THE HORIZONTAL ELECTRICITY SYSTEM THINK TANK

19th December 2023

Agenda

1. Welcome and introduction by James Matthys-Donnadieu and Leonardo Meeus
2. Vision co-chairman Leonardo Meeus
3. ENGIE – study on decarbonization pathways towards 2050
4. ELIA – Offshore market and system integration challenges triggered by massive penetration of inverter based resources
5. ELIA – System Blueprint Study
6. Feedback and agenda 2024

Welcome & vision

19th December 2023

ENGIE – study on decarbonization pathways towards 2050

BUILDING DECARBONIZATION PATHWAYS FOR EUROPE

ENGIE'S SCENARIO

AN OUTLOOK ON THE
BELGIAN ENERGY SYSTEM

December 19, 2023 (Brussels)

Our 5 beliefs

1 Activate all possible levers for decarbonization

4% / annual reduction in emissions

To achieve « Net zero » carbon in less than 30 ans

2 Combine electricity and molecules for a successful transition

450TWh of low-carbon gas by 2030

to meet "Fit for 55" objectives

3 Massive development of renewable power

80% increase

in electricity demand **in Europe** by 2050

x6

increase in power generation from solar and wind

4 Act now to anticipate flexibility needs

~x4

increase in flexibility needs **by 2050**

5 Energy efficiency is compatible with growth

34%

reduction in energy demand by 2050

Agenda

We consider a pragmatic approach to decarbonization

Mature and emerging technologies

All energy vectors & markets

European and national regulatory frameworks

NET ZERO CARBON

COST OPTIMIZATION

RESILIENCE

ENGIE'S DECARBONIZATION PATHWAY FOR EUROPE

A robust methodology

A European vision

- Modelling of **15 European countries** whose energy systems are highly interconnected
- Focusing on FR, DE, BE, NL, UK, IE, ES, PT, IT, CH, AT, PL, HU, SK & CZ (**+85% of final energy consumption** in 2019 of EU27+UK, CH)

A model that incorporates a diverse range of energy vectors

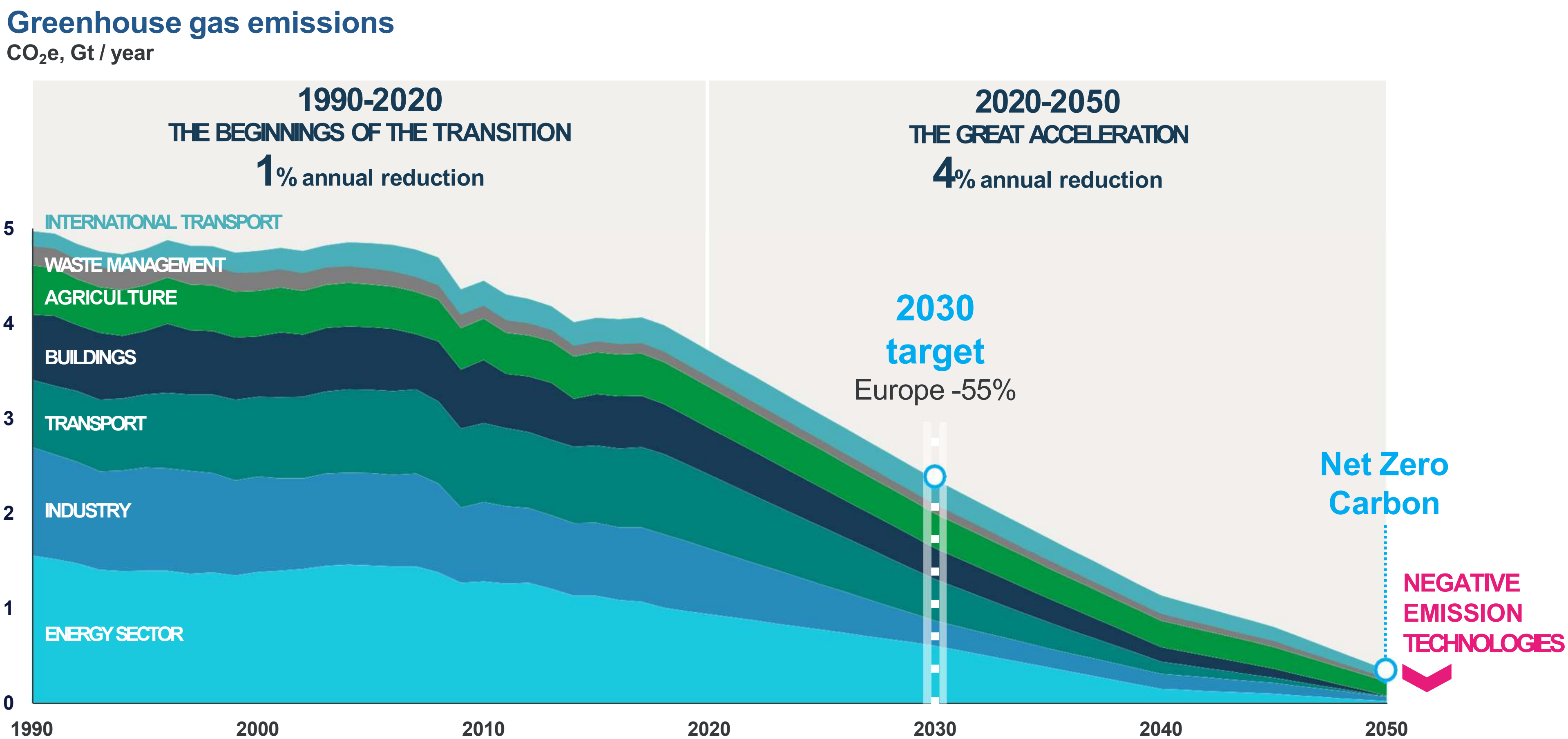
- Based on **interactions between electricity, methane, hydrogen, hydrogen derivatives and heat**
- Modelled with a **fine-grained hourly timeline** to meet resource adequacy and resilience criteria

A realistic approach to technical and economic choices

- Based on **mature low-carbon technologies** (e.g. excluding marine energy and nuclear fusion)
- Incorporates **societal factors** (e.g. limitations to the deployment of carbon capture and storage)
- Uses **external studies and benchmarks** for issues outside our area of expertise, e.g. agriculture, forestry (European Commission, ADEME, etc.)

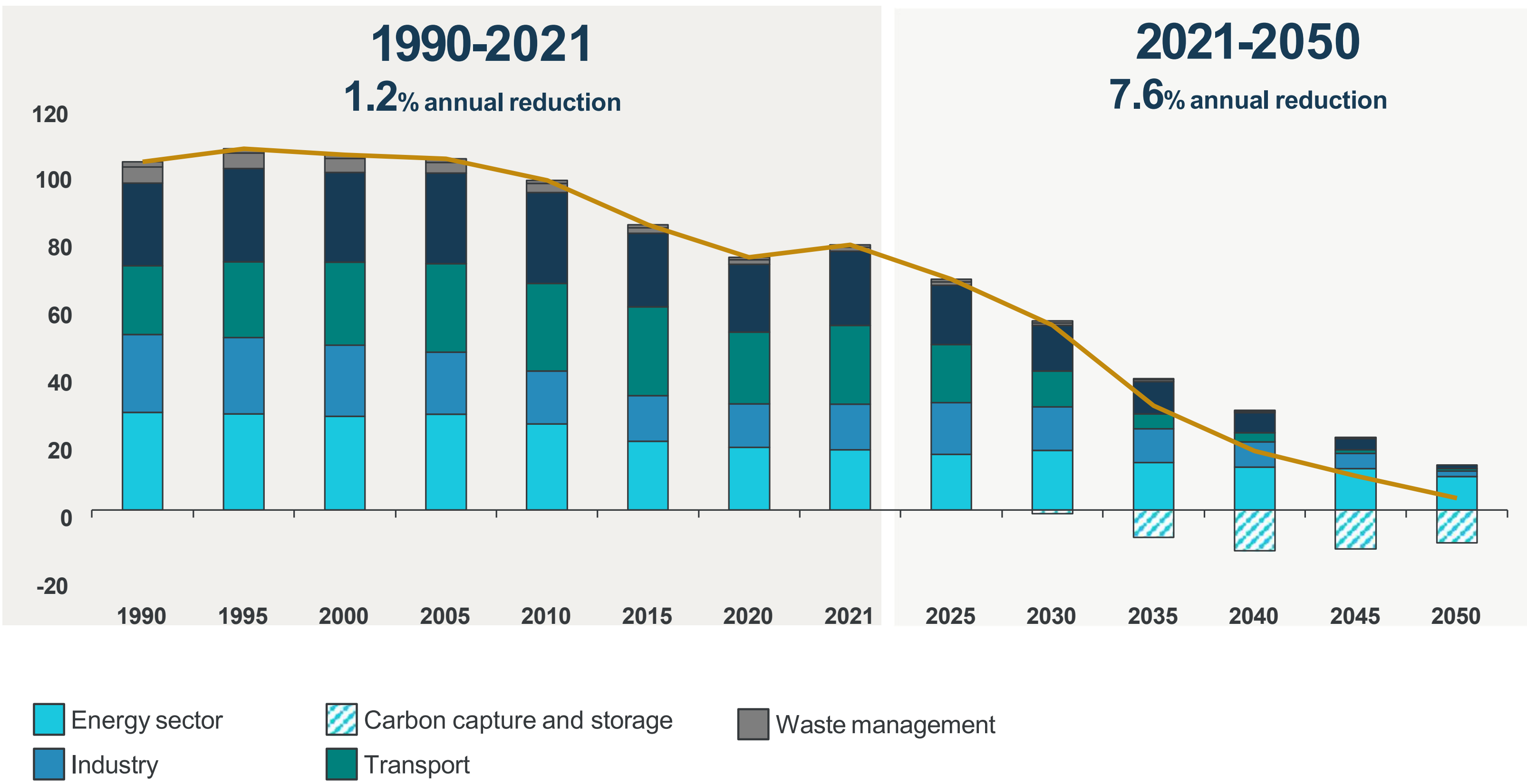
Agenda

A necessary increase in global emissions reduction efforts..



..which requires to further accelerate on energy emissions reduction

Energy CO_2 emissions(*)
CO_2, Mt / year



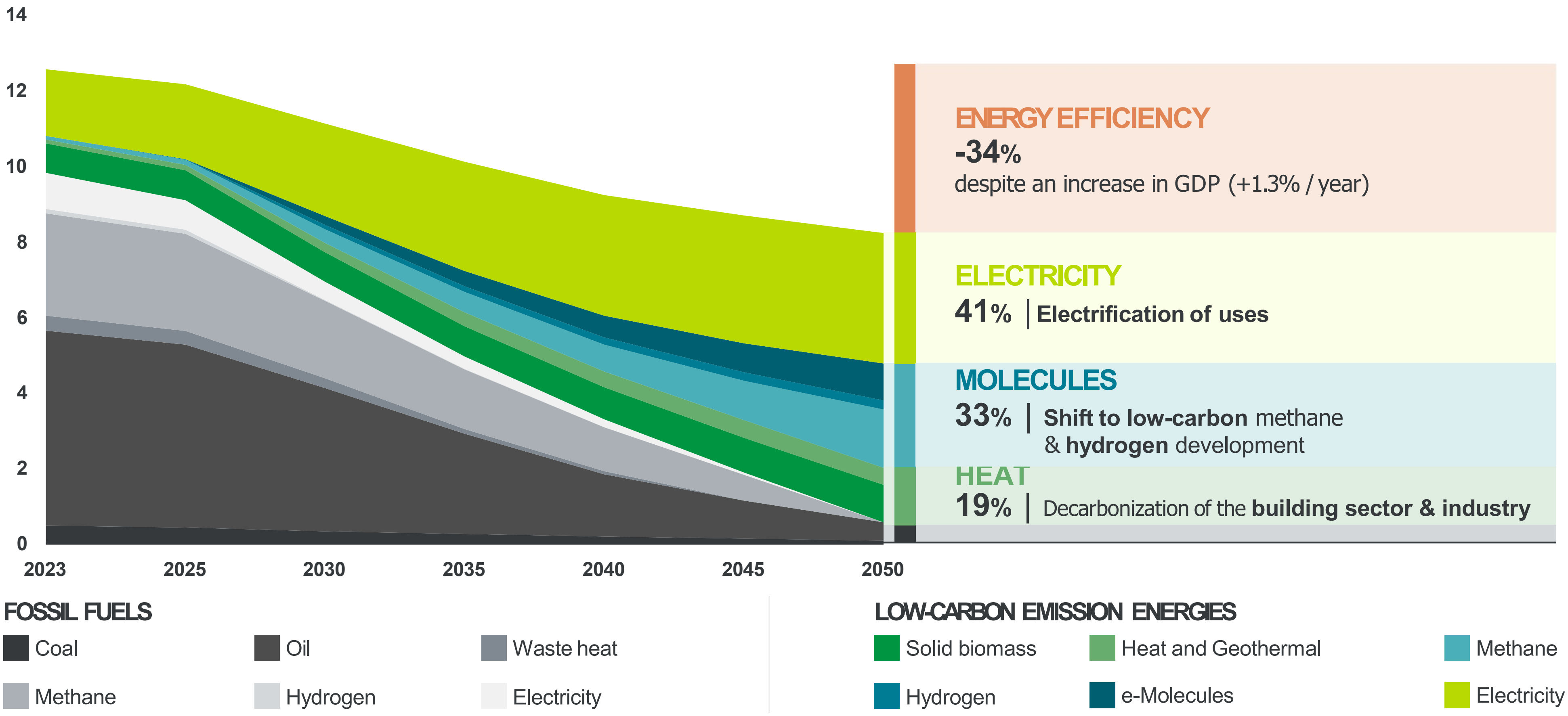
(*) excl. int. transport, process, agriculture and LULUCF.

