THE HORIZONTAL ELECTRICITY SYSTEM THINK TANK

06 June, ‘25

1. **Tractebel** – SMRs: state of play
2. **Elia** – Flex@scale
3. **Energyville/Vito** – Paths 2025
4. **Florence School of Regulation** – developments at EU level

SMRs, a technological brick to leverage?

The horizontal electricity system think tank

06/06/2025
celestin.piette@tractebel.engie.com

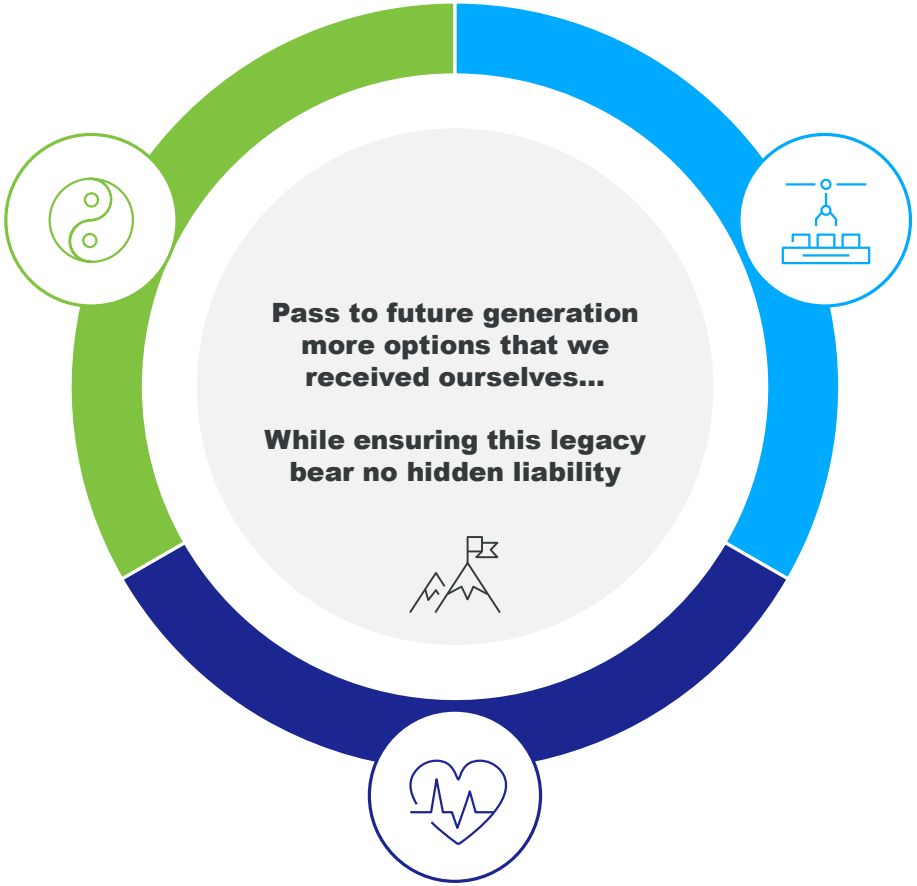
PUBLIC | INTERNAL | RESTRICTED | CONFIDENTIAL

Housekeeping
Disclaimer

- All information is publicly available, yet its compilation and coherent restitution is proprietary.
- Simplifications are deliberately made given the time and the scope of the presentation.
- This presentation reflects a state-of-the-art of the domain.

General Introduction

What is at stake?



Global changing context

Global pandemic
Exposed the fragility of over-optimized globalized supply chains

Energy crisis
Reestablished the preeminence of Energy as the lifeblood of our modern economies

War in Europe
Re-shaped and deepened former alliances

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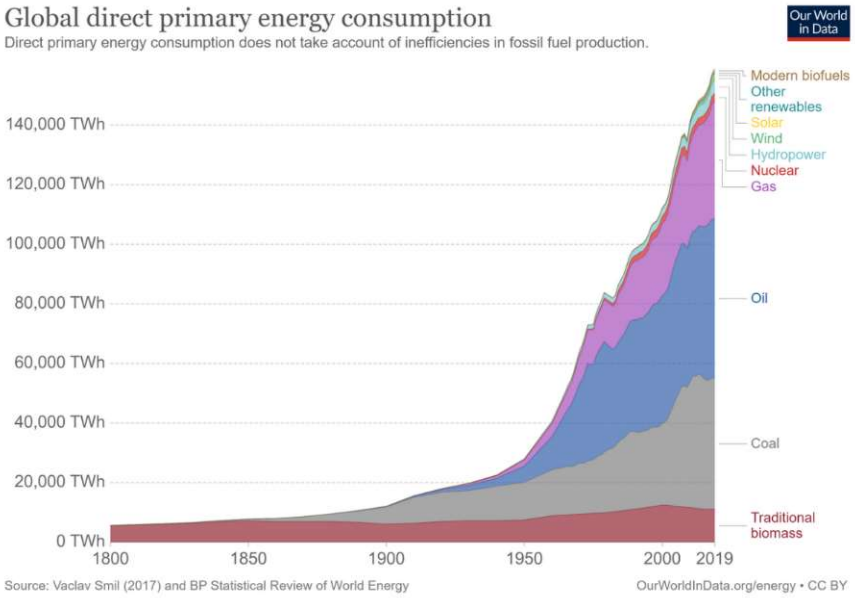
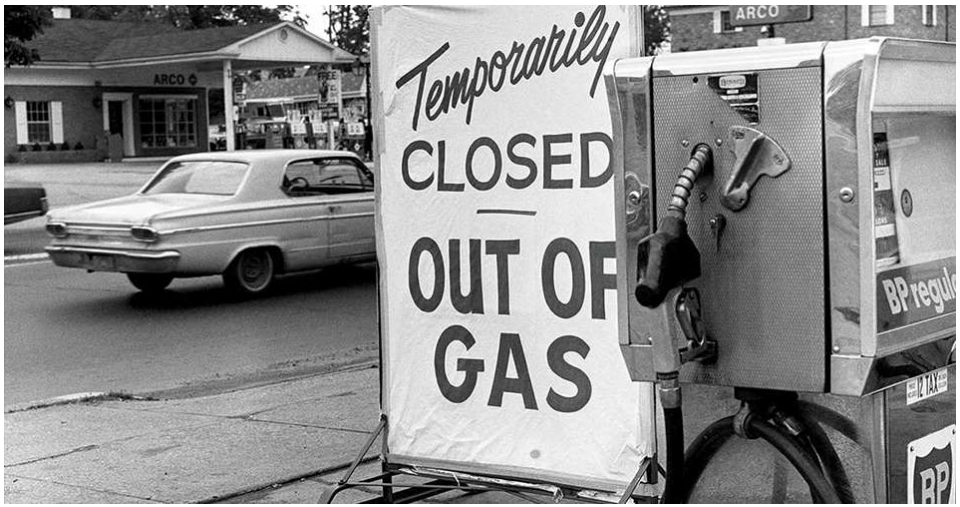
An echo of the past?

The XXth drivers for current operating fleet of nuclear reactor

Past Driver #1: Need for abundant energy



Past Driver #2: Price stability & security of supply



Archive image from 1973 oil crisis

Why was nuclear the answer then?

Amount of fuel needed to produce 1.000kWh

350kg of coal

250l gasoline

300m^3 fossil gas

4g of enriched uranium

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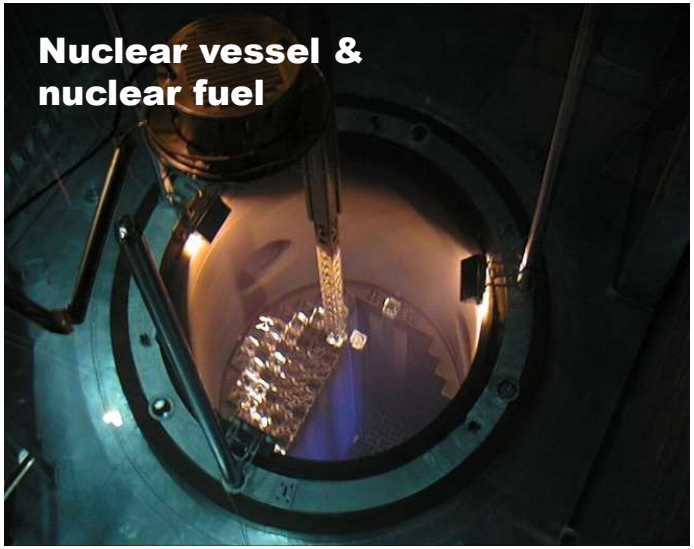
How is that energy channeled into useful energy?



What concrete impact it had delivered so far?

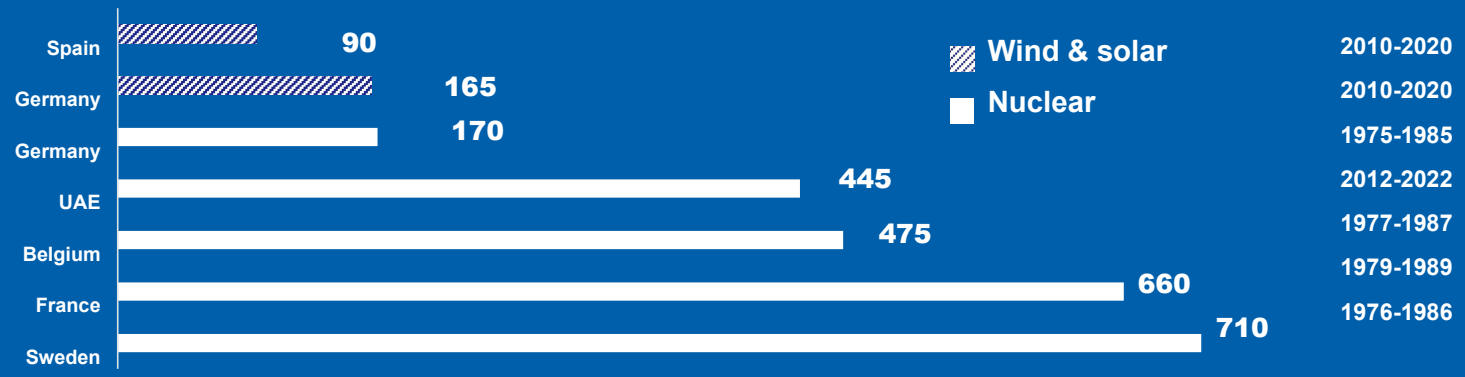
Key figures

438
NUCLEAR UNITS
Operating Worldwide

~40%
Low carbon generation
in Advanced Economies

2.735 TWh
Electricity production
2021

Historical annual addition of decarbonized energy in kWh per capita

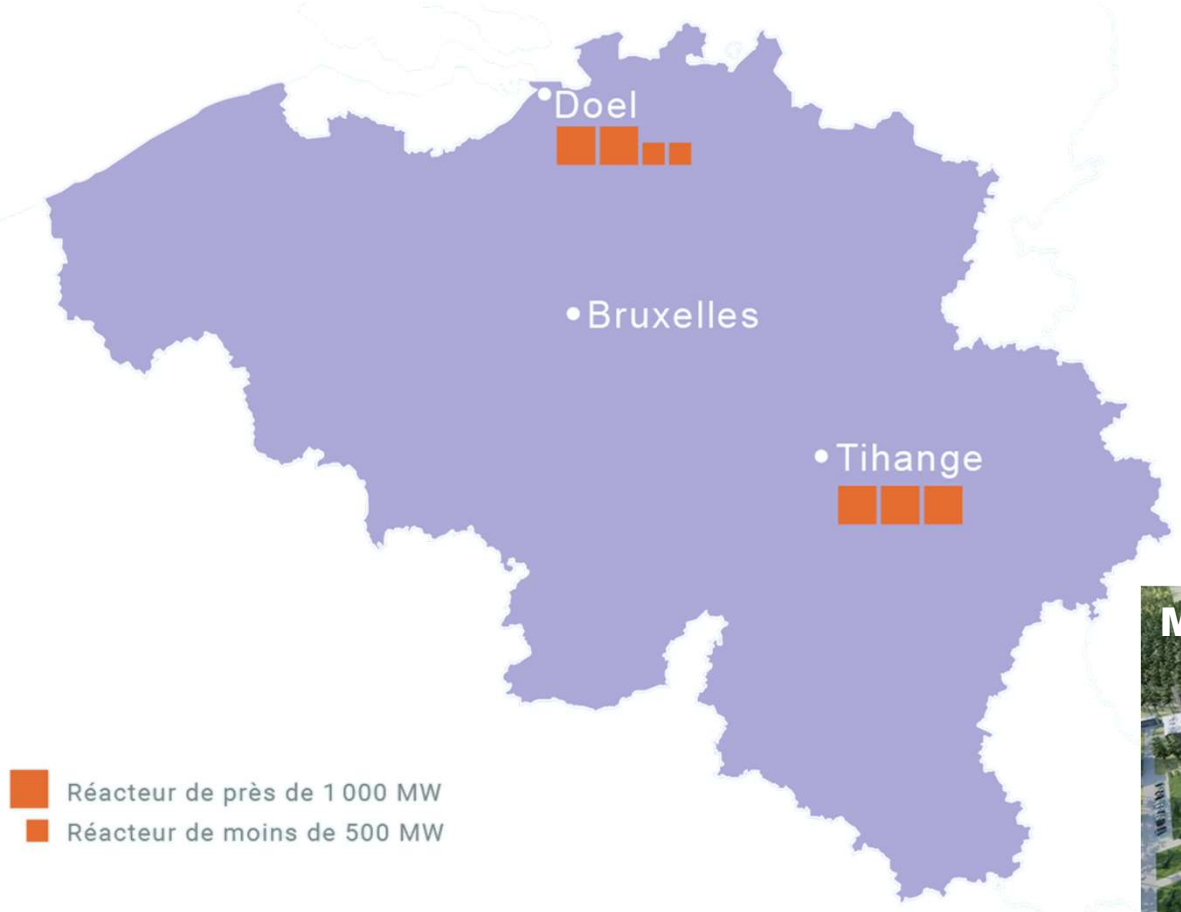


What about Belgium?

7 (-3)
Operating reactors

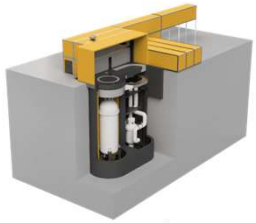
53%
Power share

1
Research reactor in dvlpt



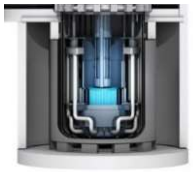
What are SMRs?

