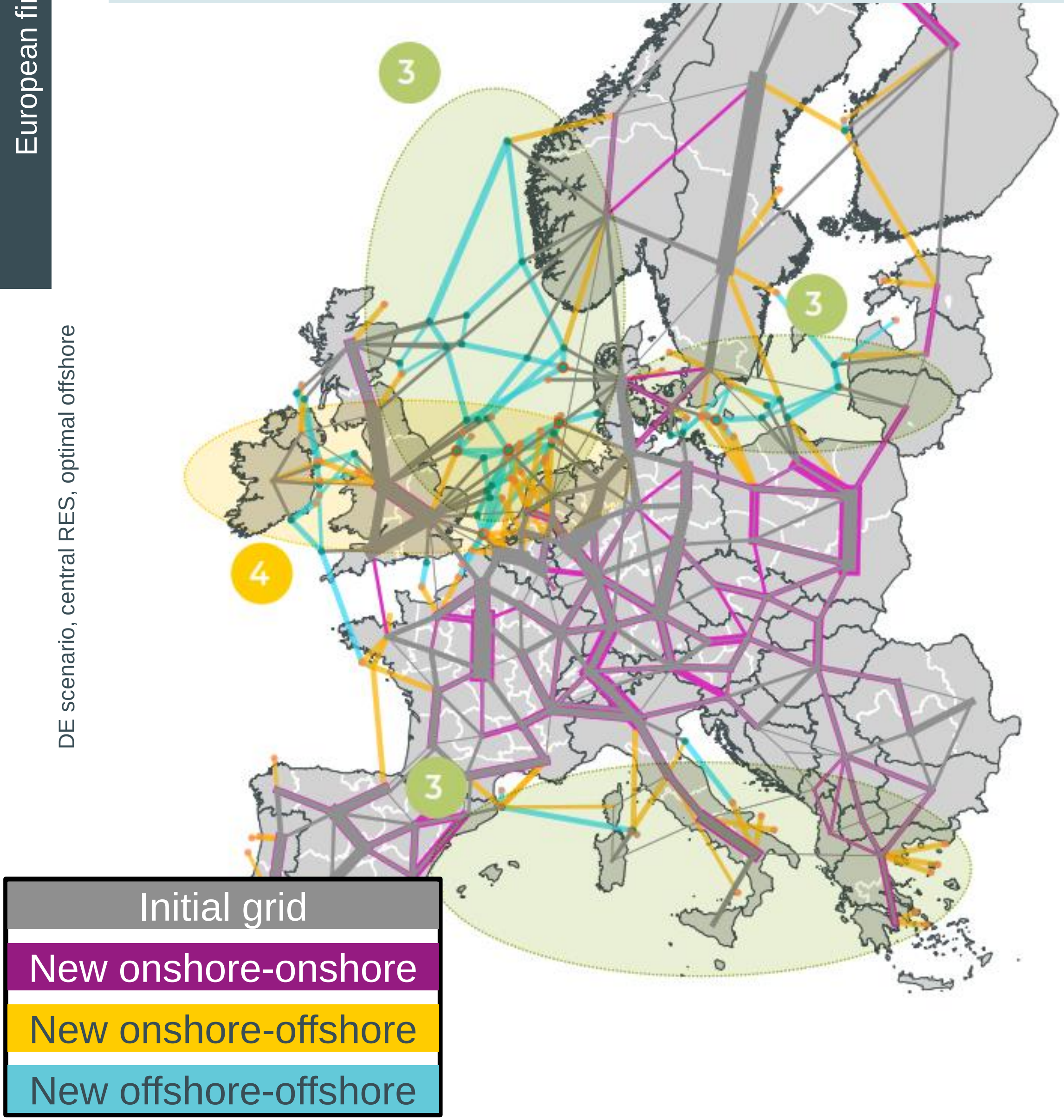
- **Energy mixes differ** by area
- **Offshore wind** forms a **significant part** of the European **energy supply.**
- **Belgium** as a **load center**

DE scenario for 2050, central RES, optimised offshore, offshore zones are aggregated in this visual.

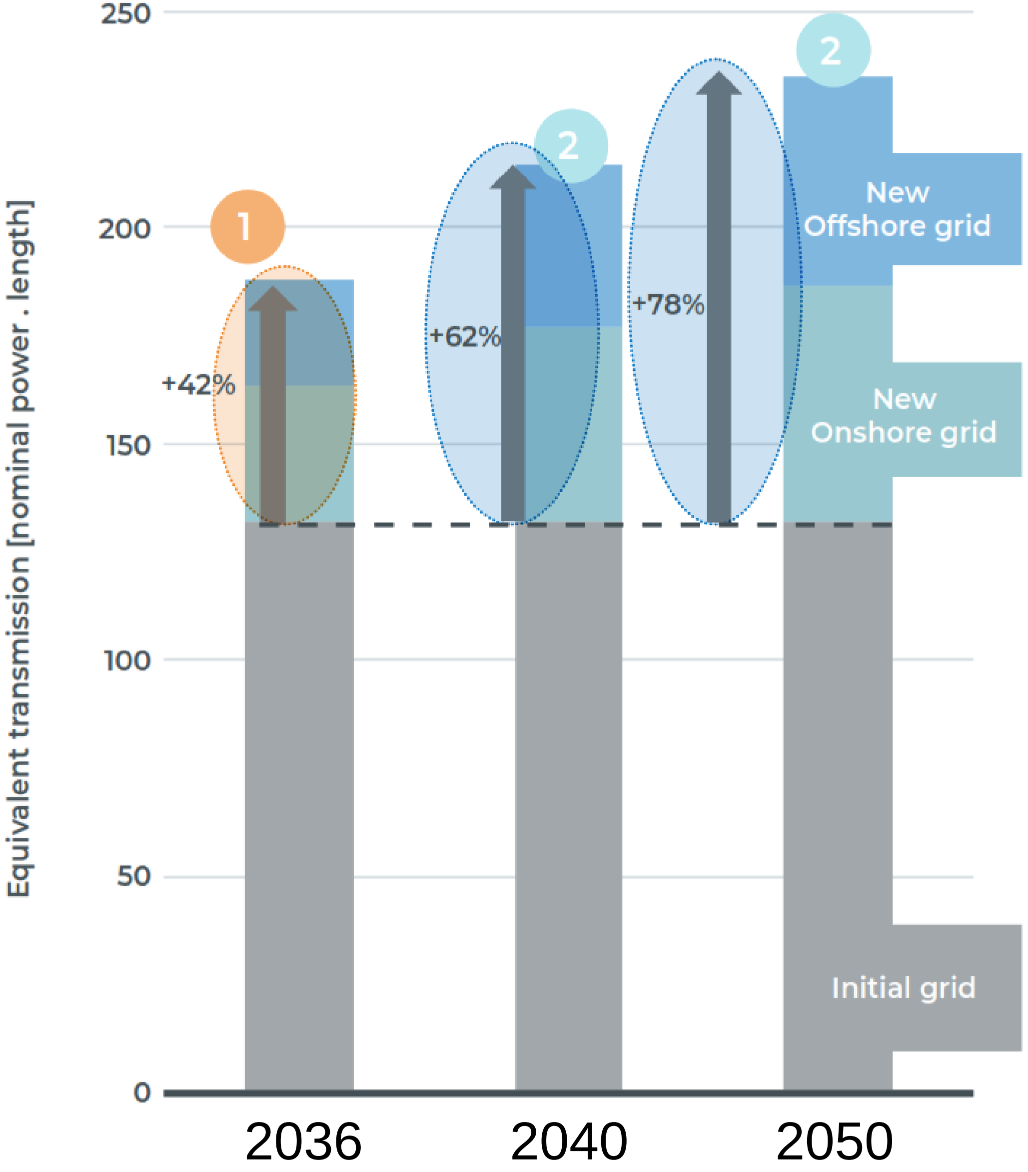
Strong transmission grid buildout is observed both on- and offshore

DE scenario, central RES, optimal offshore

2050

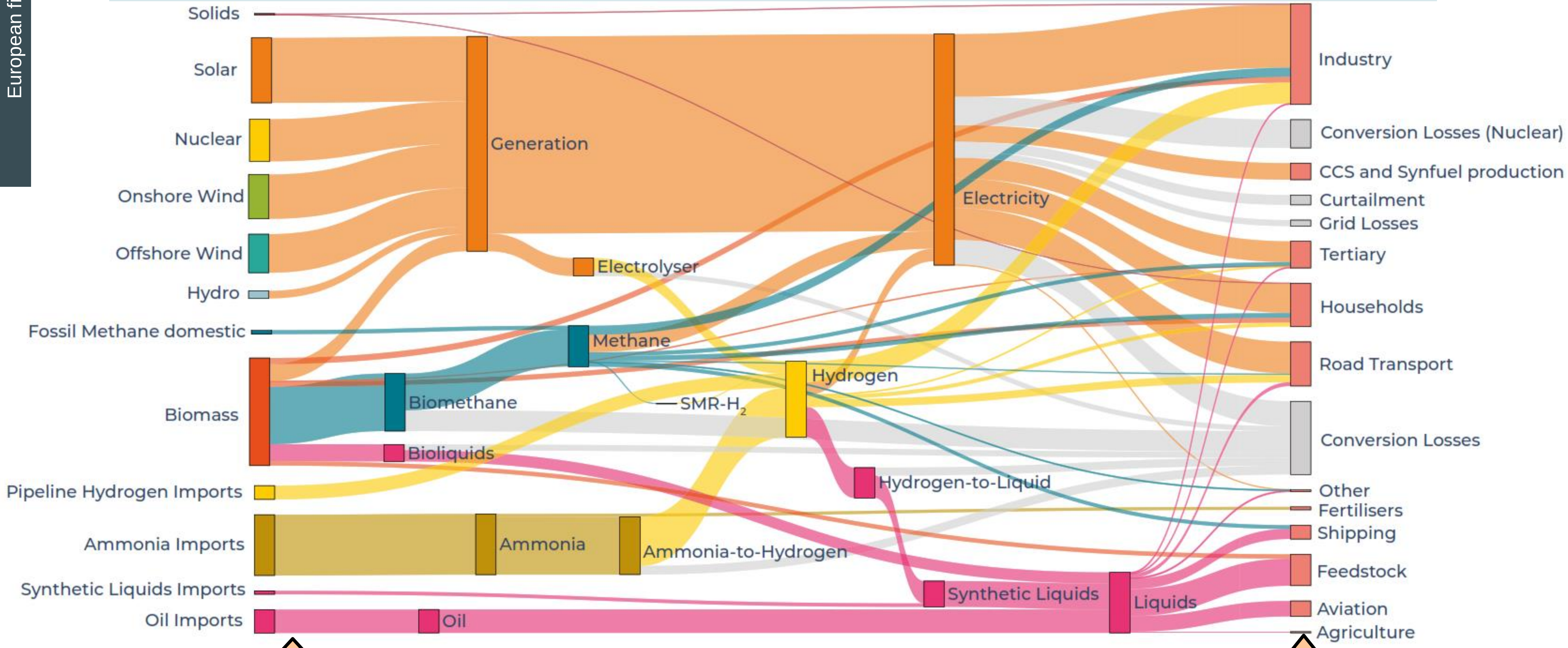


Evolution of the amount of transmission grid



A drastically different energy landscape is observed

Sankey diagram for the DE SCENARIO - 2050



Energy entering Europe

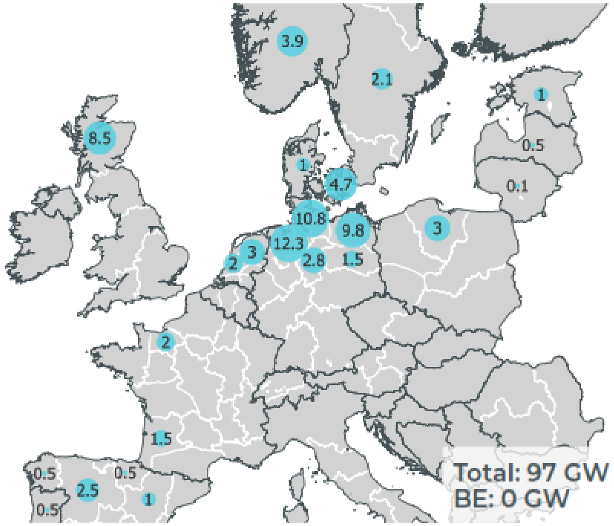
Transformations

Energy used in sectors

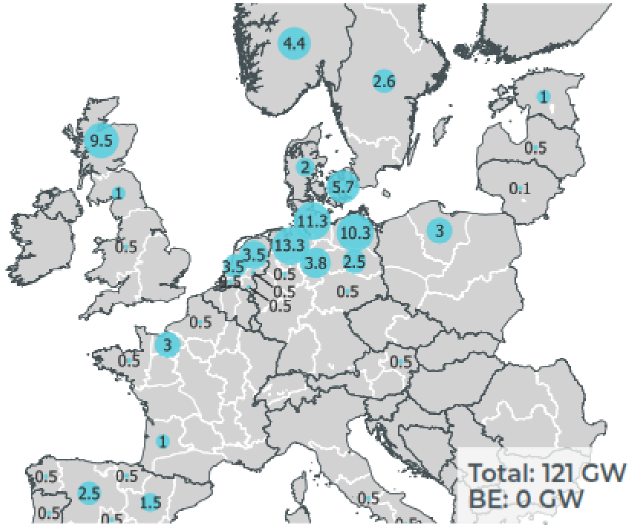
Electrolysers are located in areas with high levels of renewable supply

	2036	2050
DE		
GA		

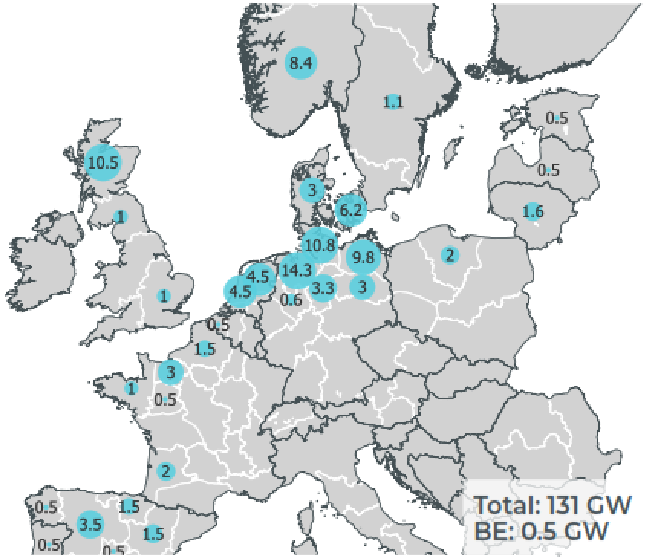
DE – **2036**



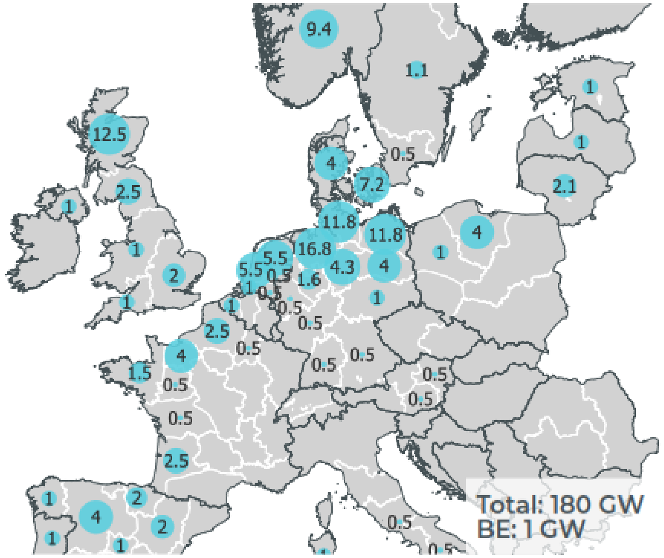
DE – **2050**



GA – **2036**



GA – **2050**



Total in 2050:

EU+: **120 GW**

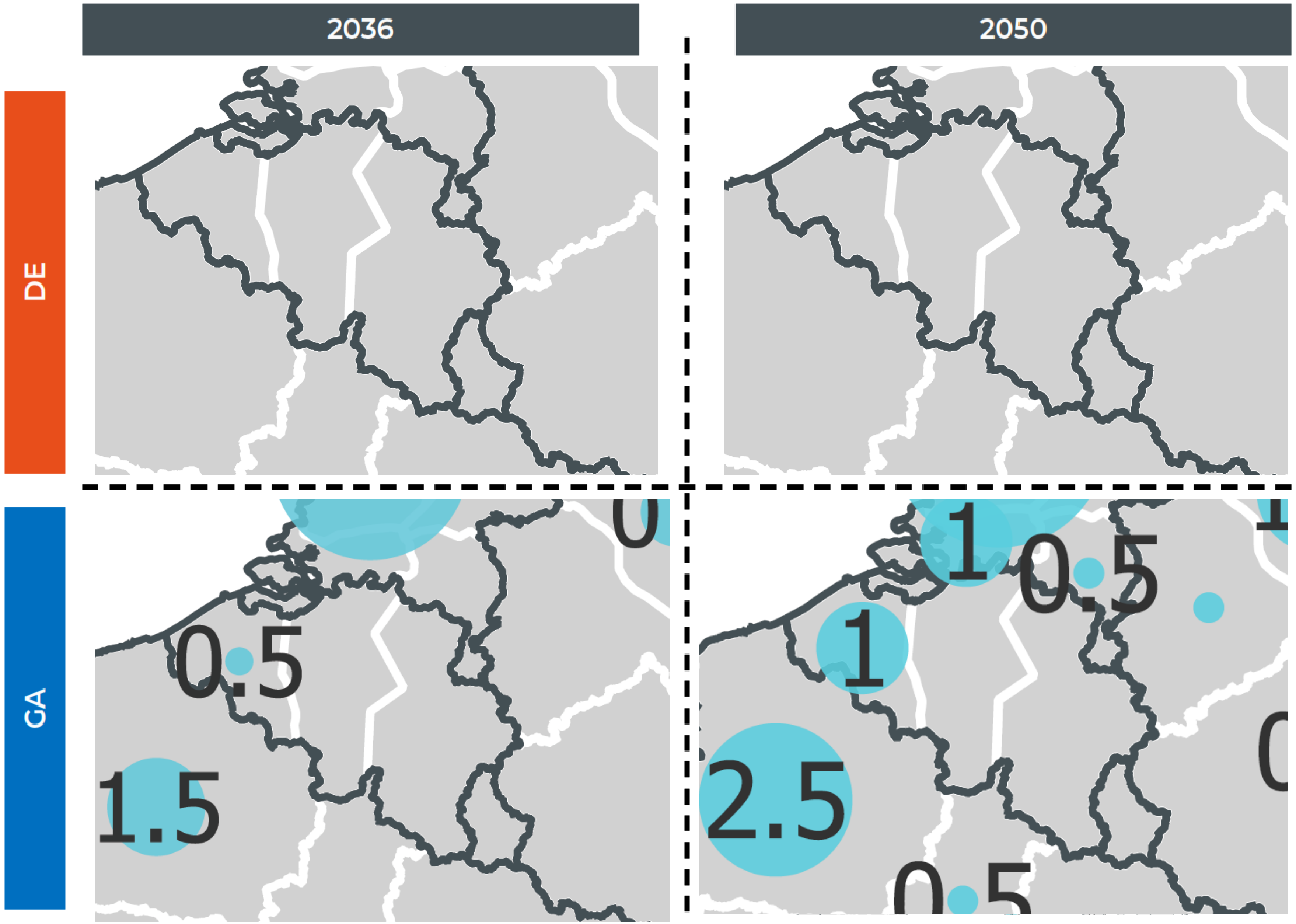
BE**: 0 GW**

Total in 2050:

EU+: **180 GW**

BE: **1 GW**

Potential for electrolysis in Belgium is very limited



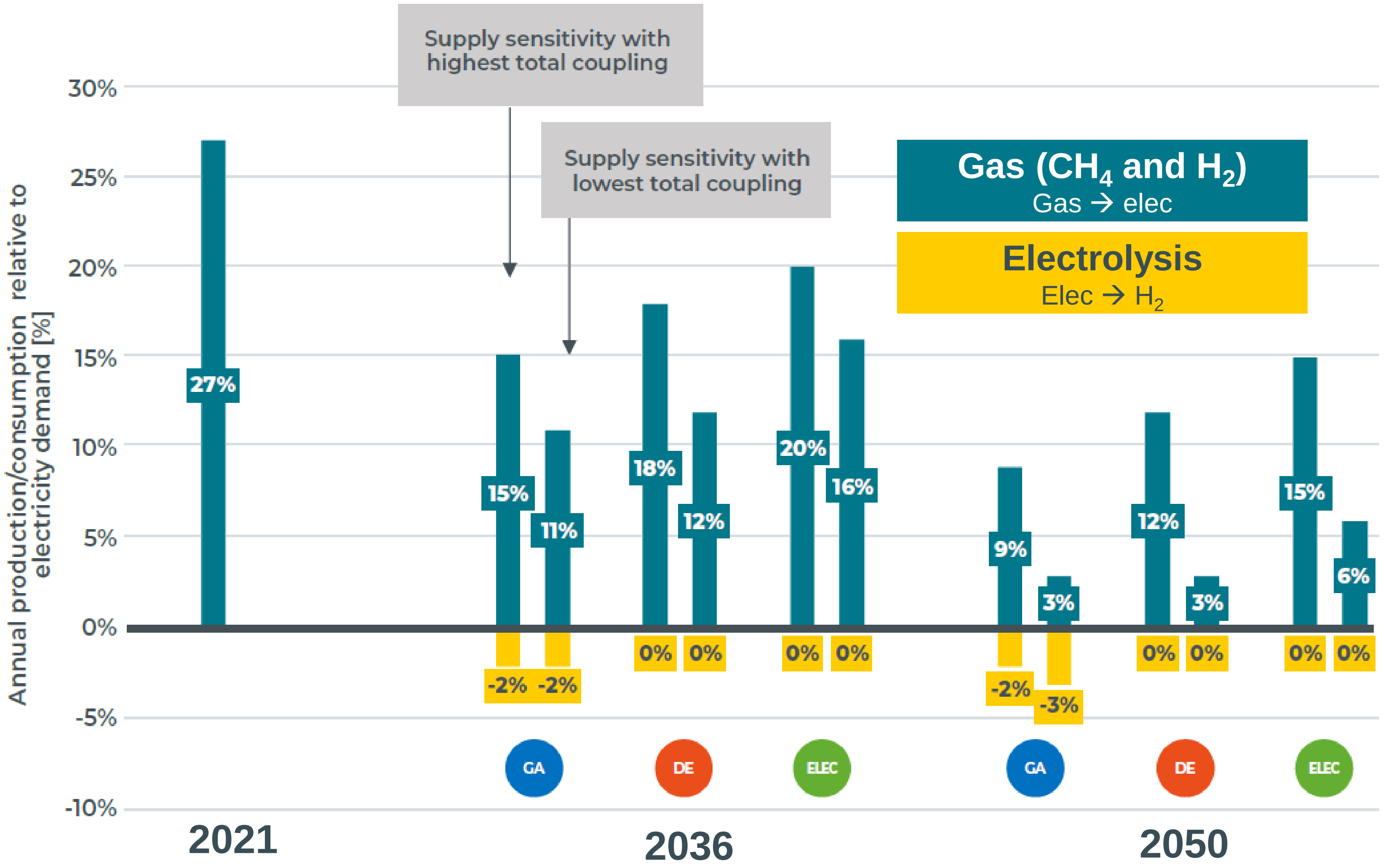
Zoom on Belgium

Total coupling between molecules and electricity system in 2050 remains stable or decreases compared to today

Linkage	17%	→	14-18%

European findings

The coupling between the electricity and gas system decreases over the years



Supply sensitivity with highest total coupling

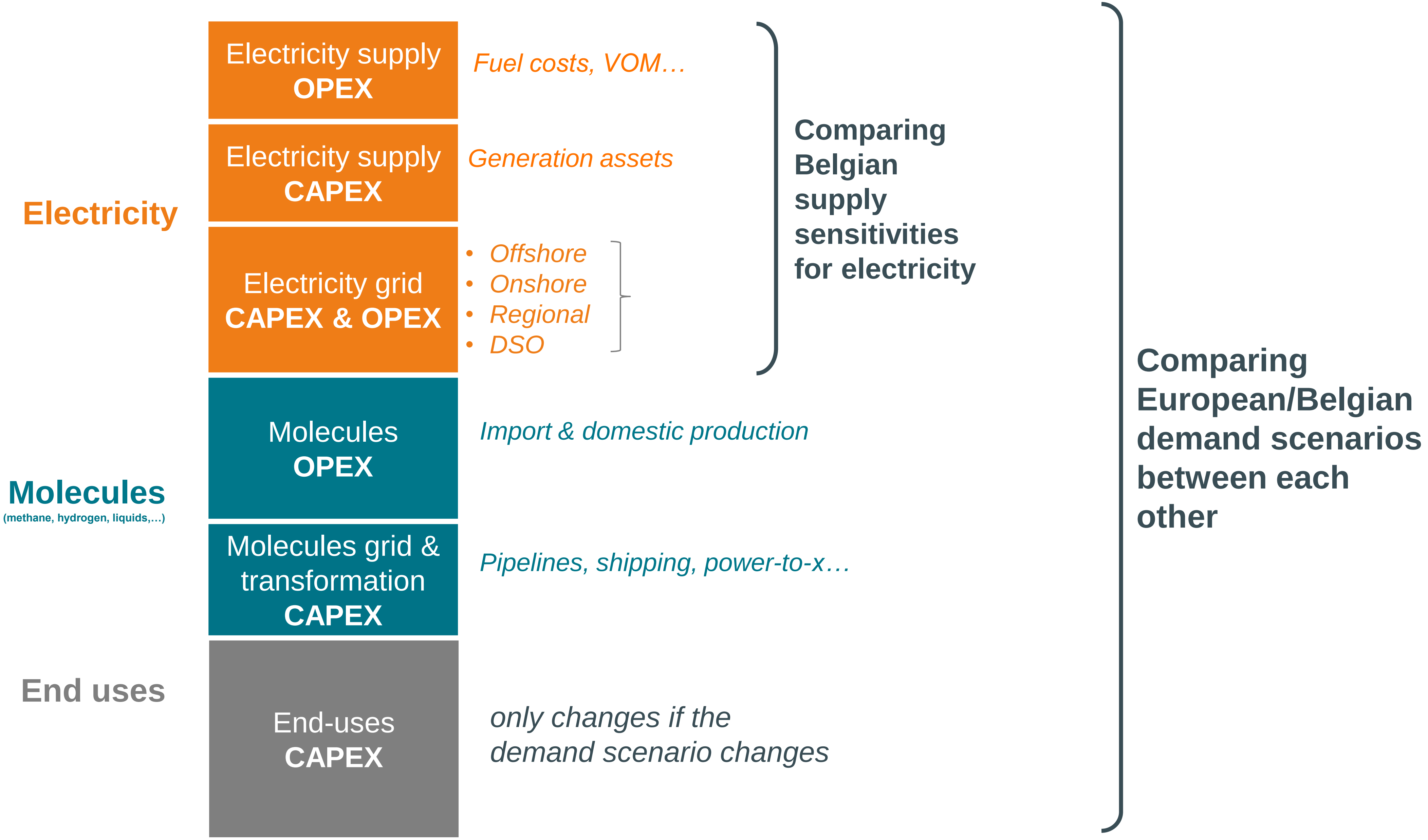
Supply sensitivity with lowest total coupling

Zoom on Belgium

Coupling between gas and electricity decreases over time for Belgium

Linkage	27% →	3-15%

How did we quantify the total system costs?