Agenda

1. Our approach and modelling assumptions
2. European greenhouse gas emissions outlook
3. How to achieve decarbonization at European level?
4. Key dynamics for Belgium
5. Conclusions

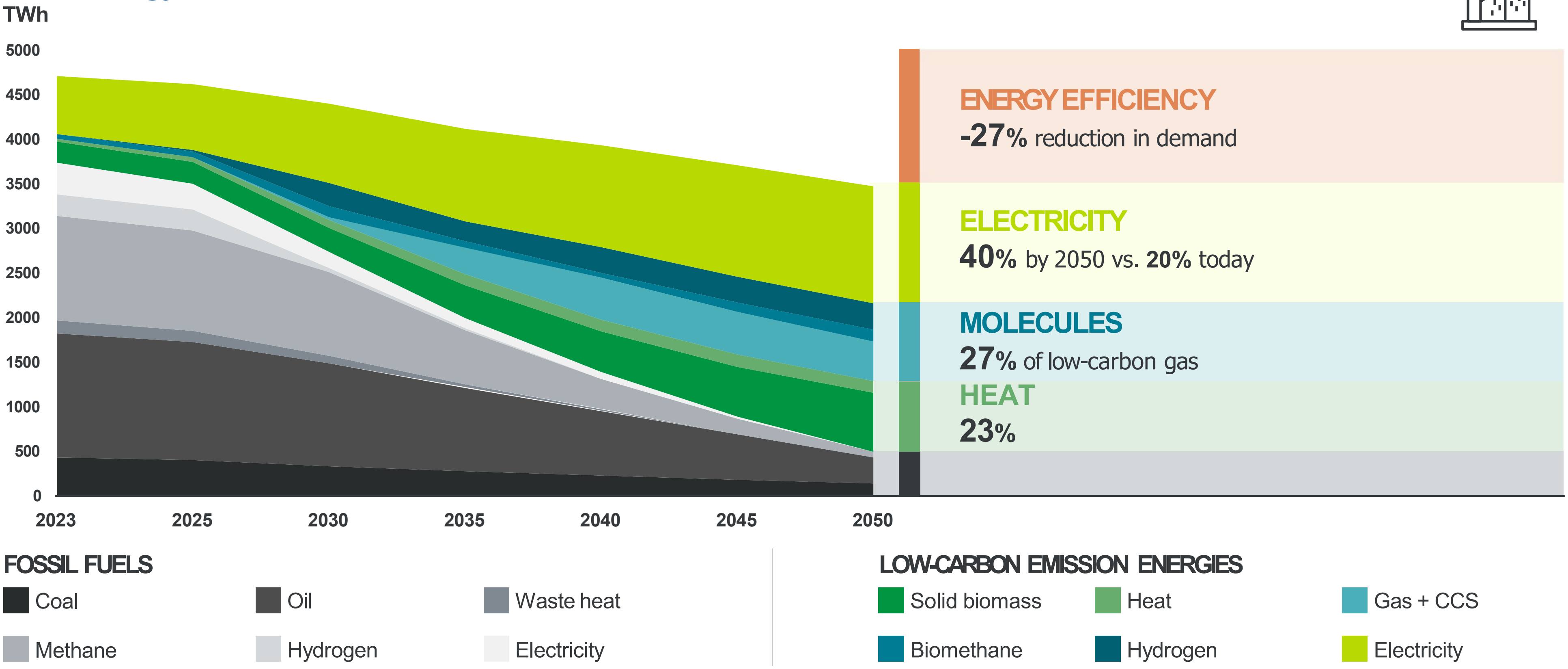
All levers are required to achieve decarbonization

Final energy mix



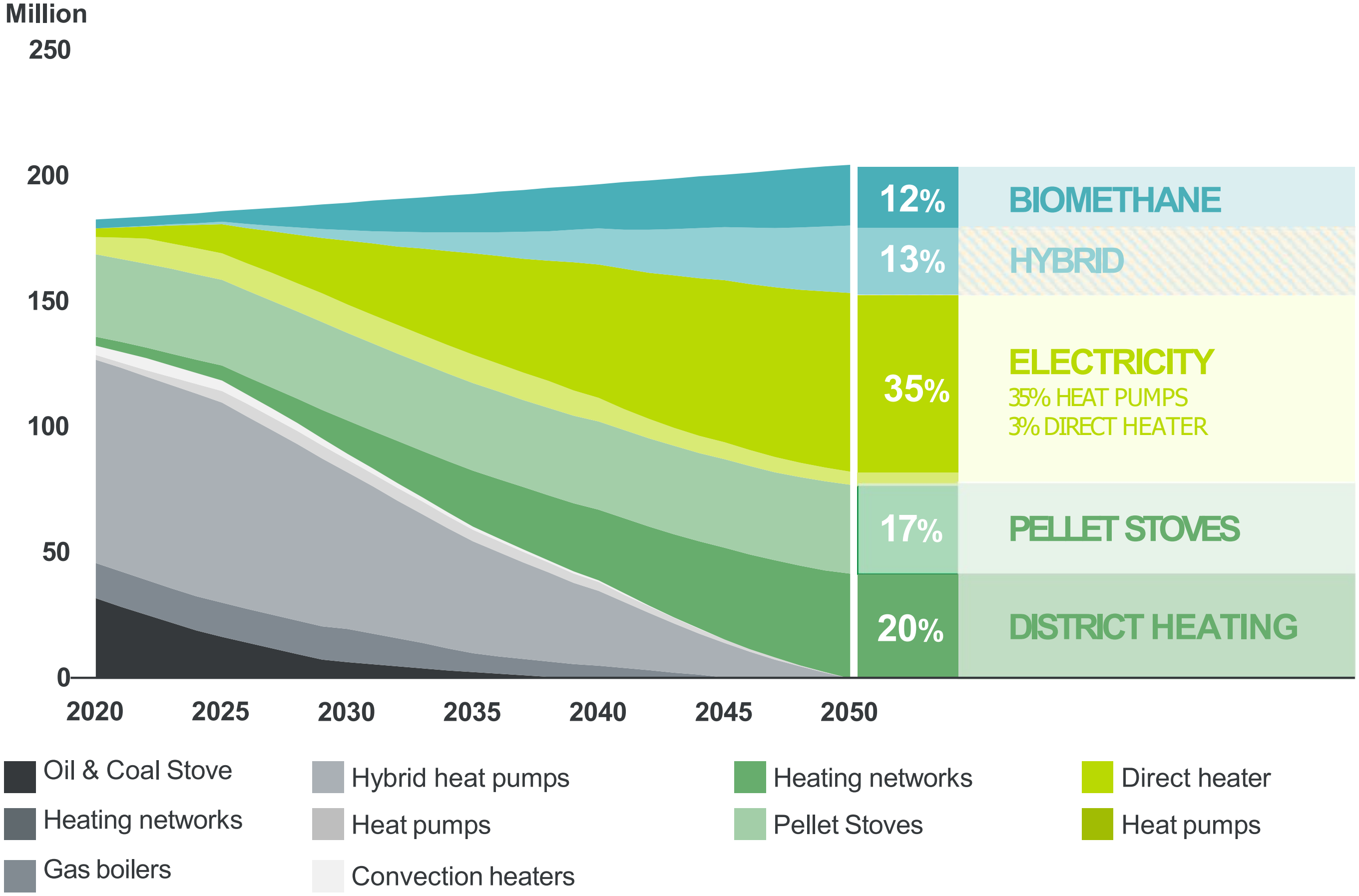
Industry: Electrification and decarbonized gases are the drivers of the transition

Final energy mix for the industrial sector



Building: need for a range of solutions

European households | Heating solutions



EFFICIENT RENOVATION BY 2050:

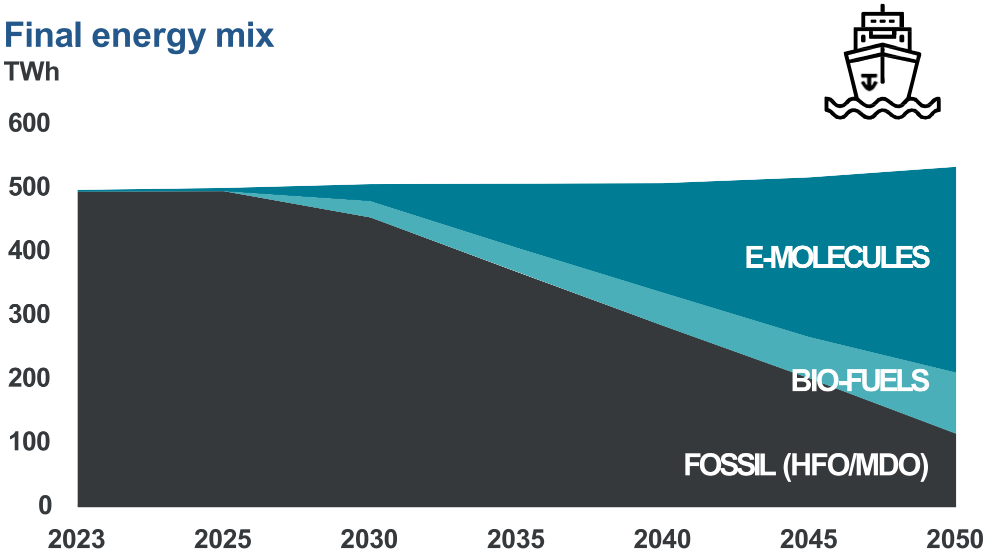
0.3 to 1.5% / year
Very strong increase
in the overall rate of renovation

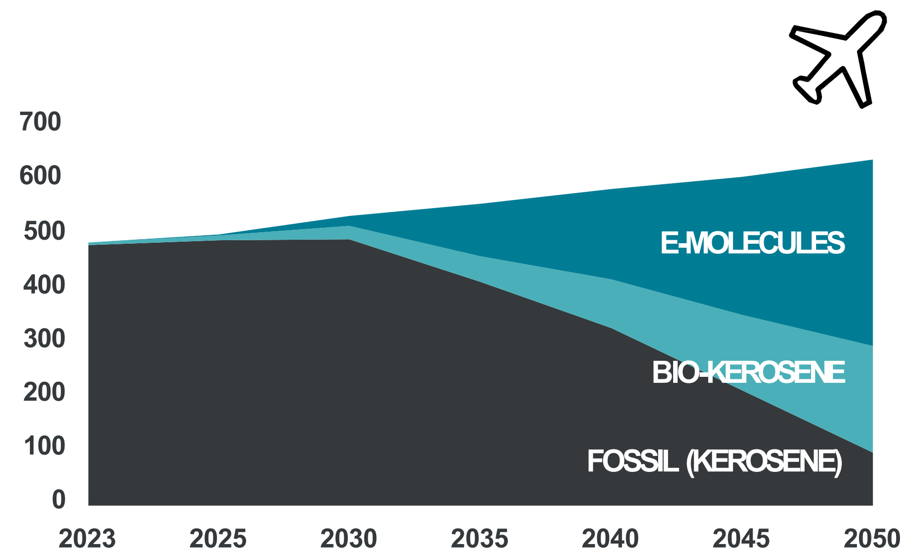
50%
Buildings
fully renovated

Maritime and air transport: green molecules, main vector for decarbonization

Final energy mix

TWh





80% EMISSION REDUCTION TARGET ACHIEVED THROUGH USE OF

- e-molecules derived from low-carbon hydrogen
- bio-LNG and bio-diesel for Maritime Transport
- bio-kerosene for Aviation

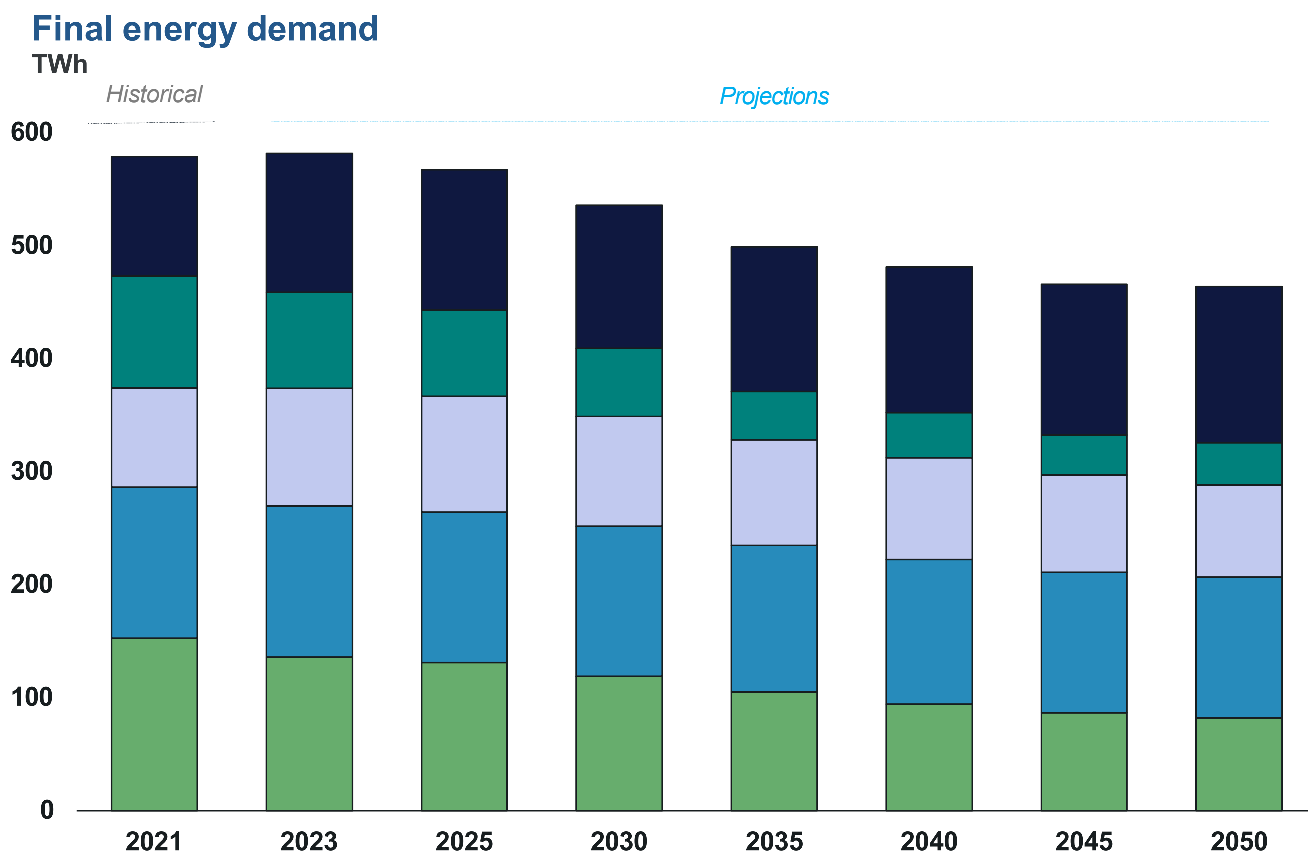
HFO: Heavy Fuel Oil,
MDO: Maritime Diesel Oil

Agenda

1. Our approach and modelling assumptions
2. European greenhouse gas emissions outlook
3. How to achieve decarbonization at European level?
4. **Key dynamics for Belgium**
5. Conclusions

Final energy demand by sector in Belgium

Final energy demand decreases thanks to fuel switching and efficiency gains in buildings and transport



ENERGY EFFICIENCY
-20% vs 2023 despite an increase in GDP

INTERNATIONAL TRANSPORT
30% | Most energy intensive sector by 2050

NATIONAL TRANSPORT **8%** | Electrification of cars

NON-ENERGY USE
17% | Industrial feedstock

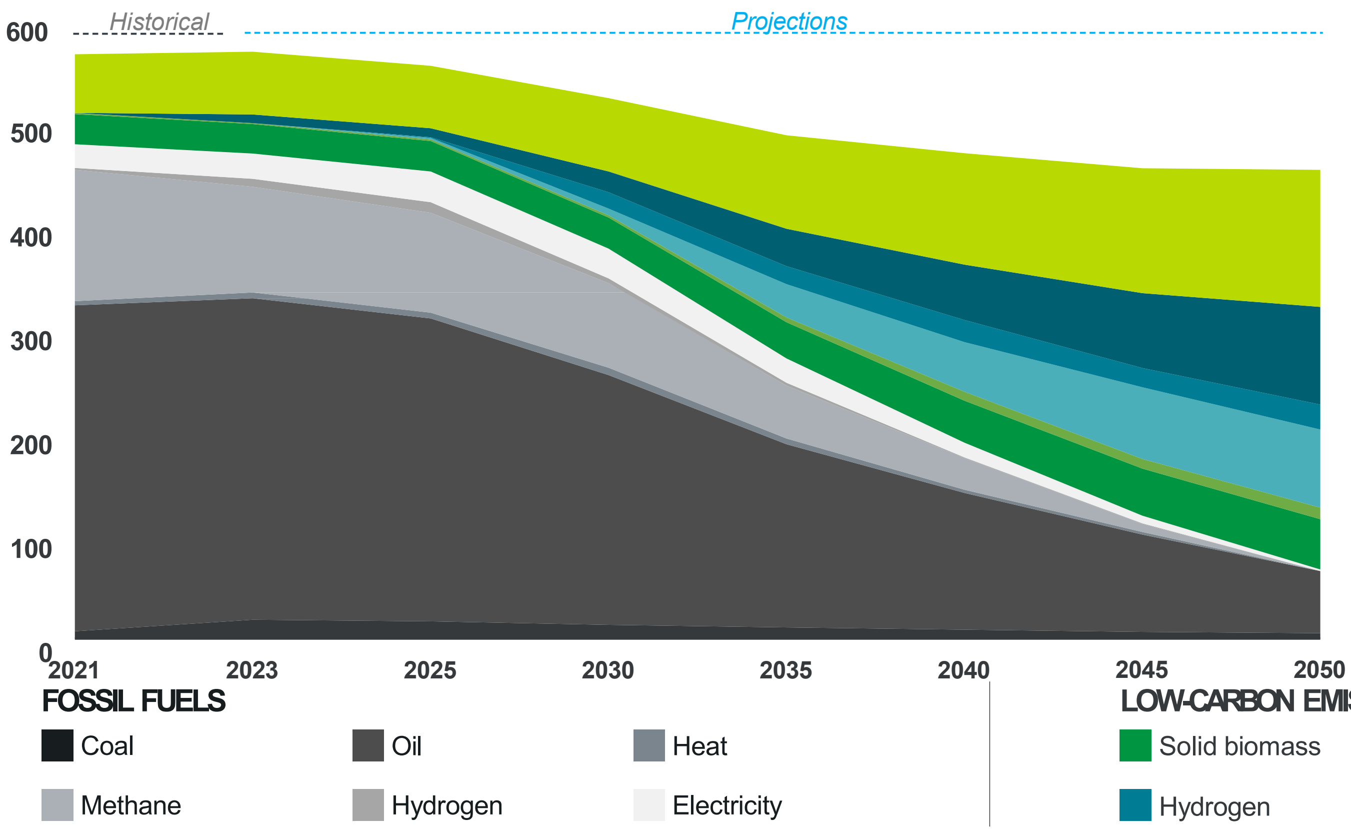
INDUSTRY
27% | Importance of chemical, construction materials, and food & beverage industries

BUILDING
18% | Renovation and energy efficiency

Final energy demand by fuel

Progressive phase-out of fossil fuels supported by electrification and development of molecules

Final energy demand by fuel



ENERGY EFFICIENCY
-20% compared to 2023 despite an increase in GDP

ELECTRICITY
29% | **Electrification of uses** across all sectors except Int. transport and non-energy usages.