The vibrant international race for Advanced Nuclear



MMR (USNC)
High temperature gas cooled micro reactor

Image source: USNC



Natrium (Terrapower)
Sodium & solar salt reactor
345MW
Expected COD: 2030, Kemmerer, WY, USA

Image source: TerraPower

Image source: Rosatom

KLT-40S (Rosatom)
Floating nuclear power plant

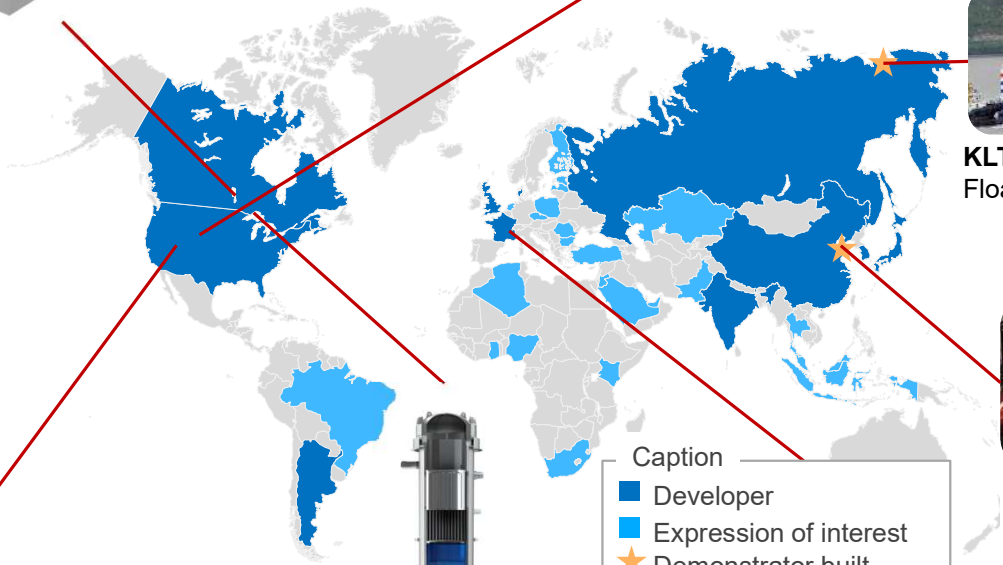


Image source: CGN

HTR-PM (CGN)
High temperature gas cooled reactor

NuScale (Fluor)
Multi-module Pressurized Water Reactor

Image source: NuScale

BWRX-300 (GE-Hitachi)
Boiling water reactor

Image source: General Electric - Hitachi

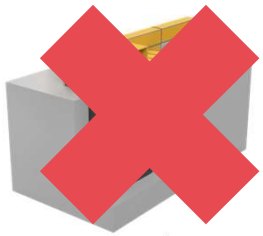
Nuward (EDF)
Multi-module Pressurized Water Reactor

Image source: Nuward EDF

Key figures

- **90+ concepts** under design
- **6+ technology**
- **10 countries** leading development
- **2 FOAK** designs **built**

The vibrant international race for Advanced Nuclear



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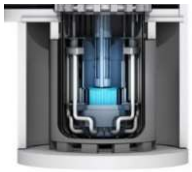

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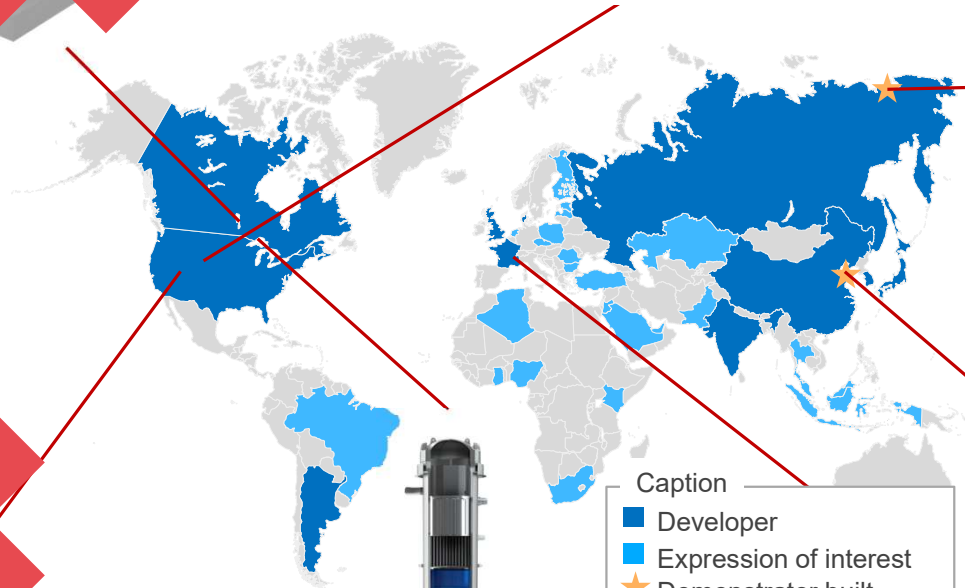

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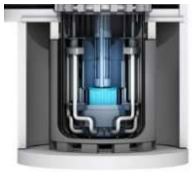
INTERNAL

The vibrant international race for Advanced Nuclear

KP-X (Kairos Power)
HT-MSR
2 x 75MW
Hermes non-power reactor expected TOD: 2027, Oak Ridge, TN, USA

Image source: Kairos Power



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345MW
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Image source: TerraPower

Image source: Rosatom

KLT-40S (Rosatom)
Floating nuclear power plant

Image source: CGN

HTR-PM (CGN)
High temperature gas cooled reactor

Xe-100 (X-Energy)
HTGR
4 x 80MW
Expected COD: 2030, Seadrift, TX, USA

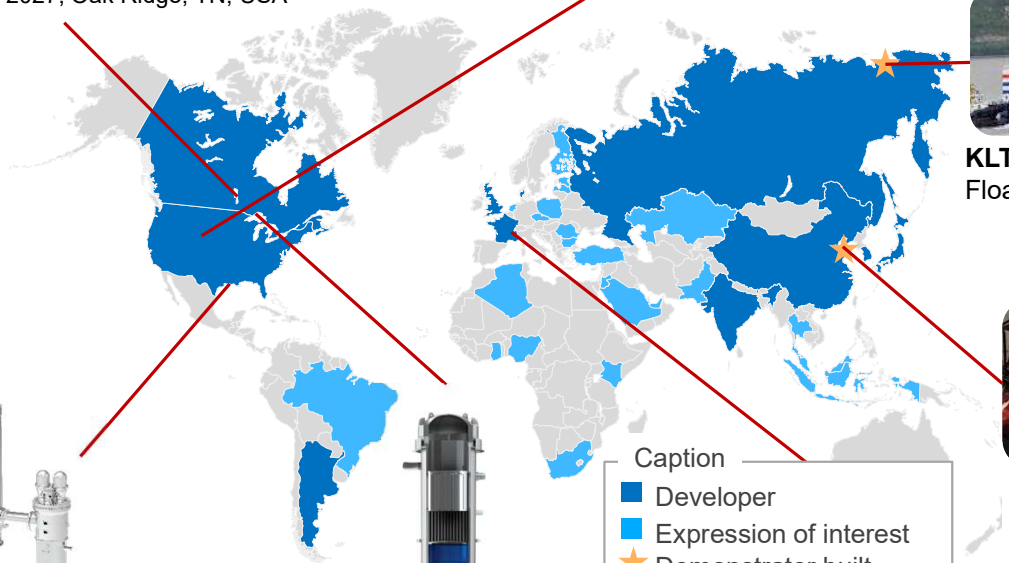
Image source: Xenergy

BWRX-300 (GE-Hitachi)
Boiling water reactor

Image source: General Electric - Hitachi

Newcleo (EDF)
Waste-burner fast led reactor

Image source: Newcleo



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INTERNAL

Why are SMRs emerging today?

XXIth century context [1/2]

New drivers for new nuclear technologies

Today Driver #1: recreate trust in nuclear safety

wnn world nuclear news

Energy & Environment | New Nuclear | Regulation & Safety | Nuclear Policies | Corporate | Uranium & Fuel | Wa

Second explosion rocks Fukushima Daiichi

14 March 2011

Share

First published: 3.08am GMT

UPDATE 1: 3.25am Addition of background information

UPDATE 2: 3.49am Technical details on pressure

UPDATE 3: 4.34am Injuries, radiation rates and pressure data

UPDATE 4: 12:00pm Subsequent radiation readings

UPDATE 5: 7.06pm Change of headline from Explosion rocks third Fukushima reactor

Another hydrogen explosion has rocked the Fukushima Daiichi nuclear power plant, this time at the third reactor unit. Initial analysis is that the containment structure remains intact.

Today Driver #2: Alleviate the fear of nuclear waste being a burden for future generations

INTERNAL

XXIth century context [2/2]

New drivers for new nuclear technologies

Today Driver #3: too big to finance…

The New York Times

Westinghouse Files for Bankruptcy, in Blow to Nuclear Power

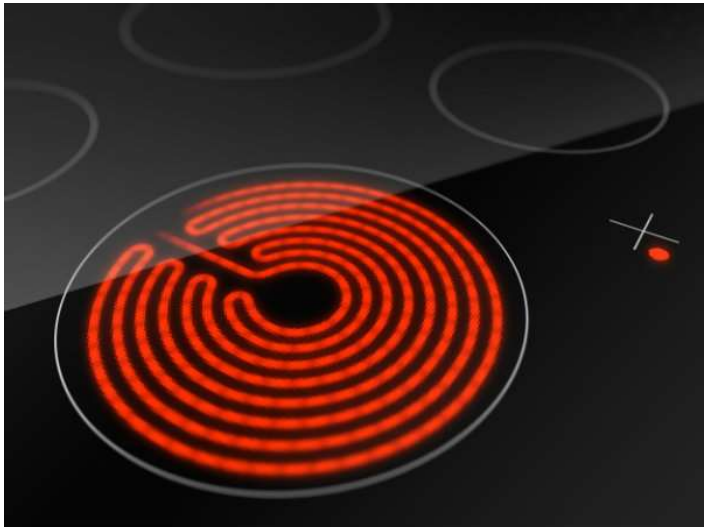
A Westinghouse project in Waynesboro, Ga., remains unfinished, its future in doubt after the bankruptcy filing. Reuters

Today Driver #4: Zero carbon energy transition with Renewable at the centre

Why this time it’s different?

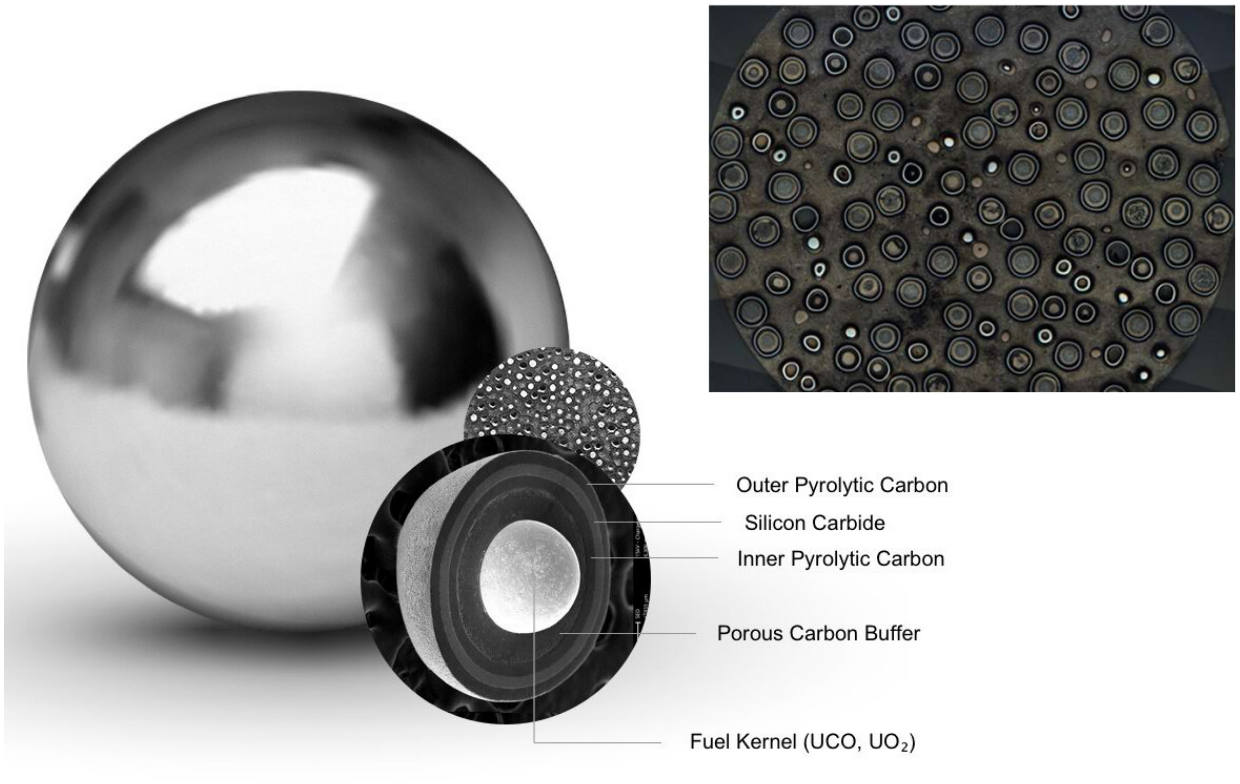
A new paradigm to safety

How to recreate public trust in nuclear safety?
Toward inherent safety



Practical elimination of risk by the physical suppression its root cause

“TRISO Particles: The Most Robust Nuclear Fuel on Earth” –US Department of Energy