Electricity

Electricity supply OPEX — *Fuel costs, VOM…*

Electricity supply CAPEX — *Generation assets*

Electricity grid CAPEX & OPEX

- *Offshore*
- *Onshore*
- *Regional*
- *DSO*

Comparing Belgian supply sensitivities for electricity

Molecules

(methane, hydrogen, liquids,…)

Molecules OPEX — *Import & domestic production*

Molecules grid & transformation CAPEX — *Pipelines, shipping, power-to-x…*

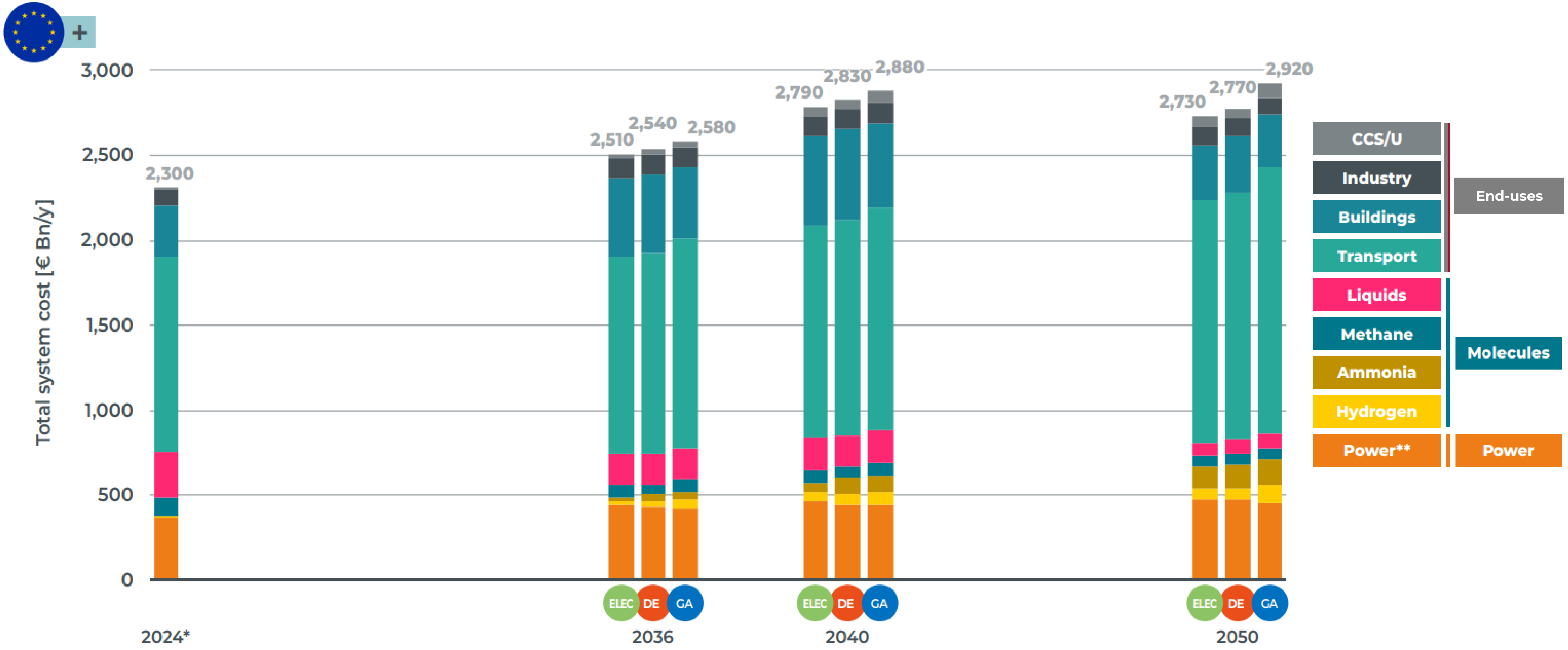
End uses

End-uses CAPEX — *only changes if the demand scenario changes*

Comparing European/Belgian demand scenarios between each other

The more electrification, the lower the overall energy system cost

SYSTEM COSTS – TOTAL EUROPEAN ENERGY SYSTEM INCLUDING END-USES INVESTMENTS

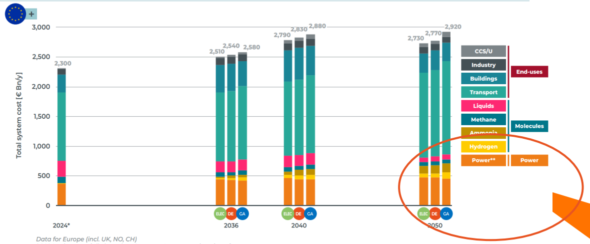


Data for Europe (incl. UK, NO, CH)
** 2024 values partially based on Compass-Lexecon estimation of current costs*
*** Power excludes methane & hydrogen fuels used for power generation, which are reported under 'methane' and 'hydrogen'*

European findings

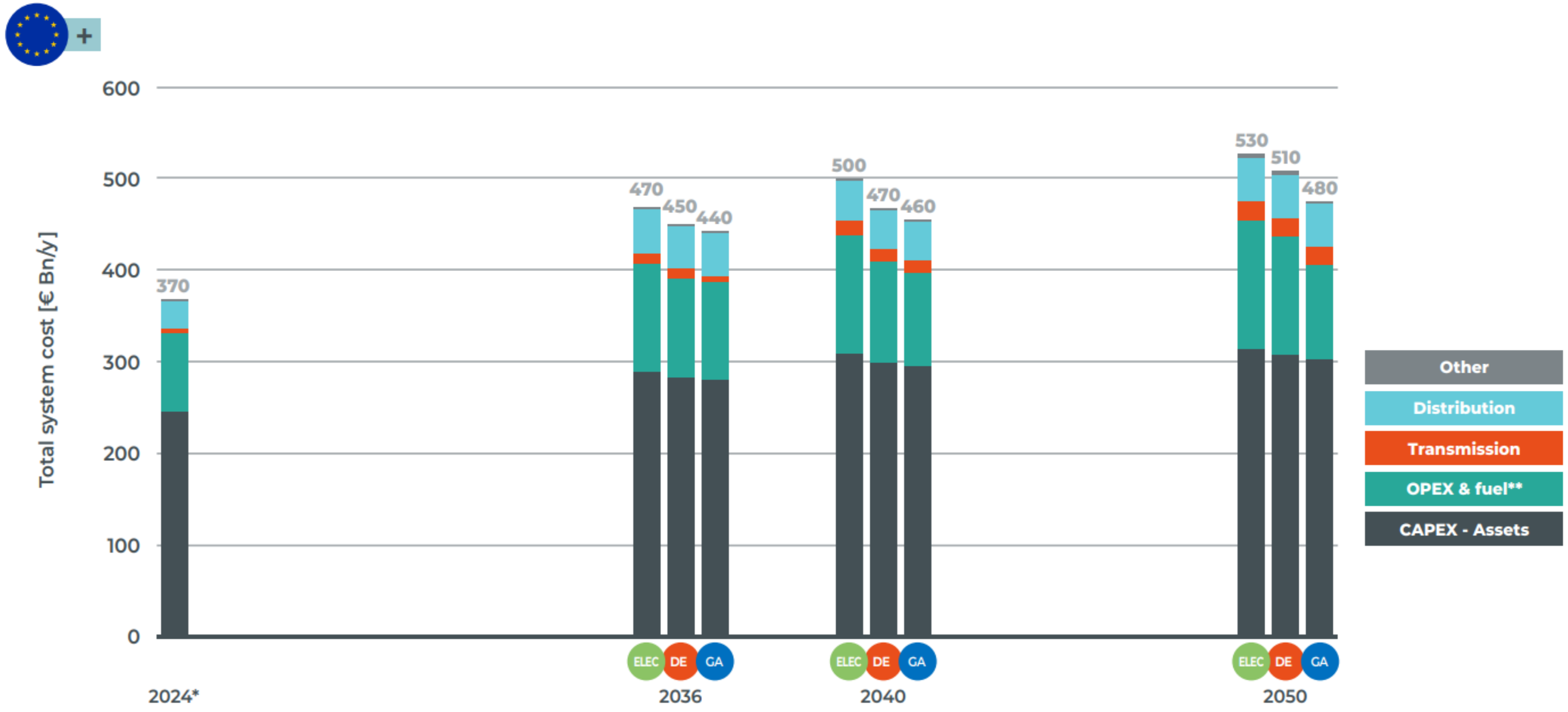
The more electrification, the lower the overall energy system cost

SYSTEM COSTS – TOTAL EUROPEAN ENERGY SYSTEM



Data for Europe (incl. UK, NO, CH)
** 2024 values partially based on Compass-Lexecon estimation of current costs*
*** Power excludes methane & hydrogen fuels used for power generation, which are reported under 'methane' and 'hydrogen'*

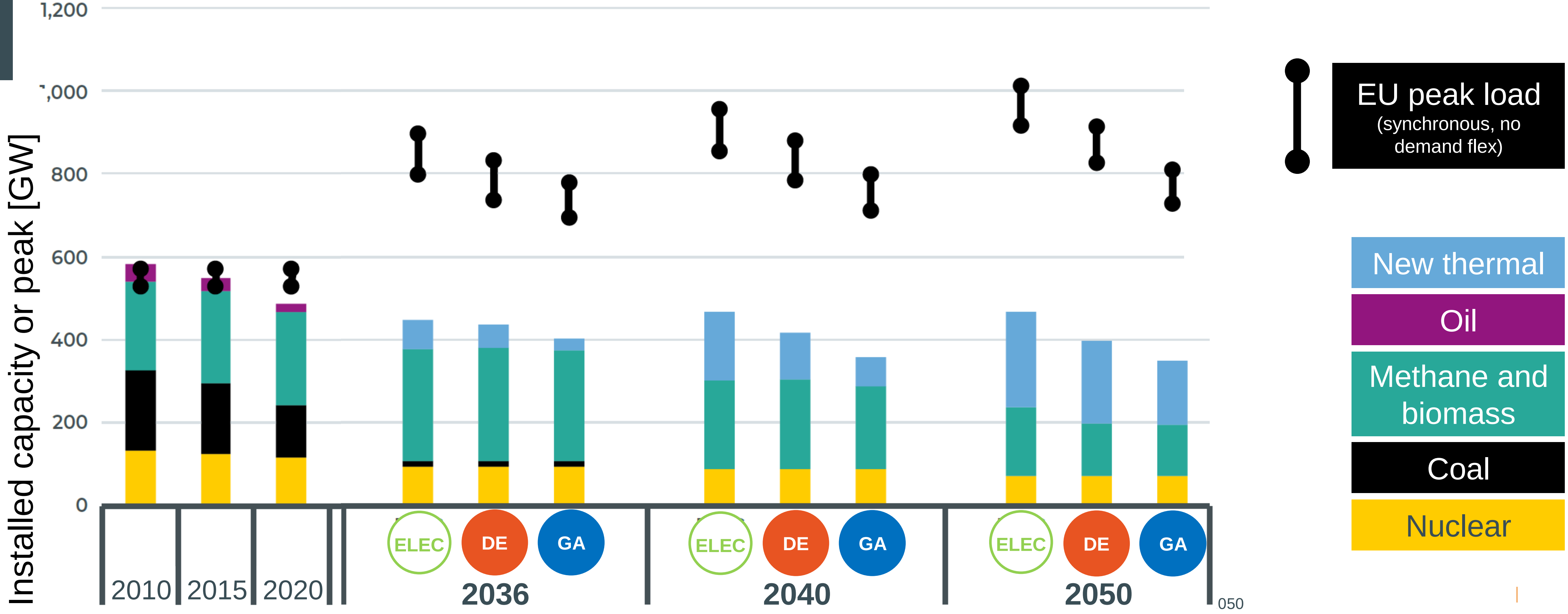
TOTAL EUROPEAN POWER SYSTEM COSTS



** 2024 values partially based on Compass-Lexecon estimation of current costs*
*** Including methane and hydrogen used for power generation*

Need for thermal generation remains in the long run despite the large volumes of flexible demand and storage assumed

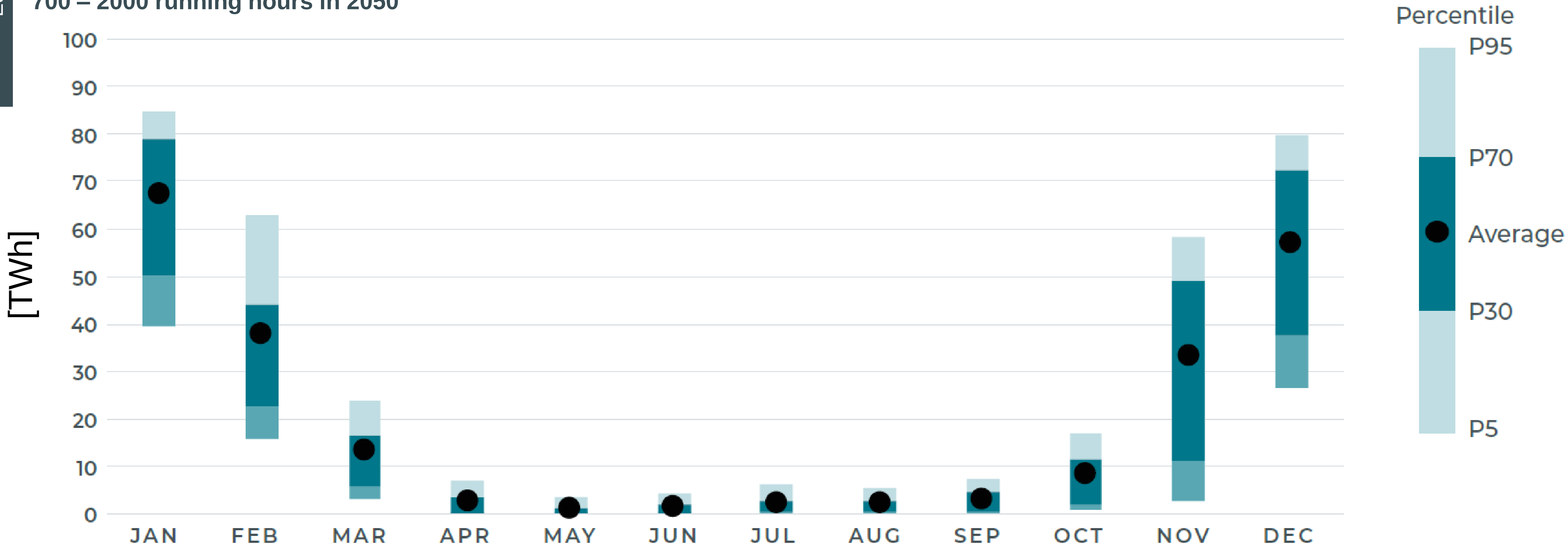
INSTALLED THERMAL CAPACITIES AND PEAK DEMAND RANGES FOR DEMAND SCENARIOS



Dispatchable thermal generation runs almost exclusively in winter in 2050

MONTHLY GENERATION OF GAS-FIRED DISPATCHABLE GENERATION IN EUROPE IN 2050

700 – 2000 running hours in 2050



Distribution over all climate years and European demand and supply sensitivities.

Key observations from the European optimization

System costs

- The **most electrified scenarios** result in the **lowest total cost** for society when accounting for all costs components

Electricity grids and offshore wind

- **Strong build out of offshore wind capacity** in Europe (>300 GW) in all scenarios. Level will depend on the onshore RES/nuclear development and imported molecule prices
- Strong build out of the onshore & offshore **electricity grids** in any scenario
- Allowing **hybrids and multi-terminal offshore** allows to reduce the costs of the system

Adequacy

- **Thermal generation** via molecules is still **needed** in the long run however the load factor will decrease over time. The amount will depend on the electrification, flexibility and grid build out.
- **Carbon capture** is identified in all scenarios but very limited for power generation

Key observations for Belgium from the European results

Electrical system

8 GW offshore as from 2040 in Belgium in all scenarios and sensitivities that were simulated

More onshore **interconnections** with neighboring countries, additional non-domestic offshore connected to Belgium at the EU optimum

Multi-Energy

Very **little electrolysers** (mostly none) are found to be optimally installed in Belgium.

The **linking between the gas** (hydrogen and methane) **and electricity** system **decreases** over the years.

BLUEPRINT

AGENDA

(and indicative timings)

Introduction	[15h00-15h10]
Process & stakeholder interactions	[15h10-15h15]
Methodology	[15h15-15h40]
European multi-energy findings	[15h40-16h15]
▶ **Belgian** findings	**[16h15-17h15]**
Energyville reasoned opinion	[17h15-17h20]
Main messages	[17h20-17h30]

BELGIAN
ELECTRICITY
SYSTEM
BLUEPRINT
FOR 2035-2050

Belgian findings

A **Belgian scenarios/sensitivities definition**

B **Belgian results for the electricity system**

1. **Imports/exports** & thermal generation
2. Occurrence of **curtailment**/low marginal costs
3. **Total system costs**
    - Definition and components
    - Impact of demand levers
    - Onshore RES development
    - Large scale carbon-free options
4. **Transition period**
5. **Adequacy & grid requirements**

Belgian findings

▶ A **Belgian scenarios/sensitivities definition**

B **Belgian results for the electricity system**

1. **Imports/exports** & thermal generation
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    - Definition and components
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    - Onshore RES development
    - Large scale carbon-free options
4. **Transition period**
5. **Adequacy & grid requirements**

Key to keep in mind – starting point of the Belgian results

Considered in the current policies scenario

- **Belgium's draft NECP** (June 2023) for domestic RES and electrification (covers up to 2030)
- **Growth rate for onshore RES extrapolated from NECP** for the period after 2030
- **8 GW offshore** wind in BE EEZ **as from 2040** (based on findings in the EU optimization)
- **Lifetime extension of 2 nuclear reactors** (Doel 4 and Tihange 3) until the end of 2035
- **Closure of older thermal units** (> 40 years)

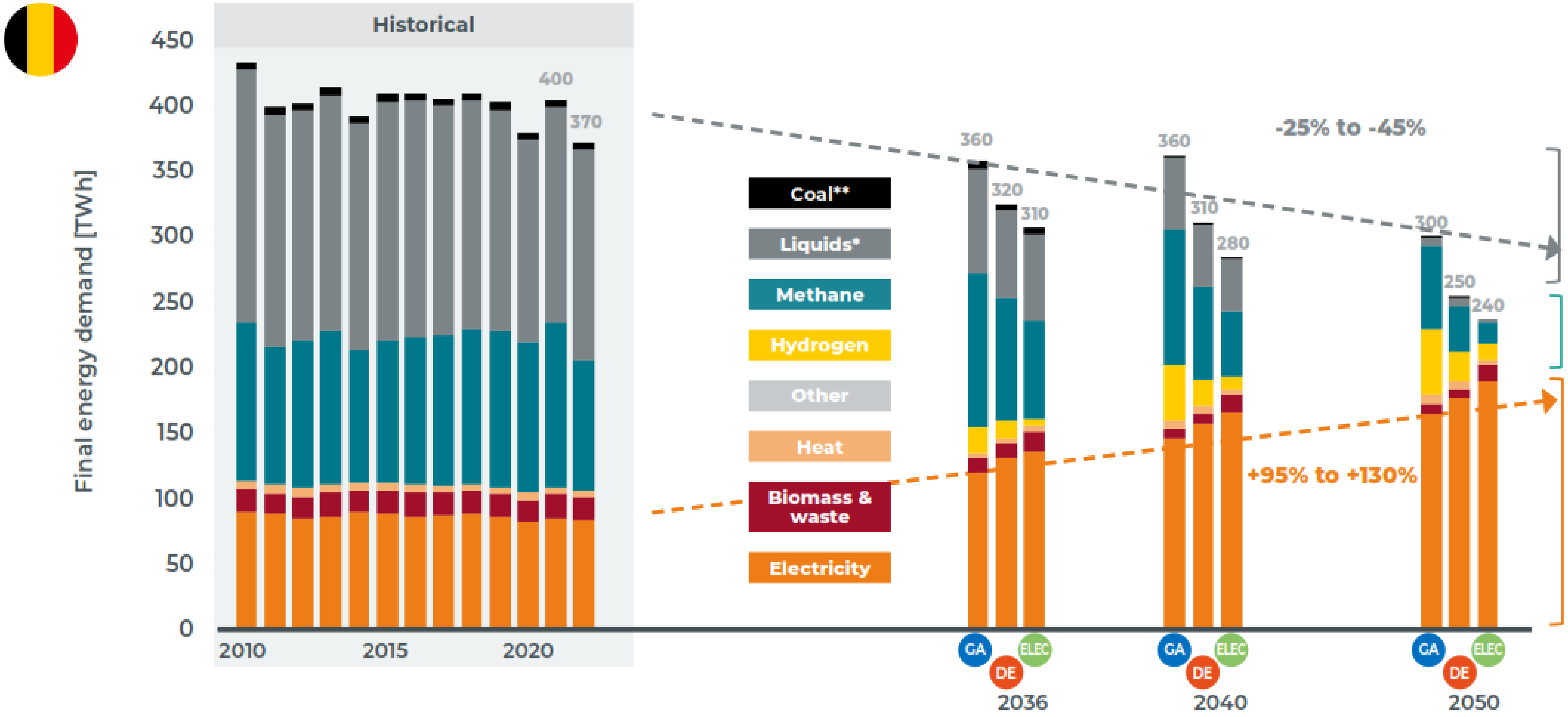
(The model can choose to keep them operational if financially interesting)

- **No new nuclear and no new non-domestic offshore connected to Belgium**
- All **grid reinforcements approved in** the last **Federal development plan**
  - **Boucle du Hainaut**
  - **Ventilus**
  - **Nautilus**
  - **…**

The current policies scenario is **complemented by a varied set of Belgian (>300) sensitivities**
These sensitivities are **focused on the electricity supply and demand**

The composition of the energy mix changes drastically over the years

Final Energy demand for Belgium [TWh]



Final energy demand reduction (electrification, sufficiency and energy efficiency)

-25% to -45% reduction of final energy demand

Gaseous Molecules

12% to 38% share of final energy demand

Electricity

Increasing from 24% in 2019 towards **55% to 80%** share of final energy demand

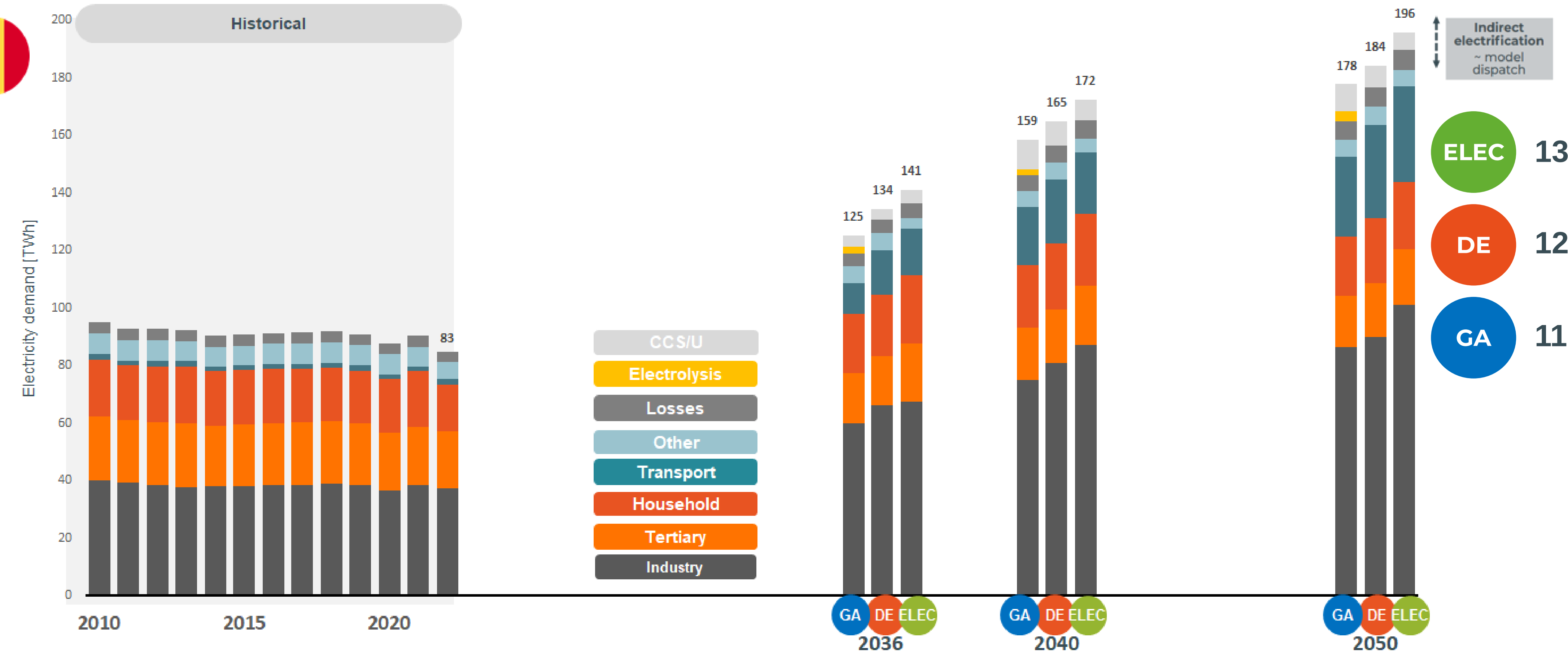
Not yet included are electricity for electrolysis and CCS/U (see later)

Excluding international aviation & shipping and non-energetic feedstock, including grid losses.
Note that energy demand for transformations such as power-to-hydrogen and carbon capture are not included here.
Values are normalised for historical climate while in the simulations, a forward-looking climate database is used, therefore the simulated demand can differ from these input values.
* Methane & liquids could be fossil, bio or synthetically sourced, which is defined in the model.
** Coal as defined as final energy demand per EUROSTAT (i.e. excluding coal consumed in blast furnaces)
Historical values based on EUROSTAT

Belgian findings

Electricity demand is set to at least double in all considered scenarios

Total electricity demand (including electricity for CCS and electrolysis) [TWh]



ELEC 135% increase

DE 120% increase

GA 115% increase

Values are normalised for historical climate while in the simulations a forward looking climate database is used, therefore the simulated demand can differ from these input values. Electrolysis, CCS and the production of synfuel is optimised within the model and the associated electricity demand depends therefore on each potential scenario and sensitivity.
Historical values based on EUROSTAT & Elia internal data

Additional heating networks and sufficiency measures were considered as possible levers to decrease the energy/electricity demand

Sufficiency

≈ - 5 TWh Measures that could be implemented in the **“shorter term”**
(e.g. heating setpoint, lower speed limit...)