MOLECULES
43% | **High importance** in Belgium, notably for **Int. Transport**

HEAT & BIOMASS
13% | Limited increase in **Industry & Buildings**

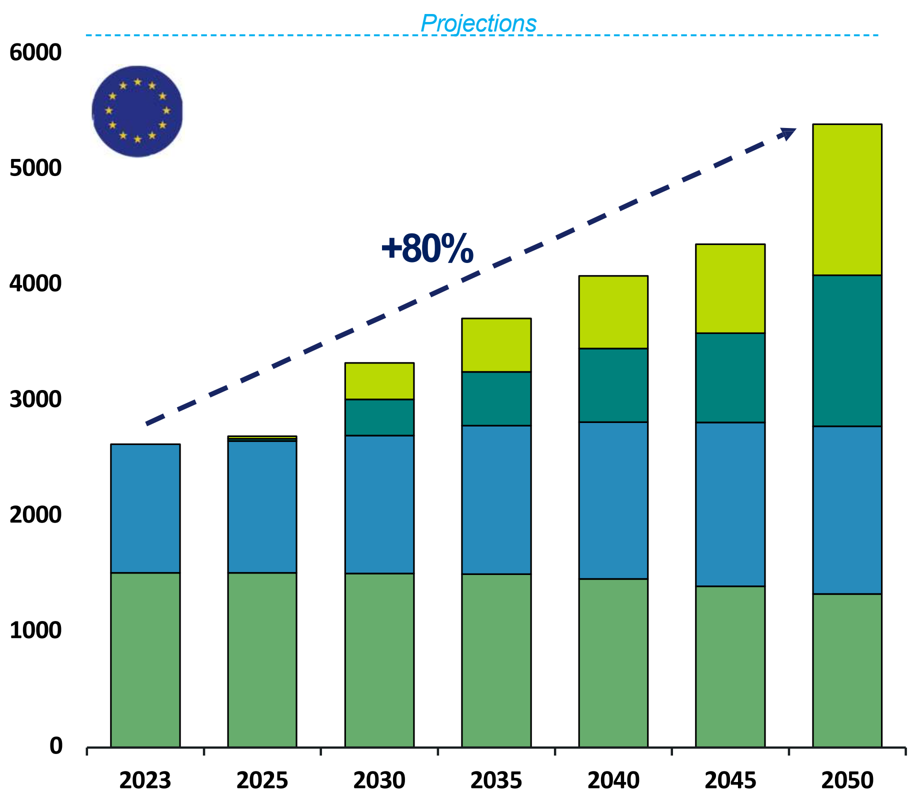
FOSSIL
15% | Non energy usages (feedstock) and Int. transport

Power demand Europe vs. Belgium

Strong electrification of industries, but little room for electrolysis in Belgium due to limited RES potential

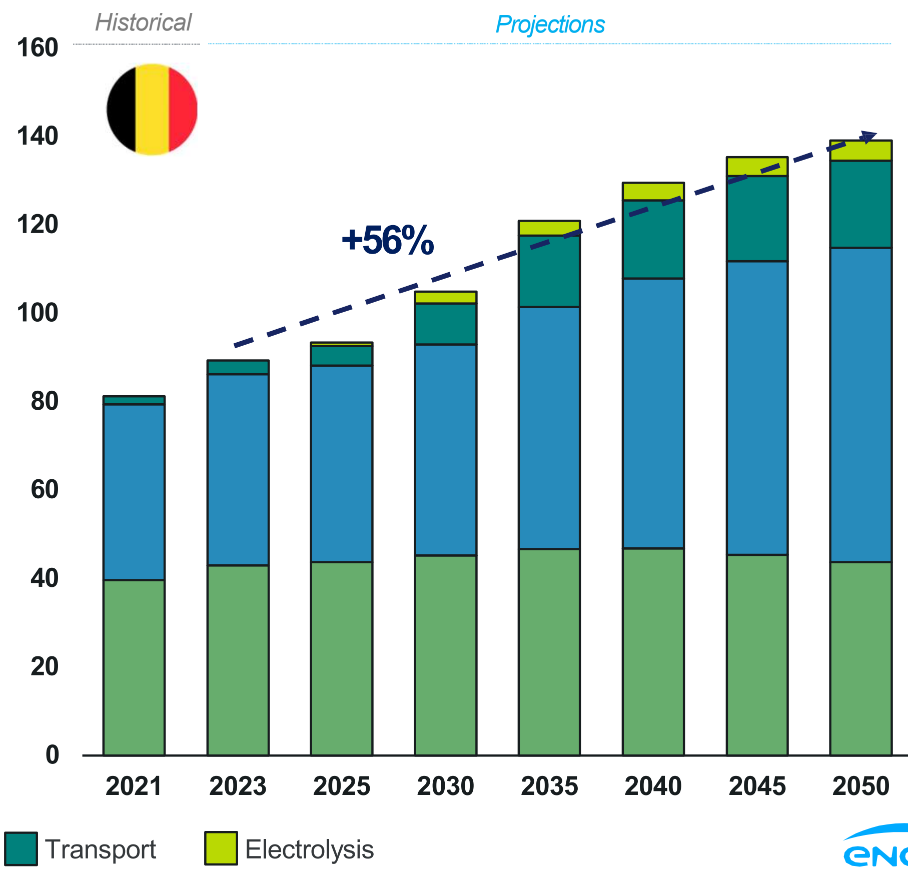
Power Demand – EU15

TWh

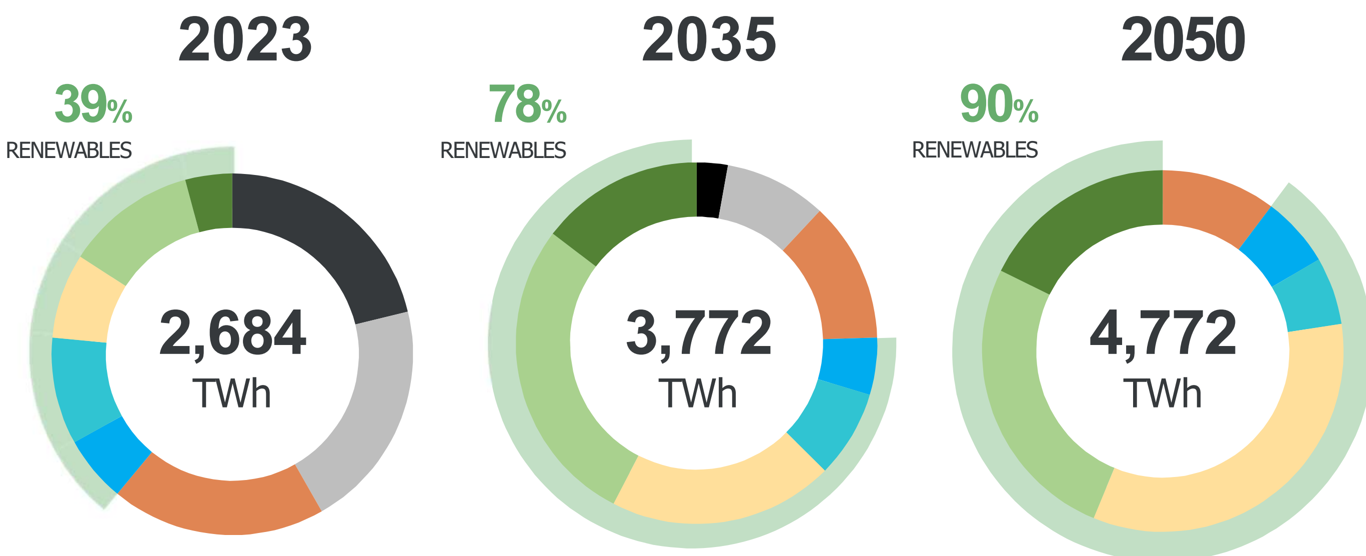


Power Demand – BE

TWh



Massive increase in renewable power generation



Solar and Wind generation

x6

by 2050

FOSSIL FUELS

- Coal, Lignite & Oil
- Fossil gases

LOW-CARBON EMISSION ENERGY SOURCES

- Nuclear
- Decarbonized thermal
- Hydraulic
- Solar
- Onshore wind
- Offshore wind