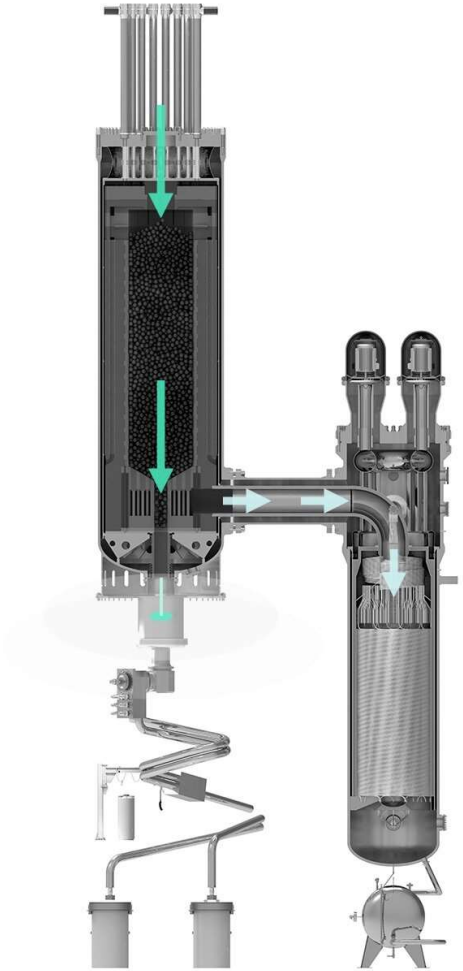


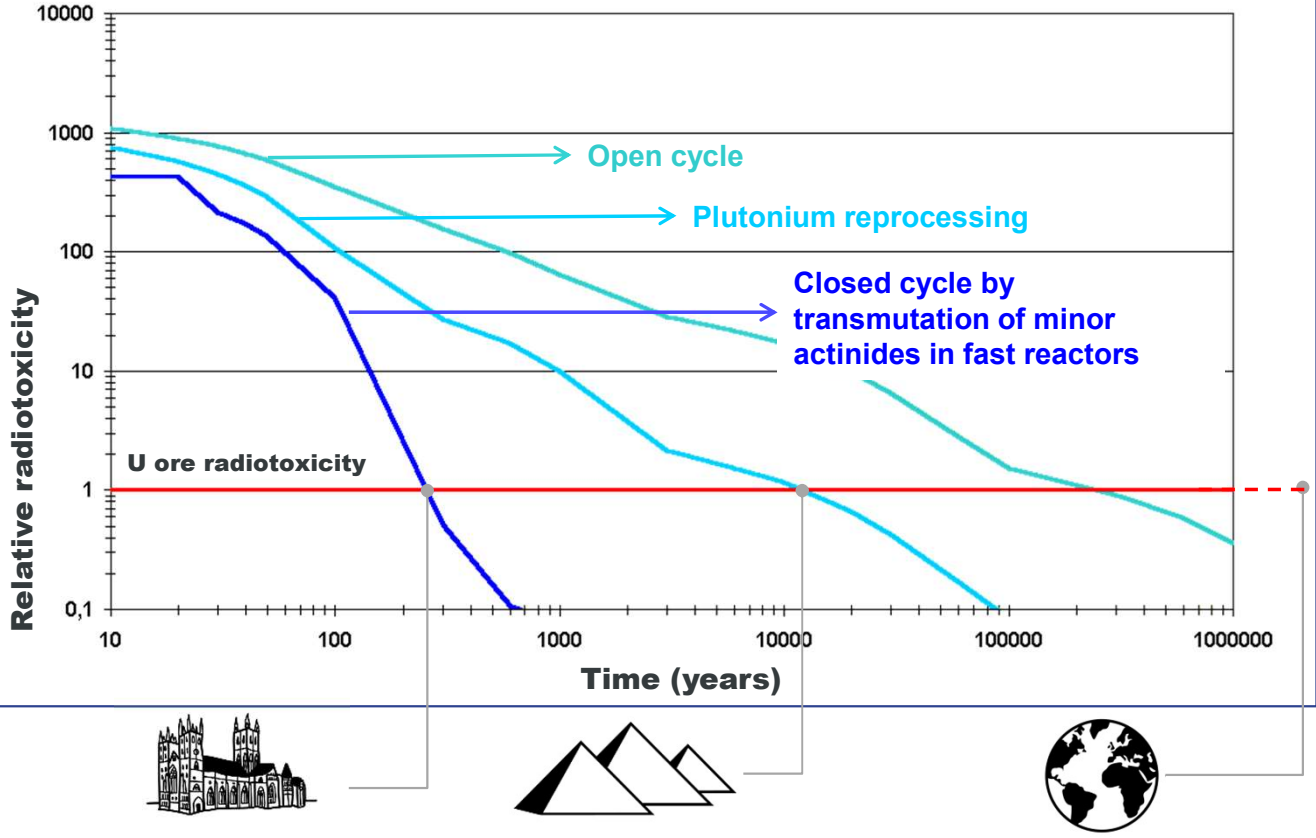
Image source: Xenergy

Opening the option to turn Waste into Watts

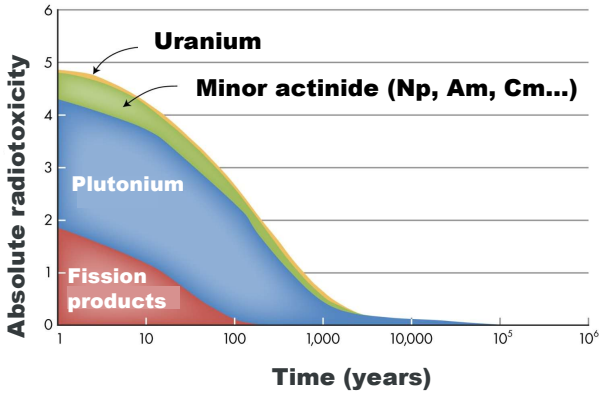
How do Nuclear Wastes evolve over time?

A fundamental property of Nuclear Wastes is that they spontaneously disintegrate over time. Speed of disintegration depends on the nature of the isotope.

Nuclear waste lifetime



Waste characterization



Understanding how nuclear waste behave overtime helps defining the strategies to manage them


SCK-CEN's
MYRRHA
Project

Economic performance: walking before running

Recent industrial failures in Western countries

French EPR

	Cost	Timing
Initial	3,4 B€	2012
Current	12,4 B€	2024

	Cost	Timing
Initial	3,4 B€	2009
Current	8,5 B€	2024

US AP1000

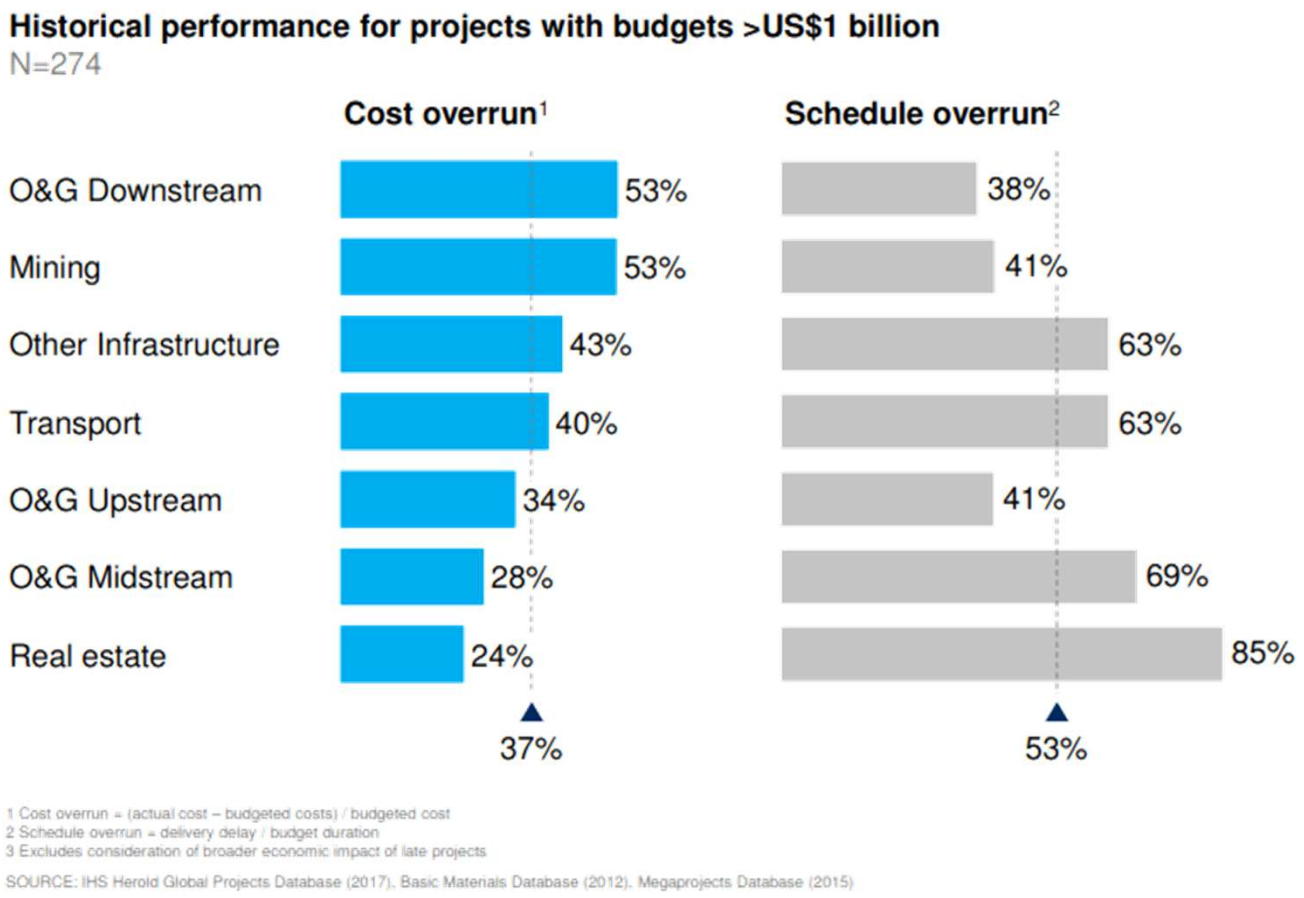
	Cost	Timing
Initial	14 B$	2016
Current	>30 B$	2022

	Cost	Timing
Initial	9,8 B$	2019
Current	>25 B€	Cancelled

Cost drivers: size, complexity and regulation

Historical performance for projects with budgets >US$1 billion

McKinsey | The art of project leadership: Delivering the world's largest projects



1 Cost overrun = (actual cost – budgeted costs) / budgeted cost
2 Schedule overrun = delivery delay / budget duration
3 Excludes consideration of broader economic impact of late projects

SOURCE: IHS Herold Global Projects Database (2017), Basic Materials Database (2012), Megaprojects Database (2015)

Are cost overrun unavoidable?

Sound optimized designs built by capable experienced teams working within strong a political momentum deliver unparallel results

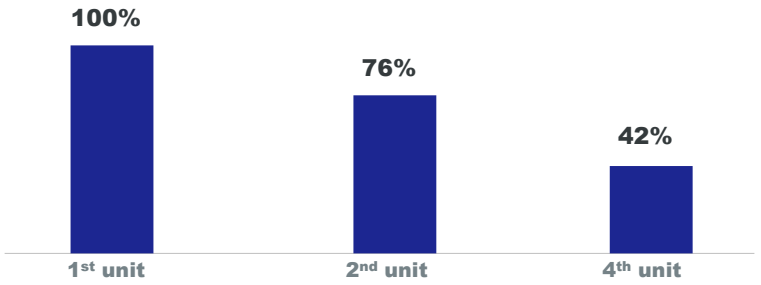
Barakah 1 construction formally complete

26 March 2018

Share

President Moon Jae-in of South Korea and Crown Prince of Abu Dhabi Sheikh Mohamed bin Zayed Al Nahyan today attended a ceremony to celebrate the completion of construction at the United Arab Emirates' first nuclear power reactor.

Celebrations mark Barakah unit 1 completion (Image: Cheong Wa Dae)

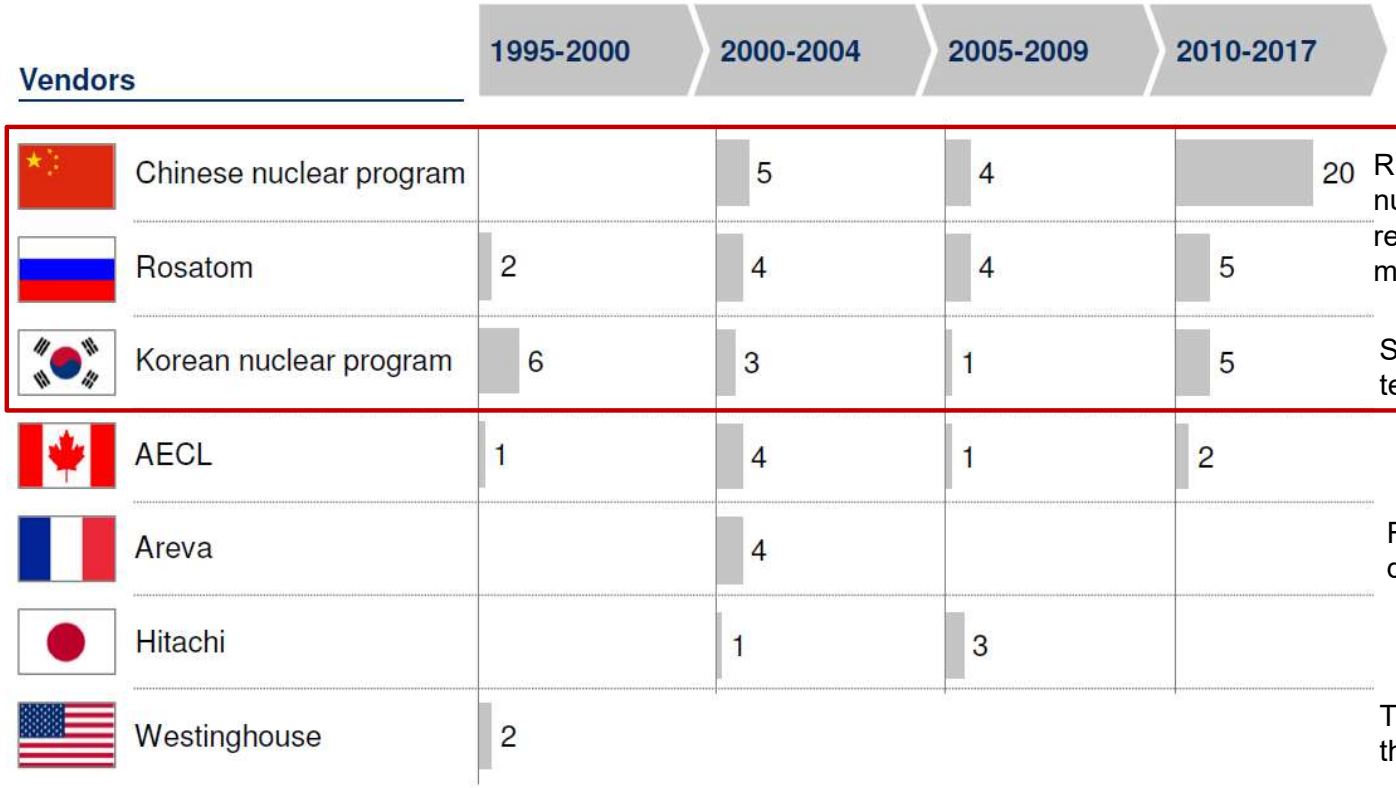


Cost performance evolution on the multi-unit site of Barakah (UAE)

INTERNAL

How can we strive for successful project

Empirical evidence indicates that maintaining industrial capabilities through continuity is key



Russia and China did not stop their nuclear industrial program and now represent >80% of the global new build market with consistent learning rates

SK successfully exported its own technology after domestic demonstration

France did not build any reactors in two decades when starting Olkiluoto project

The USA did not build any reactors in three decades when starting VC Summer

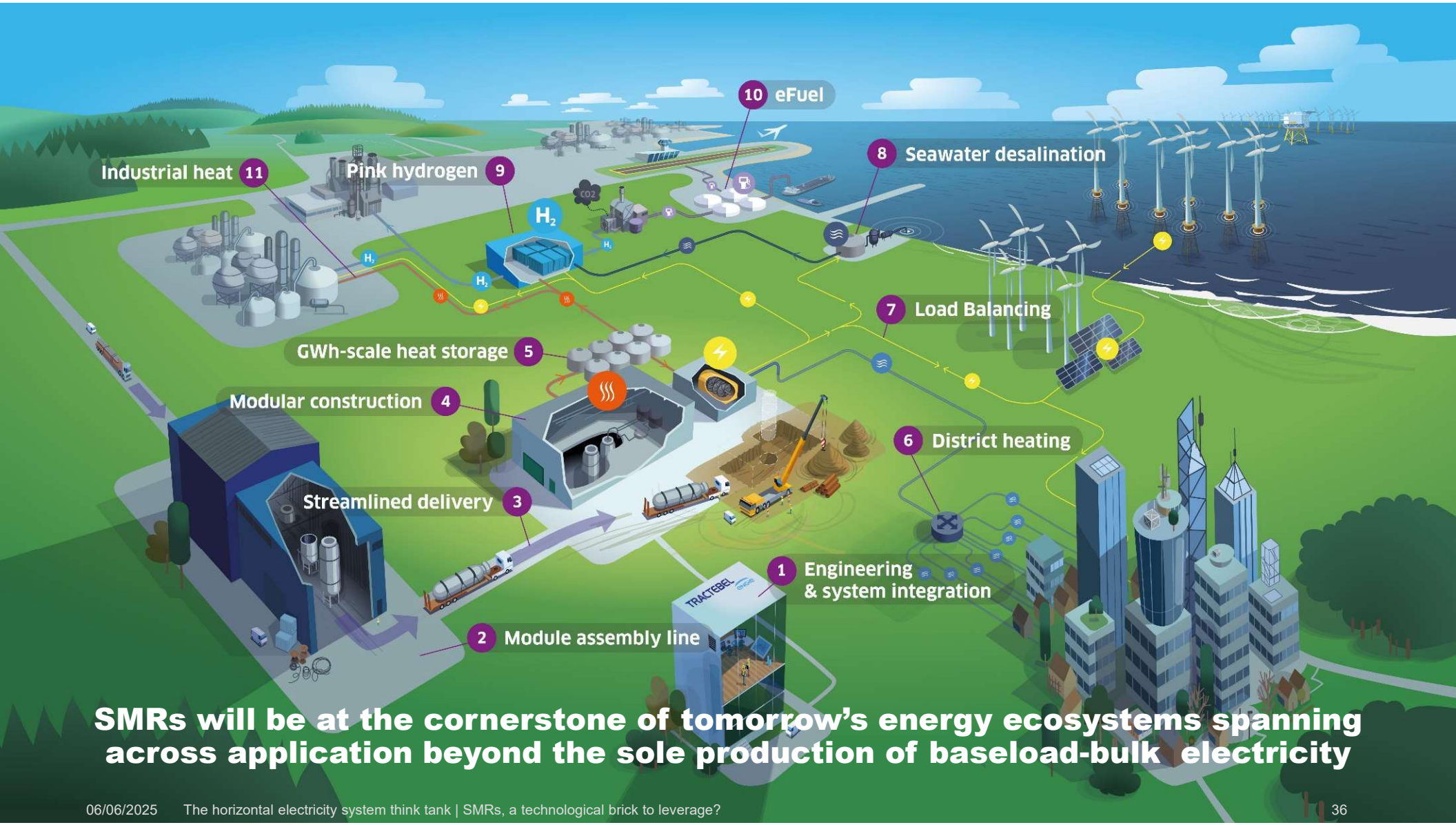
INTERNAL

Can we recreate appetite for a fleet deployment?