+

≈ - 5 TWh **Long term behaviour changes**
(e.g. car and dwelling sizes...)

+

≈ -10 TWh **Systemic changes**
(e.g. circularity, modal shift for freight, lower consumption of goods...)

(potentials based on several studies such as EnergyVille, RTE, CLEVER scenario)

⚠ **Costs of sufficiency measures not accounted for**
The amount of reduction can greatly differ depending on the electrification but can also have large benefits in other energy vectors.

Heating networks

≈ 15 TWh Of heat supplied via district heating networks
(instead of 3.5 TWh in the base case)

Assumed as replacement of decentral heat pumps, leading to:

≈ - 4 TWh	**Of annual electricity demand**
≈ - 5%	**Of peak load demand**

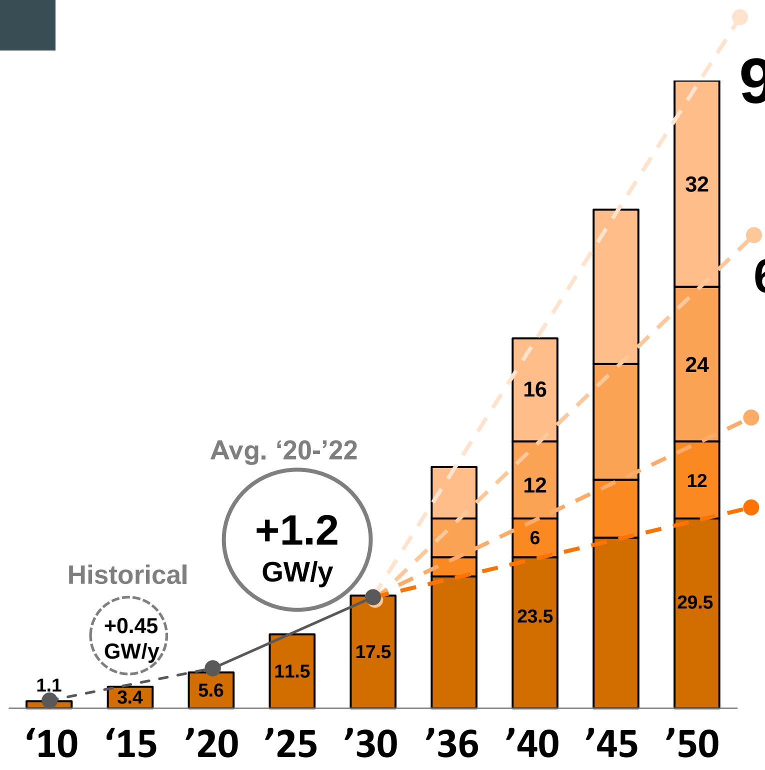
(potential based on EnergyVille, PATHS 2050)

⚠ **Costs of additional heating networks not accounted for**

Several scenarios for onshore renewable growth were considered

Solar

Capacity in GW



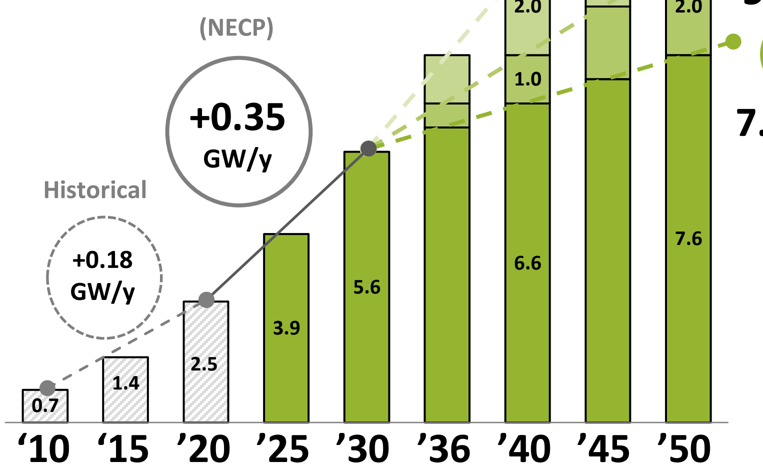
Deployment options in GW/year

97.5	Very high	=	+4 GW/y
65.5	High	=	+2.4 GW/y
41.5	Central	=	+1.2 GW/y
29.5	Low	=	+0.6 GW/y

We have also added a sensitivity where the amount of PV that can be evacuated is capped

Onshore wind

Capacity in GW



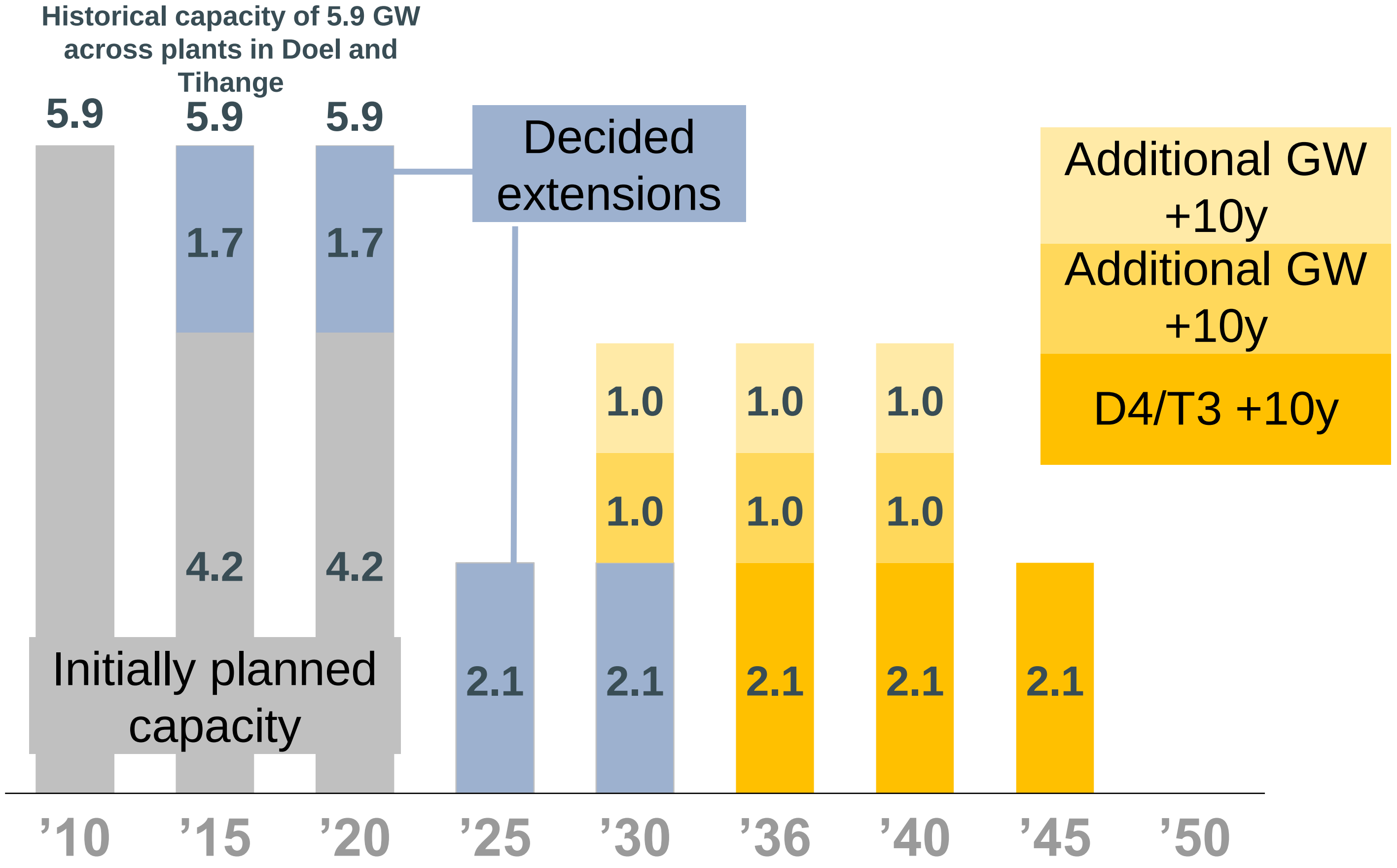
Deployment options in GW/year

13.6 GW	High	=	+0.4 GW/y
9.6 GW	Central	=	+0.2 GW/y
7.6 GW	Low	=	+0.1 GW/y

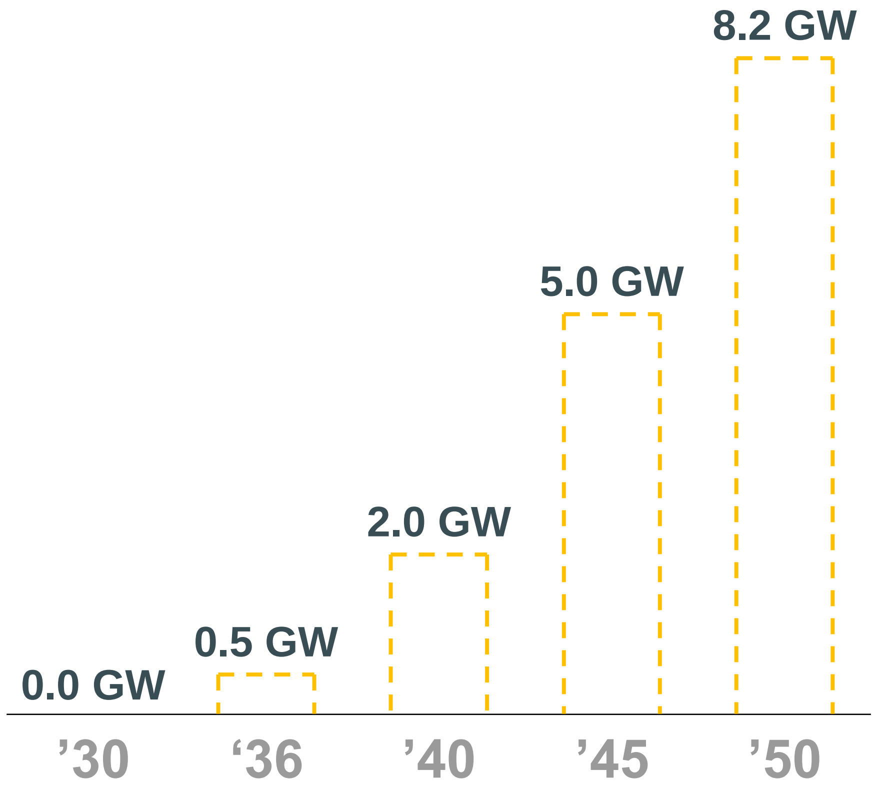
Avg. 20-'22

Both extensions of existing and new nuclear capacity were considered

Existing nuclear



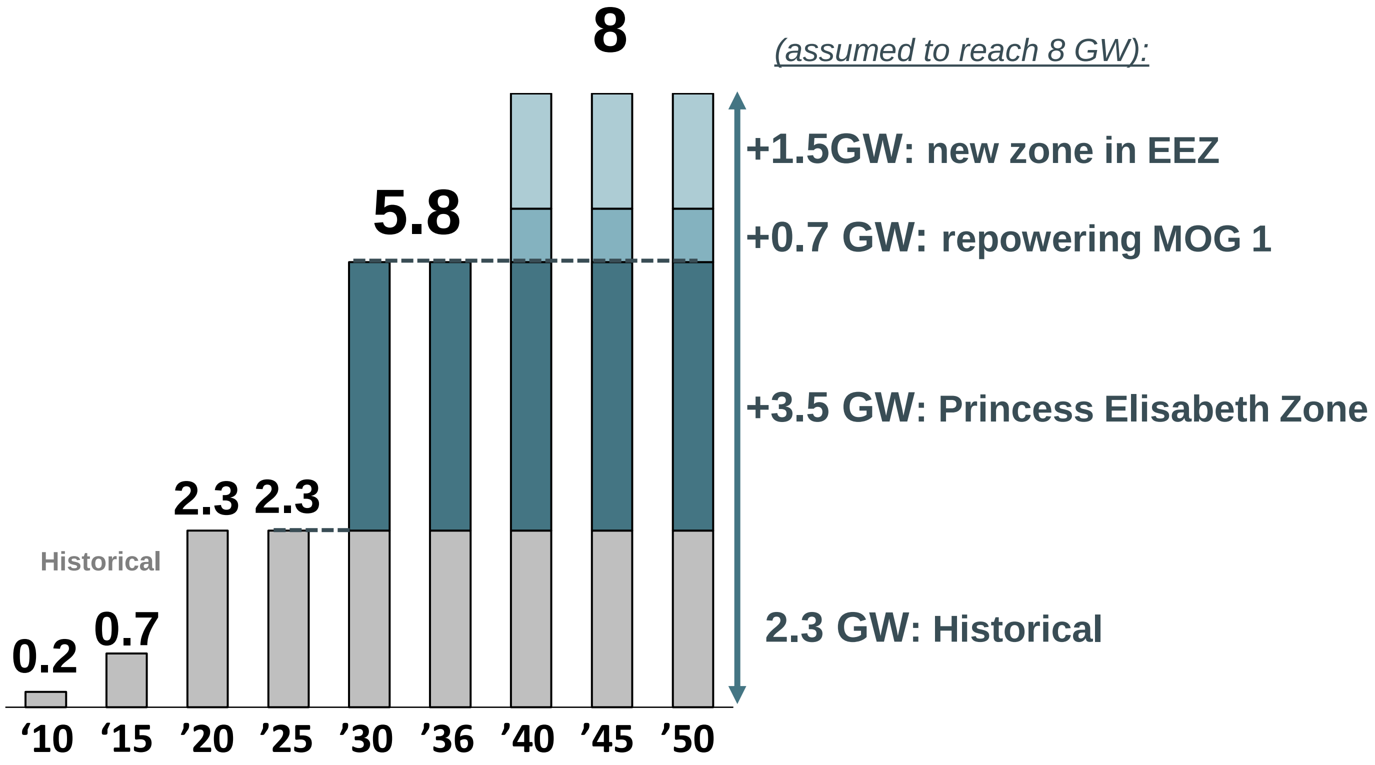
New nuclear capacities



8 GW domestic offshore and up to 16 GW non-domestic offshore were considered

Domestic offshore wind

Capacity in GW



(assumed to reach 8 GW):

+1.5GW: new zone in EEZ

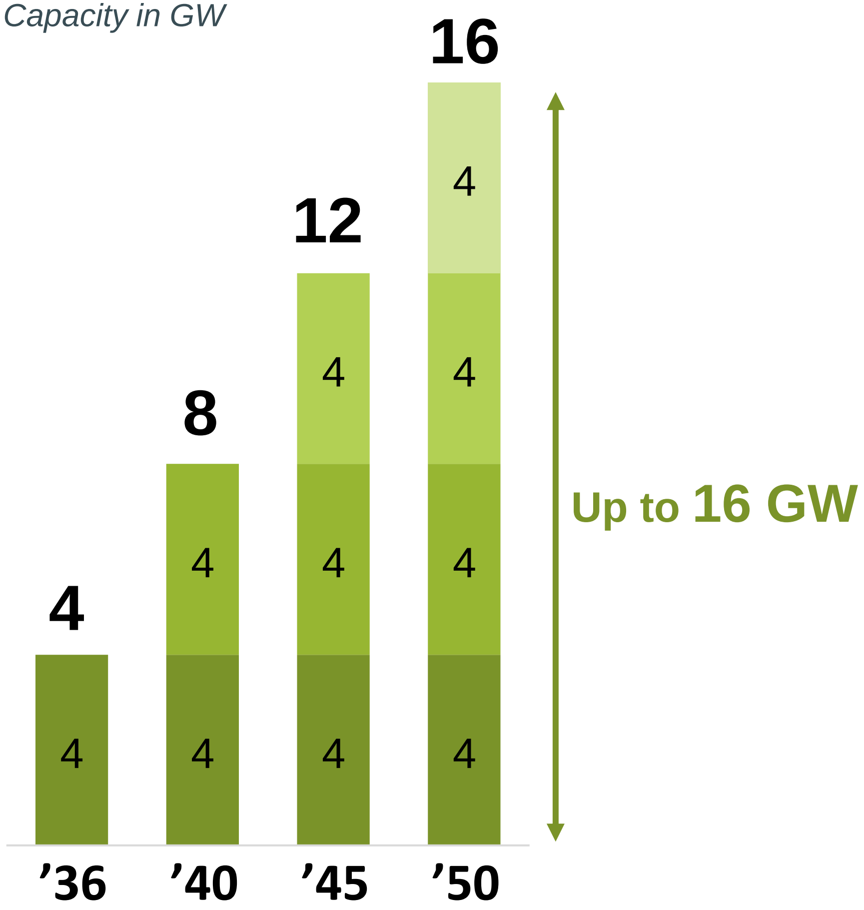
+0.7 GW: repowering MOG 1

+3.5 GW: Princess Elisabeth Zone

2.3 GW: Historical

Non-domestic offshore wind

Capacity in GW



Up to **16 GW**

A sensitivity with 'far out RES' was also considered via a direct link to Belgium from regions with high RES potential, such as the Xlinks project

Imports and required capacity for adequacy are consequences of the other levers

Imports/exports

are the result of the hourly European economic dispatch and are strongly influenced by choices on other levers

Installed Thermal capacity

Enough to be adequate. The level of **generation depends on the European merit order**

Adequacy is always guaranteed in all scenarios !

Flexibility

2050 capacity

Batteries	Large scale batteries Small scale batteries	≈ 8 GW
Demand Side Response	EVs (incl V2x) & HPs	≈ 9 GW
	Large scale DSM	≈ 4 GW
Pumped-storage	Pumped-storage reservoir/capacity	1.3 GW

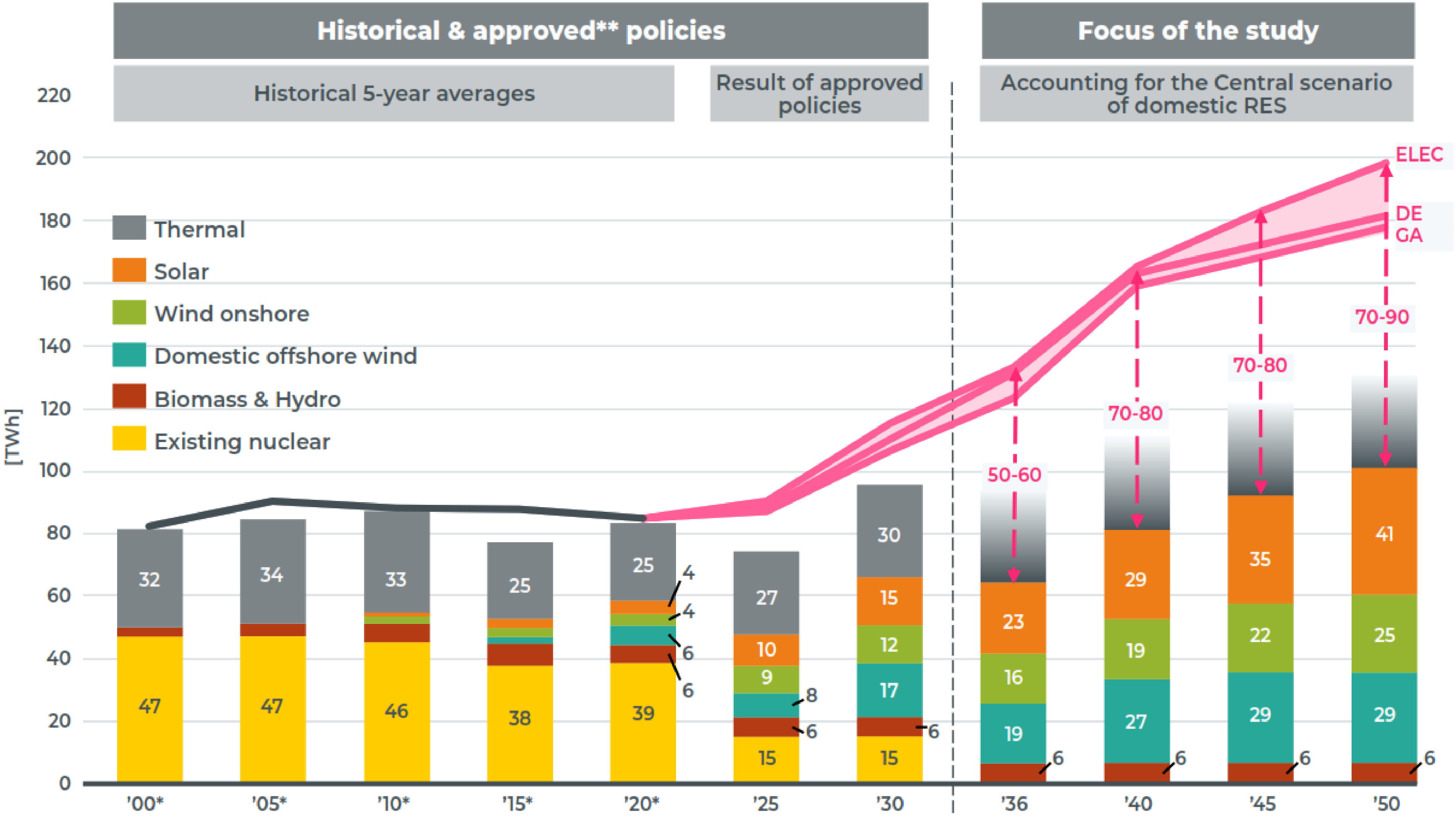
Sensitivity

High FLEX sensitivity resulting in approximately **60% additional flexibility in 2050**

For EVs/HPs & DSM, the value varies every hour of the year and other constraints are given to the model

Belgian domestic approved policies low-carbon supply will not suffice to keep up with electrical demand

Electricity Demand (incl. CCS, electrolysers and losses) & current policies supply for Belgium in TWh



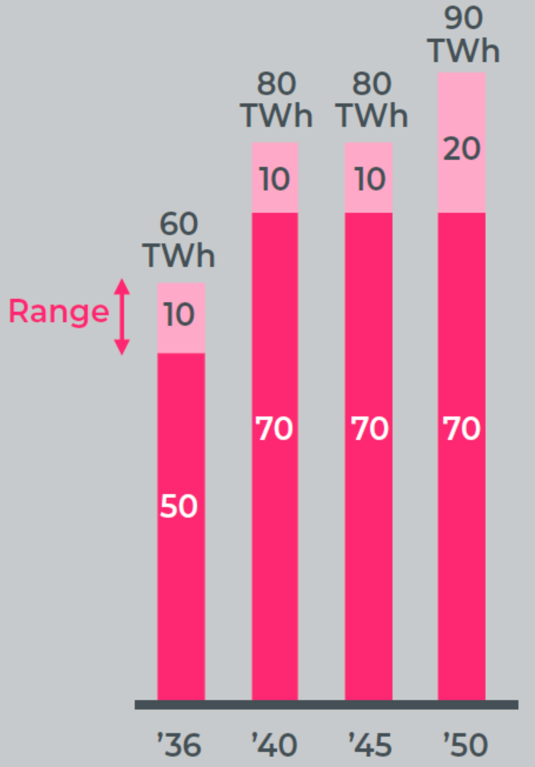
*For year X, the 5-year average in the range [X-2,X+2] is shown instead

** Approved policies: Extension of offshore wind in Belgium to 5,8 GW, extension of D4/T3 for 10 years, National/Regional energy climate plans (domestic RES, electrification, energy efficiency...), CRM

~ 70-90 TWh supply need 2050

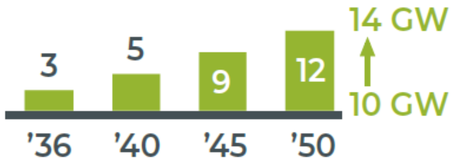
On top of central domestic RES supply

Range over the demand scenarios (DE, GA and ELEC)

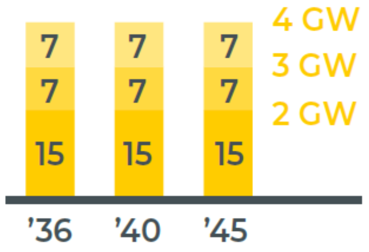


Maximum for each lever on each time horizon [TWh]