Renewables: acceleration CRITICAL to meet climate goals and keep costs down

STRESS TEST

5-year delay
in developing solar,
wind power
and the associated grid

IMPLICATIONS

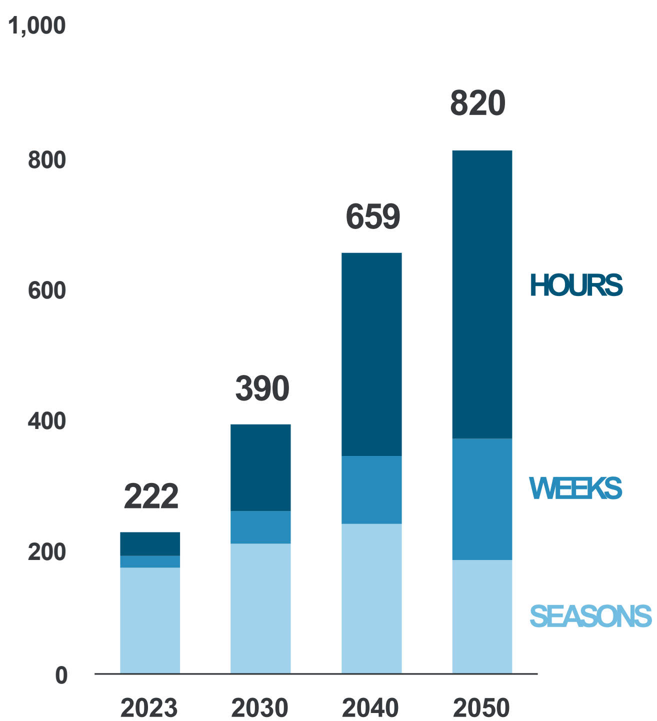
"Fit-for-55" targets not reached

+3Gt CO_2

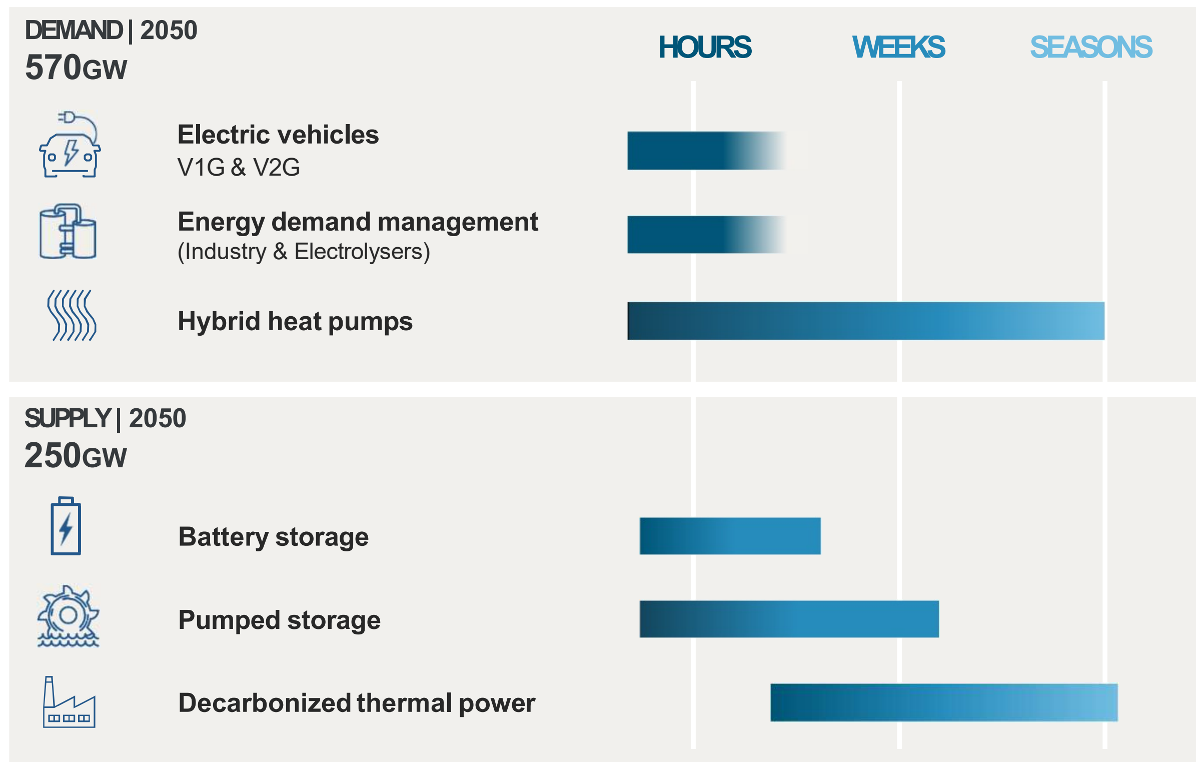
+€4bn/year until 2050

Flexibility Levers: necessary complement to intermittent renewable power sources

Flexible capacity
GW

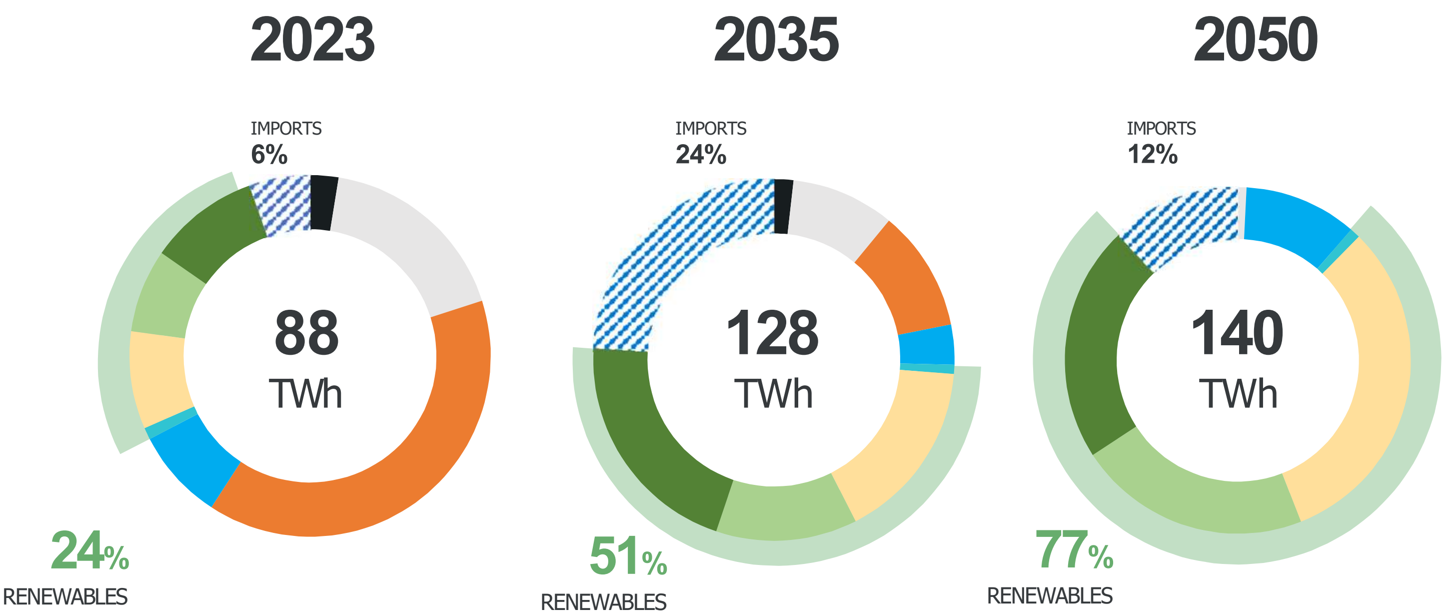


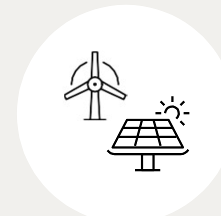
Flexibility technologies
Various technologies for meeting specific needs



Power Supply in Belgium

Fossil fuels and nuclear to be gradually replaced by RES





BE Solar and Wind generation

x4

by 2050 to ensure decarbonization and energy autonomy

FOSSIL FUELS

- Coal, Lignite & Oil
- Natural gas

LOW-CARBON EMISSION ENERGY SOURCES

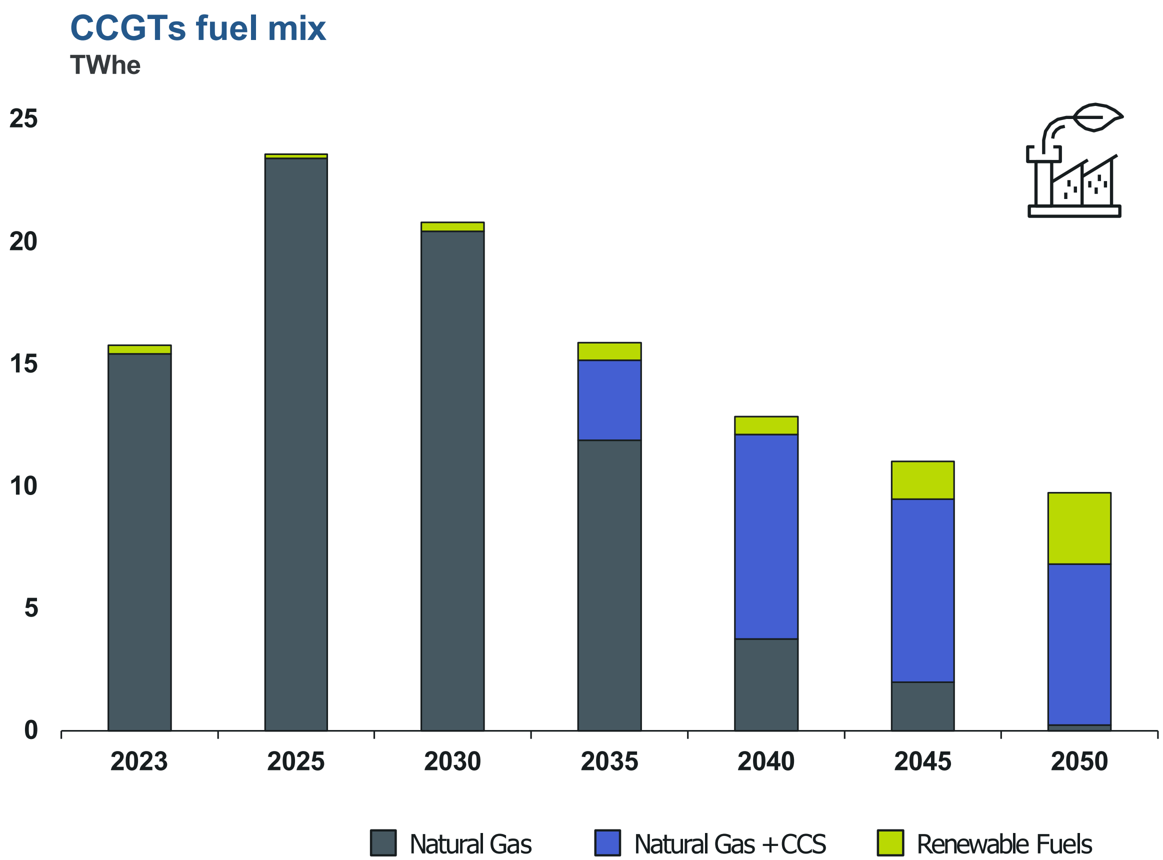
- Existing nuclear (based on current agreement with BE authorities)
- Decarbonized thermal
- Hydraulic
- Solar
- Onshore Wind
- Offshore wind
- Electricity Imports

(*) *RES-E shares include solar, wind and hydro generation*

ENGIE

Thermal power supply Belgium

Power generation from CCGTs by fuel



GROWING NEED IN THE MEDIUM TERM

CCGTs' generation peaks in 2025 with the commissioning of 2 additional units, the closure of nuclear units in BE and coal phase-out in Europe.

INCREASING DECARBONIZATION

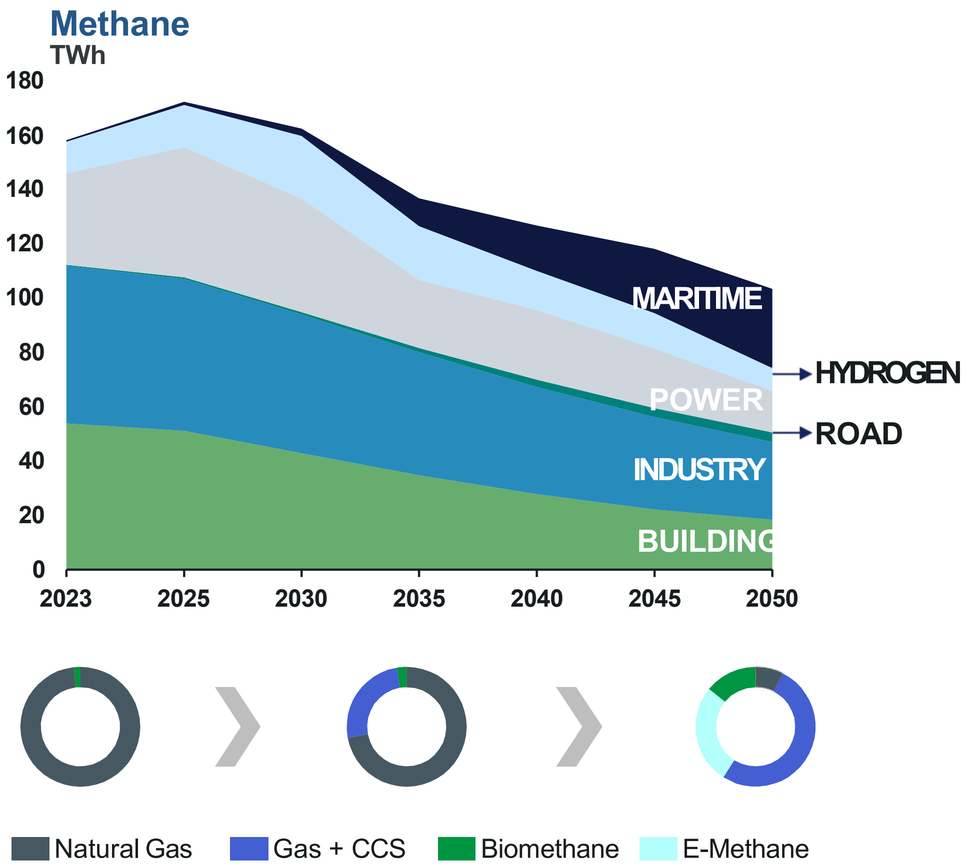
2035

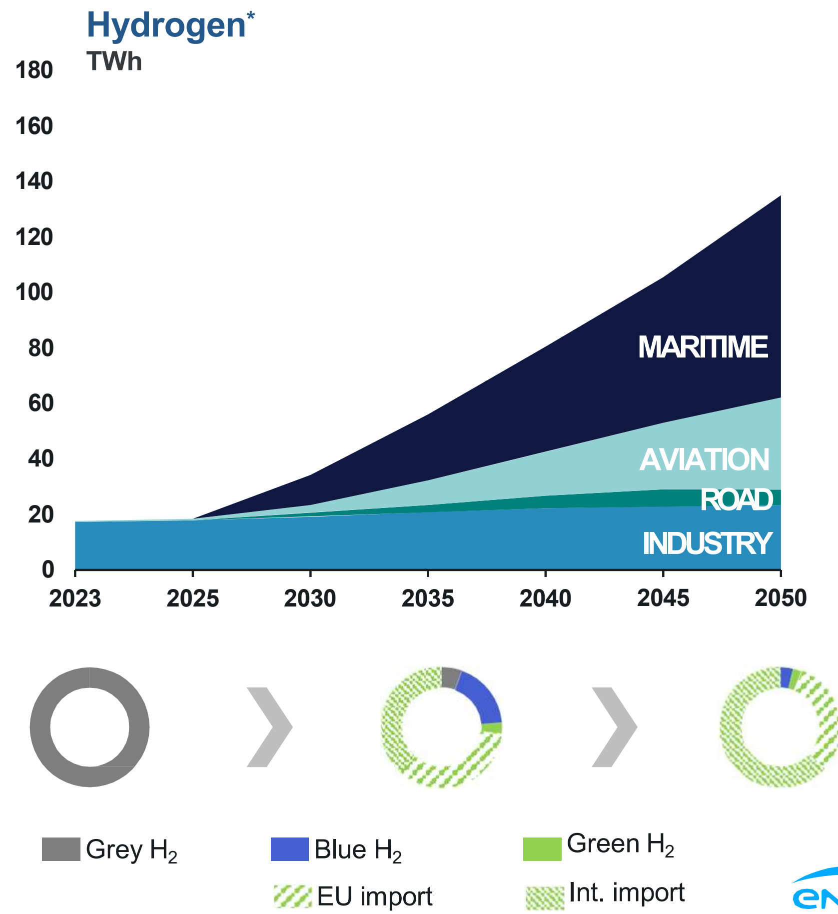
Decarbonization of the thermal fleet deployed as of 2035.

Current technology outlooks lead to a deployment of CCS followed by renewable fuels

Belgian molecules demand and supply

Declining role of methane in traditional sectors. International transport is important driver for molecule demand.

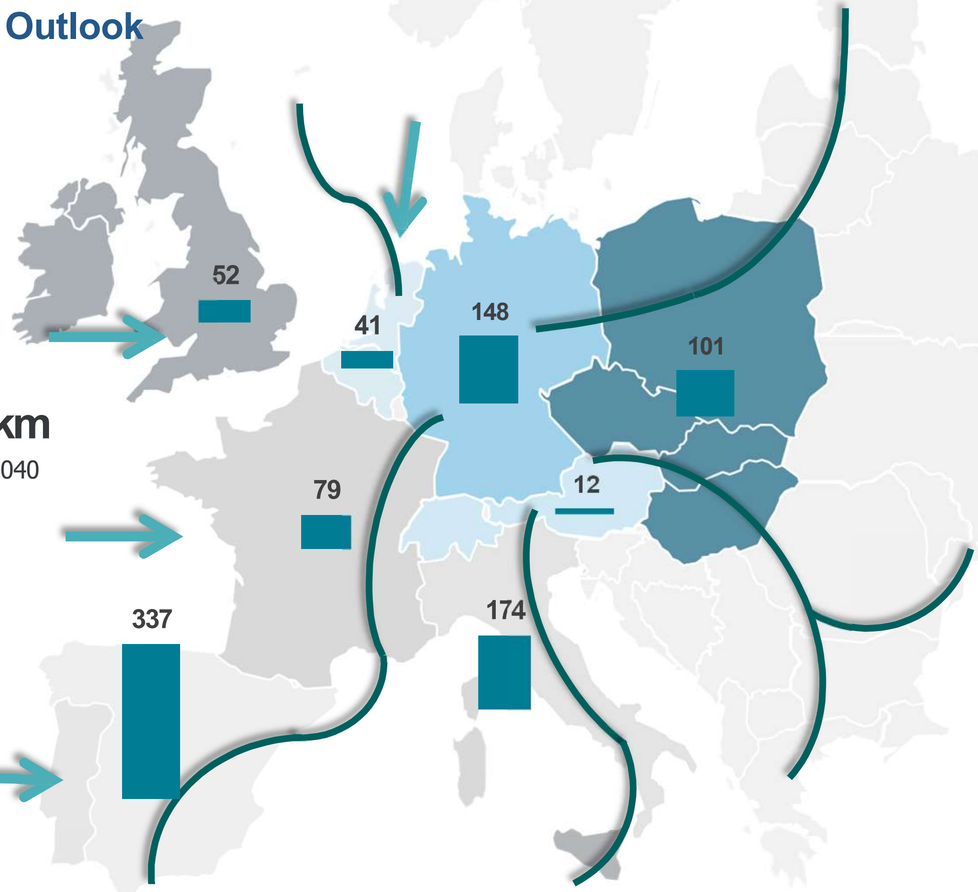




(*) *hydrogen, e-crude, e-ammonia and e-methanol*

H_2 Backbone delivers flexibility to the European energy system and ensures competitiveness of European production

Hydrogen Outlook
TWh, 2050



53,000km
of H2 transport by 2040

24TWh
of H2 underground storage by 2050

STRESS TEST

No pan-European development of hydrogen cross-border transport and underground storage infrastructures

IMPLICATIONS

+€5.7bn/year

+26%
in local hydrogen production costs

-182TWh
in EU hydrogen production

Agenda

Conclusions

- **Acceleration of decarbonization** needed across all energy sectors (7.8%/y vs. 1.2% historical).
- **Significant increase of power demand** mainly driven by industrial and transport needs. Electrolysis tends to be developed outside Belgium because of limited RES potential in Belgium while its gas infrastructure allows to import low-carbon molecules.
- **PV, wind onshore and offshore** supplying an increasing power demand, complemented with imports.
- **Decarbonized thermal generation** keeps a prominent role for addressing seasonal flexibility needs.
- **A variety of flexible technologies** address increasing short term flexibility: batteries, demand side management, electrical vehicles, heat pumps and electrolyzers.
- **Decreasing energy demand** resulting from efficiency gains and fuel switching to support economic growth.
- **Importance of low-carbon molecules**, more than in other European countries. Electrification of international transport and non-energy uses is difficult.