Amazon has announced the goal of deploying up to 5 GW of its Xenergy' small modular reactors in the USA by 2039.


Google

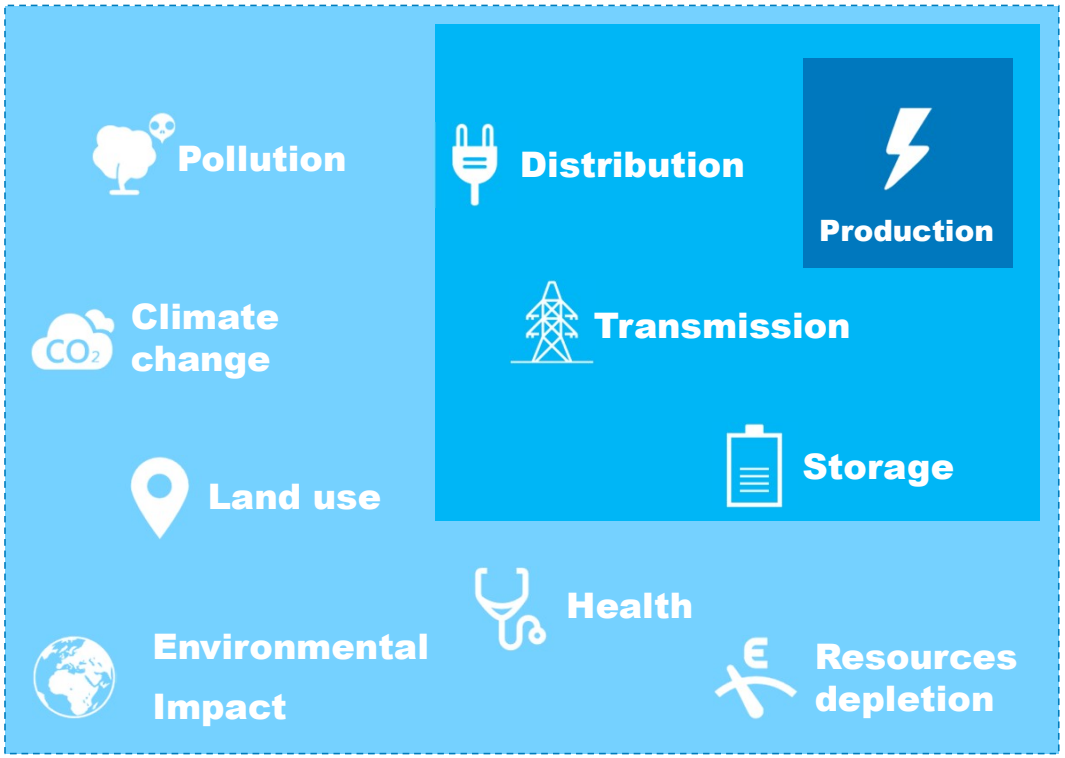
Expanding the reach of nuclear energy



SMRs will be at the cornerstone of tomorrow's energy ecosystems spanning across application beyond the sole production of baseload-bulk electricity

Industrial giant Dow and X-Energy Reactor Company have submitted a construction license application to the US Nuclear Regulatory Commission for the proposed advanced nuclear project at Dow's Seadrift site in Texas. [Construction License Submitted]

A much-needed integrated view of the complex energy market



Plant-level

Production cost at market prices (LCOE)

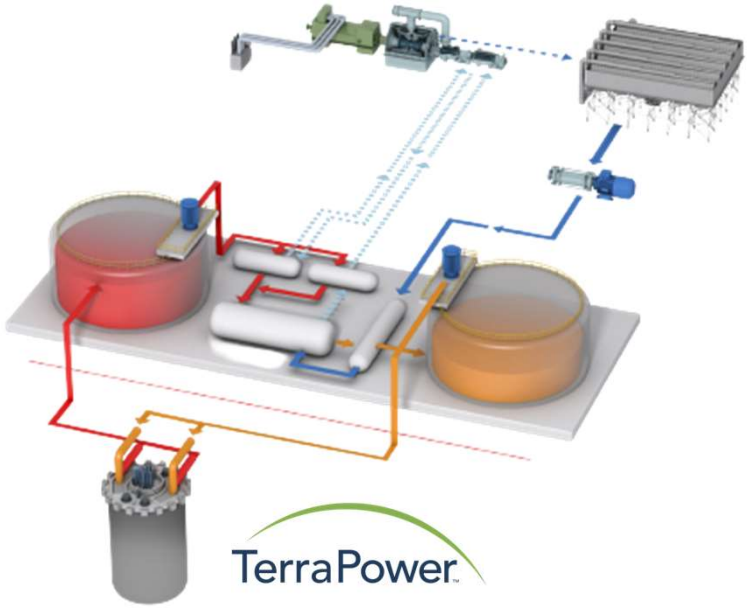
Grid-level

System cost of the whole electricity value chain

Societal-level

Full cost including external & social costs

Unlocking the storage performance of solar salt technologies through higher operating reactor temperature



In practice, how does this fit into the energy system?
Quick zoom on Tractebel's 2019 study

https://tractebel-engie.com/files/attachments/.3456/Tractebel-The-rise-of-nuclear-technology-2-0.pdf

Chapter 1 - The vibrant international race for Advanced Nuclear

Chapter 2: Beyond Baseload electricity production

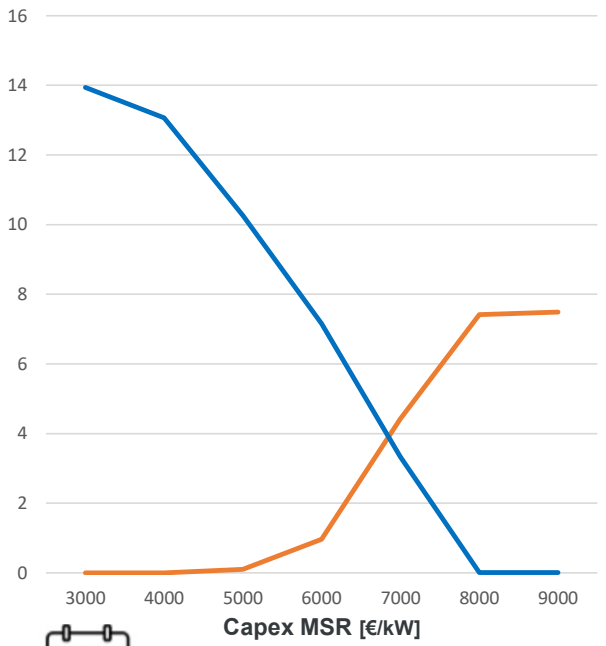
Chapter 3: European Heat Market

Chapter 4: Low-carbon Hydrogen for eMolecules

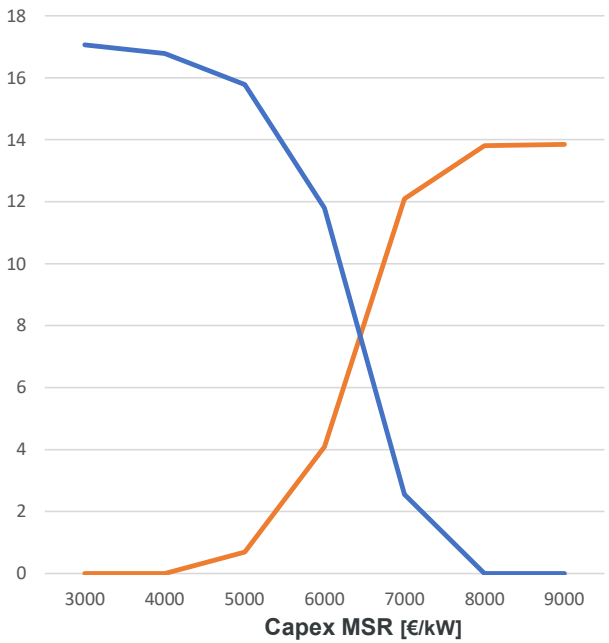
INTERNAL

Delivery cost overrun of the low maturity technologies is not a business case killer

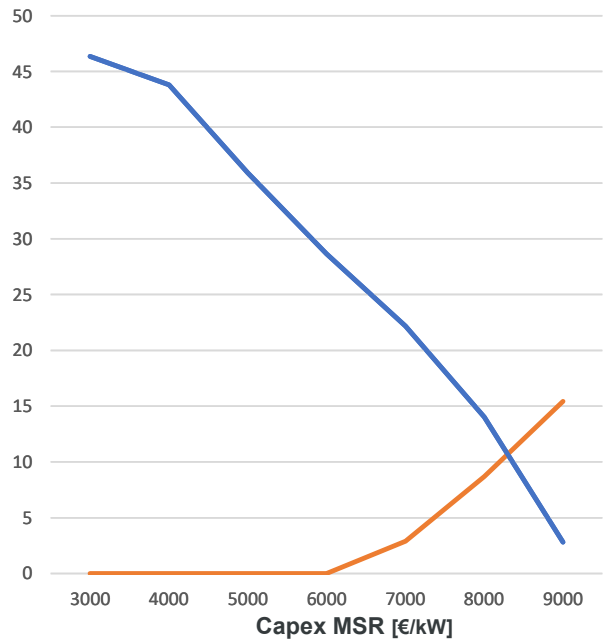
Nuclear Installed Capacity in CH* [GW]



Nuclear Installed Capacity in PL* [GW]



Nuclear Installed Capacity in GB* [GW]



2050

MSR – varying CAPEX

LW SMR – constant CAPEX

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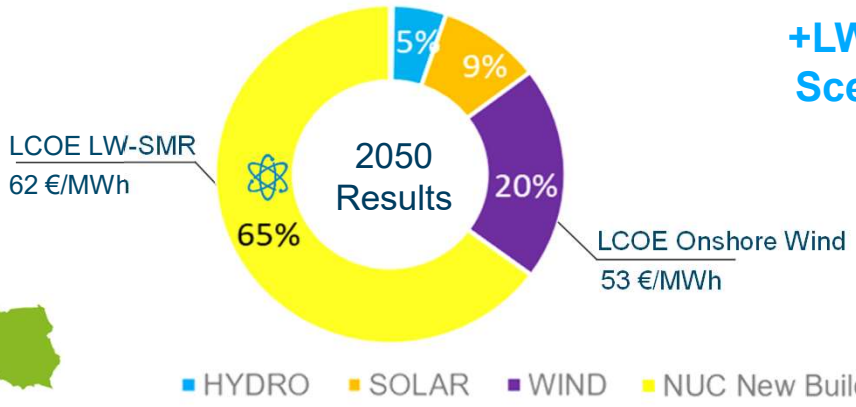
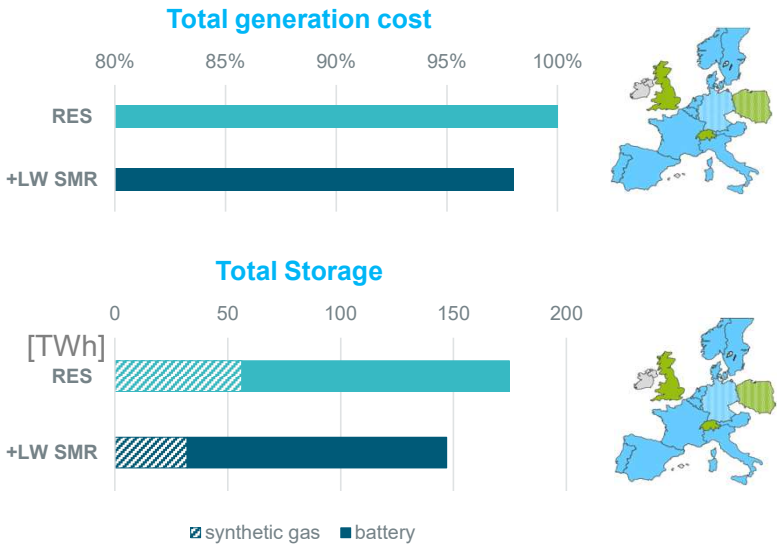
LCOE is not the whole story



+LW SMR Scenario



Key insights

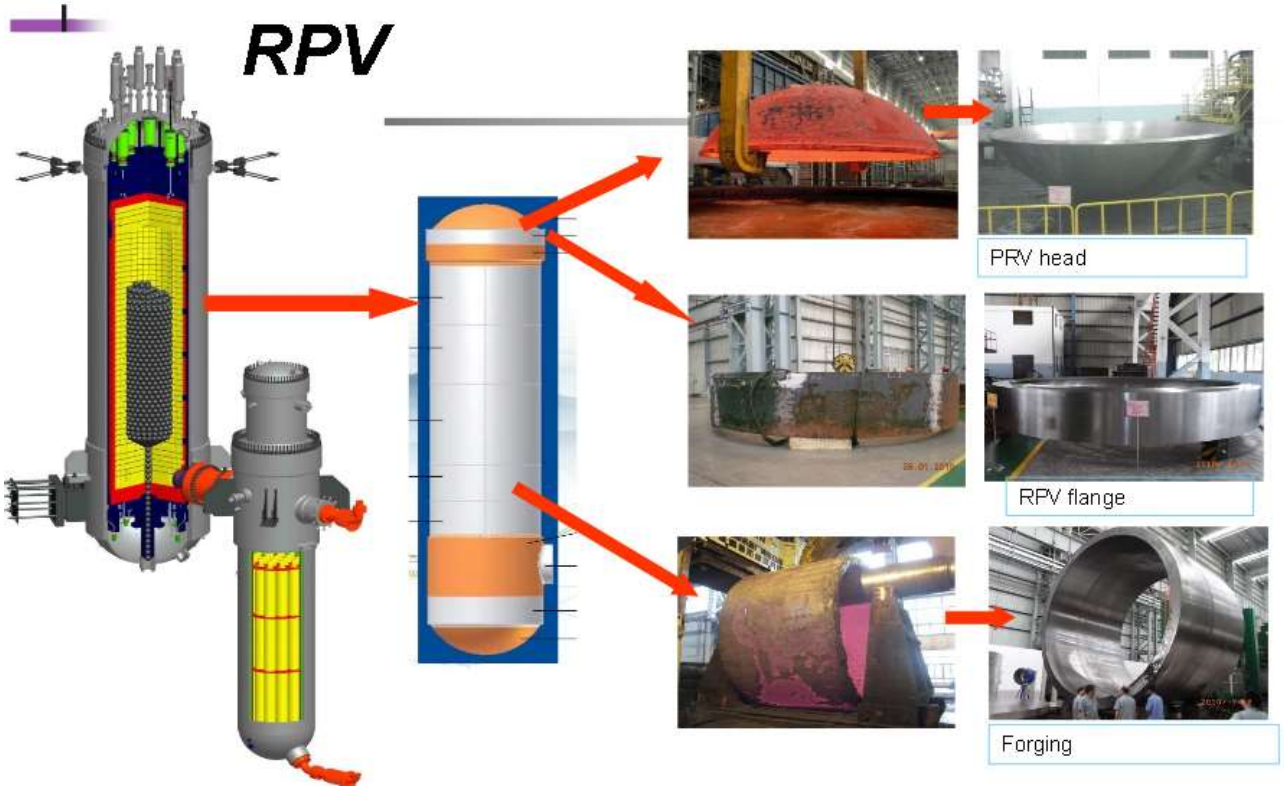
- Higher penetration of NUC projected despite WIND lower **LCOE**
- **Grid-level generation cost** is lower with **NUC** than 100% **RES**
  - Lower amount of storage required
  - Lower yearly electricity price
- Lower grid infrastructural transformation (storage, T&D) with flexible nuclear

LCOE ≡ Levelized Cost Of Electricity

When will SMRs/ARs become a reality?