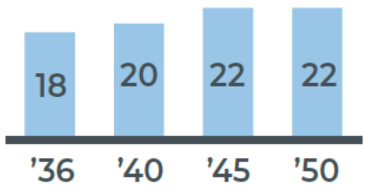
Onshore wind
x2 installation rate



Nuclear
Extend existing units



Sufficiency levers
Lower consumption

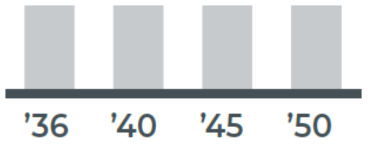


Non-domestic baseload RES
Build interco & RES

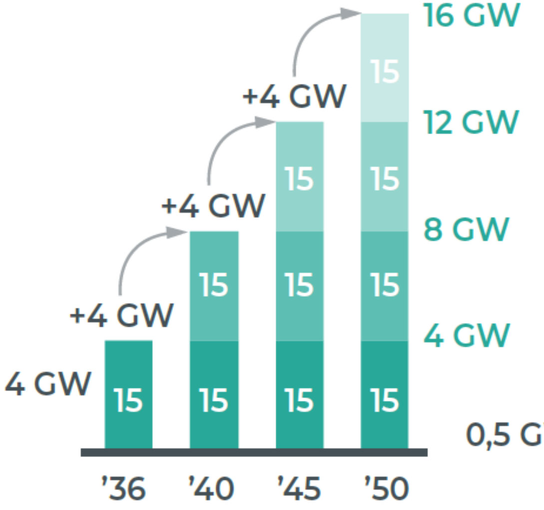
Analysed on ad-hoc basis

Imports

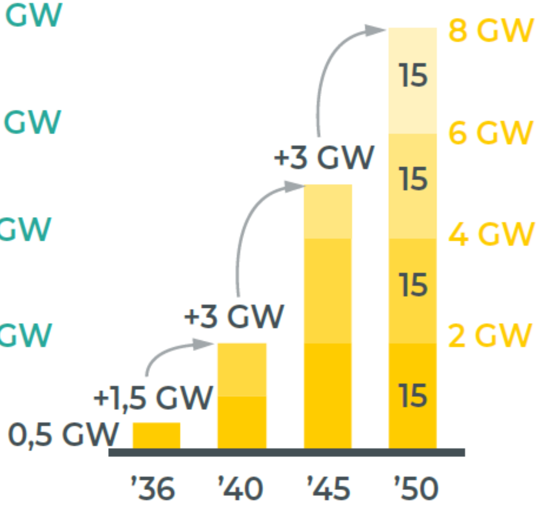
Outcome of other choices



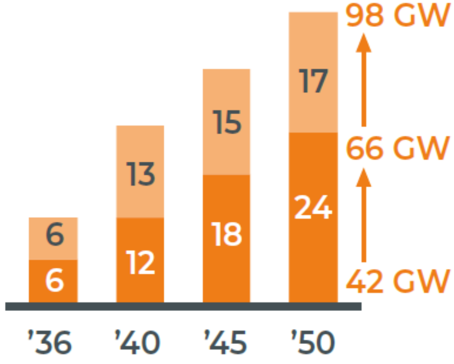
Non-domestic offshore[1]
Build interconnectors & offshore wind



Nuclear
Build new units



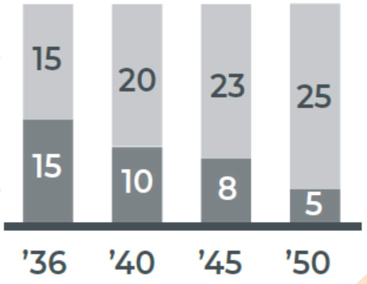
Solar PV[2]
x2-x4 installation rate



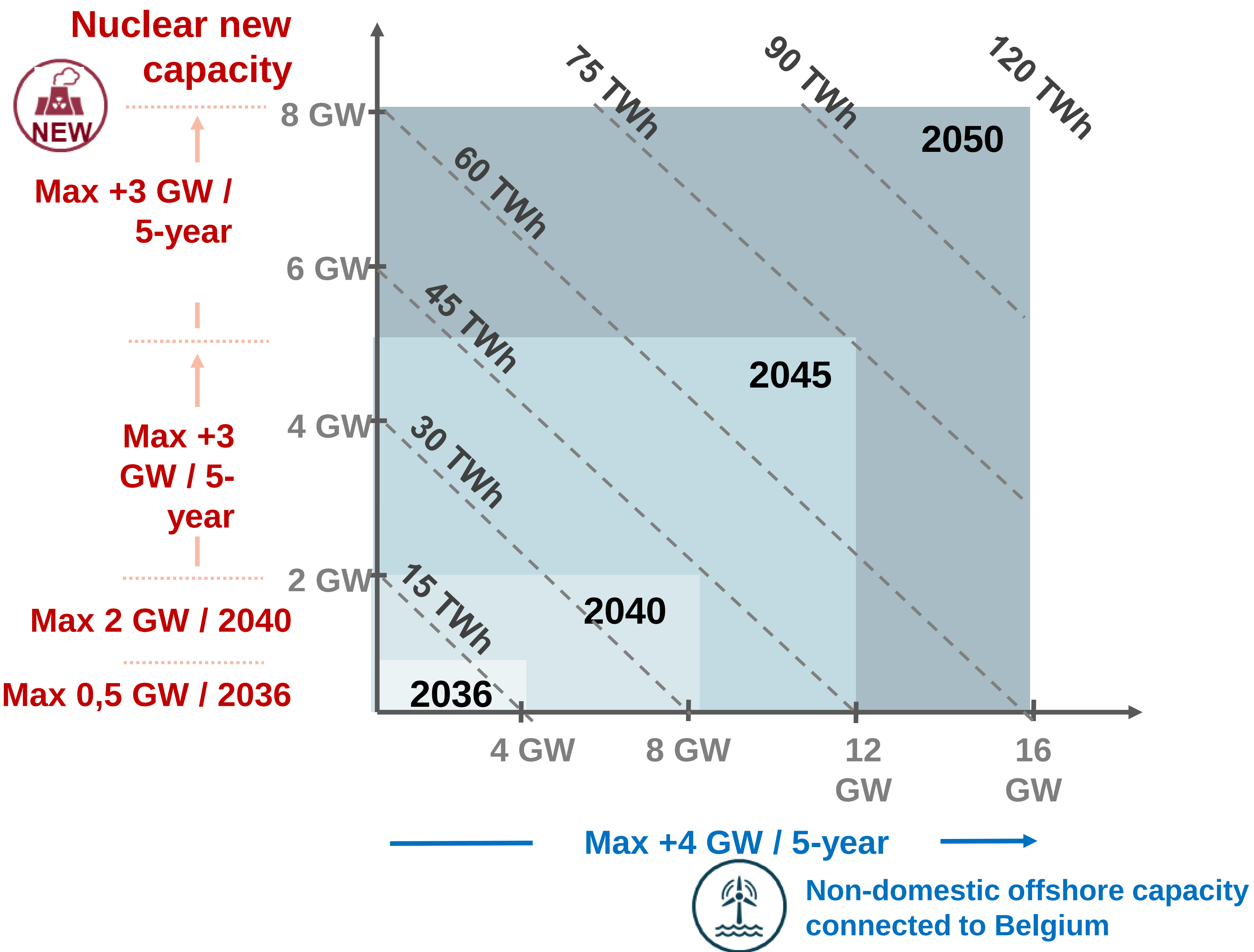
Molecule-fired generation

Outcome of the European dispatch and type of mol-fired generation installed

Range observed in the simulations



The end goal vs. the road to get there: every lever has its specific time constraints



Nuclear new capacity

Max +3 GW / 5-year

Max +3 GW / 5-year

Max 2 GW / 2040

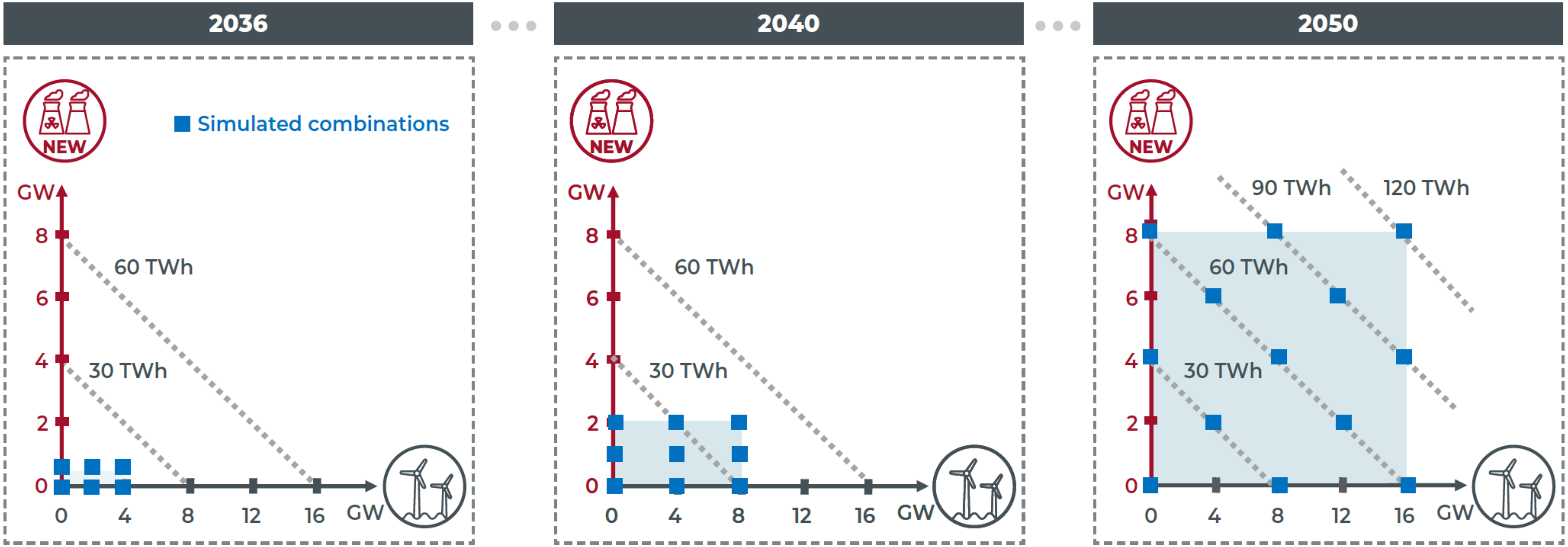
Max 0,5 GW / 2036

Max +4 GW / 5-year

Non-domestic offshore capacity connected to Belgium

Decisions are to be taken at least 10 – 15 years before in service date

Many supply sensitivities were simulated – combination of options



For different scenarios: HRES, HPV, SUFF, EXT., far RES, HEAT

Key costs assumptions to understand the results

- All costs in **EUR2022**. CAPEX expressed in **overnight costs**
- Existing technologies and new installations before 2030 are assumed to be fully depreciated.
- No replacement CAPEX assumed (apart from thermal units)
- A **WACC of 7%** is applied to all generation technologies. 6 % for grid technologies.
- A high WACC of 10% is used a sensitivity and can be applied separately to technologies.

	Reference (2030)	Reference (2050)	High (2050)
EXT	1,000 €/kW	-	-
NEW	-	7,500 €/kW	10,000 €/kW
Residential PV	950 €/kW	500 €/kW	700 €/kW
Onshore wind	1,280 €/kW	1,030 €/kW	1,300 €/kW
Offshore wind (bottom fixed)	2,200 €/kW	1,600 €/kW	2,200 €/kW
Cable-offshore	2 M€/km/GW	2 M€/km/GW	3 M€/km/GW
Convertor-offshore	590 €/kW	590 €/kW	700 €/kW

Belgian findings

A Belgian scenarios/sensitivities definition

B **Belgian results for the electricity system**

1. **Imports/exports** & thermal generation
2. Occurrence of **curtailment**/low marginal costs
3. **Total system costs**
    - Definition and components
    - Impact of demand levers
    - Onshore RES development
    - Large scale carbon-free options
4. **Transition period**
5. **Adequacy & grid requirements**

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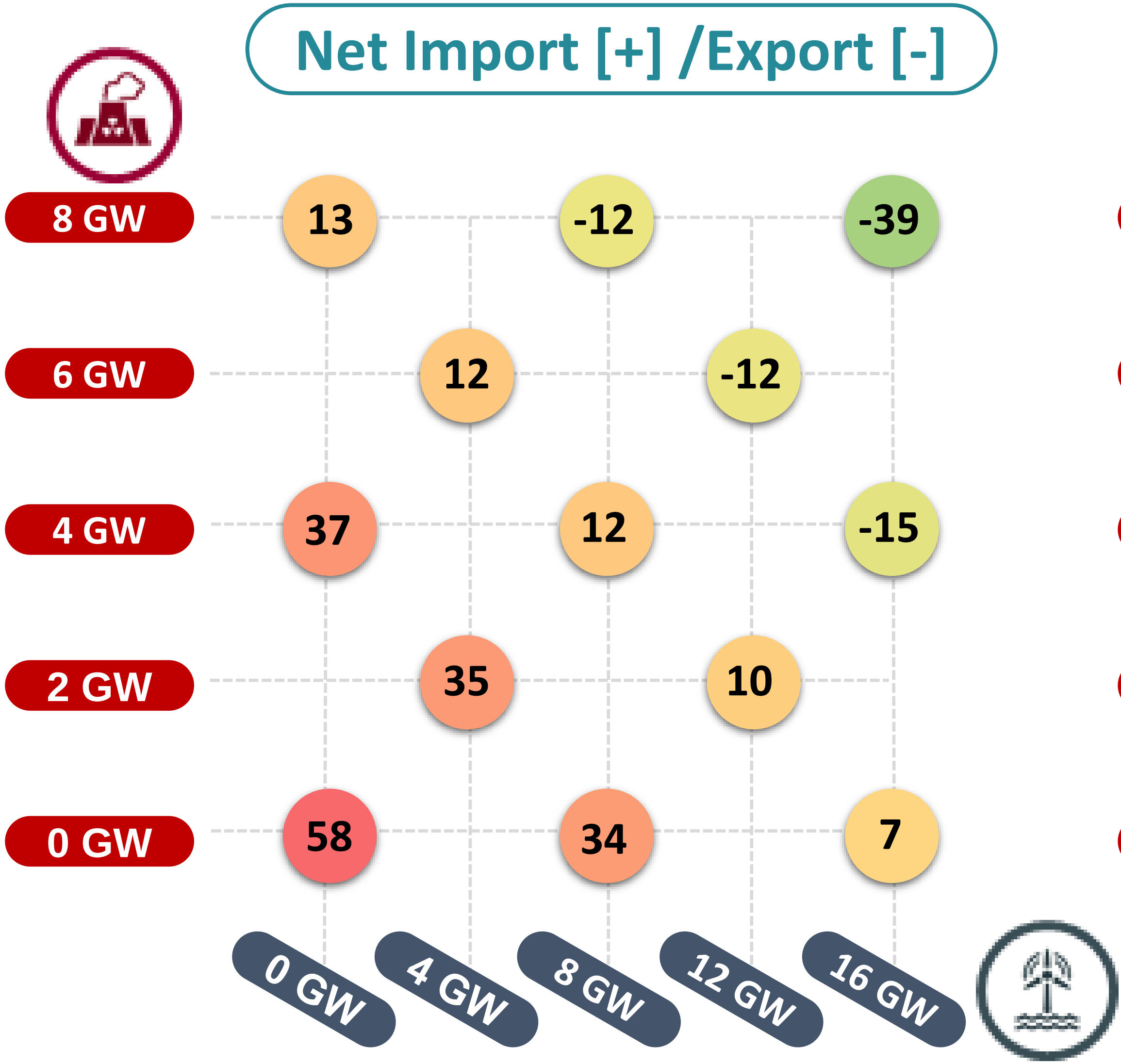
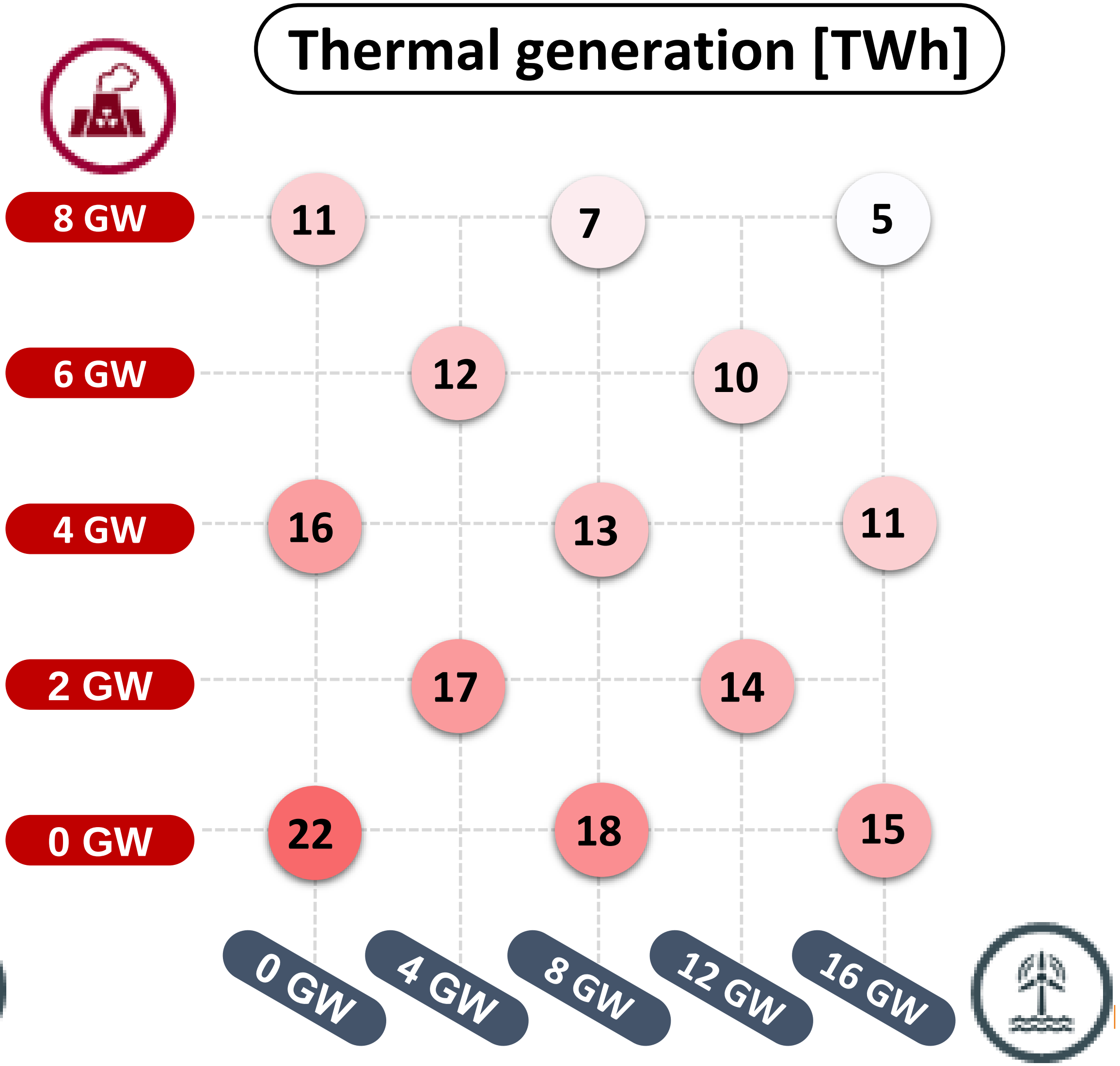
Increasing the amount of RES from central to high impacts imports more than thermal generation (2050)

DE demand + CENTRAL RES



Net Import [+] /Export [-]

	0 GW	4 GW	8 GW	12 GW	16 GW
8 GW	13		-12		-39
6 GW		12		-12	
4 GW	37		12		-15
2 GW		35		10	
0 GW	58		34		7



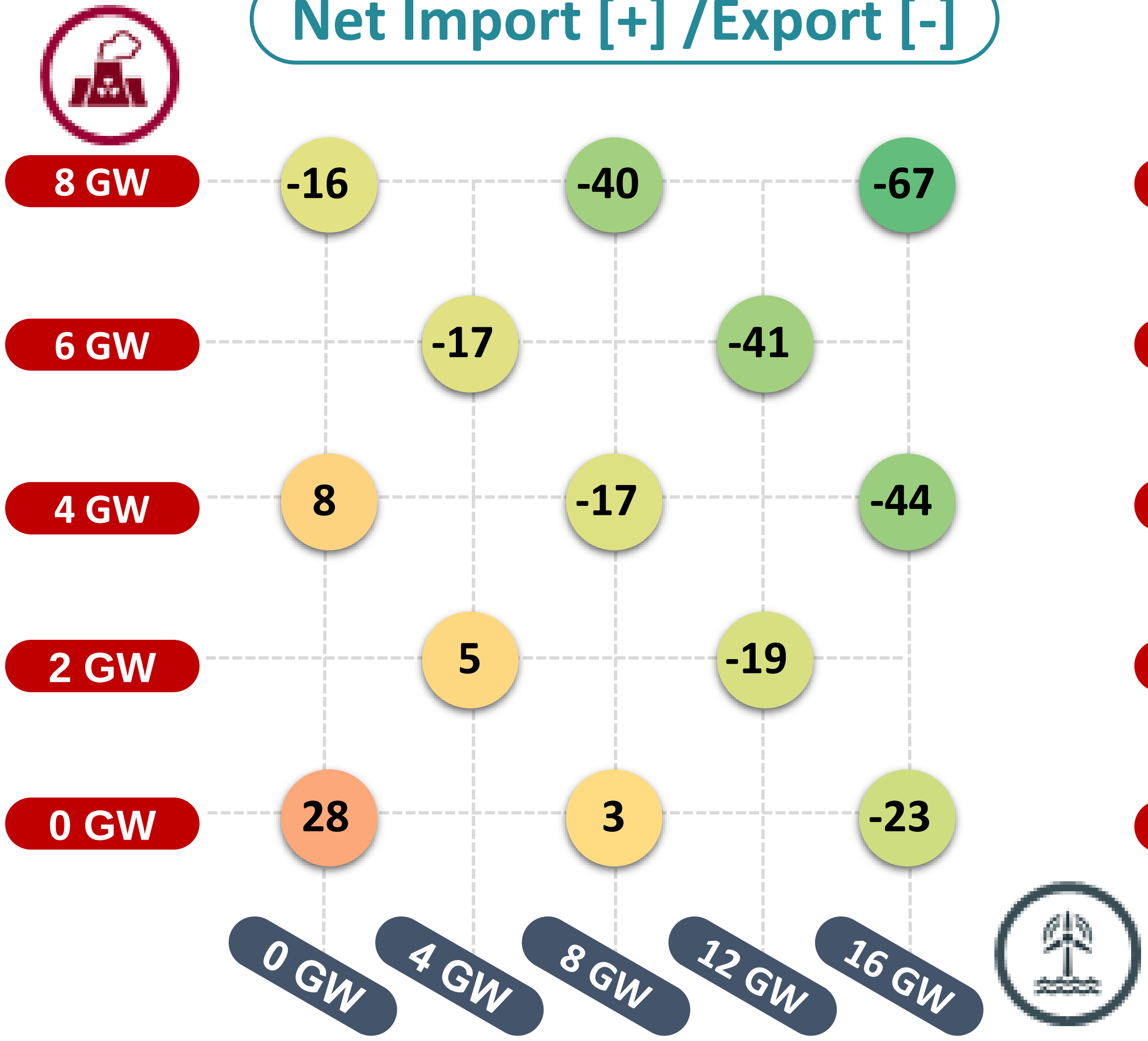
Thermal generation [TWh]

	0 GW	4 GW	8 GW	12 GW	16 GW
8 GW	11		7		5
6 GW		12		10	
4 GW	16		13		11
2 GW		17		14	
0 GW	22		18		15

Increasing the amount of RES from central to high impacts imports more than thermal generation (2050)

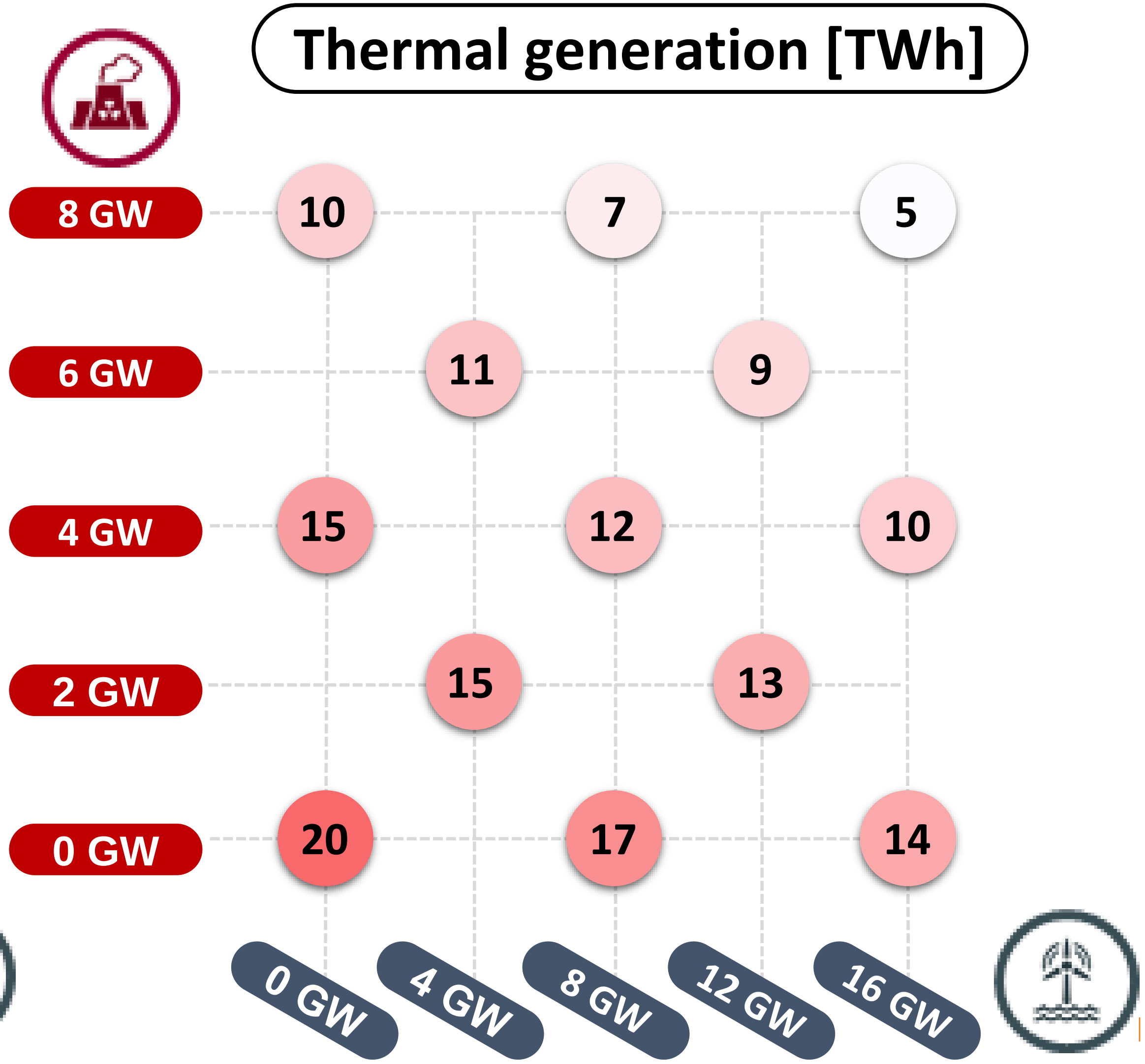
DE demand + HIGH RES

Net Import [+] /Export [-]