QUESTIONS / ANSWERS

Think tank

Offshore market and system integration challenges triggered by massive penetration of inverter based resources

19th December 2023

Agenda

- Roadmap of offshore developments
- Key technical challenges
- Implications on market design
- Takeaways

Roadmap of offshore developments


Princess Elisabeth Island

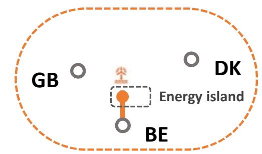
Towards +3.5 GW offshore wind integration and hybrid interconnectors for Belgium

elia
| Elia Group

2025 2026 2027 2028 2029 2030 2031 2032 2035

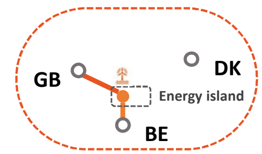
+3.5 GW offshore wind

- +700 MW offshore wind AC– phase I — when Ventilus is ready
- +1400 MW offshore wind AC – phase II — when Boucle du Hainaut is ready
- +1400 MW offshore wind DC– phase III



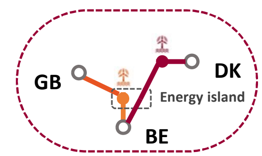
Nautilus

Nautilus hybrid (BE-GB) to be connected to the Princess Elisabeth Island from 2030 onwards



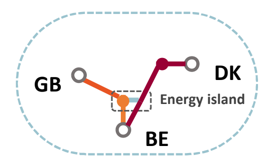
TritonLink

TritonLink hybrid interconnector** will **connect offshore wind from DK by 2031-2032

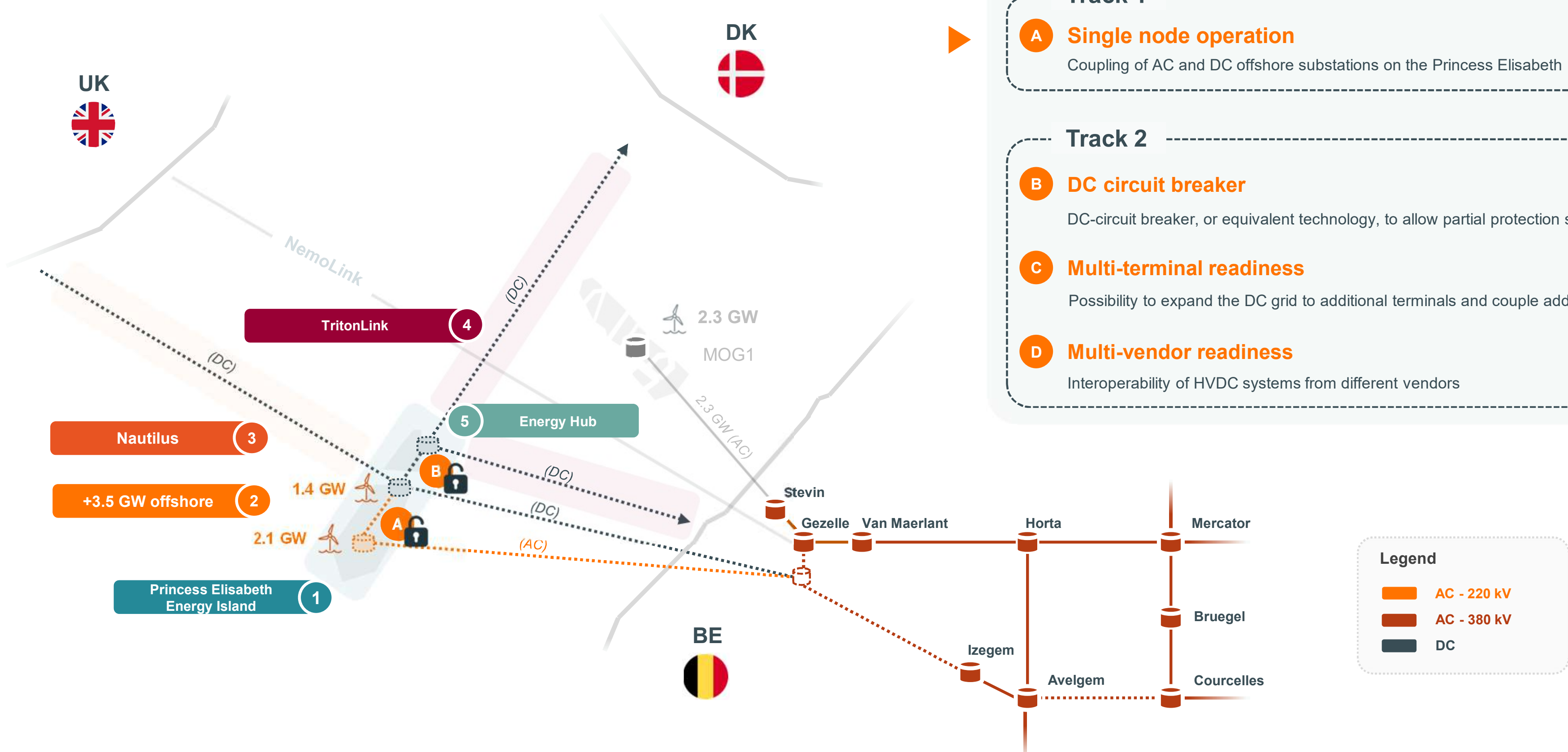


Energy hub

*HVDC substation on energy island to create an **energy hub** (BE-UK-DK)*



Towards meshed offshore grid with dispatching opportunities



4 key enablers in 2 parallel tracks to reach the offshore meshed grid

Track 1

A Single node operation

Coupling of AC and DC offshore substations on the Princess Elisabeth Island

Track 2

B DC circuit breaker

DC-circuit breaker, or equivalent technology, to allow partial protection selectivity in the DC grid

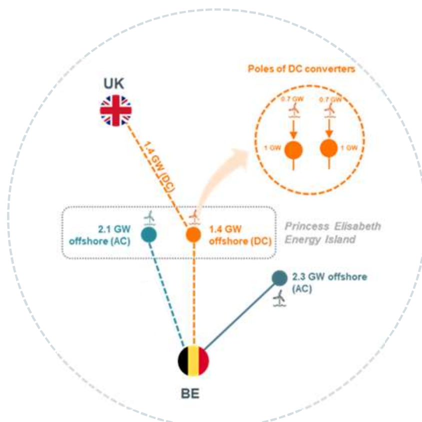
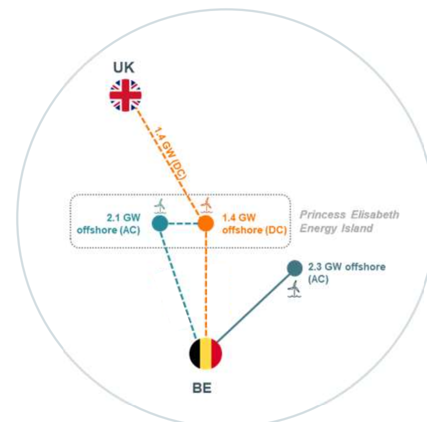
C Multi-terminal readiness

Possibility to expand the DC grid to additional terminals and couple additional interconnectors

D Multi-vendor readiness

Interoperability of HVDC systems from different vendors

Showcasing the complexity of the future with a focus on the single node – rationale

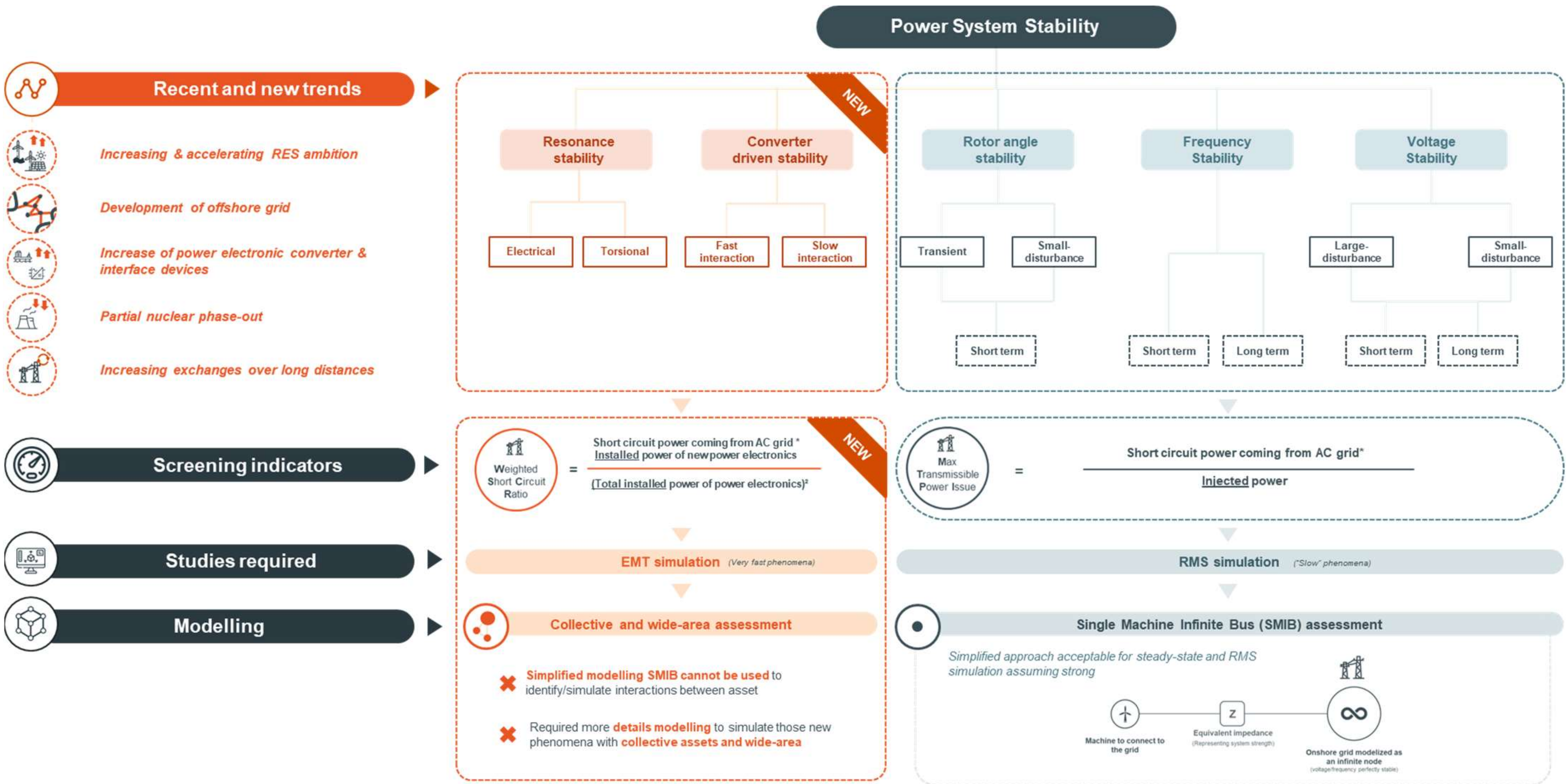
Market standard	Ambition
Split-node DC decoupled	Single-node
	

	Split-node	Single-node
Redundancy	Lower	Higher
Socio-economic welfare	Reference	Higher*

Increase of the **redundancy** and **socio-economic welfare**

Key Technical Challenges

The Belgian and European system will face massive changes in the coming years leading to new power system stability phenomena



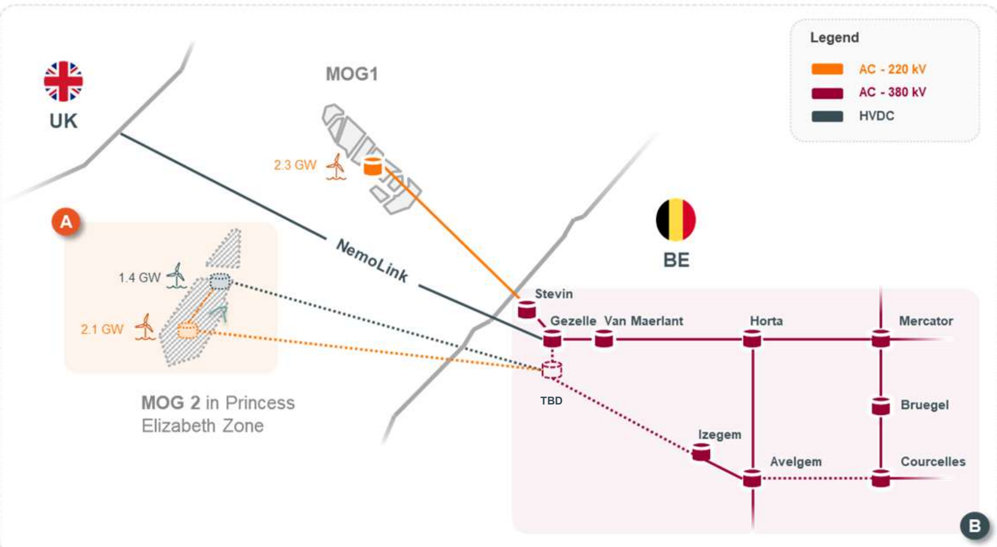
These new power system stability phenomena might have severe consequences

- **2013** — **Germany:** instability following switch on of a parallel cable where wind farm (WF) control system excited the grid at its resonance frequency
- **2016** — **Australia:** South Australia black-out due to transmission lines damaged and wrong settings of WF controller
- **2019** — **Great Britain**: Partial black-out due to interactions between WF and the grid after a topological change
- **2020** — **Scotland**: Multi-terminal HVDC with observed oscillations and unplanned disconnections
- **2022** — **France and Spain:** system interaction due to HVDC interconnection between both countries. RTE has put a lot of effort (multiple studies and tests) but root cause not detected yet, flow limited to damp the interaction between converters

These new system stability phenomena will be faced in Belgium and without proper measures will not enable the single node

elia | Elia Group

Princess Elisabeth Island grid design



Resulting instability risk for Belgium case

Starting point of the feasibility study to identify risks and mitigation means

	Single node	Split node
A Offshore	1.51	3.53
B Onshore	1.05	2.33

Weigthed Short Circuit Ratio

Grid strength calculation with WSCR indicator

WSCR	Assessment	
> 2.5	Acceptable	▶ **Standalone tuning** of IBR control system is **often sufficient** to achieve satisfactory outcomes ▶ **Standard control system parameters** are **likely to work**
1.5 – 2.5	Not guarantee	▶ **Standalone tuning** of IBR control system is **not sufficient** due to increased risk of interactions with other nearby IBR ▶ **Site-specific control system tuning** is **likely to be required**
< 1.5	Unacceptable *(not working)*	▶ **Site-specific control system** tuning by itself **is not sufficient**. ▶ **Additional equipment** like **synchronous condensers** and **grid-forming inverters** will be required to achieve acceptable behavior

Weighted Short Circuit Ratio = $\dfrac{\text{Short circuit power coming from AC grid * Installed power of new power electronics}}{(\text{Total installed power of power electronics})^2}$

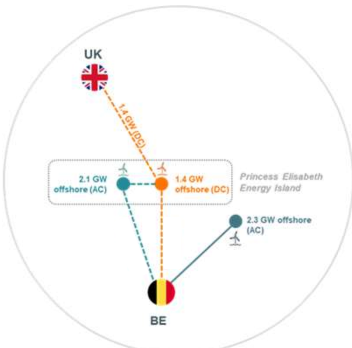
* IBR represents all resources asynchronously connected to the electric grid and are either completely or partially through power electronics (wind, solar, HVDC, energy storage etc)

Single node operation is a world premiere…What are the key development needs?