Chinese HTR-PM: Very High Temperature Reactor (VHTR)
First Of A Kind delivery process

Image source: Tsinghua University's Institute of Nuclear and New Energy Technology



Demonstration HTR-PM connected to grid

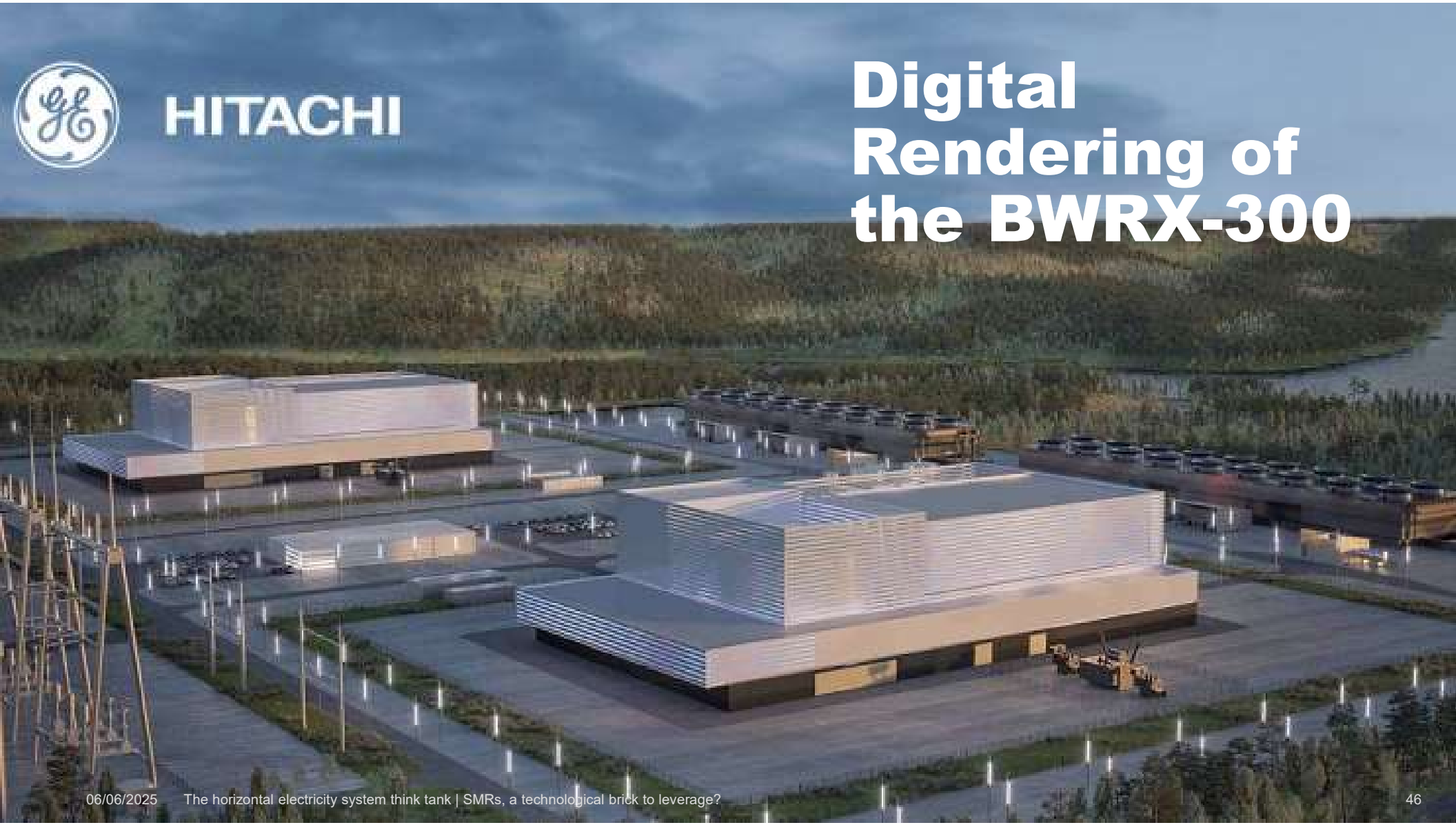
21 December 2021

Serial production of Russian RITM-200

Images source: RITM Reactor Plants for Nuclear-Powered Icebreakers and Optimized Floating Power Units, JSC “Afrikantov OKBM”

Russia commissions floating NPP

22 May 2020


HITACHI
Digital Rendering of the BWRX-300

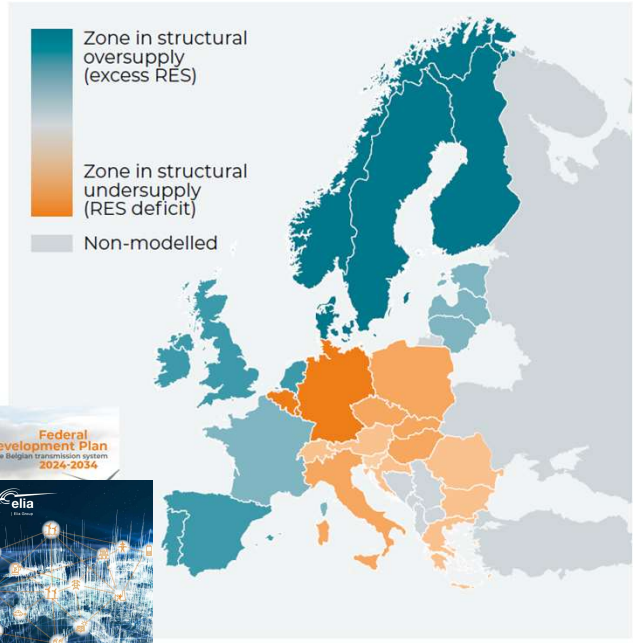
Ontario Power Generation (OPG, Canada) Darlington Construction Site for the 4x BWR-300 (General Electric Hitachi, GEH) Project

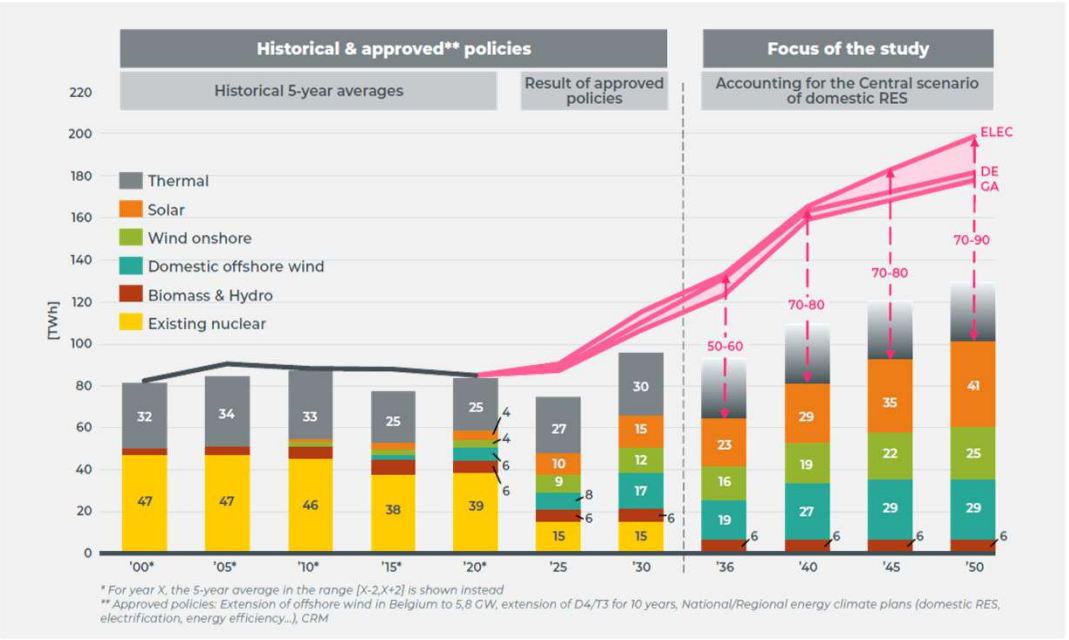
Image source: TerraPower

Pacificorp (Berkshire Hathaway) Kemmerer, WY, Construction Site for the 1x Natrium reactor (General Electric Hitachi and TerraPower)


What will it mean for Belgium?

Belgium's power capacity lags behind rising electrification. Structural limitations on renewables increase reliance on energy imports.





Standing on the shoulders of Giants

1962

BR3 – first PWR connected to the European Grid

1969 - 1985

Construction of the 7 Belgian Nuclear Units

1980 - 1987

HADES Geological Deep Disposal prototype

1998 - 2036

MYRRHA & Lead-cooled Fast Reactor Technology development

2023 – 2029

Contributing to the First SMR built in the Western World

INTERNAL

Belgium's world-renowned expertise

More than half of century of nuclear excellence

NUCLEAR QUALIFIED COMPANIES

+300

NUCLEAR PROFESSIONALS

> 20,000

SUPPLY CHAIN

1st

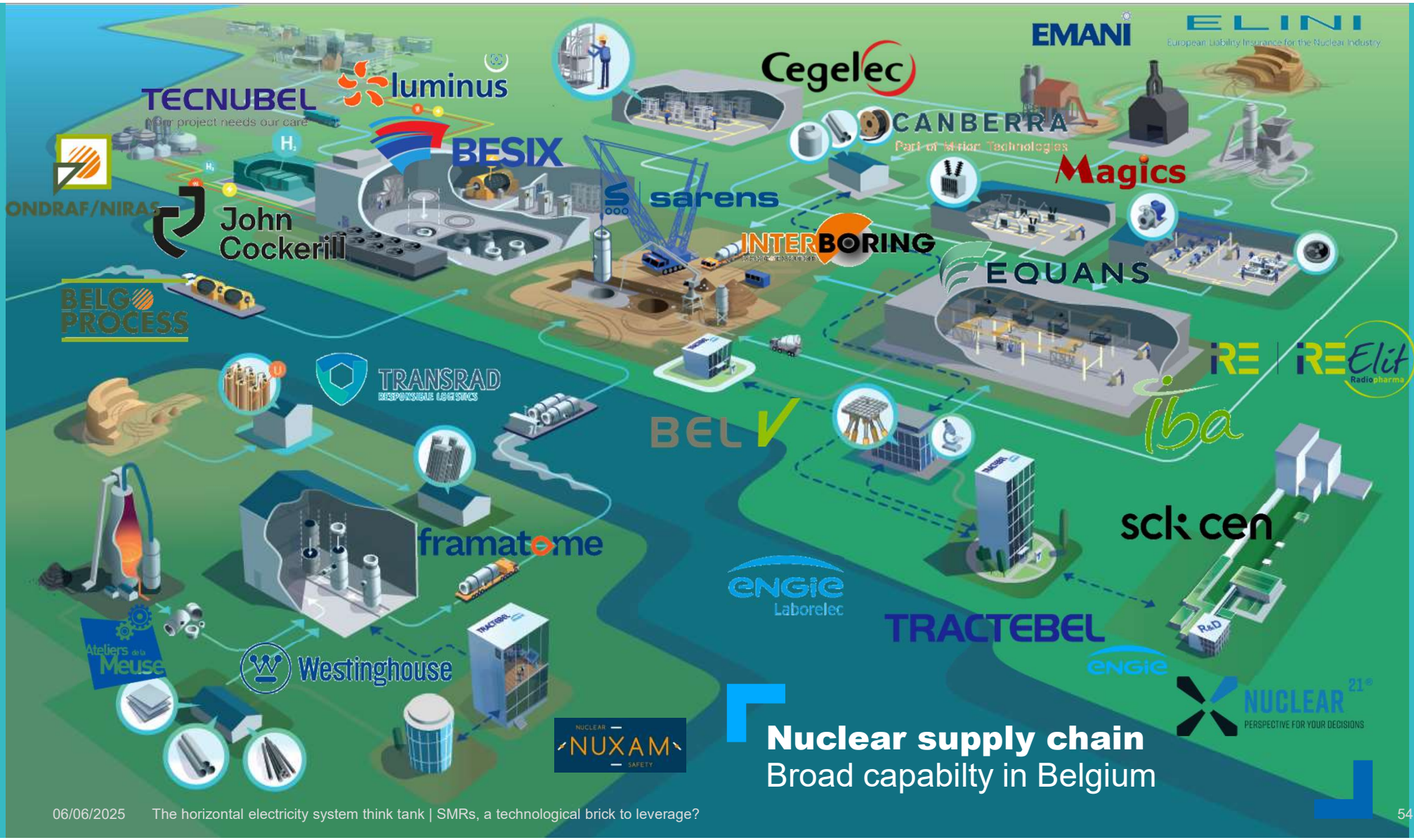
PRESSURIZED-WATER REACTOR IN EUROPE

NUCLEAR EXPERIENCE

> 70

YEARS

INTERNAL

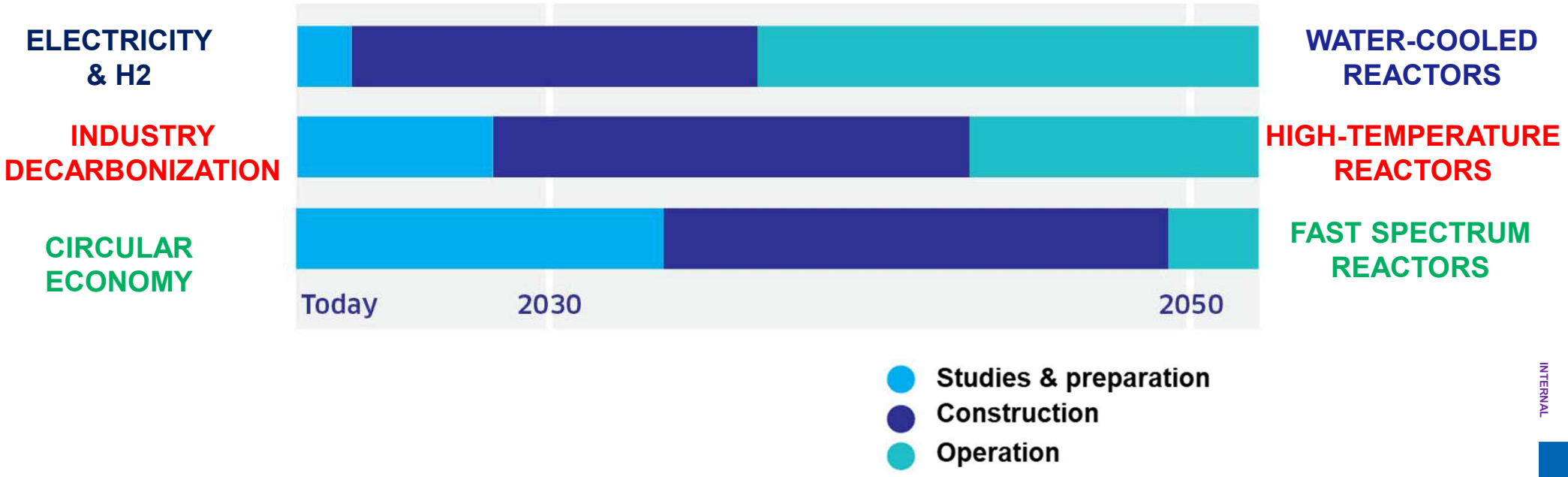


Nuclear supply chain
Broad capabilty in Belgium

New Build Nuclear is possible in Belgium within 10 to 12 years

TRACTEBEL ENGIE

CREDIBLE TIMELINE FOR NEW BUILD NUCLEAR IN BELGIUM



INTERNAL


TRACTEBEL
ENGIE
Engineering
a carbon-neutral
future

1. **Tractebel** – SMRs: state of play
2. **Elia** – Flex@scale
3. **Energyville/Vito** – Paths 2025
4. **Florence School of Regulation** – developments at EU level

Home charging of company EV fleets simplified

EVLIA ➔ EV.fleet at scale

Elia Think Tank – 6/Jun/2025

EV.fleet at scale - Summary

Context - The bigger picture of flex unlocking, and scaling ambitions (EVLIA ➔ “EV.fleet at scale”)

Solving a relevant problem - The EV fleet ecosystem has little attention for smart charging benefits, priority towards operational issues, like reimbursement of home charging.