	0 GW	4 GW	8 GW	12 GW	16 GW
8 GW	-16		-40		-67
6 GW		-17		-41	
4 GW	8		-17		-44
2 GW		5		-19	
0 GW	28		3		-23

Thermal generation [TWh]



	0 GW	4 GW	8 GW	12 GW	16 GW
8 GW	10		7		5
6 GW		11		9	
4 GW	15		12		10
2 GW		15		13	
0 GW	20		17		14

Belgian findings

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B **Belgian results for the electricity system**

1. **Imports/exports** & thermal generation
2. ▶ Occurrence of **curtailment**/low marginal costs
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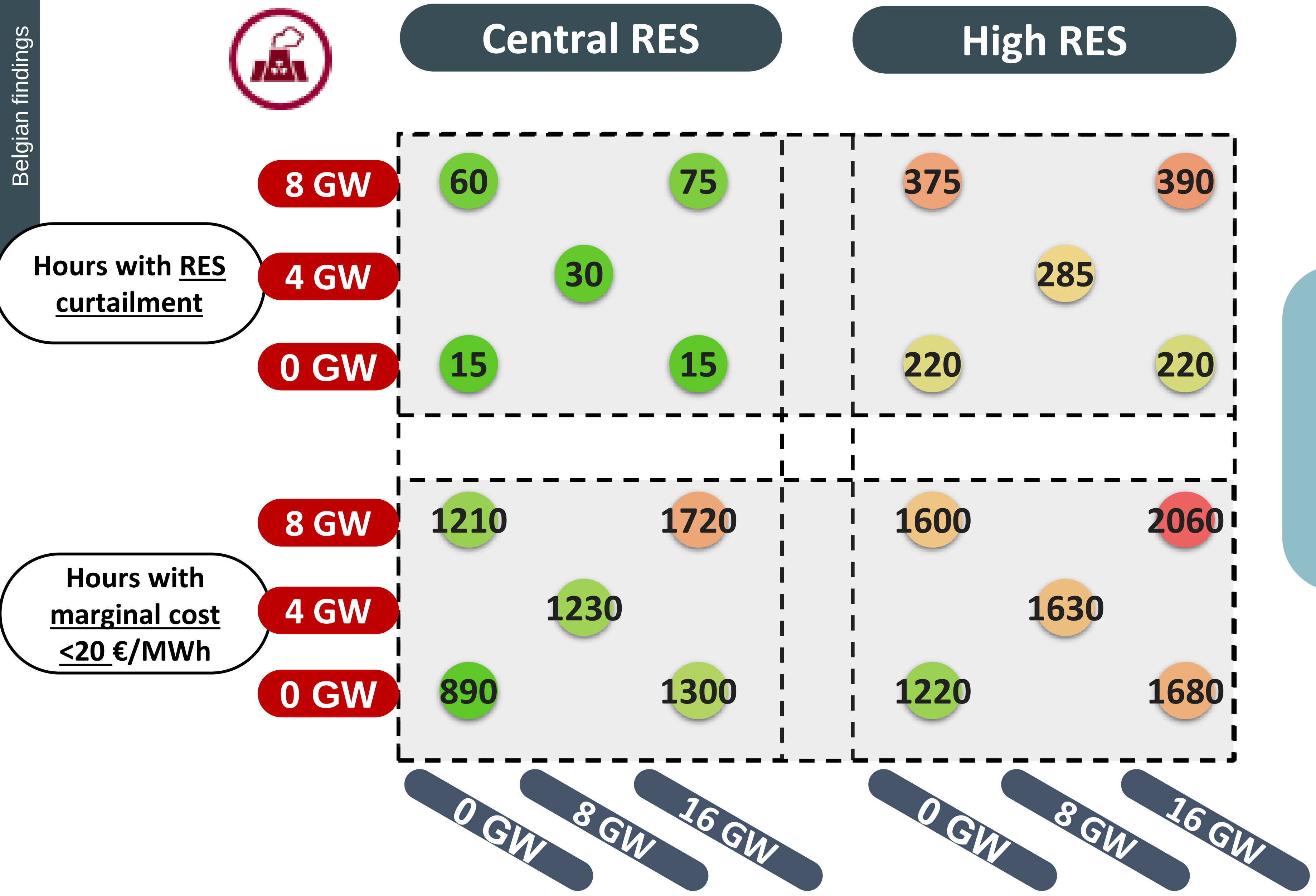
More offshore and nuclear results in more hours with low marginal costs of the system



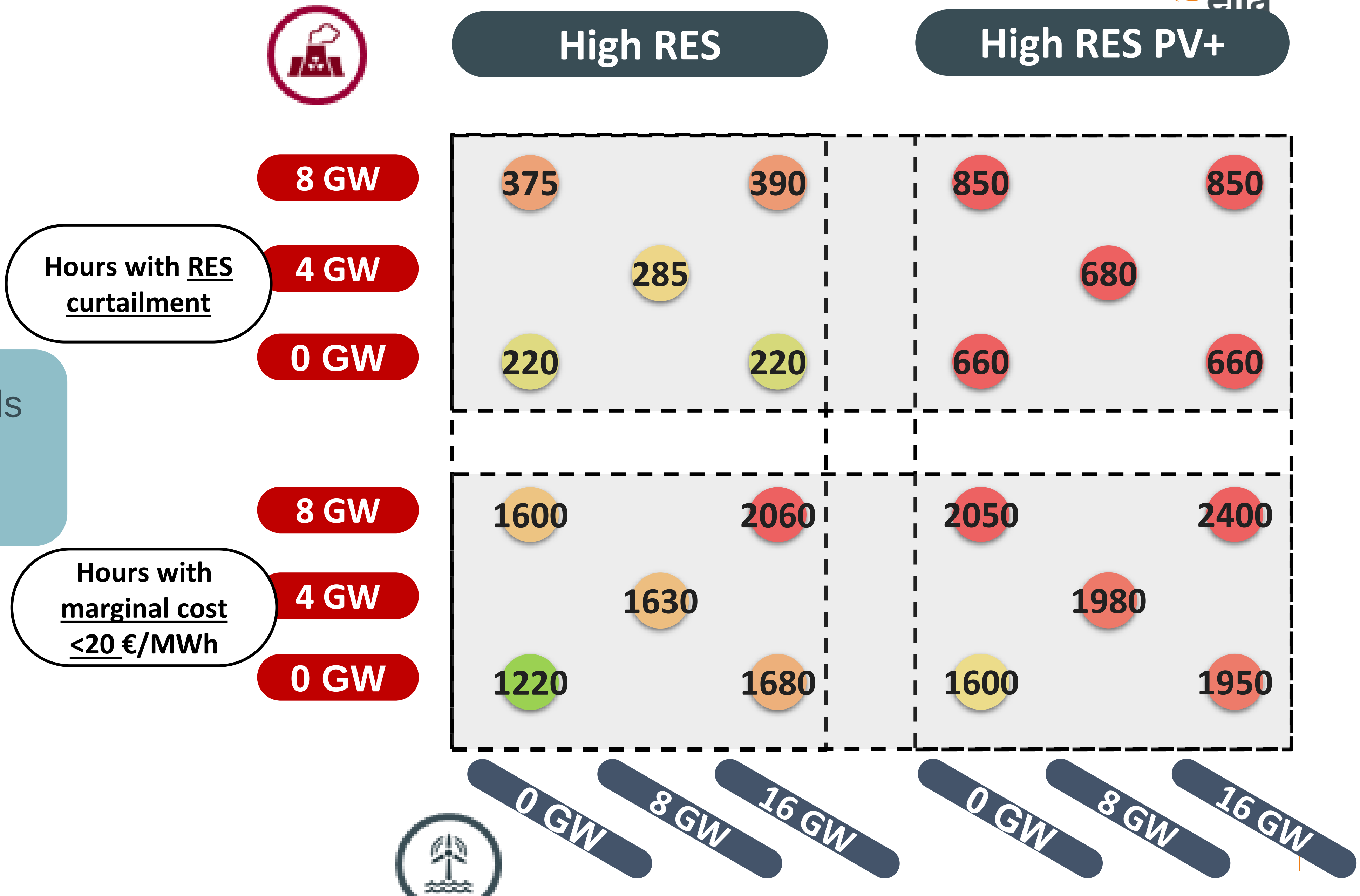
	Central RES			High RES		
	0 GW	8 GW	16 GW	0 GW	8 GW	16 GW
Hours with RES curtailment						
8 GW	60		75	375		390
4 GW		30			285	
0 GW	15		15	220		220
Hours with marginal cost <20 €/MWh						
8 GW	1210		1720	1600		2060
4 GW		1230			1630	
0 GW	890		1300	1220		1680

2050 - DE scenario

More RES results in **more hours with low marginal costs** but also **more hours with RES curtailment**

More RES results in more hours with low marginal costs

The same trend holds for the **high PV sensitivity**



Hours with RES curtailment

	High RES			High RES PV+		
	0 GW	8 GW	16 GW	0 GW	8 GW	16 GW
8 GW	375		390	850		850
4 GW		285			680	
0 GW	220		220	660		660

Hours with marginal cost <20 €/MWh

	High RES			High RES PV+		
	0 GW	8 GW	16 GW	0 GW	8 GW	16 GW
8 GW	1600		2060	2050		2400
4 GW		1630			1980	
0 GW	1220		1680	1600		1950

2050 - DE scenario

Belgian findings

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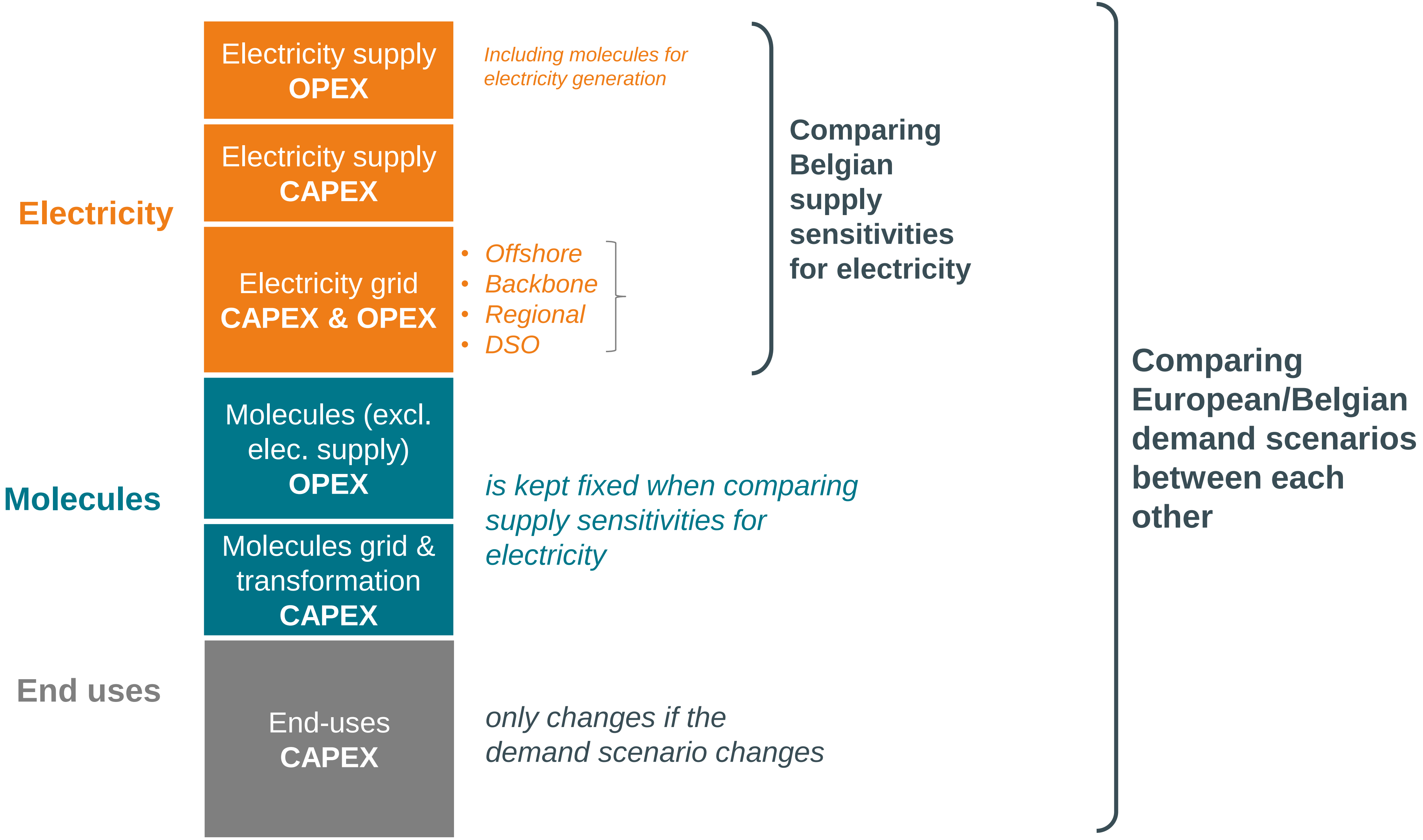
How did we quantify the total system costs?



Electricity

Electricity supply **OPEX**

Including molecules for electricity generation

Electricity supply **CAPEX**

Electricity grid **CAPEX & OPEX**

- *Offshore*
- *Backbone*
- *Regional*
- *DSO*

Molecules

Molecules (excl. elec. supply) **OPEX**

Molecules grid & transformation **CAPEX**

is kept fixed when comparing supply sensitivities for electricity

End uses

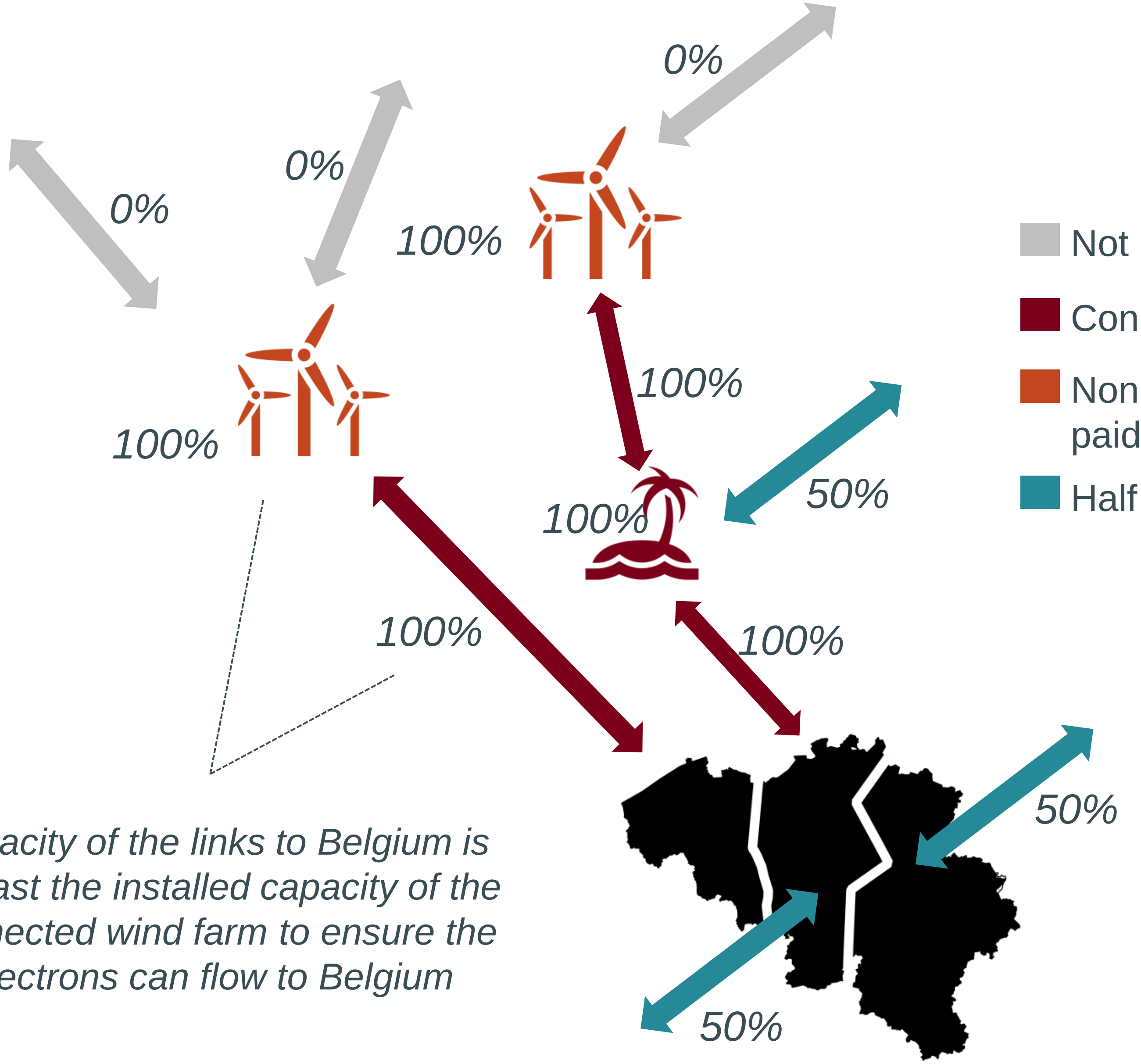
End-uses **CAPEX**

only changes if the demand scenario changes

Comparing Belgian supply sensitivities for electricity

Comparing European/Belgian demand scenarios between each other

How did we quantify the total system costs?



⬜ Not considered

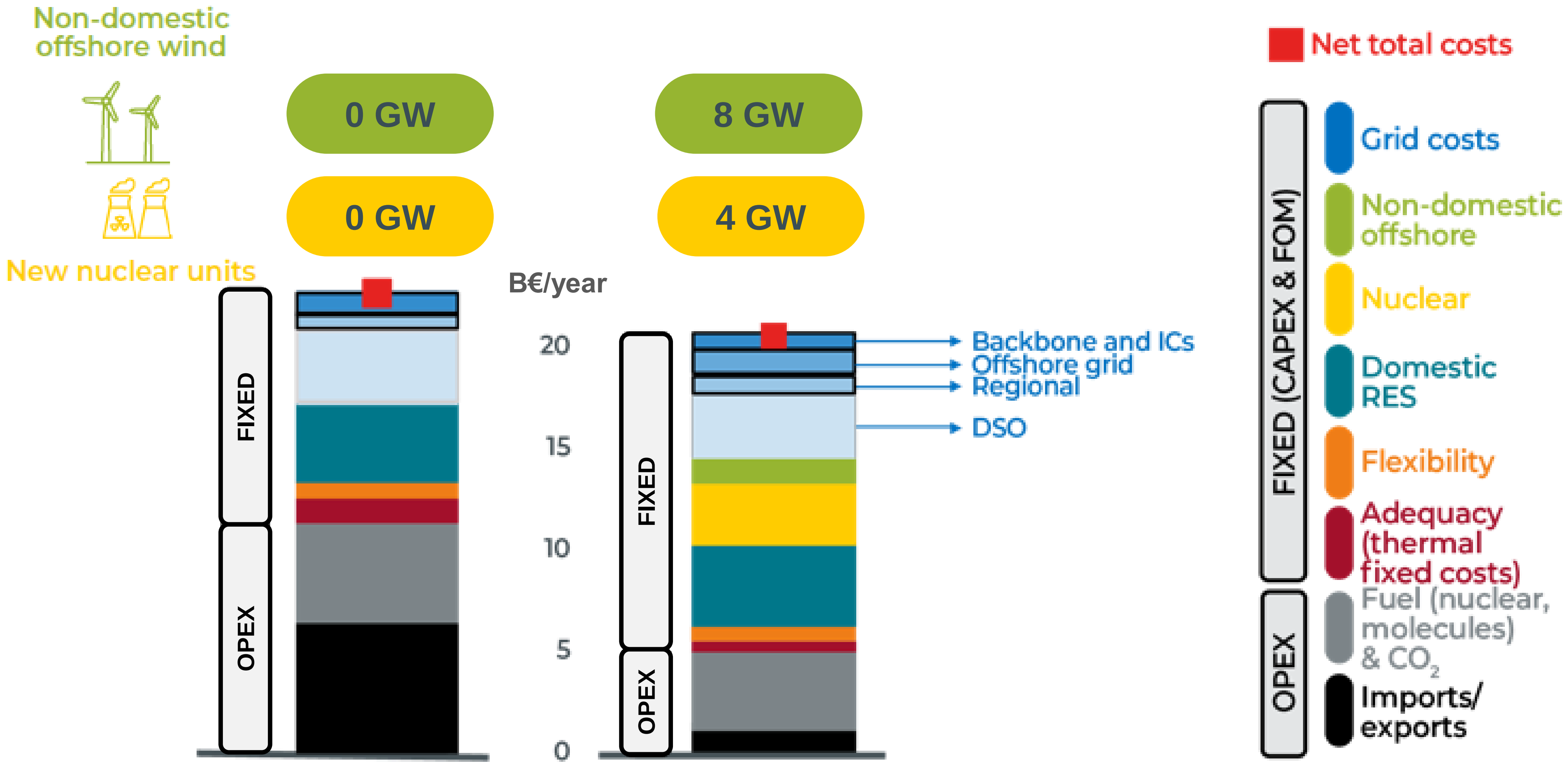
🟥 Connection fully paid by Belgium

🟧 Non-domestic offshore wind capacity reported and paid by Belgium

🟦 Half of the connection paid by Belgium

Capacity of the links to Belgium is at least the installed capacity of the connected wind farm to ensure the electrons can flow to Belgium

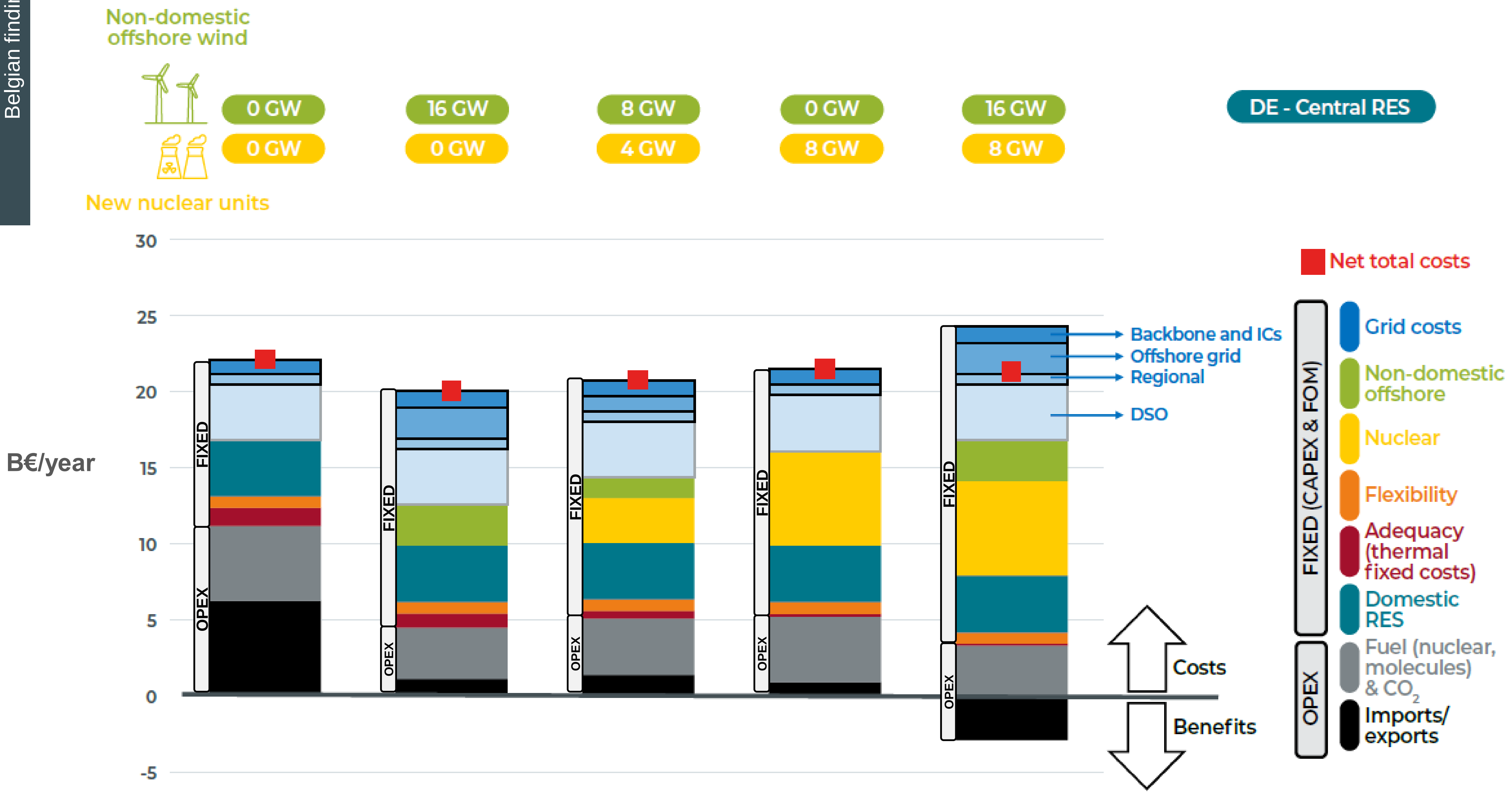
The different choices for the electricity mix lead to different proportions of costs and financing aspects