Based on RMS and EMT simulations…

Ambition

Single-node



3 key technical developments will be required to enable the single node

1 Active power set-points optimizer

Active power set-points must *be given to the offshore DC converter station in Single Node Operation and* ***must be coordinated*** *with the actual wind energy production and transmission capacity of the AC and DC systems*[1]

2 Upgraded functionalities for the HVDC control & protection system

- *New harmonic and dynamic phenomena occur due to the coupling of the AC and DC paths (e.g., power swings)*
- *Incidents are seen by both converter stations due to AC coupling of stations*
- *Spontaneous transitions between Single Node and Split Node might occur, even if very unlikely*

3 Additional mitigation measures for the risk of losing 3.5 GW of OWF production

Potential for power system stability issues[2] *and cascading effects*[3] *due to post-incident overload is increased as:*

- *any disturbance on the DC side directly impacts the AC side (and vice versa)*
- *there is a high concentration of power electronics connected in antenna on a weak connection point*

The development of **upgraded functionalities for the HVDC control and protection system** and the **co-tuning of the HVDC and OWF controllers** are major attention points. **The dynamic performance of the installations from OWF and HVDC with conformity process will be key to secure the stability of the power system**

STEP 2 - Key technical developments

1 Active power set-points optimizer — *Elia*

Existing initiatives at Elia group level that can be used in this framework (MiO 2.0)

2 Upgraded functionalities for the HVDC control & protection system — *HVDC vendor*

Non-standard control (grid forming) + control strategy

3 Additional mitigation measures for the risk of losing 3.5 GW of OWF production due to:

Part 1

Cascading effects due to post-incident overload

- a **OWF modulation**
- b **Local automatism**

Elia

Part 2

Power system stability issues

- c **Harmonic filters (to be confirmed)**
- d **(Co-)Tuning of HVDC controllers**

HVDC vendor

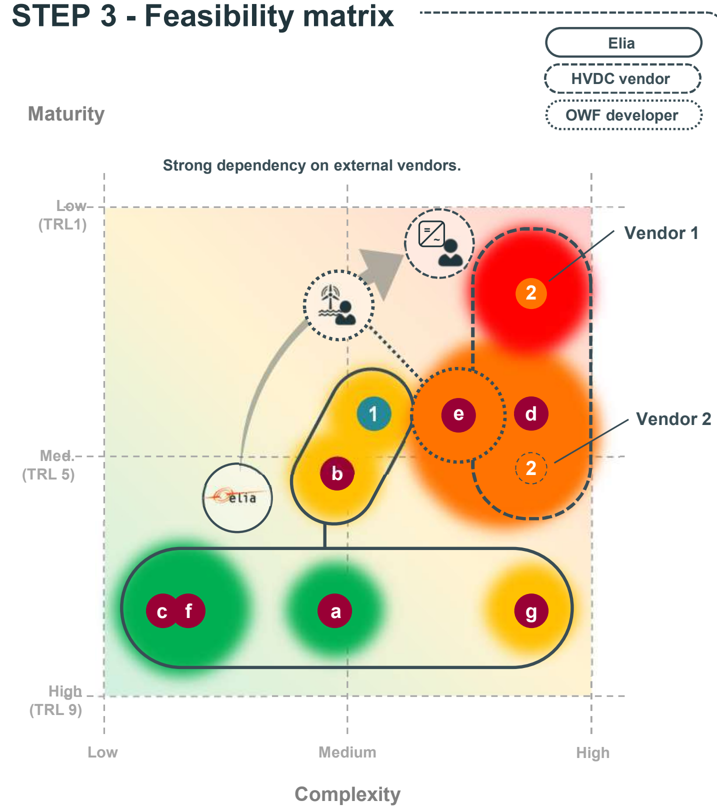
- e **(Co-)Tuning of OWF controllers**

OWF developer

- f **Synchronous condensers**
- g **SIPS**

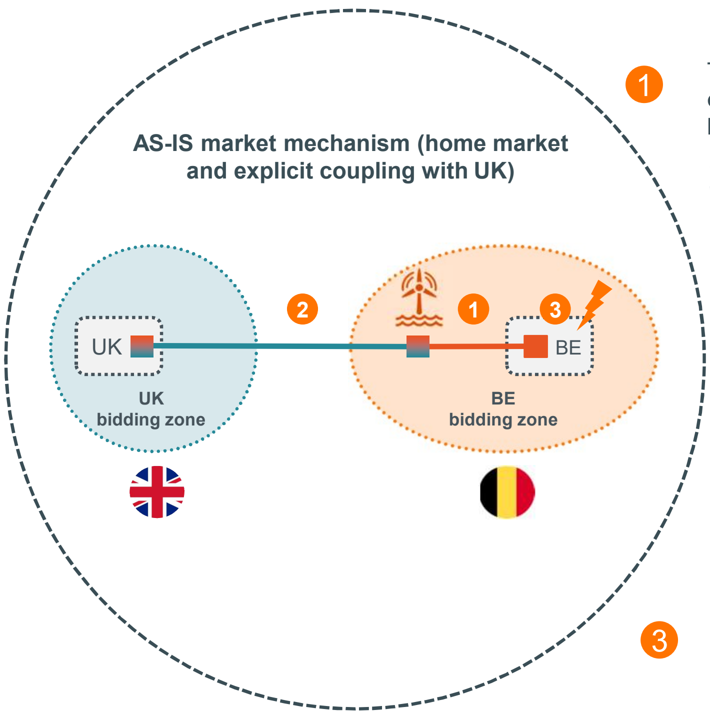
Elia

STEP 3 - Feasibility matrix



Market design for hybrid interconnectors
… and implications of the single node

The inefficiencies linked to the current market design approach



1 The market clearing will not take into account **the technical limit of the offshore grid** and will be based on forecasting of wind production from PEI leading to intrinsic inefficiencies

Offshore wind would physically inject all their offered energy in the Belgian bidding zone without consideration of the technical limits of the offshore infrastructure.

2 **With Brexit, capacity allocation with UK is taken into account 'explicitly'** (ex-ante) and will be based on forecast, leading to inefficiencies

In case of underestimation of wind farm from PEI, infeed on PEI-BE onshore coast will exceed physical limit of the asset
In case of overestimation of wind farm from PEI, link PEI-BE will be under-utilised

3 **In case of overload, Elia will need to intervene** to reduce the wind production from Princess Elisabeth Island to secure operational limit and will perform **redispatching to compensante** the wind reduction with costly means

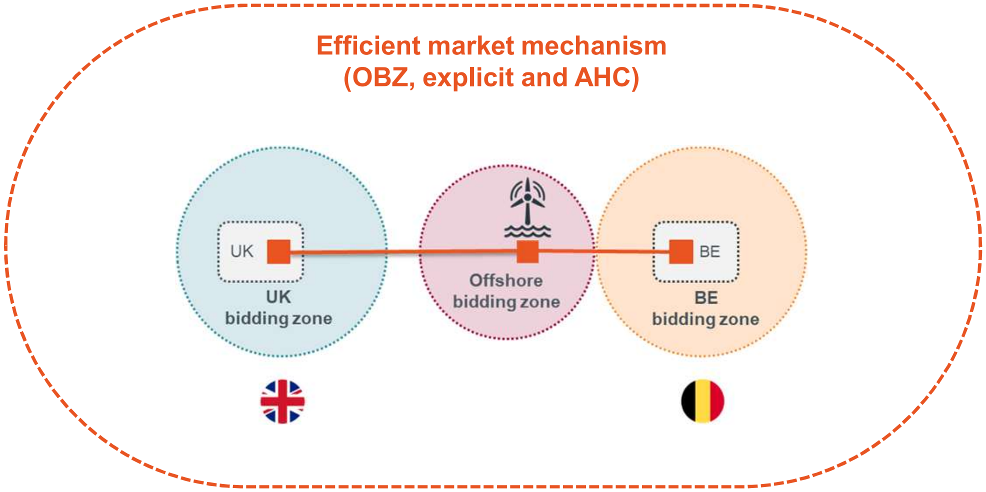
Wind will be ramped down, and the resources available to ramp up will typically be gas-fired powerplants

Tarket market design for Princess Elisabeth Island

Offshore Bidding Zone + **Implicit price coupling with UK** + **Advanced Hybrid Coupling**

What does the market mechanism need?

- **Visibility** on the scarce transmission capacity
- **Freedom to do the arbitrage** of how to best use this scarce transmission capacity until real-time



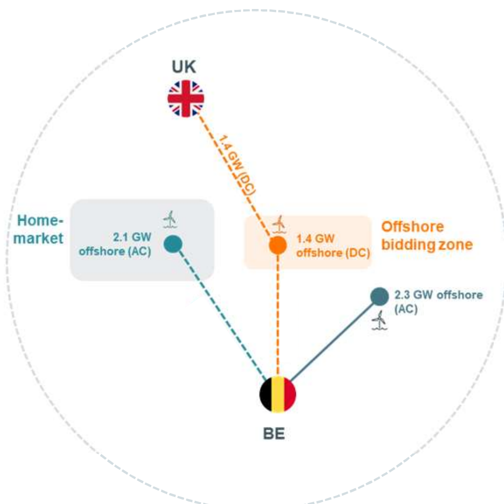
Why does it matter?

- **Maximize socio-economic welfare**: a bigger cake to share
- **Correct incentive**: enable an optimal dispatch
- **Maximize offshore wind production**
- **In line with European legislation**

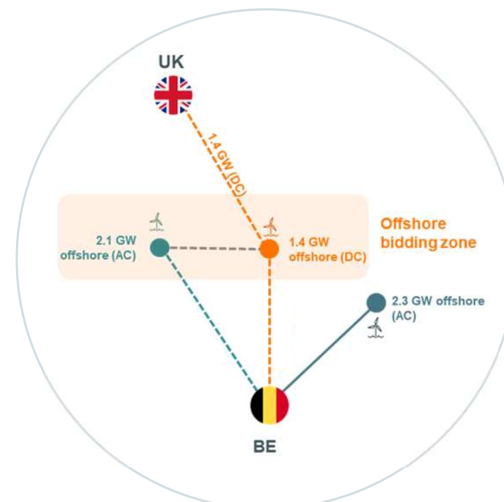
An evolution to a single-node would imply an evolution of the scope of the OBZ: it would be extended to the full PEZ instead of being limited to the DC part only

Ambition

Split node → ? → Single node



- Uncertainty regarding market set-up
- Uncertainty on business case
- Impact on business case



Support mechanism that is protecting the revenues against a transition to an OBZ ("capability-based CfD") and which allows to get back under CfD in case of market change

Takeaways

Key takeaways

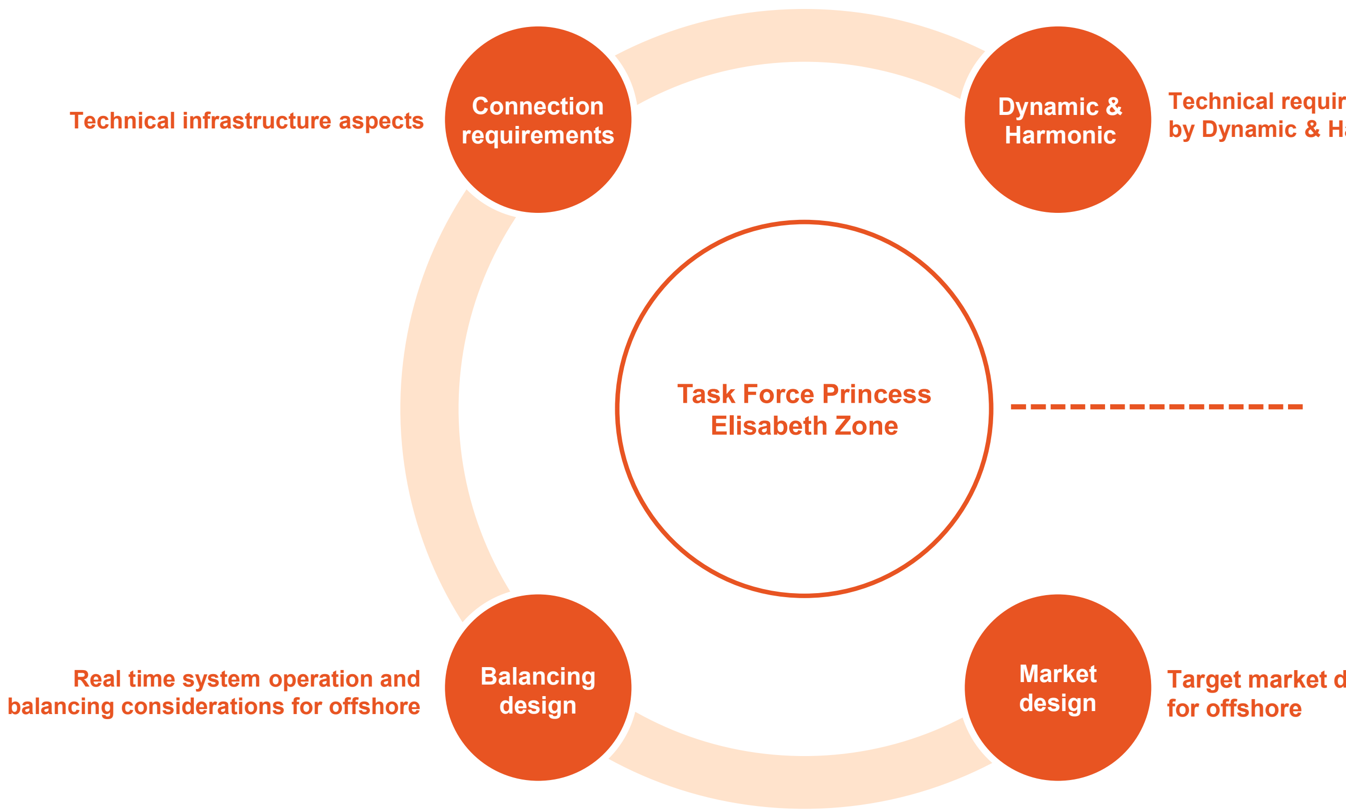
1 With increased shared of inverter based resources in the system, **complexity is increasing**. This will impact TSOs, but also grid users.

2 **Expertise domains** that were previously well delineated tend to be **more and more intertwined**: from assets, to system, to market.

3 The complexity of the system is increasing. **A helicopter view on the different areas of expertise** is required to find innovative solutions at the cross-roads of different fields

Elia launched recently a public consultation Task Force Princess Elisabeth Zone (PEZ) covering these topics, and others, in preparation of the offshore tenders PEZ held Q4 2024

Public consultation Task Force Princess Elisabeth Zone



- Summary of **2** years discussions with stakeholders
- **+250** pages
- **2** months for consultation *(20/11/2023 – 22/01/2024)*

More info

WWW **Elia website public consultation**

Thank you

Think tank
System Blueprint Study

19th December 2023

Electricity System BluePrint study

Horizontal Electricity Think Tank 19/12/2023

Generated with AI (FireFly)

What are we going to talk about ?