Home charging reimbursements in 2025 – Employee gets a monthly reimbursement: the exact energy (kWh) at a flat market-average price (“the CREG price”). Fiscally approved, by lack of a better mechanism.

Volume split unlocks new solutions – Splitting the energy flows behind the meter, allows the energy supplier to split the bill. This unlocks 3rd party payment of the energy bill + easy, low-risk entry into smart charging.

So what? – Considering each stakeholder’s perspective: end-consumer, fleet owner and energy supplier.

Many-to-many challenge – Connecting multiple fleets to multiple energy suppliers.

What’s happening now? – Coalition-building to formalize the scale of the demand and willingness to provide solutions. Pilots to demonstrate feasibility & viability of the end-to-end solution.

Join the coalition!

Context

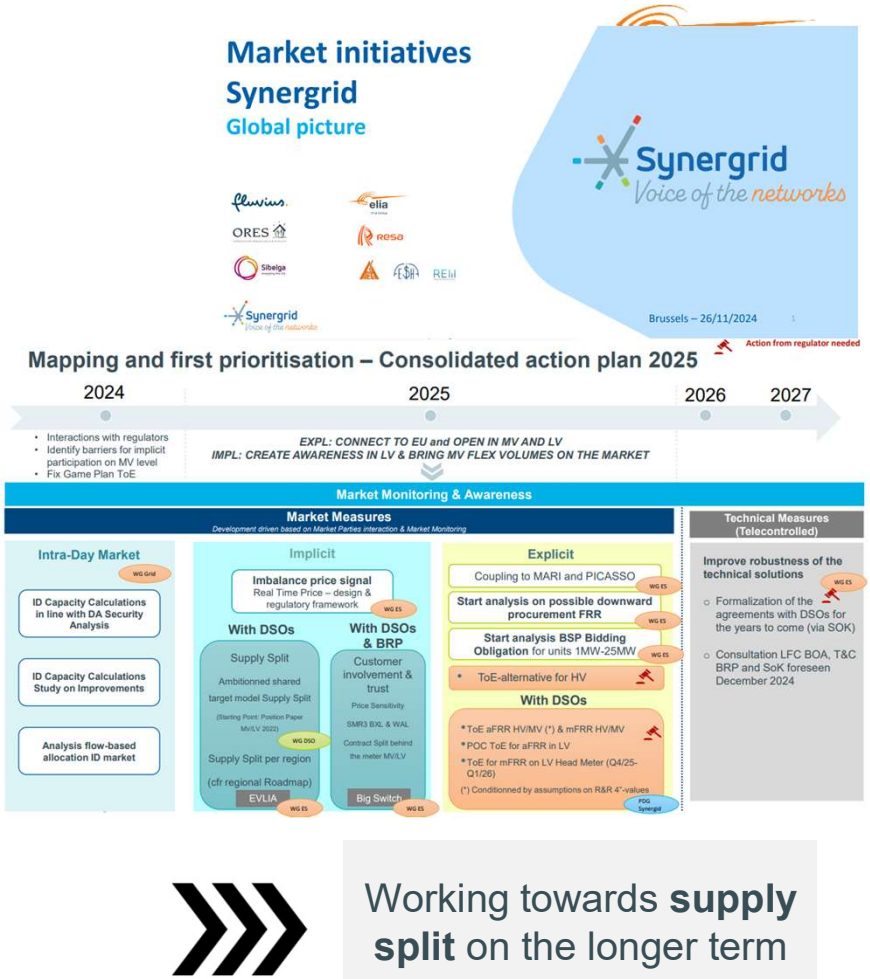
Elia launched the initiative “EVLIA” (Nov 2024), as a strategic initiative to showcase the **unlocking of flexibility from EV’s in Belgium at scale**.
This also supports the joint Synergrid action plan, with a focus in 2025 on creating awareness for implicit flexibility on LV.

Focus is on **implicit flexibility**, and the largest segment of EV’s in Belgium: **company cars**.

To kickstart the initiative, Elia opened their EV fleet, but the aim has always been to **extend to other company fleets, to demonstrate the scalability throughout Belgian fleets**.

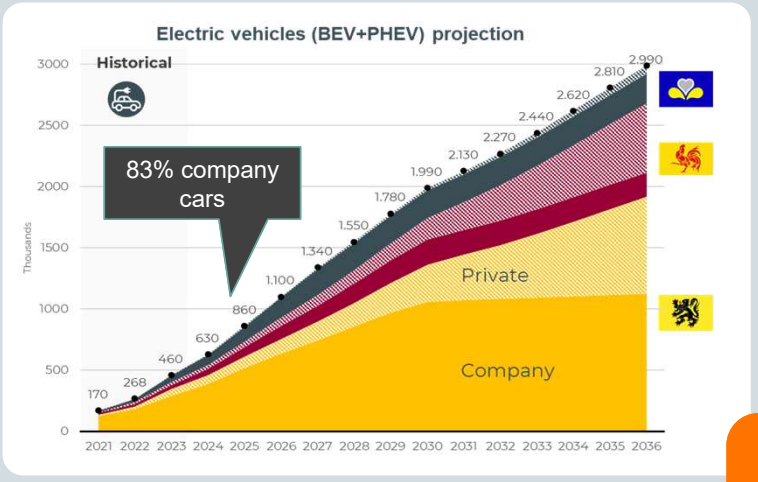
Along the route, we changed the initiative’s name to better reflect the scaling ambition to not stop at Elia’s fleet:

EV.fleet at scale

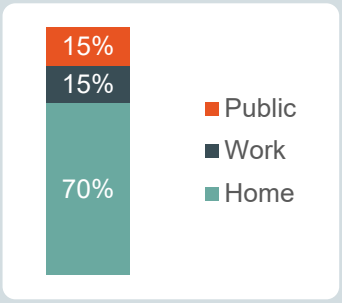


Working towards **supply split** on the longer term

Company fleets are driving the electrification of mobility



Mainly charging at home or at work

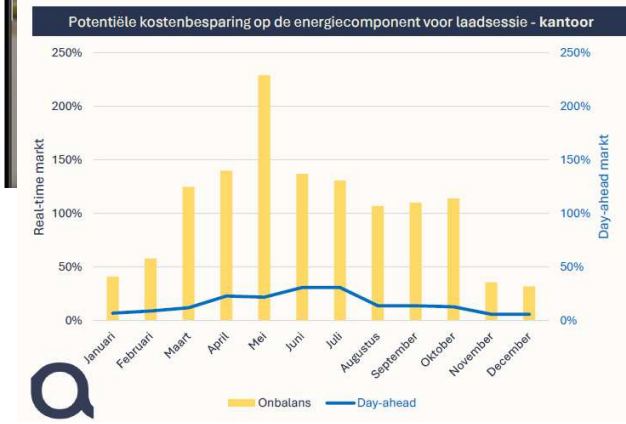


… bringing a lot of *potential* value from smart charging/flexibility

Smart Charging

Average savings on energy cost of charging session:

- Day-ahead market optimization: 6-31%
- Real-time market: 32-230%



Value remains largely untapped in 2025

… charging happens behind the meter

Solving a relevant problem

"I'm missing the opportunity of cost savings from flexibility in my EV fleet."

"Home charging reimbursements are a headache. Many questions, unhappy employees, even people avoiding to charge at home."

Home charging cost reimbursements

Employees pay their home energy bill, which **includes the energy of EV home charging…**

To:
home owner
Lindestraat 2,
Mechelen

Energy Supplier

HOME ENERGY BILL

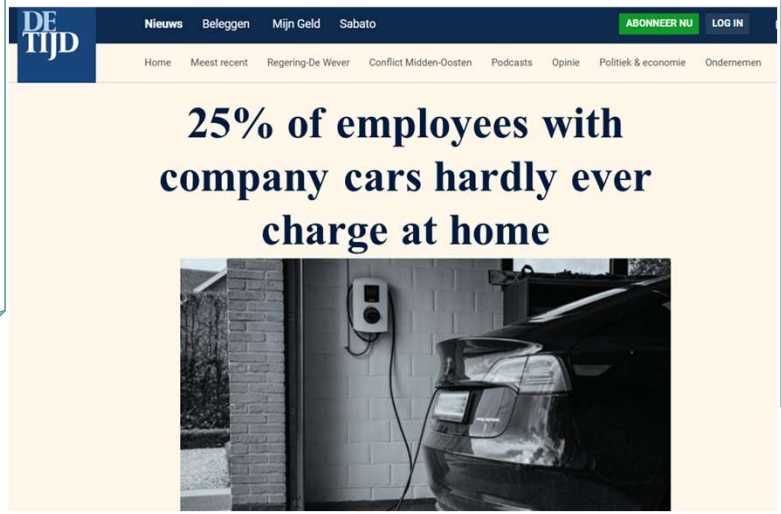
Fixed or Variable price contract

ELECTRICITY – EAN 541448820012345678

Energy offtake (529 kWh)	€ xxx
Energy injection (63 kWh)	- € xxx
Grid costs (Capacity tariff)	€ xxx
Taxes & levies	€ xxx
SUBTOTAL	**€ xxx**

TOTAL TO BE PAID (incl VAT) **€ xxx**

Hard/impossible to match, leading to questions, distrust or even refusal.



… and get a monthly reimbursement from employer for the charged energy, **valued at a flat-rate tariff** (set by employer).

FOD Finance has defined a ceiling for the flat-rate tariff, based on average historical market prices.

From:
Employer fleet manager

To:
home owner
Lindestraat 2,
Mechelen

REIMBURSEMENT NOTE EV home charging

Reimbursement of home charging (200kWh) at flat-rate tariff	€ xxx
SUBTOTAL	**€ xxx**

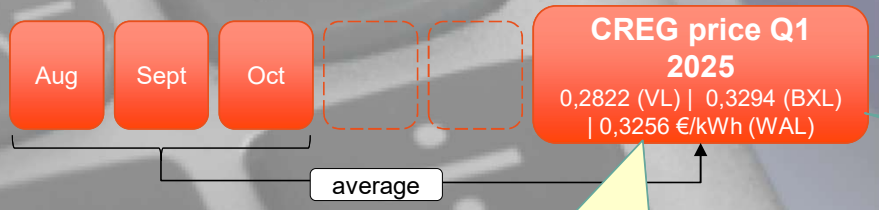
The story of home charging reimbursements

Background

With its circulaire 2024/C/77, the Federal financial administration brought **clarification and certainty about the reimbursements** of home charging sessions by employer, **until end of 2025**.

The Administration recognizes that an **exact calculation of the real electricity costs related to home charging is not obvious**, due to the many parameters to be considered: type of home supply contract, location-based grid fees, capacity tariff, self-consumption of solar energy, supplier switches throughout the year, …

Employer is allowed to apply a fixed tariff for the reimbursements. This fixed tariff shall not exceed the quarterly CREG price, that is a 3-month average of the published monthly CREG prices:



Fleet manager: *"What after 2025?"*

Employee: *"This amount doesn't match my home energy bill. I'm not reimbursed correctly"*

Employee: *"Even though I have a home charger, I'd rather charge at work or publicly, because of uncertainty of reimbursed amount"*


FISCALITEIT / Inkomstenbelastingen / Administratieve richtlijnen en commentaren / Circulaires / Circulaires - Personenbelasting

Circulaire 2024/C/77 over de terugbetaling van elektriciteitskosten door de werkgever voor het thuis opladen van een bedrijfswagen

A. Principe

IV. Eigen wagen

V. Inwerkingtreding - buitenwerkingtreding

VI. Terugbetalingen vóór 01.01.2025

What if we could have it all?

No more inaccurate reimbursements

and

Access to the benefits from smart charging?

Bringing the ease of home Internet employer payments…

To:
home owner
Lindestraat 2,
Mechelen

Telecom Provider

HOME INTERNET BILL

INTERNET – TELEVISION - TELEPHONE

Internet package	€ xxx
Subscriptions	€ xxx
Television & telephone	€ xxx
SUBTOTAL	**€ xxx**

3rd party payment

Employer 3rd party payment of home internet (forfait)	- € xxx

TOTAL (incl VAT) **€ xxx**

… to EV charging and the home energy bill

To:
home owner
Lindestraat 2,
Mechelen

Energy Supplier

HOME ENERGY BILL

ELECTRICITY – EAN 541448820012345678

Energy offtake (529 kWh)	€ xxx
Energy injection (63 kWh)	- € xxx
Grid costs	€ xxx
Taxes & levies	€ xxx
SUBTOTAL	**€ xxx**

HOME CHARGING SESSIONS

Employer payment of home charging sessions (350 kWh)	- € xxx

TOTAL (incl VAT) **€ xxx**

By applying the same "3rd party payment" logic of home internet to the home energy bill, EV charging sessions at home can be **invoiced directly from energy supplier to employer**. No more reimbursements.

How can energy supplier know which **exact amount** to invoice to the employer? ➔

Home EV charging

3rd party payment by employer

To:
home owner
Lindestraat 2,
Mechelen

Energy Supplier

HOME ENERGY BILL

ELECTRICITY – EAN 541448820012345678

Energy offtake (529 kWh)	€ xxx
Energy injection (63 kWh)	- € xxx
Grid costs	€ xxx
Taxes & levies	€ xxx
SUBTOTAL	**€ xxx**

HOME CHARGING SESSIONS

Employer payment of home charging sessions (350 kWh)	- € xxx

TOTAL TO BE PAID (incl VAT) **€ xxx**

"Volume split" as technical enabler

One energy supplier

Energy flows

"Volume split" technically enables the energy supplier to split energy flows behind the meter. Supplier can then calculate the exact cost of EV home charging.

Volume split also unlocks a second advantage for company fleets and EV drivers ➔

“Volume split” enables hybrid supply contracts…

One supplier, separate billing

Existing tariff (fixed/variable)

Dynamic pricing

No risk for end-consumer

Access to flexibility benefits

… which creates value from smart charging without impacting the home

To:
home owner
Lindestraat 2,
Mechelen

Energy Supplier

HOME ENERGY BILL

Fixed or Variable price contract

ELECTRICITY – EAN 541448820012345678

Energy offtake (529 kWh)	€ xxx
Energy injection (63 kWh)	- € xxx
Grid costs	€ xxx
Taxes & levies	€ xxx
SUBTOTAL	**€ xxx**

HOME CHARGING SESSIONS

Employer payment of home charging sessions (350 kWh)	- € xxx
Smart charging incentive	- € xxx

TOTAL TO BE PAID (incl VAT) **€ xxx**

Participates in smart charging, by using a mobile application, and gets a **smart charging discount**

What does this mean for

end-consumer, fleet owner, energy supplier

What does this mean for the employee, the end-consumer?