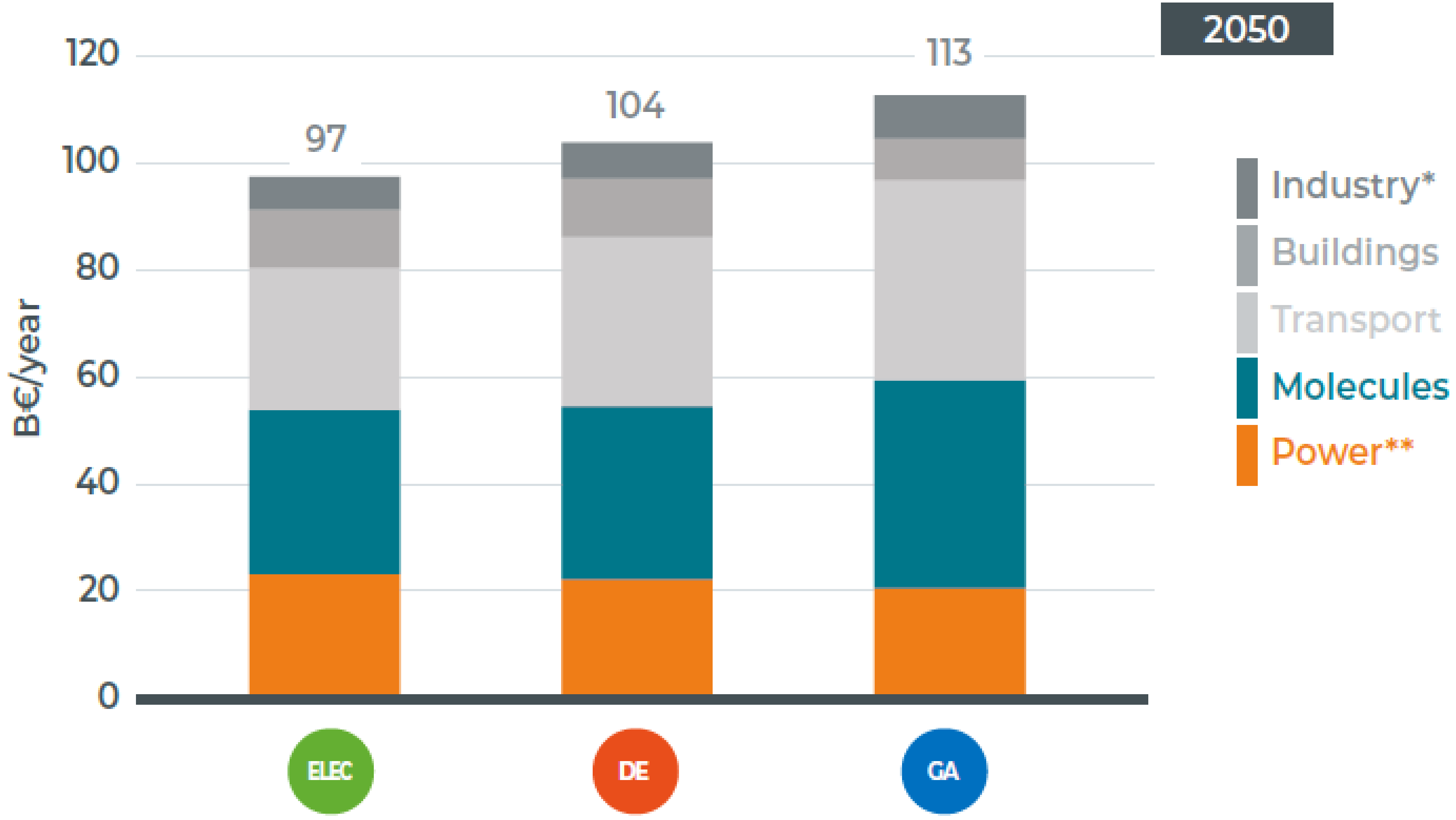
DE2050, central RES

annuities of investments as of 2030

The different choices for the electricity mix lead to different proportions of costs and financing aspects



Total system costs for Belgium – putting them in perspective



End-uses

~half of the costs or more

Results for the 'Current Policies' electricity supply scenario (no new nuclear, non-domestic offshore connected to BE and central onshore RES trajectory)

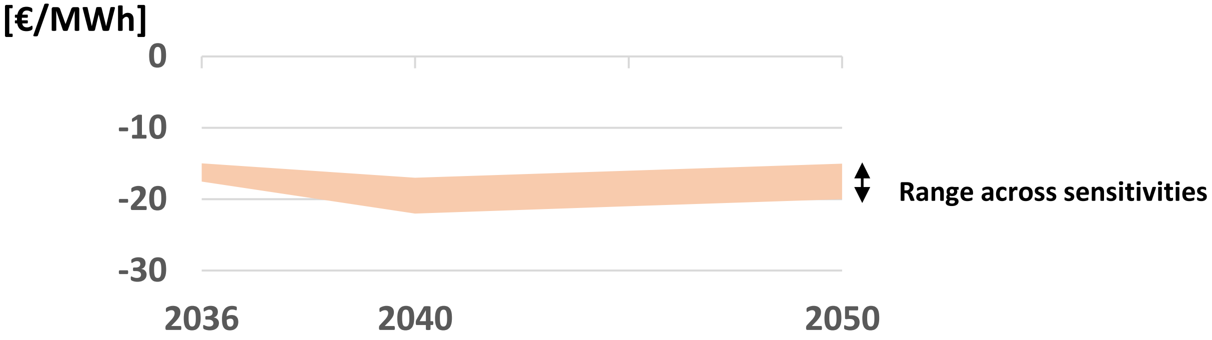
** Includes the cost for carbon capture*

*** Includes the cost of methane and H2 used for power generation (excluded in molecules)*

Sufficiency could have a positive impact on several key indicators

Impact of additional sufficiency measures (max potential identified) compared to the DE scenario

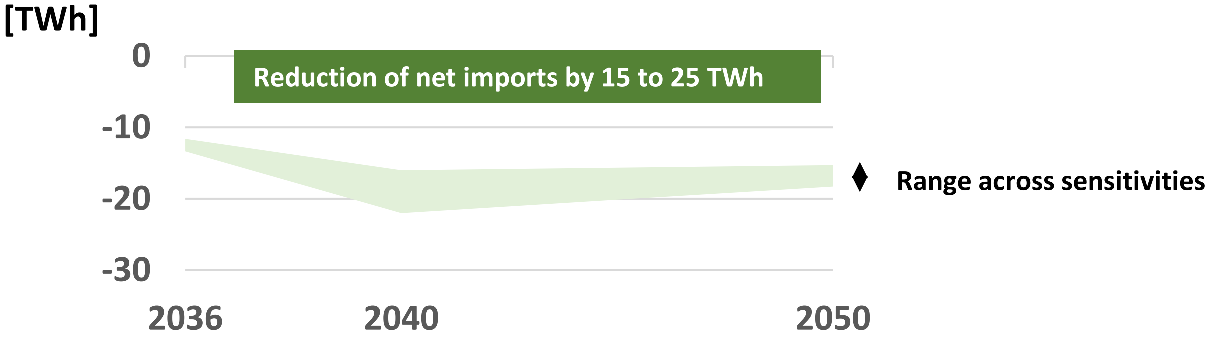
Impact on costs of the electricity system in [EUR/MWh]



Reduction of system costs between 15 - 20 €/MWh

⚠ Costs of sufficiency measures not accounted for

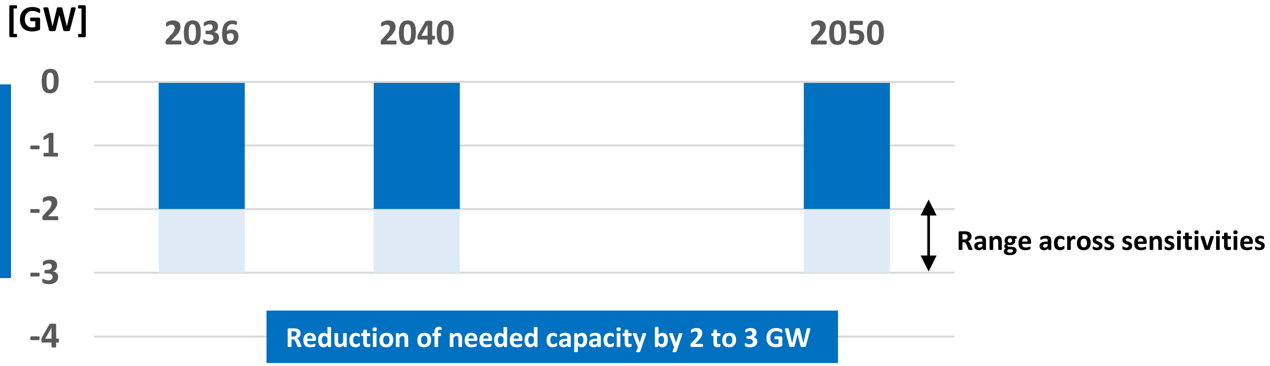
Impact on net electricity imports in [TWh]



Reduction of net imports by 15 to 25 TWh

Reduction of net imports by 15 to 25 TWh

Impact on needed capacity for adequacy in [GW]

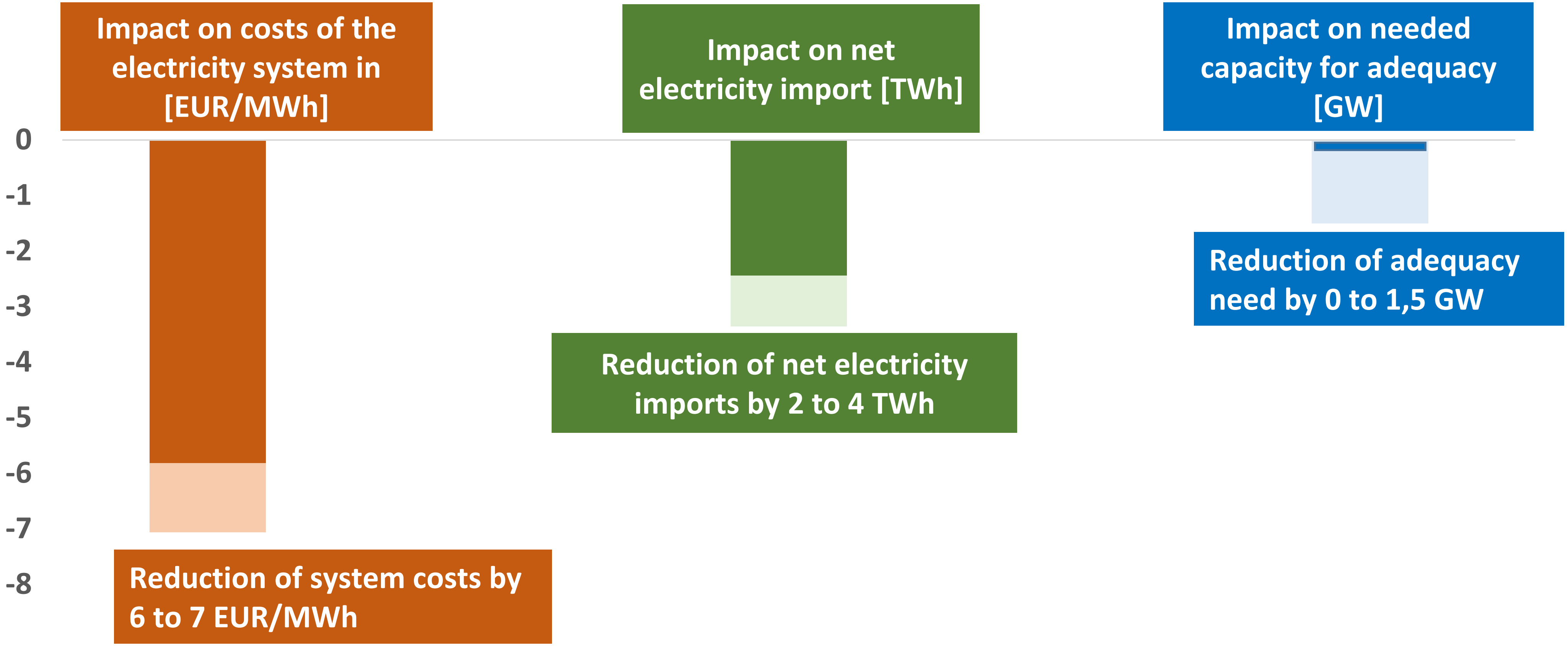


Reduction of needed capacity by 2 to 3 GW

Reduction of needed capacity by 2 to 3 GW

Additional district heating could have a positive impact on several key indicators

Impact of additional district heating on the electricity system costs for 2050

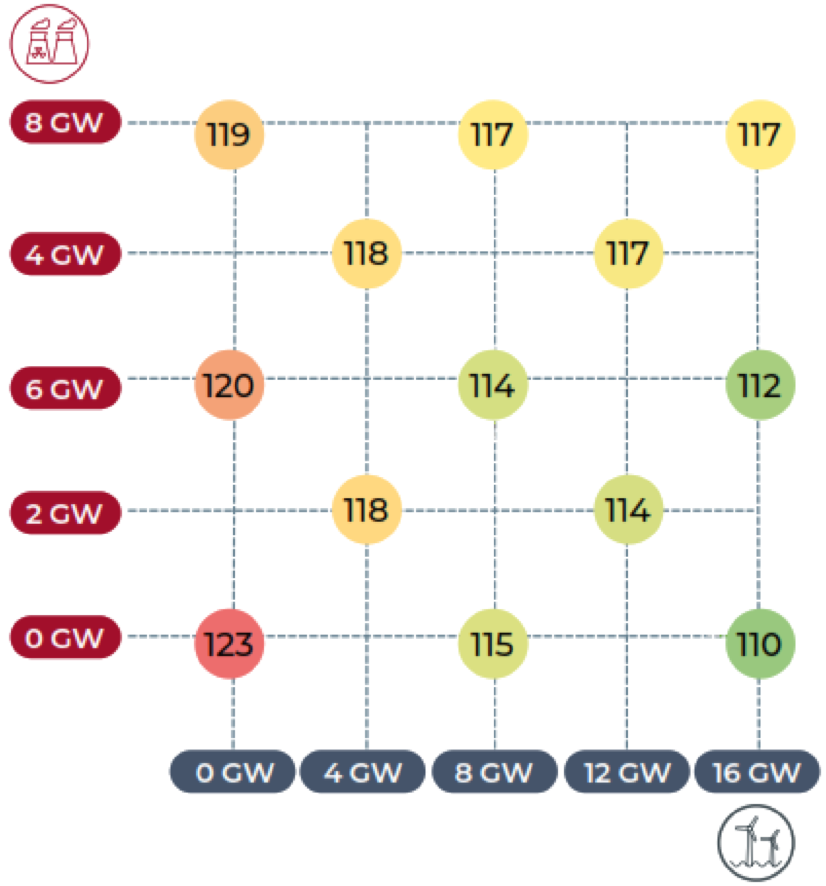


Costs of heating networks not accounted for

From 3.5 TWh district heating to 15 TWh in 2050

Maximising domestic renewables is a cost-optimal solution

CENTRAL RES



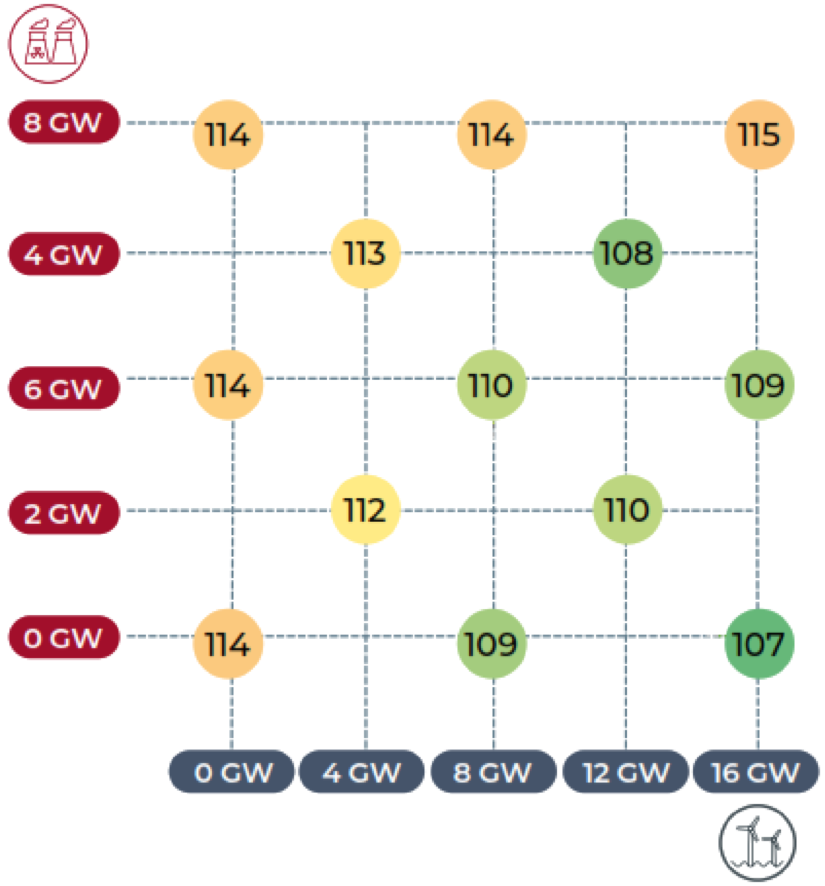
	0 GW	4 GW	8 GW	12 GW	16 GW
8 GW	119		117		117
4 GW		118		117	
6 GW	120		114		112
2 GW		118		114	
0 GW	123		115		110

-9 to **-2**€/MWh

Onshore wind
x2 installation rate

Solar PV
x2 installation rate

HIGH RES



	0 GW	4 GW	8 GW	12 GW	16 GW
8 GW	114		114		115
4 GW		113		108	
6 GW	114		110		109
2 GW		112		110	
0 GW	114		109		107

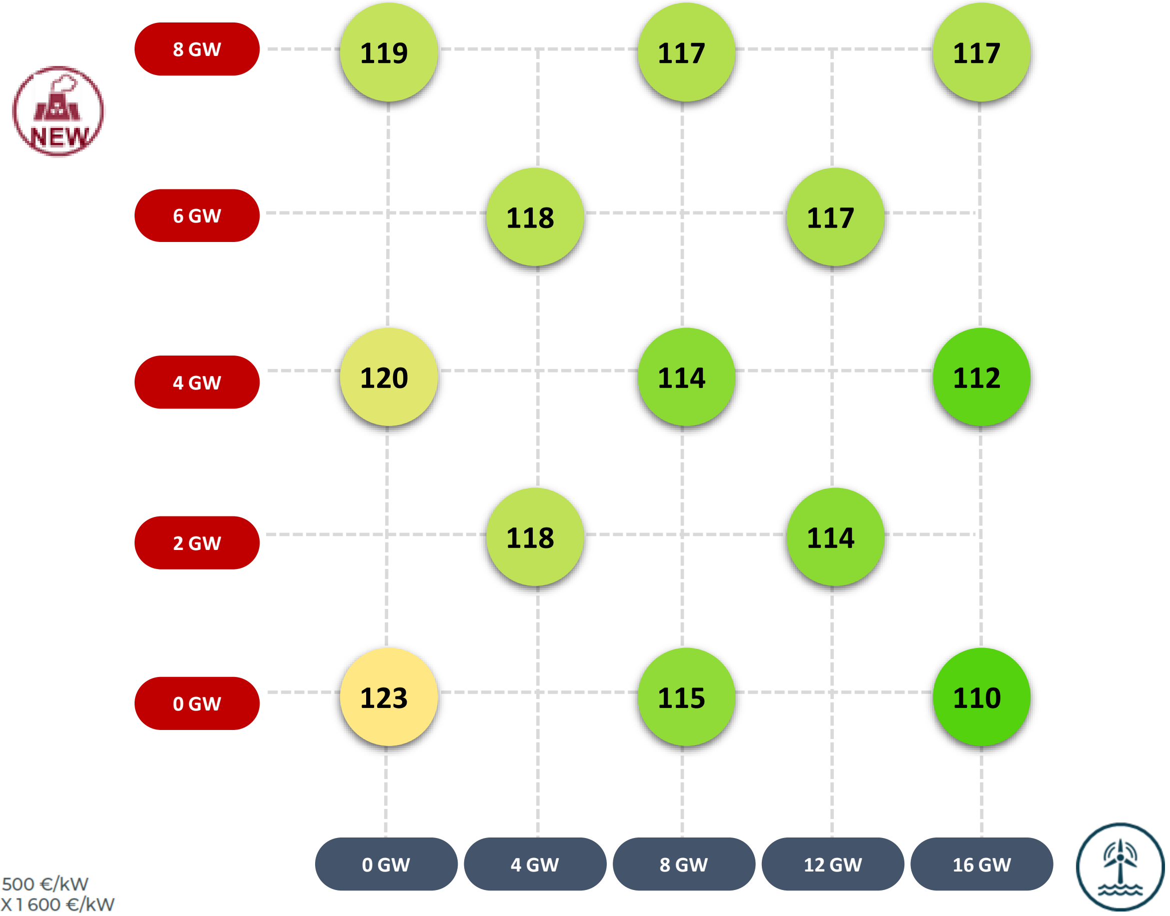
Reference overnight CAPEX and WACC 7% for all supply technologies for 2050
- *7,500 EUR/kW for new nuclear*
- *1,600 EUR/kW for offshore (without grid: accounted separately)*

With respect to offshore wind in the Belgian EEZ, a capacity of 8 GW by 2050 is cost-efficient and considered in all simulated scenarios

Without a clear policy regarding electricity supply towards 2050, Belgium will likely end up in the most costly scenario.

Reference | High nuclear costs & risks | High HVDC & offshore costs

Total system electricity costs for Belgium in 2050 [€/MWh]



Nuclear WACC 7%; overnight CAPEX 7 500 €/kW
Offshore wind WACC 7%; overnight CAPEX 1 600 €/kW
Reference grid costs

- Without a clear policy regarding electricity supply towards 2050, Belgium will likely end up in the most costly scenario.
- As a large-scale energy source, nondomestic offshore wind appears to be more cost effective than the development of new nuclear generation.

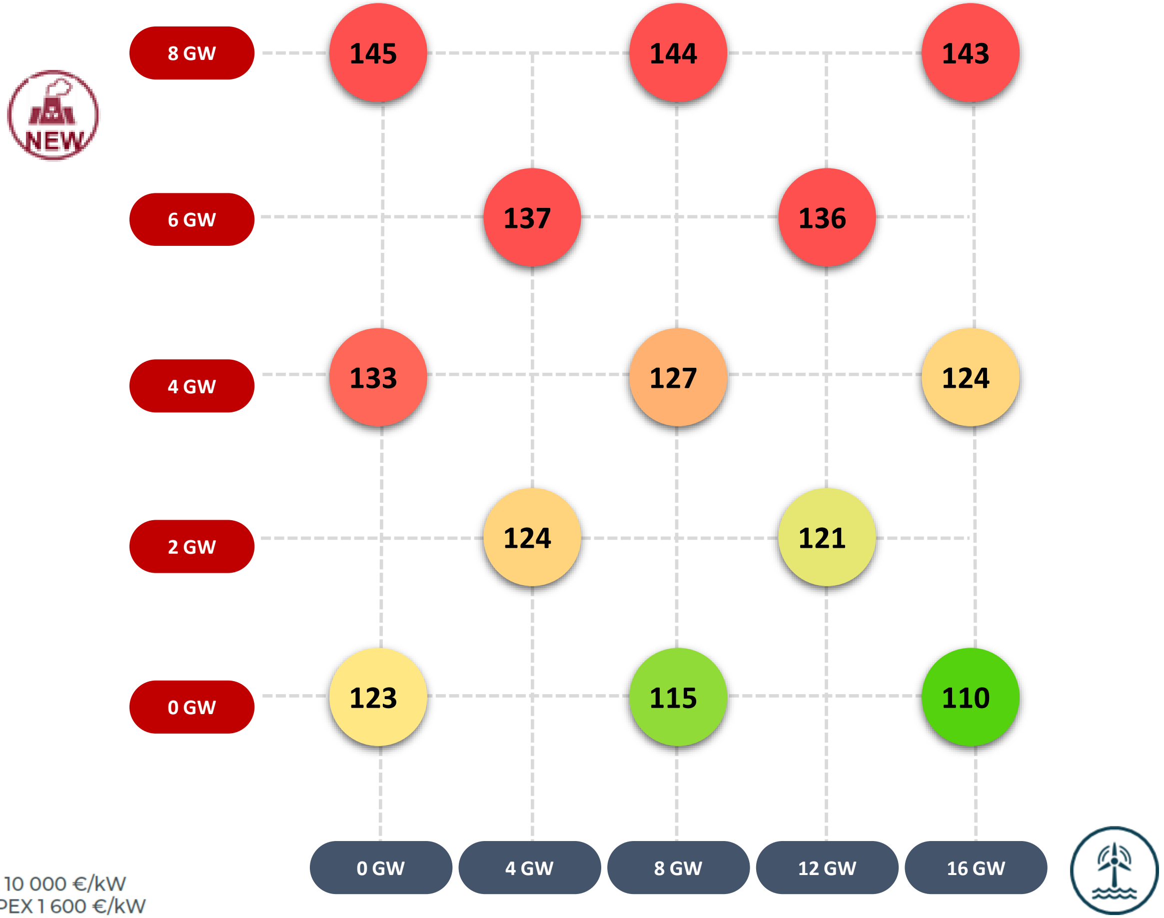
Without a clear policy regarding electricity supply towards 2050, Belgium will likely end up in the most costly scenario.

Reference

High nuclear costs & risks

High HVDC & offshore costs

Total system electricity costs for Belgium in 2050 [€/MWh]



8 GW	145		144		143
6 GW		137		136	
4 GW	133		127		124
2 GW		124		121	
0 GW	123		115		110
	0 GW	4 GW	8 GW	12 GW	16 GW

- While new nuclear plants are a viable solution, this option carries its own challenges related to areas including safety, complexity, and financing.
- Costs and risk premiums are crucial factors to consider as illustrated on the figure.