- Recap study objectives
- What happened since September ?
- Improvements introduced after the workshops
- Scenarios updates

Blueprint study: a comprehensive study examining various energy scenarios for 2036, 2040 and 2050 reaching divergent visions for Belgium/Europe

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As electricity TSO we…

…have 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, grid physical constraints …

…have to develop a future electricity grid 'fit for purpose'

- Grid infrastructure projects >10 years to build
- Need to require grid infrastructure corridors
- Highlight necessary steps and decisions in coming legislation period

- Further inform the general public & policy makers on impact of different visions for Belgium energy landscape
- First step for future federal network development plan post 2035

What happened since the first Think Tank in September ?

3 dedicated workshops & a consultation

- Workshops
  - 24/10. On methodology and assumptions/scenarios.
  - 13/11. On costs components, held by Compass Lexecon
  - 13/12. On improvements to the methodology and assumptions/scenarios

- A consultation for one month on the costs, methodology and assumptions that ended 18/12

Main feedback received & discussions during the workshops (non exhaustive)

- questions related to the modelling of other vectors (hydrogen, heat, methane, liquids...)
- costs assumptions for certain technologies, WACC
- costs for non explicitly modelled vectors and scope of the cost assessment
- flexibility that can be harvested in heating networks, cogeneration...
- optimization of investments in other generation assets than offshore & thermal
- simplifications that could be introduced in the geographical granularity
- clarifications regarding methodology, models, assumptions, scope of the assessment
- ...

We would like to thank you for the attendance during the workshop & the interactions, feedback and questions raised.
The presented slides were sent by mail as par to the consultation that ended yesterday as well as minutes summarizing the main points/questions raised during the workshop

Feedback from the consultation

Several bilateral feedback calls/exchanges were held:

- Belgian Offshore Platform
- GE Vernova
- EDF Luminus
- Fluxys
- EnergyVille (through Febeliec)

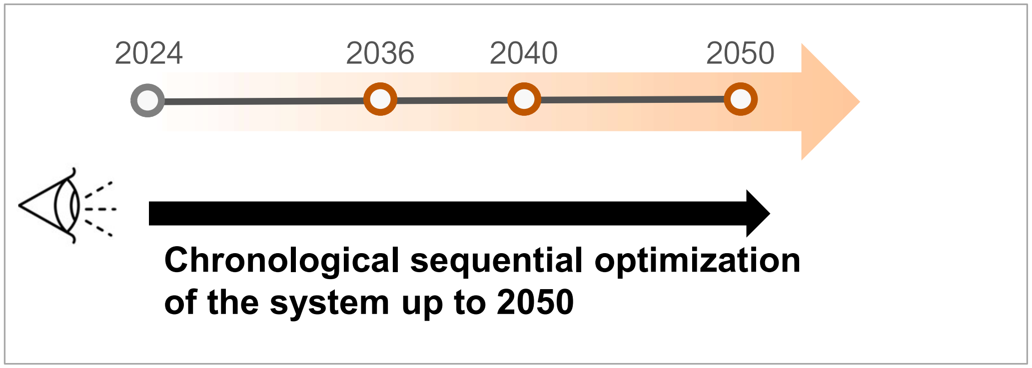
Written feedback received from:

- Belgian Offshore Platform
- EDF Luminus
- EDORA
- Engie
- Essenscia
- FEBEG
- Febeliec
- Fluxys
- GE Vernova

We are still looking into the different comments received yesterday

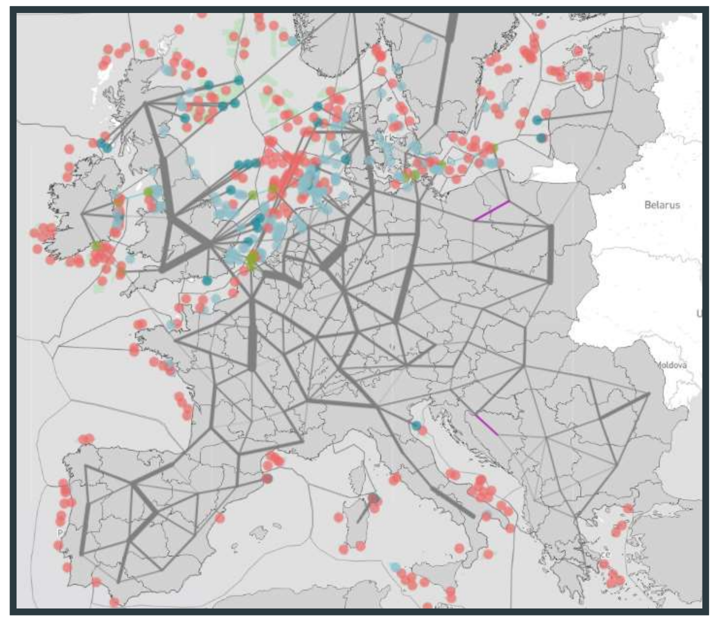
Methodology – state of play

High level methodology



- 3 timehorizons
- Net Zero in 2050 at European level.

- Electricity market model including all interfaces to other vectors*
- Multi climate year with a forward-looking climate DB integrating climate change
- Hourly dispatch including hydro, demand flexibility in EV, heating & industry, storage for each zone
- European perimeter (incl. imports outside of EU)
- Flow based (grid constraints accounted for between small zones)
- 100 zones onshore, 250 offshore zones
- Endogenous investment in infrastructure, thermal, electrolysers, offshore wind (radial, hybrids, multi-terminal), storage



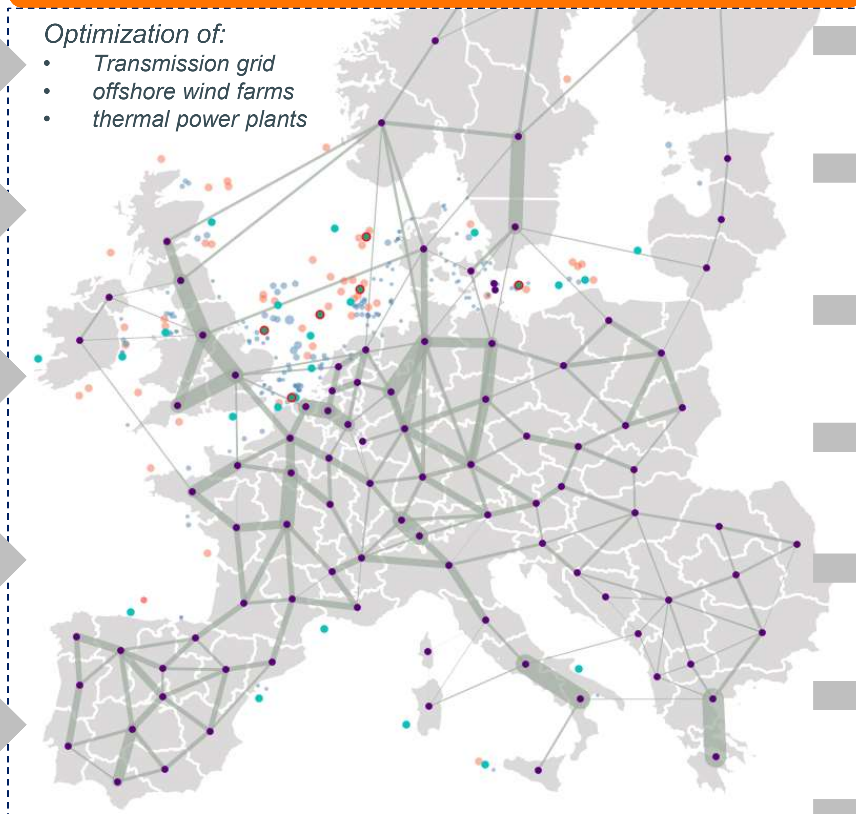
see also later for improvements introduced for other vectors (e.g.: H_2 model)

Using our expertise, we are building a model which will help in seeking answers

Inputs

- Hourly electricity demand, PV, wind
- Thermal capacities, constraints, fuel prices
- Physical constraints on the European HV grid
- Investment candidates (offshore, grid, electrolysers, storage...)
- …

EU-scale zonal electricity model (KARI)



Outputs

- *(Optimal)* Electricity mix
- CO_2 emissions
- System Costs *(CAPEX + OPEX)*
- Onshore & offshore transmission grid
- Electrolysers & imports of hydrogen
- Marginal prices
- …

Improvements introduced after discussion and feedback received

Improvements added after feedback during the workshops:

- Addition of a **hydrogen model** to get more realistic prices for H_2. Those are then linked to the prices used in potential hydrogen turbines and electrolysers (see next slide)
- Endogenous investments in **daily storage** (in addition to the ex-ante predefined scenario values)
- Full **adequacy assessment** (similar to the AdeqFlex methodology)
- Distinction between bottom-fixed / floating offshore for the costs estimates

Still under investigation:

- Addition of **heating networks** providing flexibility to the electricity heat requirements at residential level
- Heat storage
- Explicit modelling of **fuel switching in industry** (e-boilers -> gas/CHP boiler)
- Explicit modelling of **additional vectors** (CH_4, CO_2, ammonia, liquids (oil derivatives), methanol...)

H_2 model – How does it work?

The goal of adding such a model is to have a better representation of the other vectors to assess the impact on the electricity system.

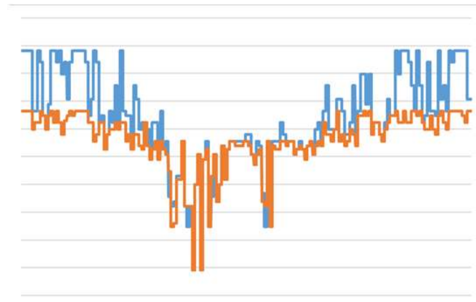
- **~Daily** dispatch and **yearly** optimization

Aggregated modelling

Modelling by country

Not explicitly modelled

Example of outputs



H_2 prices for all studied zones

Zone A

Zone B

H_2 Imports

example here: intl. shipping

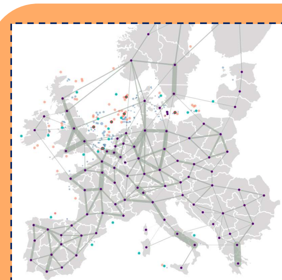
…

H2 model – Interaction with the electricity model

➢ Iteratively optimizes the electrical transmission grid, taking into account an “optimized” H2 model

Initial setup:
- H2 prices
- Non-E-linked H2 demand
- Starting grid
- Import potentials & prices
- …

KARI model



- Update H2 prices
- Run simulation
- Invest in electrical transmission candidates
- Invest in $P2H_2$ / H_22P
- …

H2 consumption generators
Electrolyser dispatch

~daily H2 prices

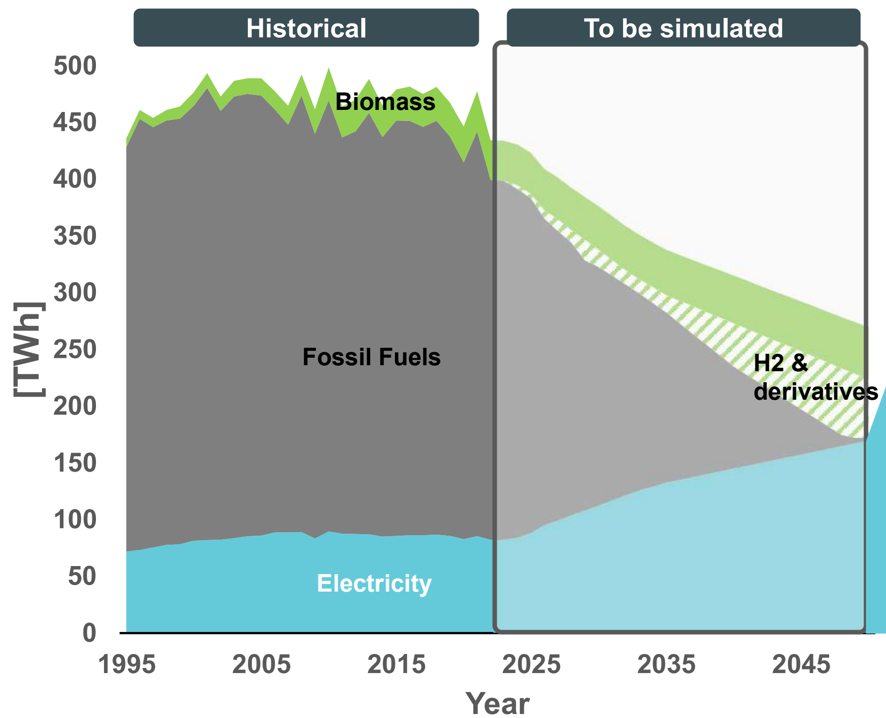
H2 model

- Update E-linked H2 demand & generation
- Simulate
- **Fully** iteratively optimize for each electrical iteration
  - H2 grid
  - H2 storage
  - …
- Calculate final ~daily H2 prices

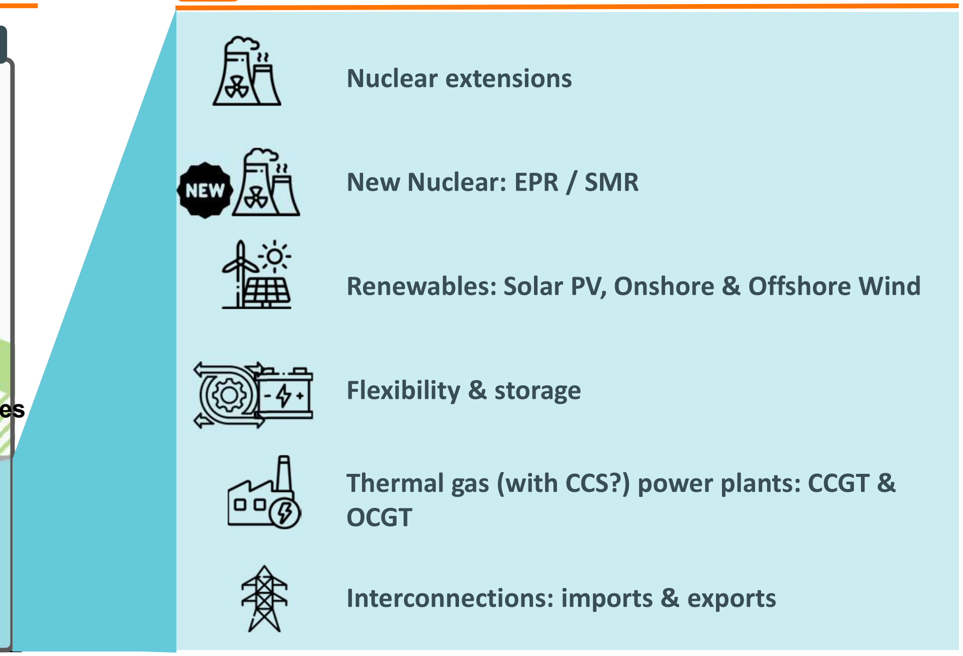
Scenarios – state of play

Several long term need to be scenarios assessed

1 Evolution of final energy demand



2 Multiple Supply and storage options



Which sources will be used to supply this electricity?