- No more reimbursements for home charging, meaning:
  no more worries about not being reimbursed correctly.
- Opportunities created:
  - **Lower capacity tariff** for the home (Flanders) as the connection is shared with employer chargepoint.
  - Own solar PV production that went into the car can still be reimbursed at interesting price (offtake price?), **incentivizing self-consumption**.
  - Receiving a part of the **generated value from smart charging**.
- **Low entry barrier**:
  - No change of supply contract needed.
  - Everything is handled through the known supplier energy invoice.
  - No extra hardware/installations required. Smart charging is unlocked by means of a mobile companion app

EV driver **keeps existing home supply contract**

To:
home owner
Lindestraat 2,
Mechelen

Energy Supplier

HOME ENERGY BILL
Fixed or Variable price contract

ELECTRICITY – EAN 541448820012345678

Energy offtake (529 kWh)	€ xxx
Energy injection (63 kWh)	- € xxx
Grid costs	€ xxx
Taxes & levies	€ xxx
SUBTOTAL	**€ xxx**

HOME CHARGING SESSIONS

Employer payment of home charging sessions (350 kWh)	- € xxx
Smart charging incentive	- € xxx

TOTAL TO BE PAID (incl VAT) **€ xxx**

No more (uncertainty about) **reimbursements**

Participates in smart charging, by using a mobile application, and gets a **smart charging discount**

What's in it for the employer / fleet manager?

Happy employees:
Less doubts or questions around home EV charging, making it more convenient.

To:
home owner
Lindestraat 2,
Mechelen

Energy Supplier

HOME ENERGY BILL

Variable price contract

ELECTRICITY – EAN 541448820012345678

Energy offtake (529 kWh)	€ xxx
Energy injection (63 kWh)	- € xxx
Grid costs	€ xxx
Taxes & levies	€ xxx
SUBTOTAL	€ xxx

HOME CHARGING SESSIONS

Employer payment of home charging sessions (350 kWh)	- € xxx
Smart charging incentive	- € xxx

TOTAL TO BE PAID (incl VAT) € xxx

sharing

To:
Employer company fleet manager

FLEET EXPENSE NOTE

Home charging Lindestraat 2, Mechelen (350 kWh) incl VAT	€ xxx
Home charging home 2	€ xxx
Home charging home x	€ xxx
SUBTOTAL	**€ xxx**
Split-bill service subscription	€ xxx
Smart charging incentive	- € xxx

TOTAL TO BE PAID (incl VAT) € xxx

Fleet manager pays the **exact price** & no more questions about reimbursements.

Reduced TCO thanks to smart charging

Employer advantages

Happy employees: less questions/doubt *around home EV charging*

Easy, exact & compliant *payment of home charging sessions (no more reimbursements).*

Capture value *from smart charging*

Home charging sessions could be ***supplied with 100% renewable energy*** *(to be confirmed)*

What's in it for the energy suppliers?

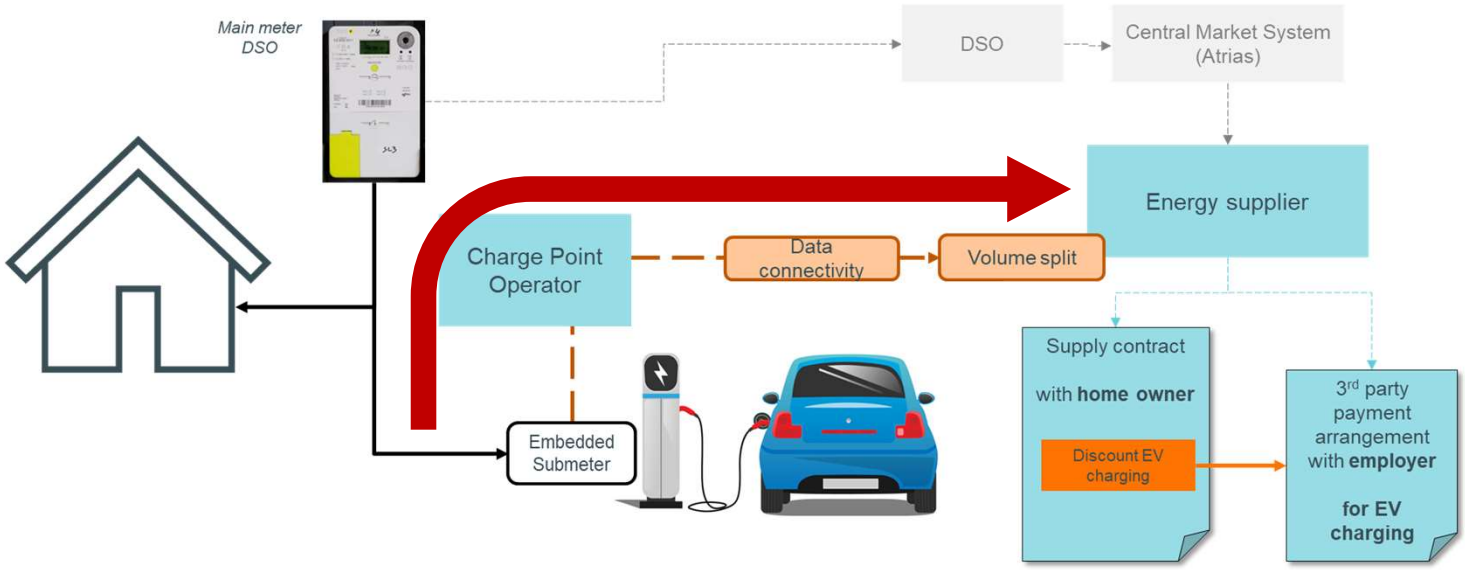
Scalable access to new demand-side flexibility
&
Competitive advantage

*Visibility behind the meter enables **new product offerings** to customers*

***More demand-side flexibility** in my portfolio, better forecasts & more value captured*

***Less credit risk**, as part of the home energy bill is paid by corporates*

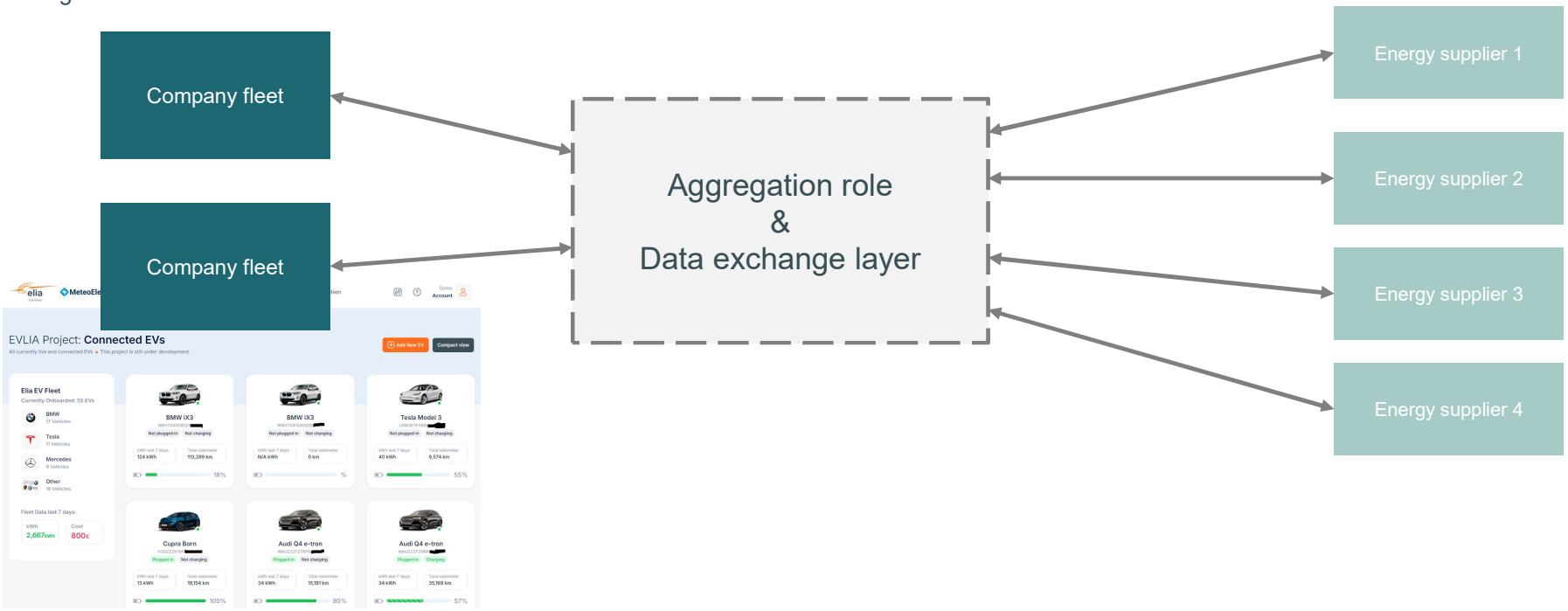
***Scalable** solution, no extra hardware needed. Data connection also suitable for steering, no more dependency on car APIs*



Bringing this at scale requires a many-to-many model

Company fleet managers need a unified solution, avoiding the need to conclude agreements with every single supplier active in the region.

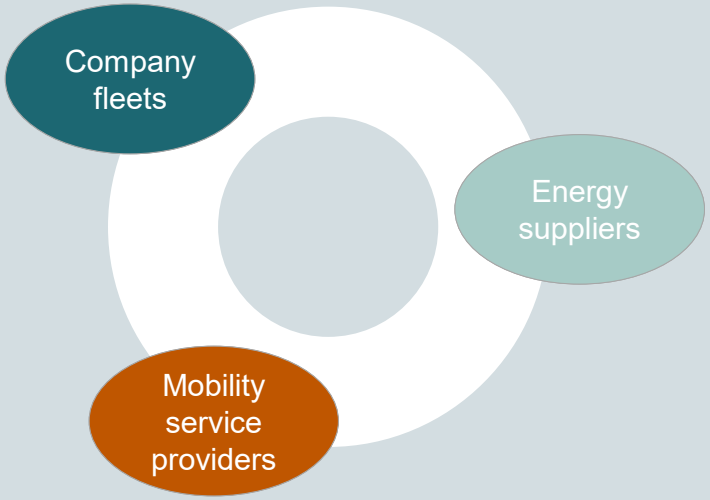
Energy suppliers needs harmonized access to behind-the-meter energy flows.



A first version of many-to-many approach will be set up in the EV.fleet at scale initiative, with participating actors.

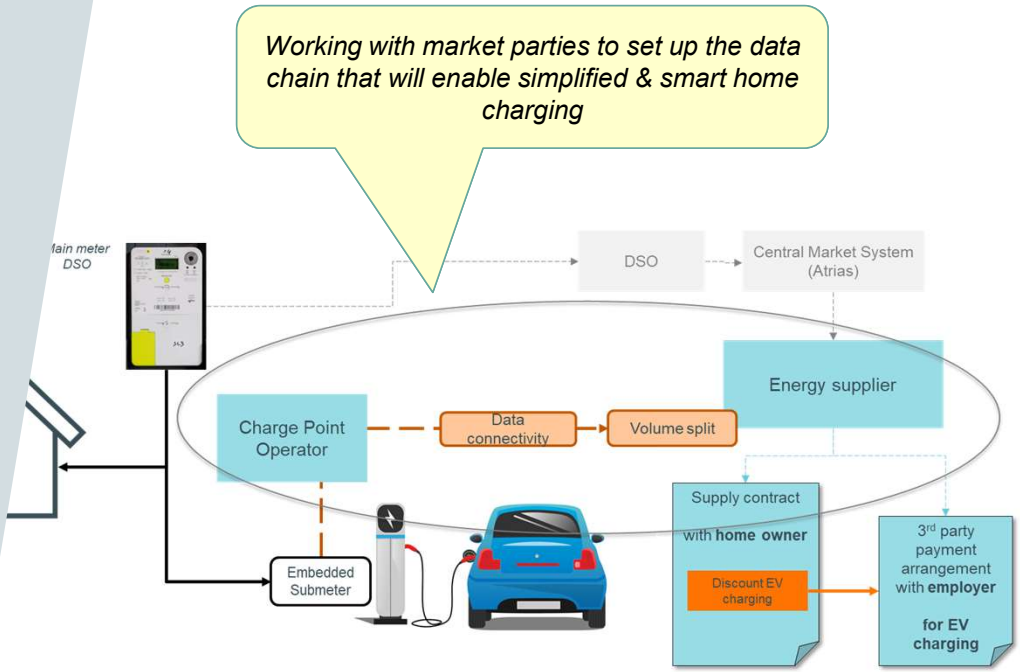
Where are we today?

Coalition building to prove interest at demand & supply side



&

Proof-of-concepts with market actors to prove feasibility



EV.fleet at scale: route to impact

End June ‘25:
- First coalition of fleet managers, energy suppliers & CPO willing to implement an EV.fleet at scale solution.
- First results of proof-of-concepts with frontrunner suppliers & a subset of fleets

30/Sep/2025:
EV.fleet at scale gets public visibility at the Elia **Flex at scale event**.
- Successful pilots in the picture
- Announcement of the coalition at demand (fleet) and supply (suppliers & CPO) side to underline the scale.

End of 2025:
First commercial implementations of EV.fleet at scale concept with volume split visible in fleets.

Join the coalition?

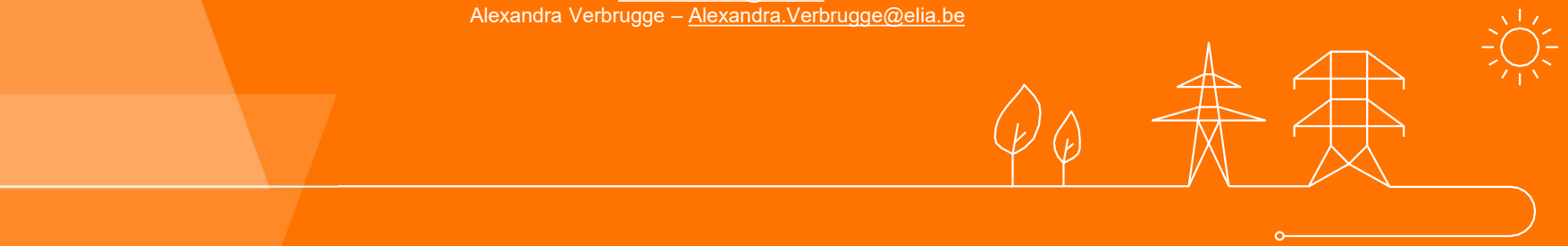
This coalition gathers employers, energy suppliers, mobility providers & representative associations interested in the "EV.fleet at scale" solution.

Coalition members support the initiative, and show **commitment to investigate & try out the EV.fleet at scale solution**.