Nuclear WACC 10%; overnight CAPEX 10 000 €/kW
Offshore wind WACC 7%; overnight CAPEX 1 600 €/kW
Reference grid costs

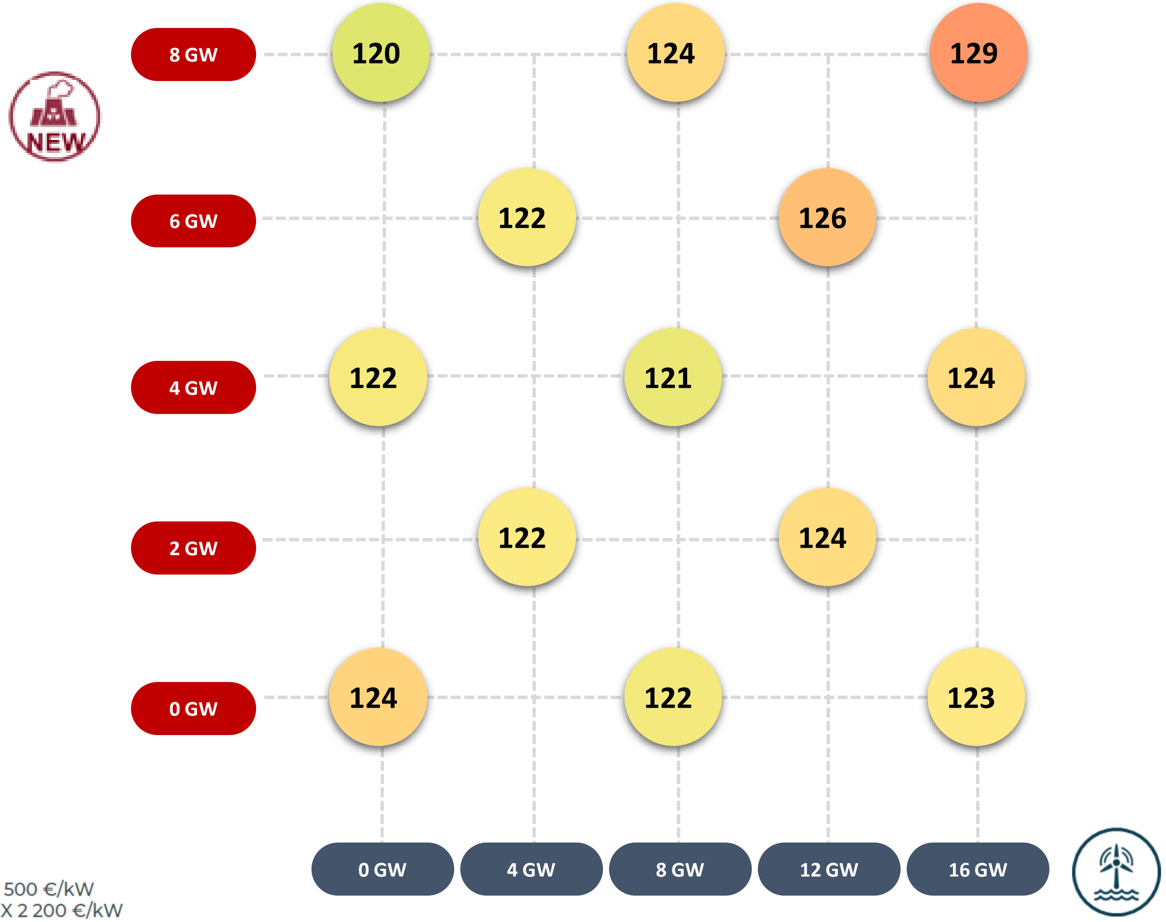
Without a clear policy regarding electricity supply towards 2050, Belgium will likely end up in the most costly scenario.

Reference

High nuclear costs & risks

High HVDC & offshore costs

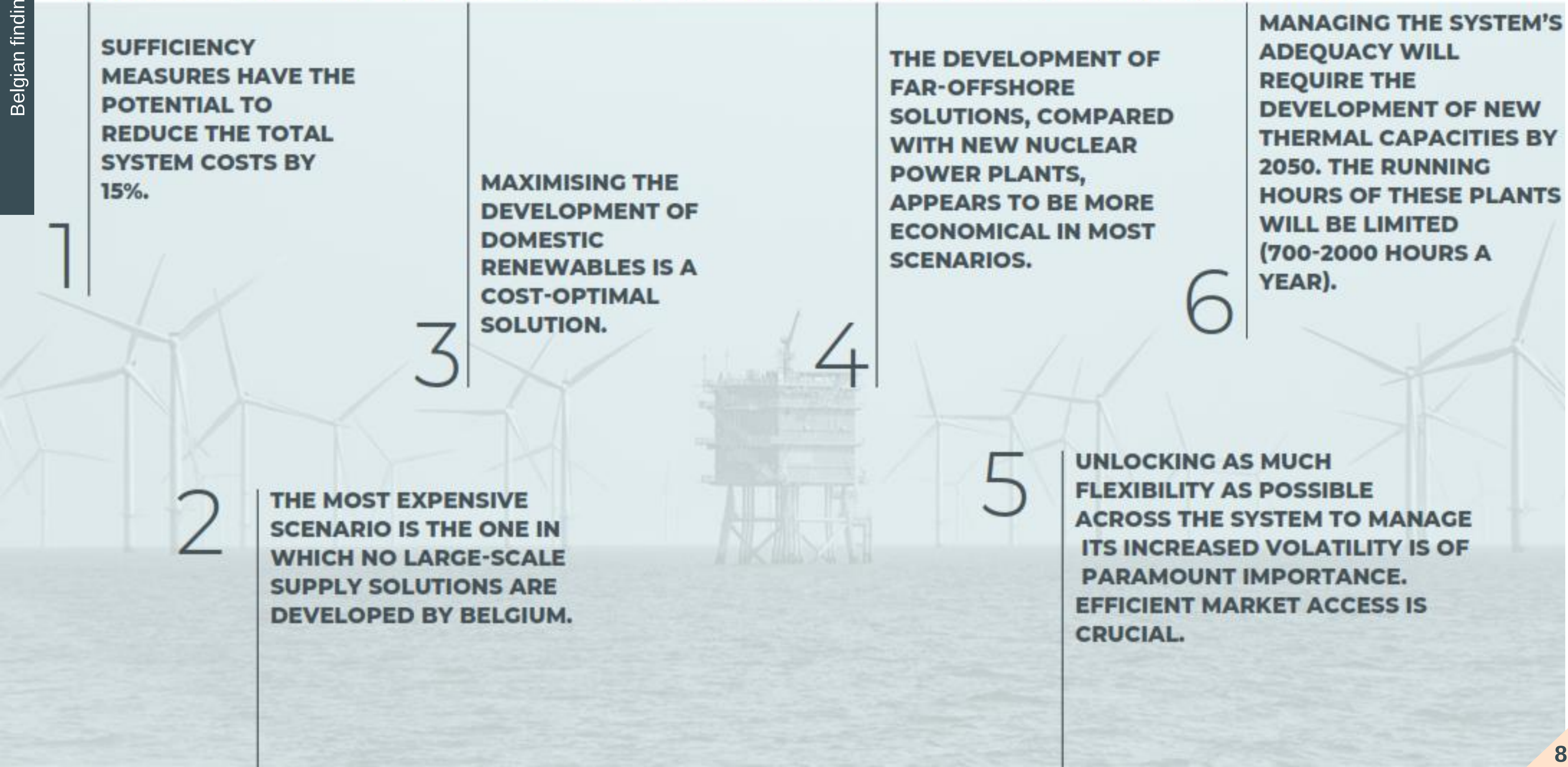
Total system electricity costs for Belgium in 2050 [€/MWh]



Nuclear WACC 7%; overnight CAPEX 7 500 €/kW
Offshore wind WACC 7%; overnight CAPEX 2 200 €/kW
High grid costs

- As a large-scale energy source, nondomestic offshore wind appears to be more cost effective than the development of new nuclear generation.
- Nonetheless, the scaling up of offshore development requires significant efforts.

POLICYMAKERS CAN USE THE FOLLOWING KEY INSIGHTS WHEN TAKING DECISIONS RELATED TO BELGIUM'S 2050 ENERGY MIX



1

SUFFICIENCY MEASURES HAVE THE POTENTIAL TO REDUCE THE TOTAL SYSTEM COSTS BY 15%.

2

THE MOST EXPENSIVE SCENARIO IS THE ONE IN WHICH NO LARGE-SCALE SUPPLY SOLUTIONS ARE DEVELOPED BY BELGIUM.

3

MAXIMISING THE DEVELOPMENT OF DOMESTIC RENEWABLES IS A COST-OPTIMAL SOLUTION.

4

THE DEVELOPMENT OF FAR-OFFSHORE SOLUTIONS, COMPARED WITH NEW NUCLEAR POWER PLANTS, APPEARS TO BE MORE ECONOMICAL IN MOST SCENARIOS.

5

UNLOCKING AS MUCH FLEXIBILITY AS POSSIBLE ACROSS THE SYSTEM TO MANAGE ITS INCREASED VOLATILITY IS OF PARAMOUNT IMPORTANCE. EFFICIENT MARKET ACCESS IS CRUCIAL.

6

MANAGING THE SYSTEM'S ADEQUACY WILL REQUIRE THE DEVELOPMENT OF NEW THERMAL CAPACITIES BY 2050. THE RUNNING HOURS OF THESE PLANTS WILL BE LIMITED (700-2000 HOURS A YEAR).

Belgian findings

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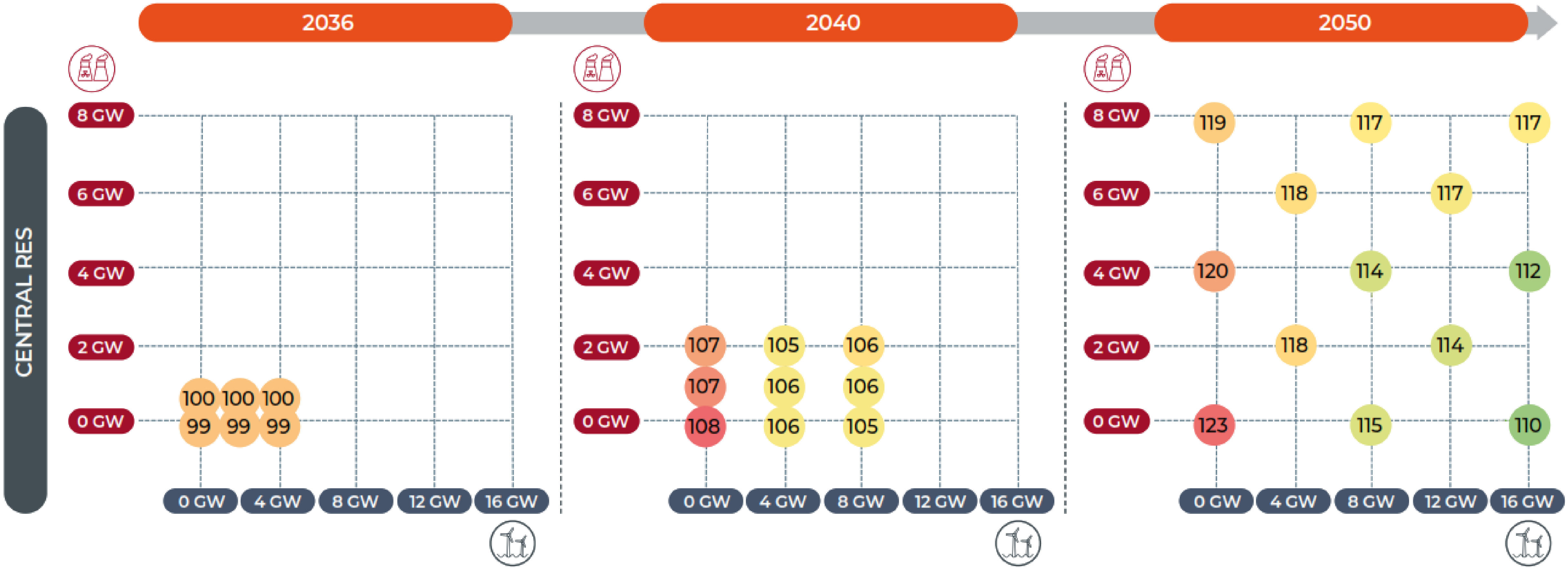
Belgian findings

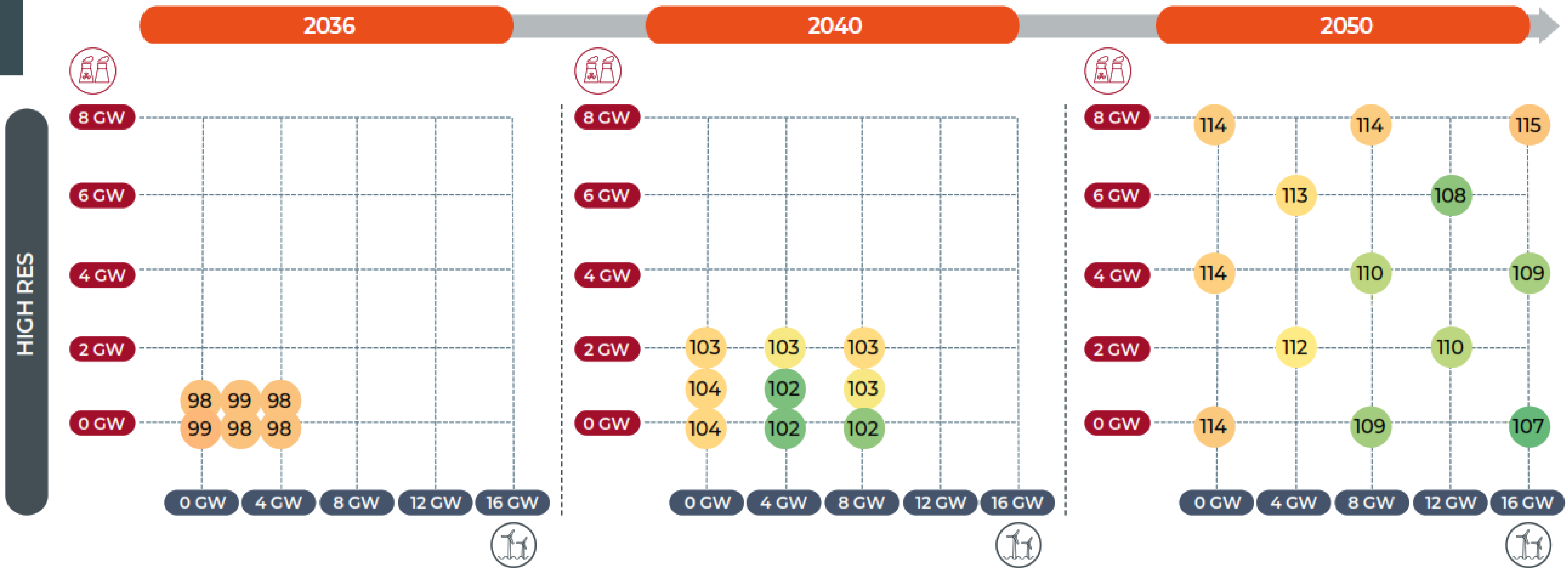
While the spreads are more limited, it is crucial to consider the transition period

TOTAL ELECTRICITY SYSTEM COSTS FOR BELGIUM FOR THE DE SCENARIO IN in €/MWH



The HIGH RES scenario shows lower electricity system costs for all studied scenarios

TOTAL ELECTRICITY SYSTEM COSTS FOR BELGIUM FOR THE DE SCENARIO IN in €/MWH



Belgian findings

Prolonging existing nuclear appears to be interesting from a system cost point of view

elia
| Elia Group

IMPACT OF EXTENDING EXISTING NUCLEAR ON TOTAL ELECTRICITY SYSTEM COSTS FOR BELGIUM FOR THE DE SCENARIO IN €/MWH

2036

Total electricity system costs [€/MWh]

	1000 EUR/kW - 7%		1200 EUR/kW - 10%	
Extension of	0 GW	4 GW	0 GW	4 GW
4 GW	-4 to -7		-2 to -5	
3 GW	-4 to -7		-2 to -5	
2 GW	-3 to -5		-2 to -4	
0 GW	99	98	99	98

Impact when extending

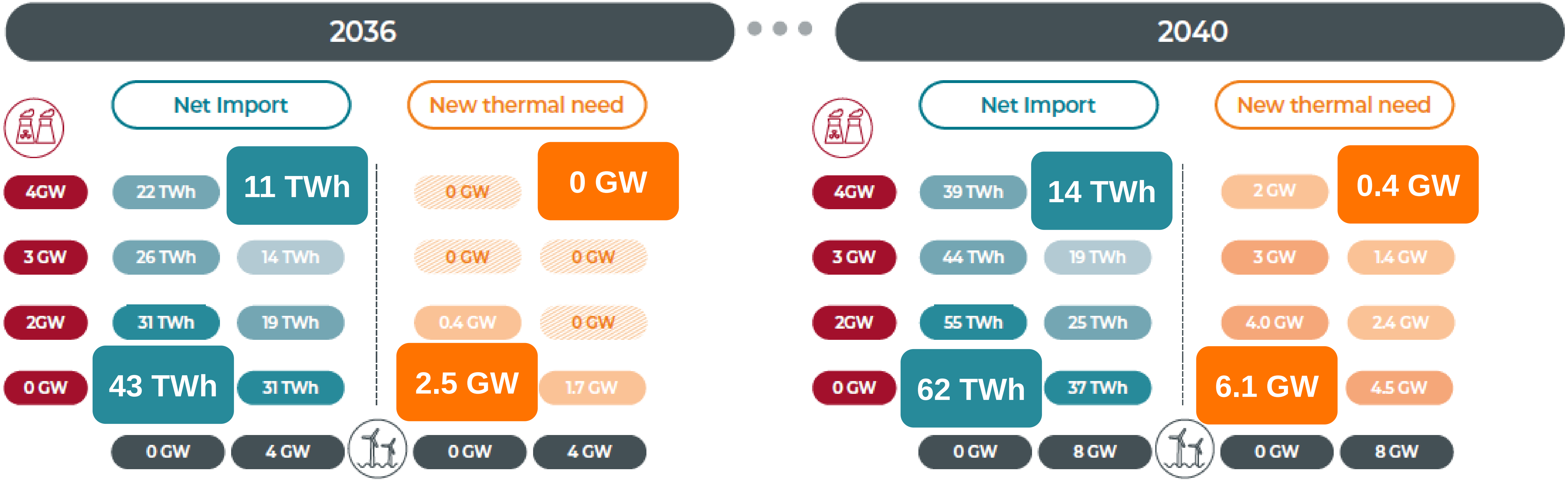
2040

Total electricity system costs [€/MWh]

	1000 EUR/kW - 7%		1200 EUR/kW - 10%	
Extension of	0 GW	4 GW	0 GW	4 GW
4 GW	-11 to -14		-9 to -12	
3 GW	-8 to -11		-7 to -10	
2 GW	-6 to -8		-5 to -7	
0 GW	108	105	108	105

The need for imports and new thermal capacity in the intermediate period depends strongly on the chosen electricity mix

IMPACT OF EXTENDING EXISTING NUCLEAR ON NET IMPORTS AND NEW THERMAL NEED



2036

	Net Import		New thermal need	
4GW	22 TWh	**11 TWh**	0 GW	**0 GW**
3 GW	26 TWh	14 TWh	0 GW	0 GW
2GW	31 TWh	19 TWh	0.4 GW	0 GW
0 GW	**43 TWh**	31 TWh	**2.5 GW**	1.7 GW
	0 GW	4 GW	0 GW	4 GW

2040

	Net Import		New thermal need	
4GW	39 TWh	**14 TWh**	2 GW	**0.4 GW**
3 GW	44 TWh	19 TWh	3 GW	1.4 GW
2GW	55 TWh	25 TWh	4.0 GW	2.4 GW
0 GW	**62 TWh**	37 TWh	**6.1 GW**	4.5 GW
	0 GW	8 GW	0 GW	8 GW

Alongside long-term preparations, managing the transition period will require attention.

ONGOING

Implementing current policies

Capacity Remuneration Mechanism (Y-4 & Y-1)

Prolongation with 10 years of the lifetime of Tihange 3 and Doel 4 nuclear units and implementation of CRM's auctions results

Extending offshore wind in the Belgian EEZ towards 5.8 GW through the Princess Elisabeth Island

Further developing the transmission grid and interconnectors, and a first non-domestic offshore wind hybrid interconnection

CONTRIBUTION IN THE SHORT TERM

Additional domestic RES and sufficiency

- Speed up domestic RES deployment & ensure efficient integration into the power system
- Consumption moderation (sufficiency)

Prolonging the life-span of existing generation

- both thermal backup generation and further extending the operational life of the nuclear fleet beyond 2035*

More imports

- An increased reliance on foreign supplies could contribute to a (transitory) solution

**Subject to technical, safety and regulatory constraints*

!! The short-term actions should not reduce the urgency to also initiate long-term preparations

Belgian findings

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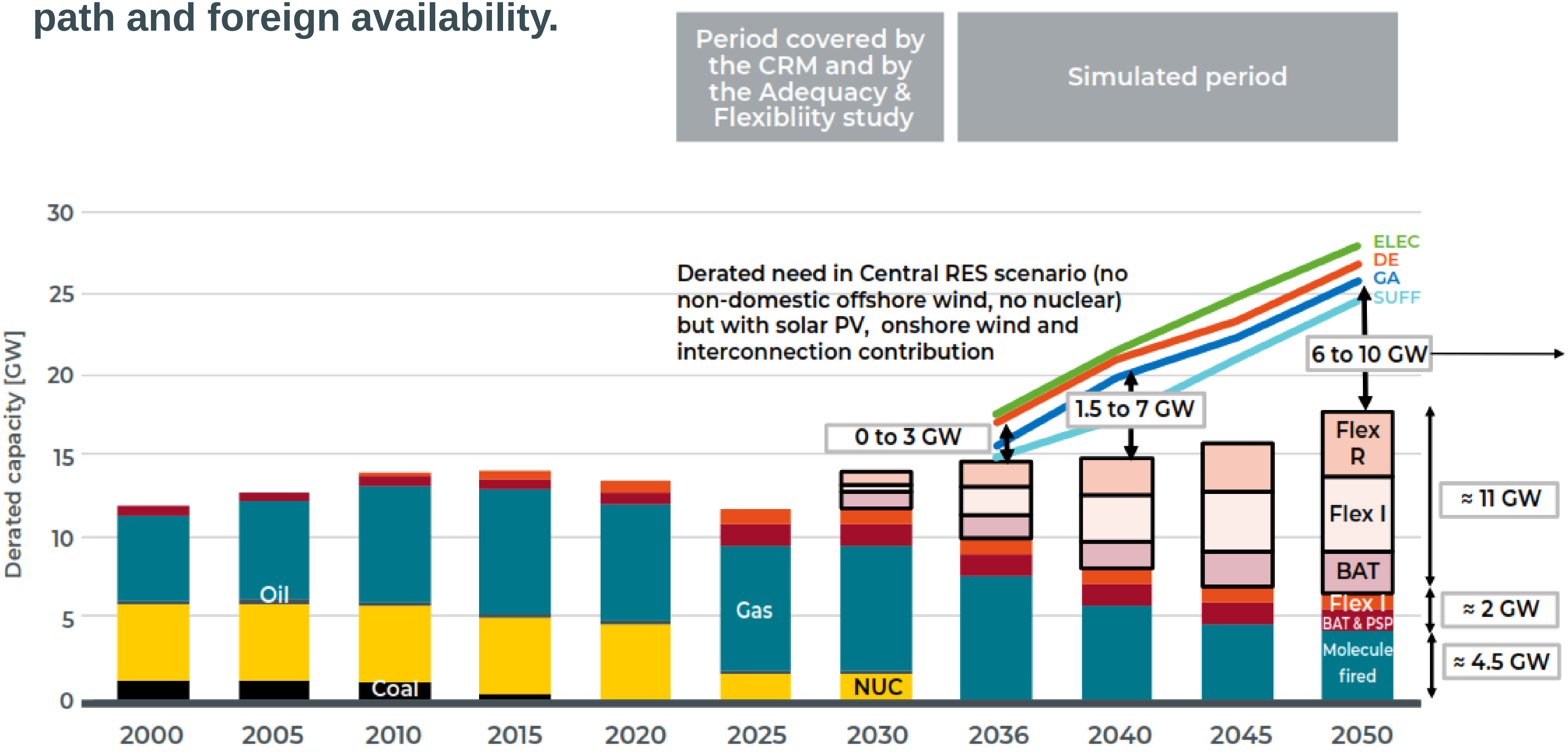
Need for (new) thermal capacity remains by 2050. The amount will depend on the electrification, flexibility developments, interconnectors, chosen energy path and foreign availability.



Derated need in Central RES scenario (no non-domestic offshore wind, no nuclear) but with solar PV, onshore wind and interconnection contribution

Assumed new thermal in the Central scenario (no nuclear, no new non-domestic offshore wind). However, this can be additional flex and storage aswell.