➢ **Multi Energy demand scenarios are used for whole Europe**

Proposed scenario framework

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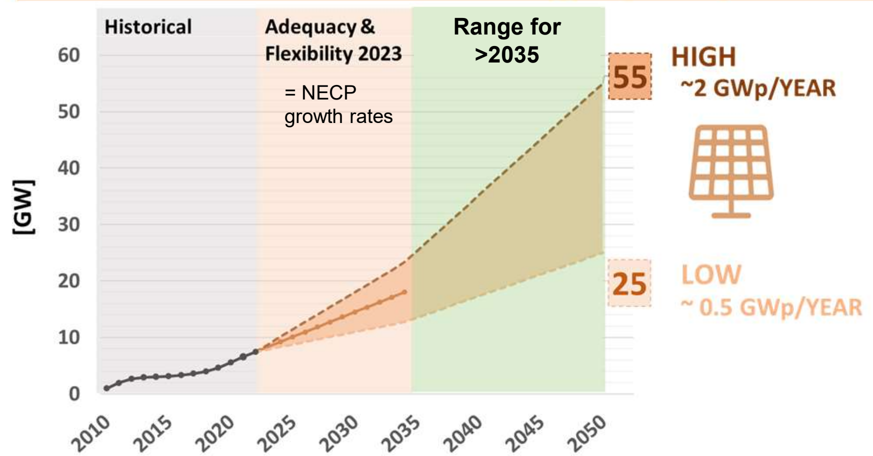
	Main supply & demand scenario	Potential sensitivities
EU Demand & supply potentials	DE · GA — 'Distributed Energy' and 'Global Ambition' scenarios from preliminary data from TYNDP 2024. Reality check with NECPs and national studies	*Possible sensitivities:* • *High PV in (Southern) Europe* • *Nuclear "renaissance" in Europe* • *Sufficiency/sobriété at EU* • *…*
BE Demand	ELEC — Accelerated electrification · MOL — Moderate electrification	SUF — Sufficiency/sobriété sensitivity — *Reduction of the end-use energy demand due to behavior changes*
EU Optimization	Offshore in Europe, EU electricity grid, H2 storage, supply & grid, P2x location, Adequacy (=thermal generation needed), storage requirements... for each country/zone	
Starting BE Supply	Amount of min "baseload" supply in/to Belgium in 2050: 8 GW · 6 GW · 4 GW · 0 GW	*Sensitivity on the type of baseload (not affecting the dispatch, only the total system costs)* • *High PV with high baseload* • *Nuclear for industrial heat* • *Heating networks* • *…*
BE Optimization	BE (& from/to) electricity grid , Offshore connections to BE, BE Adequacy...	

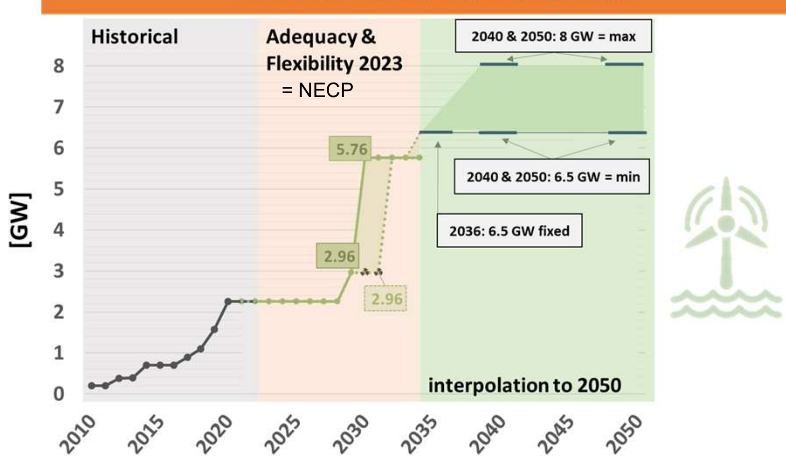
RES potential in BE evolution - Today to 2050

- Start from Adequacy & Flexibility assumptions and interpolated to 2050 targets
- For offshore we assume a fixed capacity of 6.5 GW in 2036 in the BE EEZ.
- Further investment (on top of the base assumption) in offshore in the BE EEZ is possible up to 8 GW in time horizons after 2036.
- Investments in offshore not in the BE EEZ connected to Belgium is possible in all years

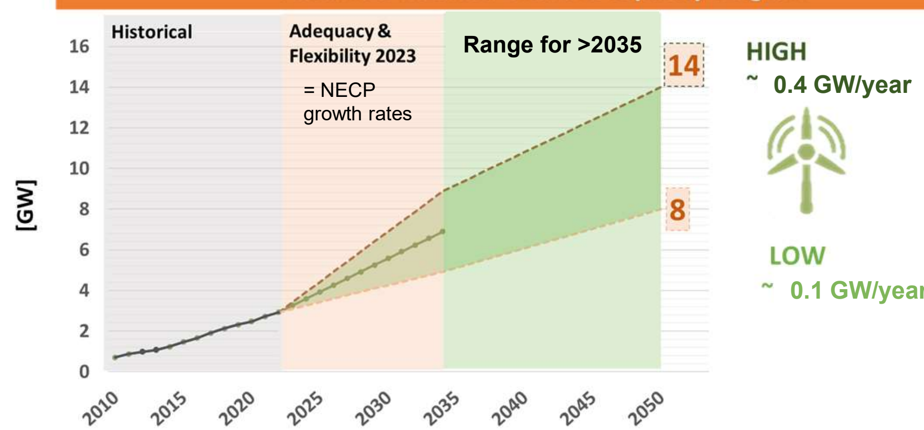
Assumed installed solar capacity in Belgium



Assumptions offshore wind in Belgium EEZ



Assumed installed onshore capacity Belgium

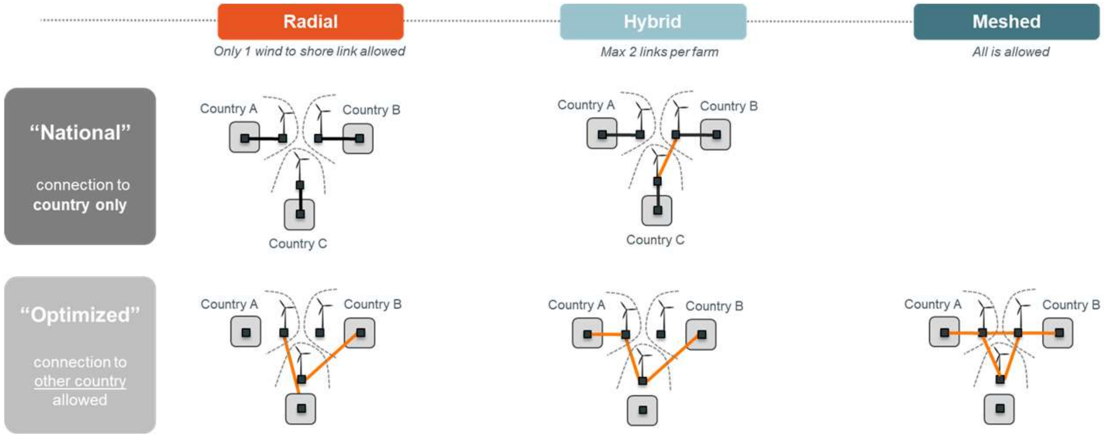


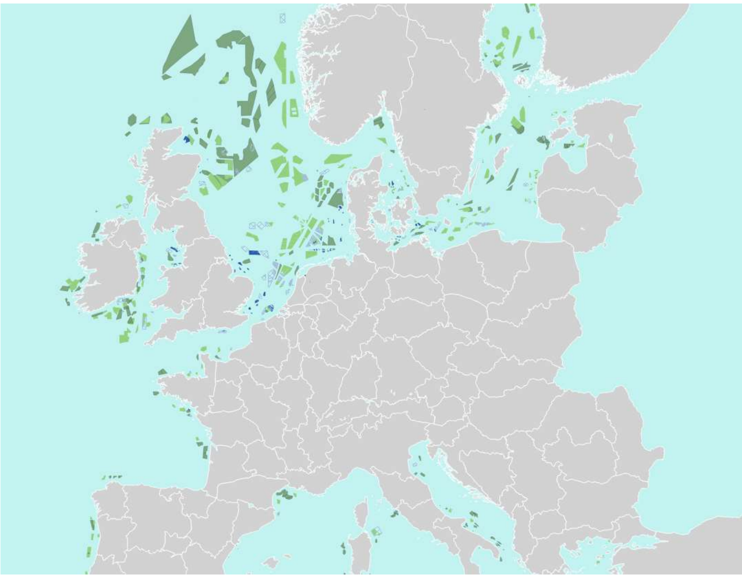
European offshore investment options

Offshore wind potential

- Based on existing government ambitions, an initial capacity of 120 GW is assumed to be installed in the North sea region by 2030. This is taken as the minimum for 2036
- For the entire simulation (entire EU) perimeter we have a total potential volume of 840 GW for 2050
- Offshore investments are clustered by 2 GW windfarms

Different options to connect offshore windfarms for which the landing onshore point is not known:

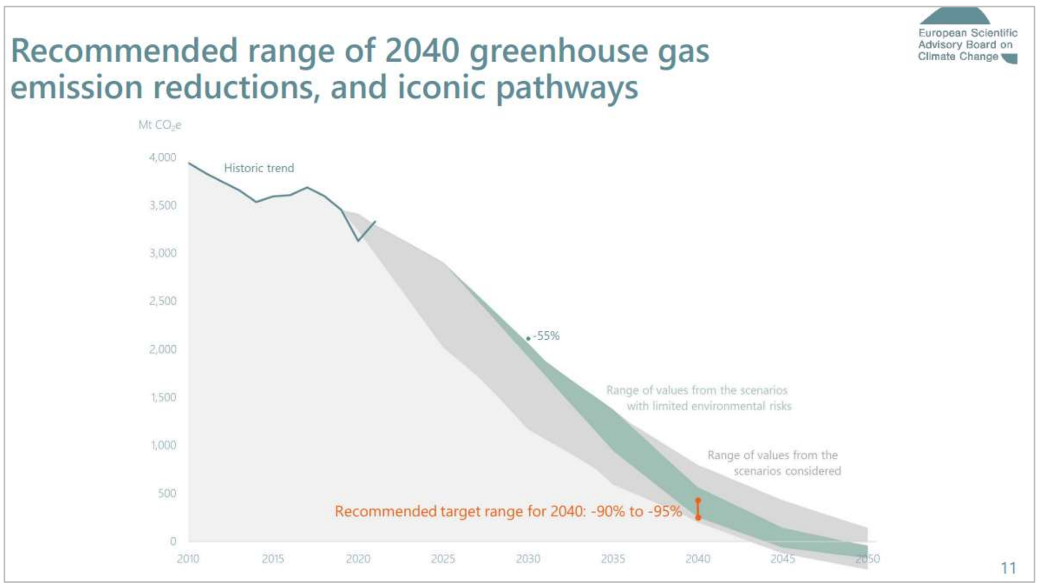




- Existing
- Initial capacity – no further interconnections
- Initial capacity – further interconnection allowed
- Candidates for 2036, 2040 & 2050
- Candidates for only 2050

CO2 emission trajectories – an EU-level target

- We propose to set as initial benchmarks at an EU level:
  - Emissions set in the FF55 EU plan for 2030
  - Net zero for the energy sector by 2050 at EU level
- We need to set intermediate targets for 2036 and 2040



Source: The EU Climate target for 2040 – stakeholder workshop
18 Oct 2023 – Joeri Rogelj

- Several studies mention -90% as possible target for 2040
- What targets should we set for 2036 & 2040? Do you have any proposals? – still awaiting feedback from stakeholders

Potential sensitivities that were identified during the workshops or in bilateral calls

- What if the final usage of the demand is strongly reduced (suffiency/sobriété) ?
- What if offshore is always connected radially ?
- What if the volume of demand flexibility is significantly increased ?
- What if there is a nuclear renaissance in Europe ?
- What if the import prices of H_2 is much higher/much lower ?
- How would the results evolve with additional heating networks ?
- Impact of higher/lower costs on the results ?
- ...

Next steps

- We are processing the feedback from the consultation on methodology, costs and scenarios; All comments and feedback/questions will be published in January on our website together with the answers and adaptations made to the model and methodology.
- Identified improvements are still being implemented in the modelling framework
- Final scenarios will be quantified & added to the models
- A dedicated workshop will be planned in end-February/March

Questions ?

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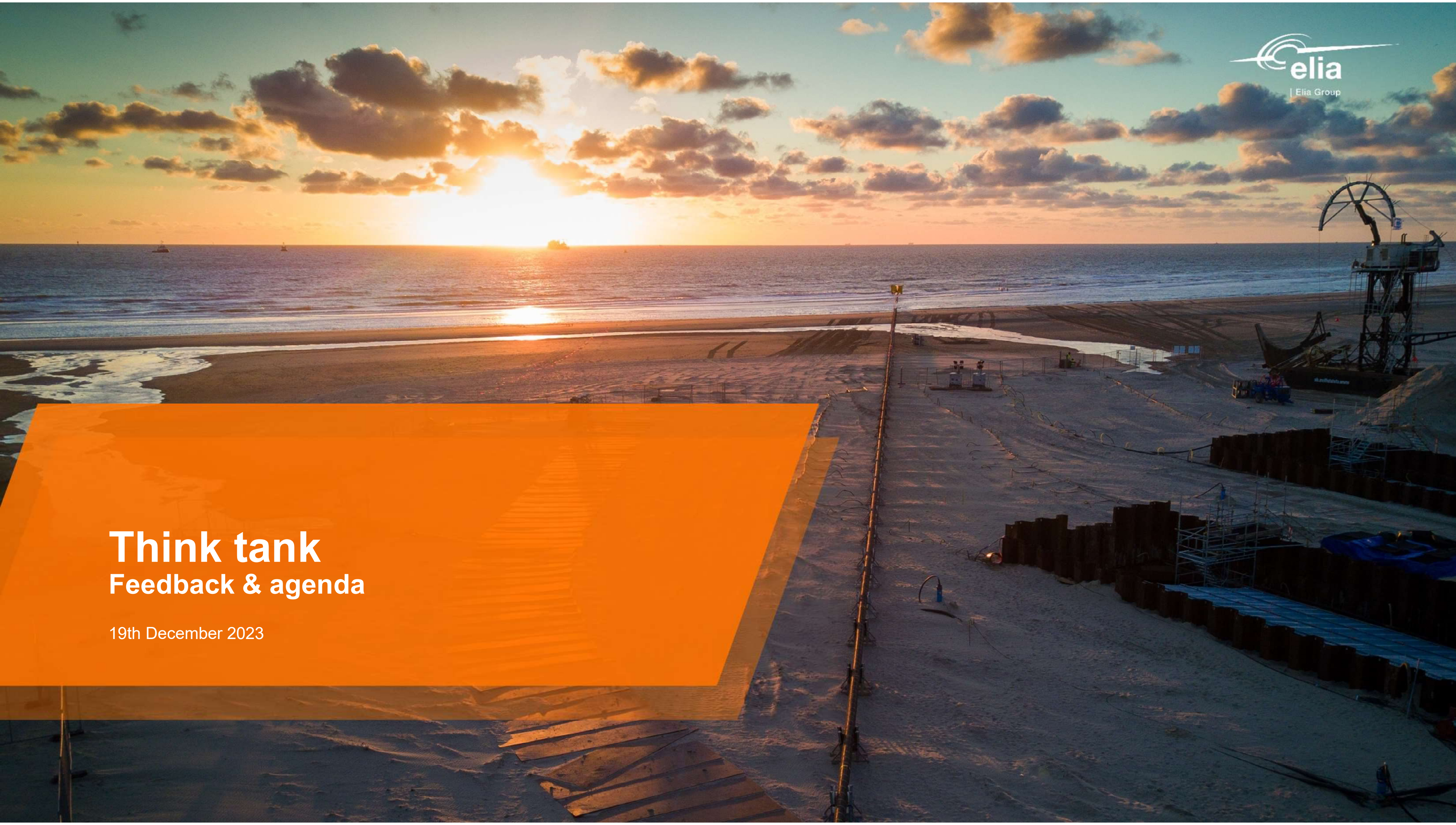

Think tank
Feedback & agenda

19th December 2023

Feedback & agenda

Agenda 01/03/2024:

1. TBD

Data 2024 – 13-16u:

- 01/03/2024
- 10/06/2024
- 23/09/2024
- 25/11/2024