Assumed new Flex in the Central scenario

Existing Flex & Storage estimated in 2025

Existing thermal on gas with assumed decomissionings (old units)

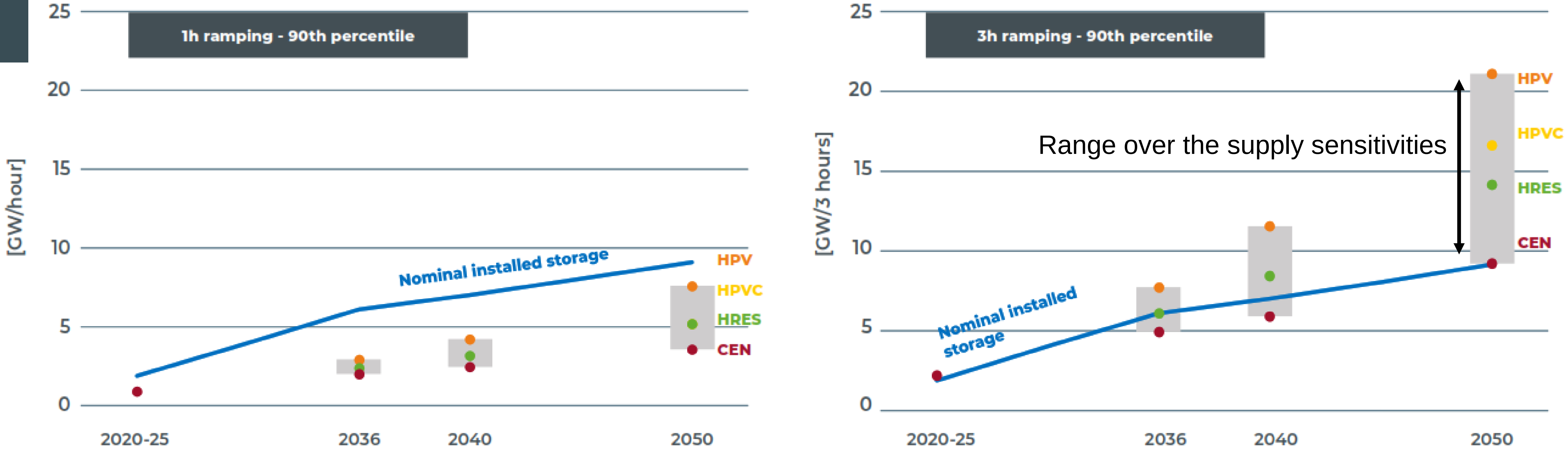
Year 2045 is not simulated.
Legend : Flex R = flexibility in the residential sector; Flex I = flexibility in industry sector; BAT = batteries; PSP = Pump-Storage Plant

☐ *New derated capcity assumed.*

■ *Existing derated capacity estimated in 2025 for Flex & Storage, and with assumed decommissioning for the thermal fleet.*

Unlocking as much flexibility as possible across the system to manage its increased volatility is of paramount importance

HOURLY AND 3-HOURLY RAMPINGS OF THE RESIDUAL DEMAND



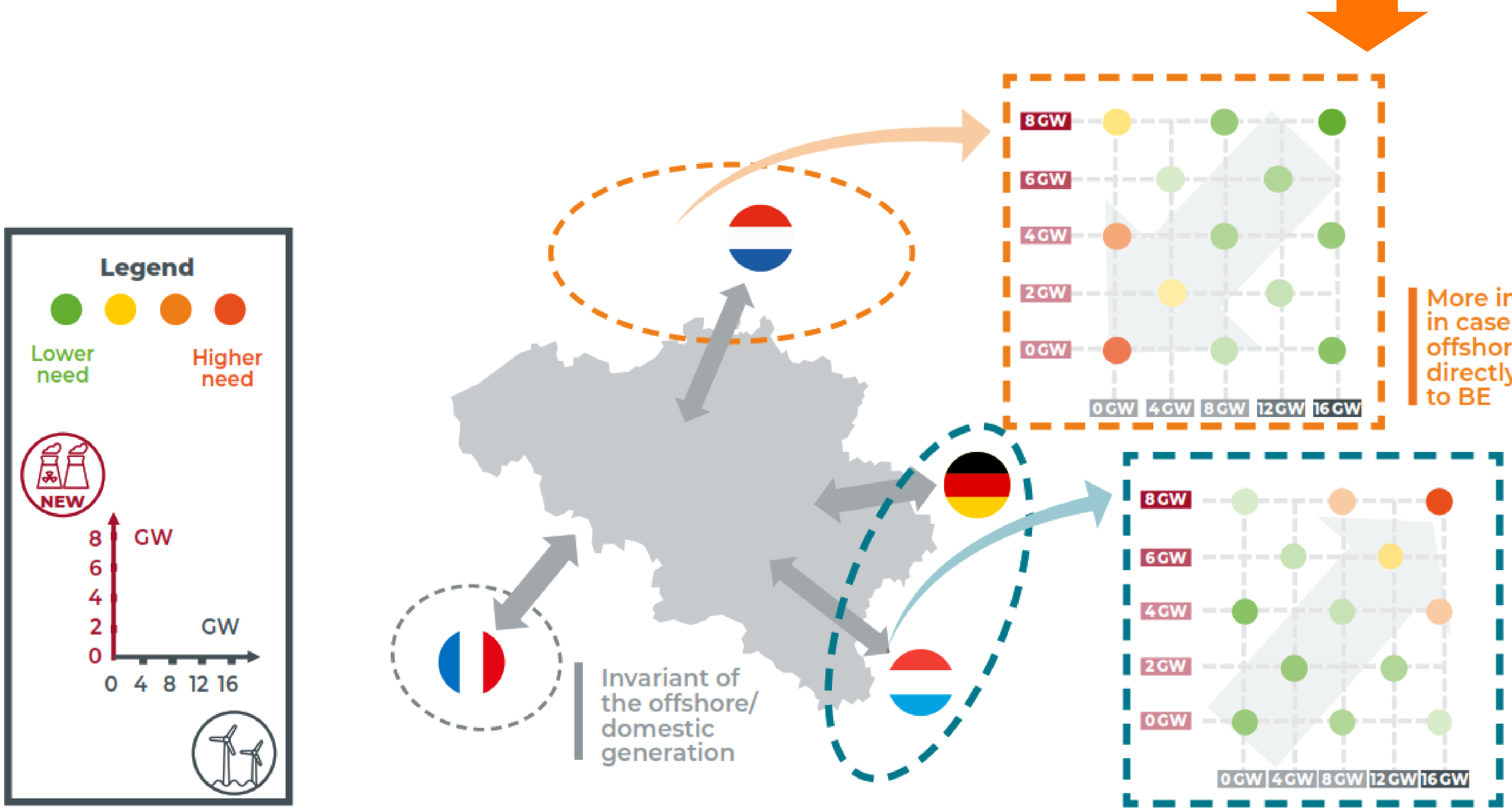
Domestic (excludes non-domestic offshore) residual ramping (90th percentile for each scenario) calculated in perfect foresight: demand minus domestic renewables including dispatch of demand flexibility.
This does not account for flexibility needs due to short term deviations (forecast errors, outages...).

Depending on the vision of Belgium's energy future, different borders should be prioritised

STRENGTHENING DISTRIBUTION AND LOCAL TRANSMISSION GRIDS

EXPANDING GRIDS FOR INDUSTRIAL CLUSTERS

REINFORCING ONSHORE INTERCONNECTION



More interesting in case of less offshore generation directly connected to BE

Invariant of the offshore/ domestic generation

More interesting in case of more generation in Belgium

Note: this is the need for XB reinforcement calculated as the marginal benefit reducing European electricity costs in a zonal setting. The impact on the Belgian costs can be different and should be further investigated.

Grid infrastructure investments depend on policy decisions

REINFORCEMENTS NEEDED TO CONNECT DOMESTIC, CENTRALISED GENERATION

On prolonging existing nuclear generation plants

- If the extension of over 2 GW is selected, the electrical infrastructure around current nuclear sites needs to be prepared.
- Additional grid users nearby and changes to European legislation have reduced the grid hosting capacity for such extensions.

On new nuclear plants

- Identifying potential future new nuclear sites is an essential step.
- This involves preparing the most probable location of these sites and integrating them into the overall Belgian backbone.

REINFORCEMENTS NEEDED TO CONNECT ADDITIONAL NON-DOMESTIC OFFSHORE WIND

- Hybrid offshore solutions and offshore hubs prove to be the most cost-efficient approach for incorporating non-domestic offshore wind into the Belgian electricity mix.
- The concrete developments will have to be approved in the next federal development plan if the aim is to have them commissioned before 2040.
- Collaboration with international partners is essential for identifying promising options and establishing the necessary organisational structures and agreements.
- The east-west axis of the internal backbone will have to be further reinforced.

BLUEPRINT

AGENDA

(and indicative timings)

Introduction	[15h00-15h10]
Process & stakeholder interactions	[15h10-15h15]
Methodology	[15h15-15h40]
European multi-energy findings	[15h40-16h15]
Belgian findings	[16h15-17h15]
▶ **Energyville** reasoned opinion	**[17h15-17h20]**
Main messages	[17h20-17h30]

BELGIAN ELECTRICITY SYSTEM BLUEPRINT FOR 2035-2050

Multi-energy integration

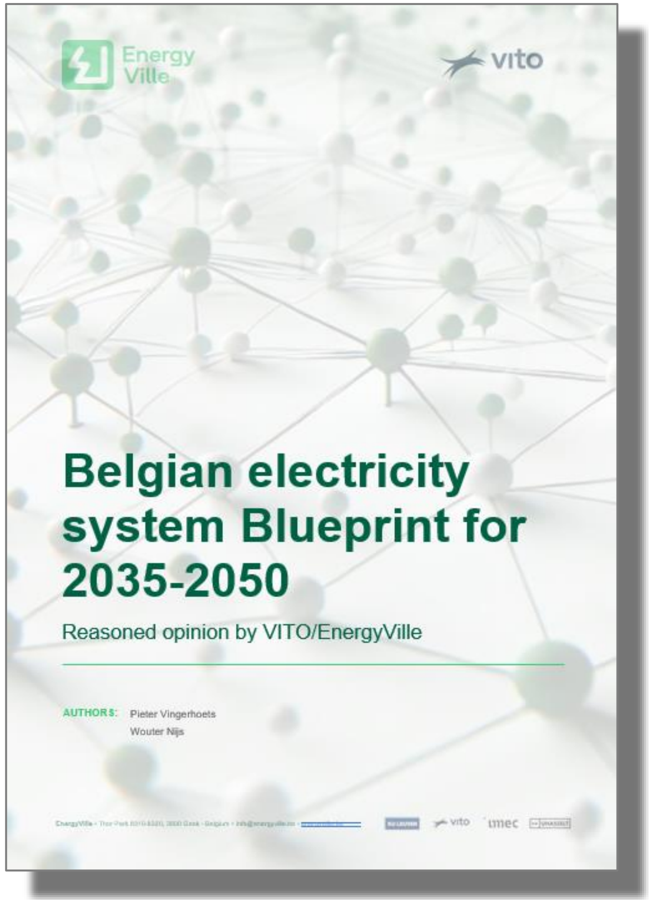
Flow-based zonal interconnection simulations across Europe.

Optimising carbon management

> 300 sensitivities

Data from reputable bodies

Great efforts to further increase **transparency in data accessibility**.



Belgian electricity system Blueprint for 2035-2050

Reasoned opinion by VITO/EnergyVille

AUTHORS: Pieter Vingerhoets
Wouter Nijs

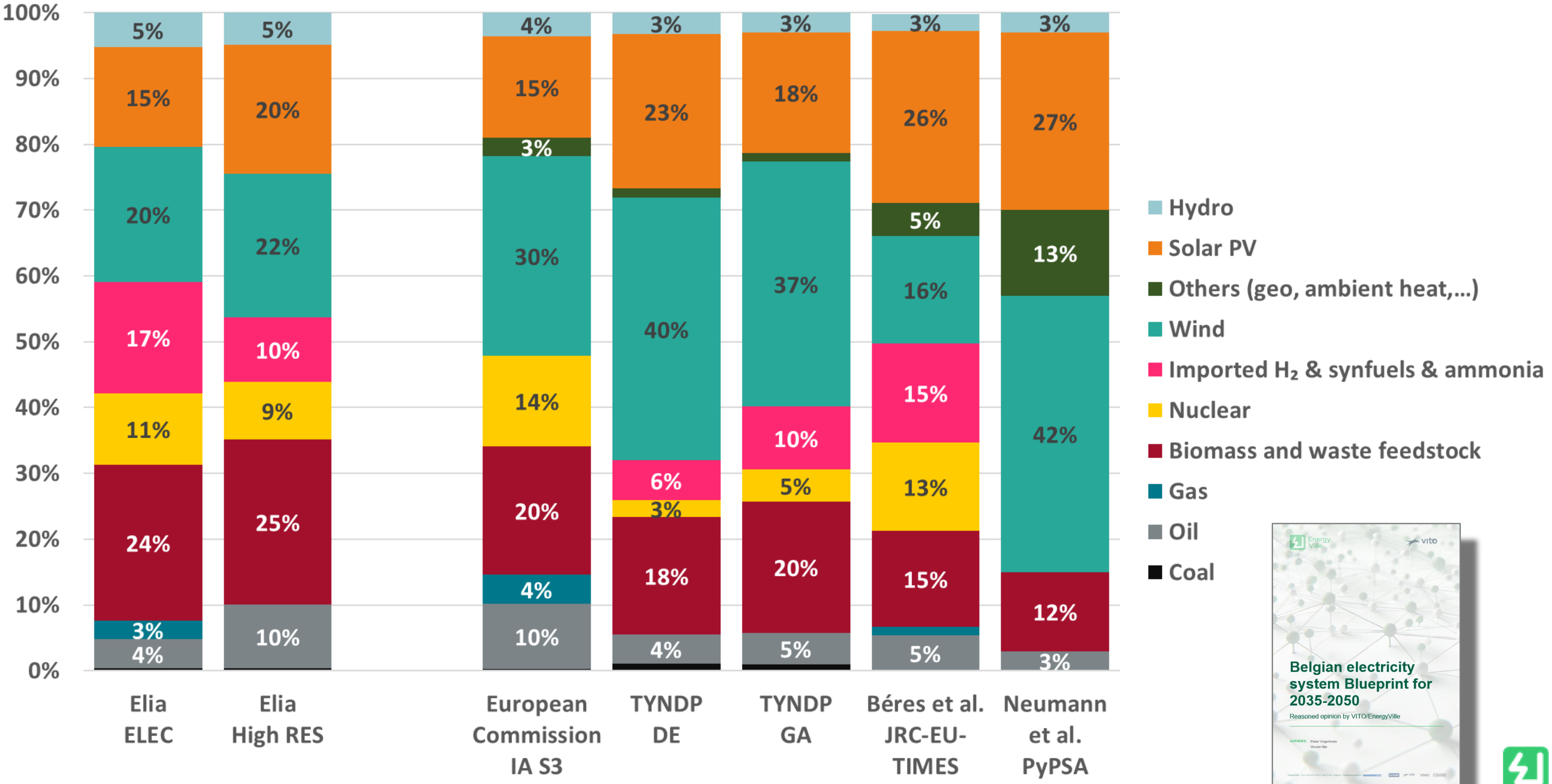
> “ *This Blueprint, along with other modelling work, clearly demonstrates that a significant expansion of the electricity grid is required, extending beyond current plans.* ”

Pieter Vingerhoets
Senior expert

> “ *Like EnergyVille’s PATHS2050 exercises, the Blueprint shows that the energy transition will significantly reduce our dependency on foreign energy. We will not necessarily produce all the electricity we need in Belgium.* ”

Gerrit Jan Schaeffer
General manager

Primary energy demand comparison



Belgian electricity system Blueprint for 2035-2050

Reasoned opinion by VITO/EnergyVille

Energy Ville ENERGY IN TRANSITION

Thank you !

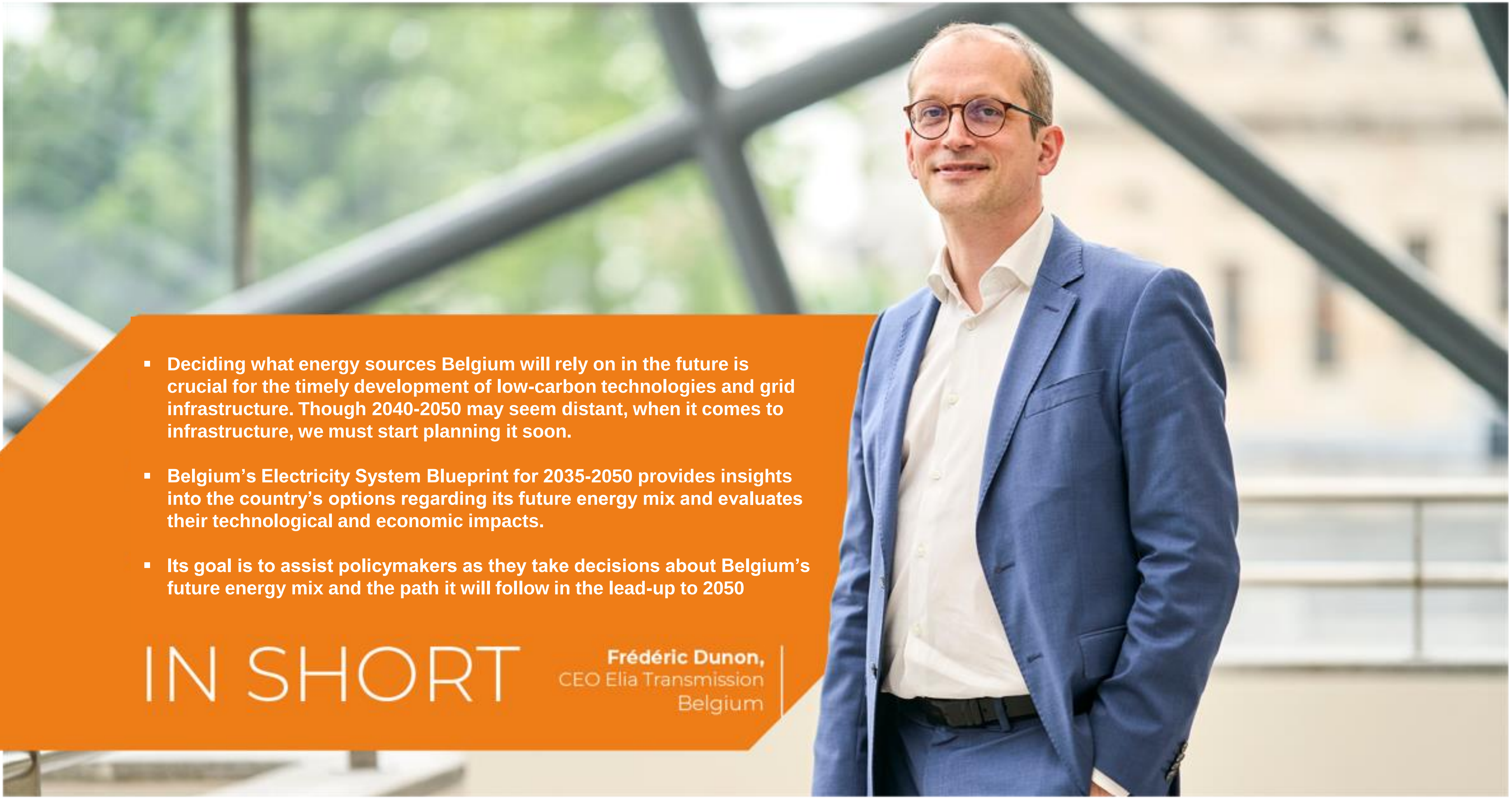
BLUEPRINT

AGENDA

(and indicative timings)

Introduction	[15h00-15h10]
Process & stakeholder interactions	[15h10-15h15]
Methodology	[15h15-15h40]
European multi-energy findings	[15h40-16h15]
Belgian findings	[16h15-17h15]
Energyville reasoned opinion	[17h15-17h20]
▶ **Main messages**	**[17h20-17h30]**

BELGIAN
ELECTRICITY
SYSTEM
BLUEPRINT
FOR 2035-2050

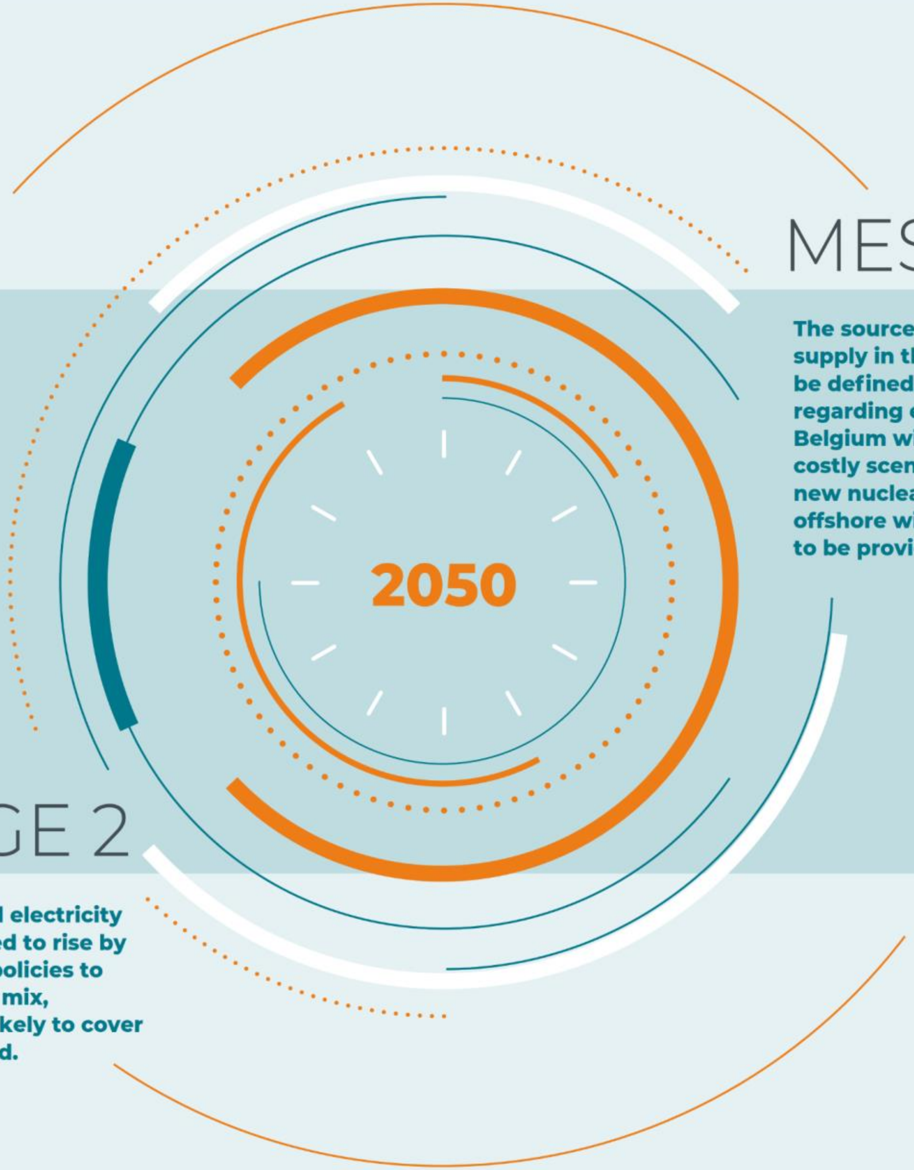


- Deciding what energy sources Belgium will rely on in the future is crucial for the timely development of low-carbon technologies and grid infrastructure. Though 2040-2050 may seem distant, when it comes to infrastructure, we must start planning it soon.
- Belgium's Electricity System Blueprint for 2035-2050 provides insights into the country's options regarding its future energy mix and evaluates their technological and economic impacts.
- Its goal is to assist policymakers as they take decisions about Belgium's future energy mix and the path it will follow in the lead-up to 2050

IN SHORT

Frédéric Dunon,
CEO Elia Transmission
Belgium

5 KEY INSIGHTS ABOUT BELGIUM'S ENERGY SYSTEM IN THE LEAD-UP TO 2050



MESSAGE 1

By 2050, Belgium's final energy demand will decrease by 25-45%, meaning its energy dependency will reduce by a factor 2. Both electrons and molecules will play a role in the country's future energy supply.

MESSAGE 2

By 2050, Belgium's final electricity consumption is expected to rise by 95-130%. Without new policies to shape its future energy mix, domestic supplies are likely to cover only half of this demand.

MESSAGE 3

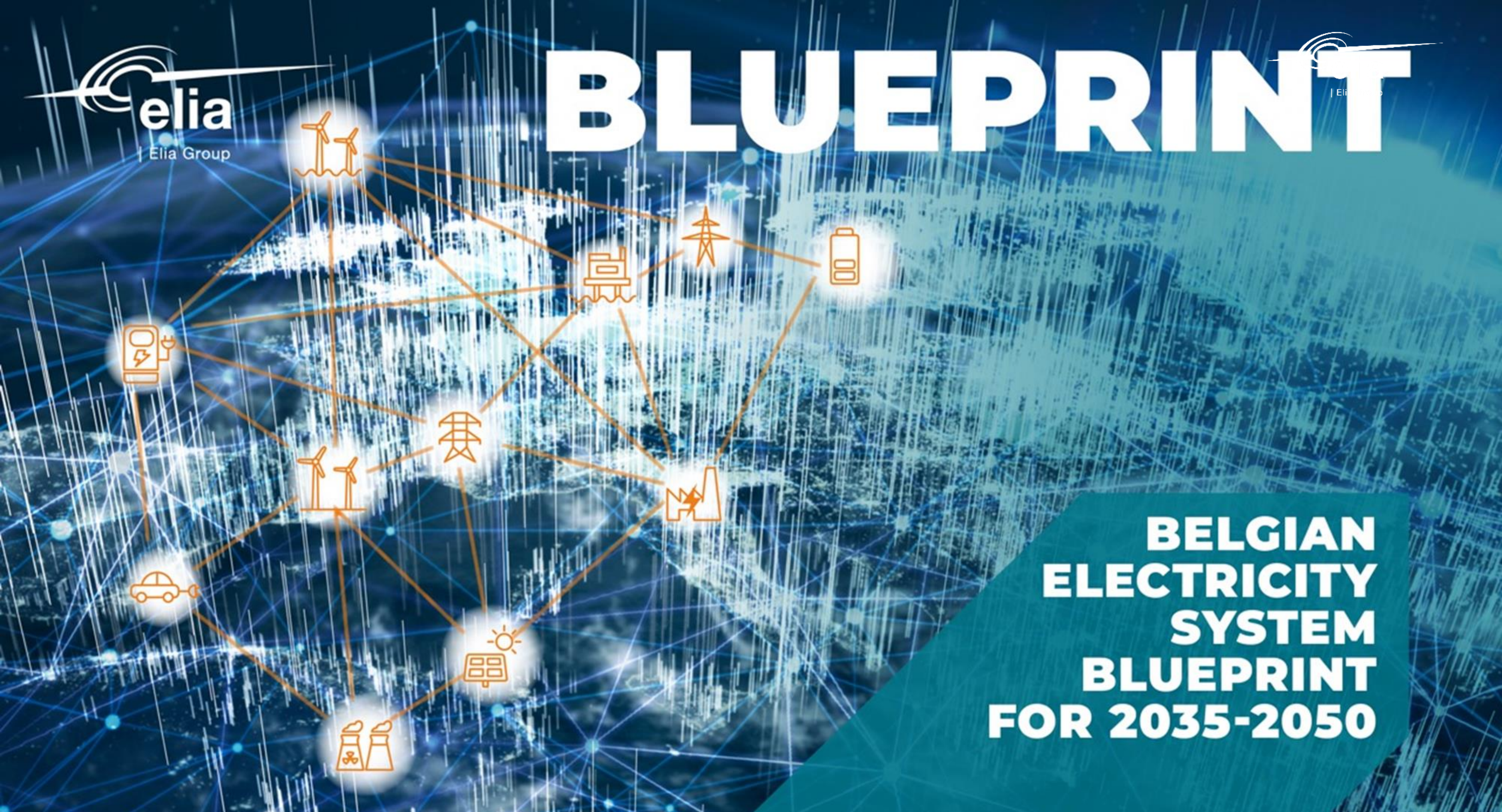
The source of half of Belgium's electricity supply in the lead-up to 2050 still needs to be defined. Without a clear policy regarding electricity supply towards 2050, Belgium will likely end up in the most costly scenario. Large-scale options, like new nuclear units and non-domestic offshore wind farms, require clear signals to be provided in the years to come.

MESSAGE 4

Alongside long-term preparations, managing the transition period will require some attention. Cost-effective options include maximising Belgium's domestic renewable energy sources (RES), applying sufficiency measures, prolonging the lifespan of existing generation units and developing the country's access to non-domestic offshore wind. Each of these is subject to their own specific constraints.

MESSAGE 5

The future energy mix and the location of future power projects will play a crucial role in the development of the electricity grid. In all scenarios, the reinforced and completed 380 kV grid (backbone) is the basis for further developments.



BLUEPRINT

BELGIAN ELECTRICITY SYSTEM BLUEPRINT FOR 2035-2050

23/09/2024 – Horizontal Electricity System Think Tank