EV.fleet at scale

Home charging for company EV fleets simplified

Contact:
Michaël Piron – Michael.Piron@elia.be
Alexandra Verbrugge – Alexandra.Verbrugge@elia.be



1. **Tractebel** – SMRs: state of play
2. **Elia** – Flex@scale
3. **Energyville/Vito** – Paths 2025
4. **Florence School of Regulation** – developments at EU level

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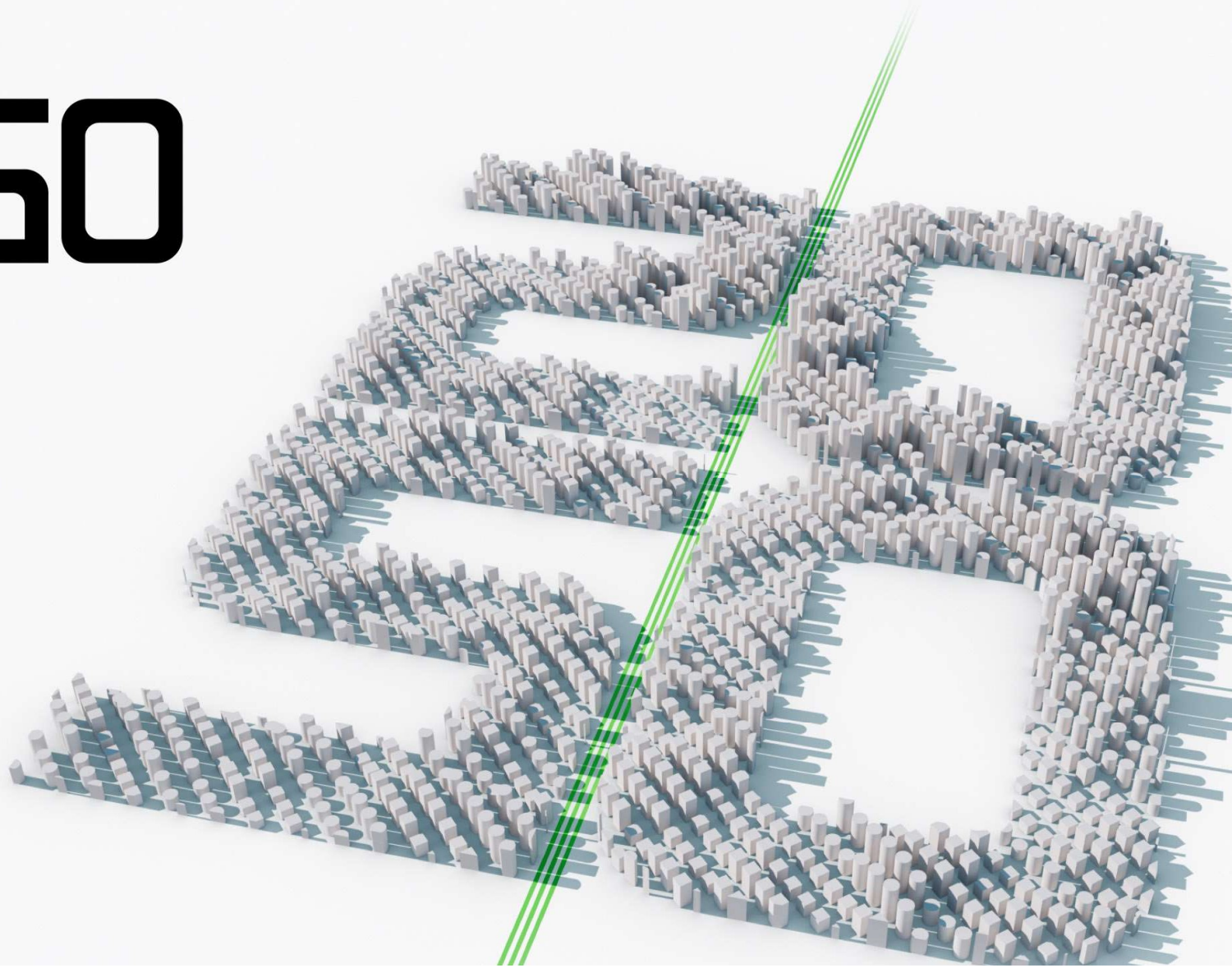
The Power of Perspective



THE PATHS2050 COALITION

ArcelorMittal

BASF
We create chemistry

elia
Elia Group

fluxys

luminus

PATHS 2050
Coalition

- **Exchange and challenge** insights on how the future Belgian energy system could look like
- Created **data-driven pathways** for Belgium towards 2050, as guiding compass for policy makers and industry

“Climate change is still on top of the global agenda.”

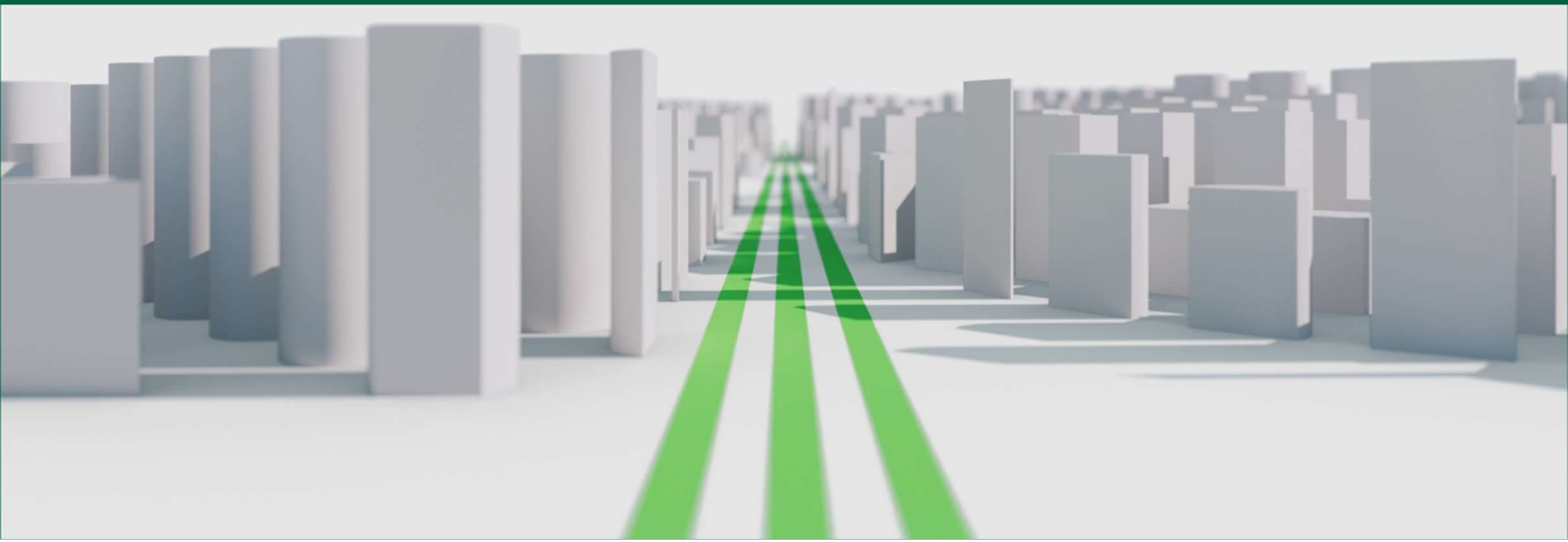
Special Address by President von der Leyen at the World Economic Forum, January 21 2025

“At the heart of the collaborative plan for decarbonisation and competitiveness is the Clean Industrial Deal, which will pave the way towards a proposed 90% emission-reduction target for 2040."

The 2025 Commission work programme: a bolder, simpler, faster Union, press release February 12, 2025

We want to cut the ties that hold you [companies] back so that Europe can not only be a continent of industrial innovation, but a continent of industrial production.

MAIN ASSUMPTIONS & SELECTED SCENARIOS



The EnergyVille TIMES Be Model

- Most detailed, **full system optimization** model of the Belgian energy system, to date
  - Cross-vector: covering energy use (fossil fuels, renewables, clean molecules and electricity), feedstock
  - Cross-sector: covering all supply (refineries, power sector) and end-use demand sectors (industry, residential, commercial, transport, agriculture)
  - Cross-border: projected and timesliced import/export cost curves for electricity from other EU countries, possible import of clean molecules

- **Societal cost optimization from now to 2050**: gives insights into pathways to 2050 with intermediate 2030-2040 milestones @ 3% social discount rate

- Reporting on **combustion and process scope 1 CO_2 emissions** = 85% of Belgian GHG emissions today

economie

EPOC 2030-2050

BREGILAB

Procura

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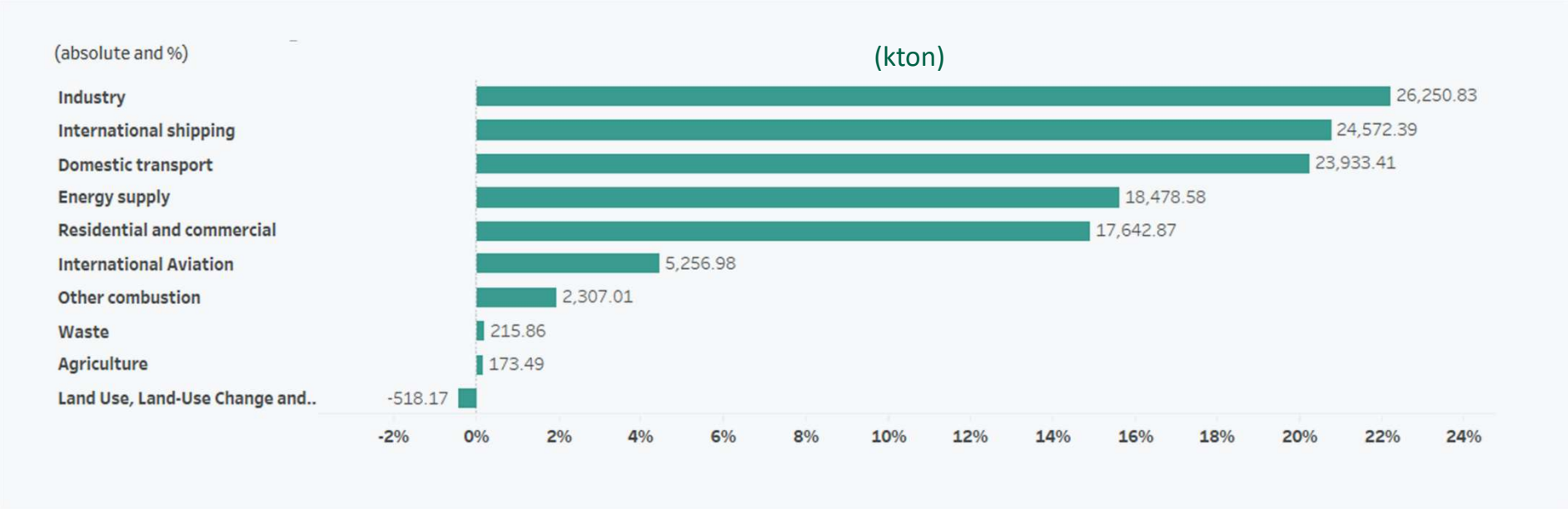
KEY UPDATES TO THE PREVIOUS VERSION 2022

- All costs are updated or discounted towards EUR2024 values
- Energy use, technology stock has been calibrated to 2024 as baseyear
- The residential buildings sector has been updated, with a new, more detailed structure, renovation measures and costs
- Industry updates to steel sector, chemical, refineries, CCS
- Transport sector Vehicle-to-grid included
- Data centers are added with an increasing electricity demand towards 2050
- High voltage interconnections, H_2 and CO_2 pipelines costs added
- Biomass, biogas and biomethane potential (locally available + imported) for Belgium has been updated to increase from 22 TWh in 2022 to 43 TWh by 2050.
- The International maritime and aviation sectors are added to the net-zero target by 2050, accordingly to EU policy ambitions.

SECTORAL BELGIAN CO_2 SHARES IN 2022



- International transport relates to bunkering/fueling in Belgium, but emissions are released outside Belgian borders.
- Not included in the model: Non-CO_2 GHG emissions amounted to 14,6 Mt in 2022

KEY ASSUMPTIONS

INFRASTRUCTURE NEEDS
Costs included for Transmission – distribution & Pipelines

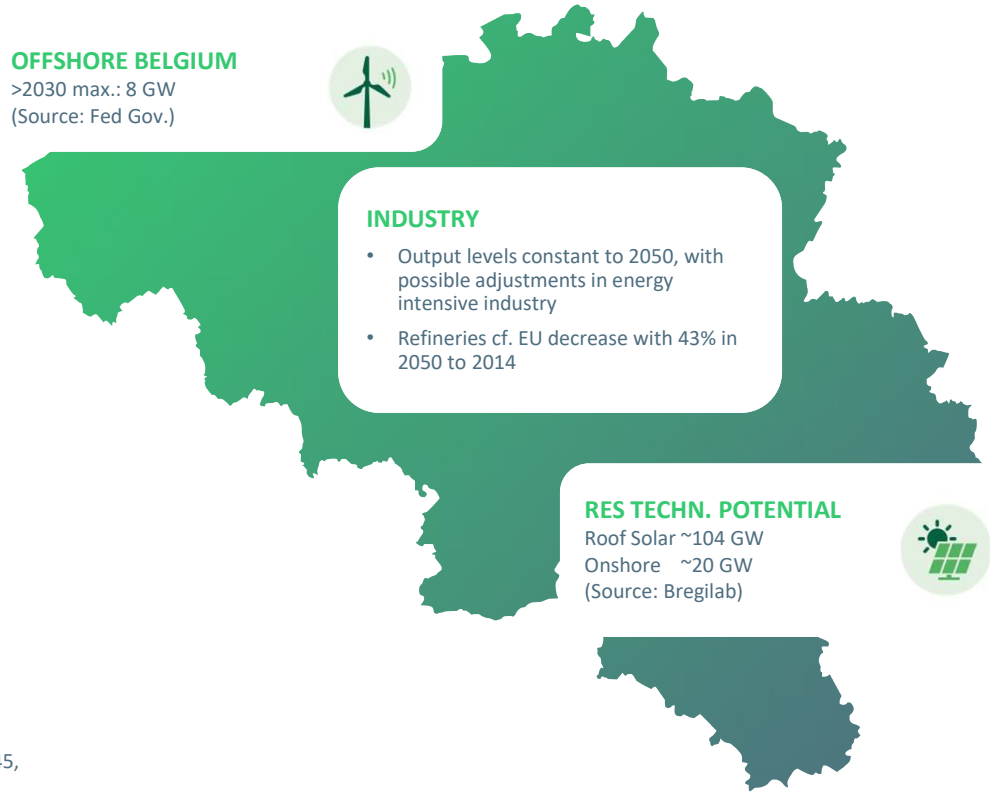
OFFSHORE NORTH SEA
2040: ~320 GW
(Source ENTSO-E TYNDP 2020)
EU countries ambitions 2030, 2050 …
Max 16 GW Direct access for Belgium, AF ≈60%

ELECTRICITY IMPORT
~6.5 GW existing peak import (excl. transit flows)
Investments allowed

CARBON CAPTURE UTILIZATION & STORAGE
Updated technology options, transport and storage costs

IMPORT OF CLEAN MOLECULES
Carrier: H_2, CH_4, CH_3OH, NH_3
Shipping + pipeline import
Updated costs
(Source: International literature)

NUCLEAR TECHNOLOGY
D4-T3 operation extension up to 20y
New EPR (2040) & Small/Advanced Modular Reactors by 2045, compliant with EU taxonomy



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3 NEW, MAIN SCENARIOS TO NET-ZERO 2050

ROTORS

Access to:

- 20 GW of onshore wind
- 8 GW Belgian offshore + direct access to +16 GW far offshore
- 20y operation extension D4T3
- Max 4 GW new nuclear SMR from 2045
- Max 10 Mton/a CO_2 storage
- Average clean molecule import prices

REACTORS

Access to:

- 10 GW of onshore wind
- 8 GW Belgian offshore + direct access to +6 GW far offshore
- 20y operation extension D4T3
- Max 8 GW new nuclear: large scale EPR gen III+ from 2040 + SMR from 2045
- Unlimited CO_2 storage
- Average clean molecule import prices

IMPORTS

Access to:

- 10 GW of onshore
- 8 GW Belgian offshore + direct access to +6 GW far offshore
- No 20y operation extension of D4T3 & no new nuclear
- Unlimited CO_2 storage
- Very low clean molecule import prices

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MAIN MESSAGES

FINAL ENERGY DEMAND IN BELGIUM

Final energy demand decreases by a

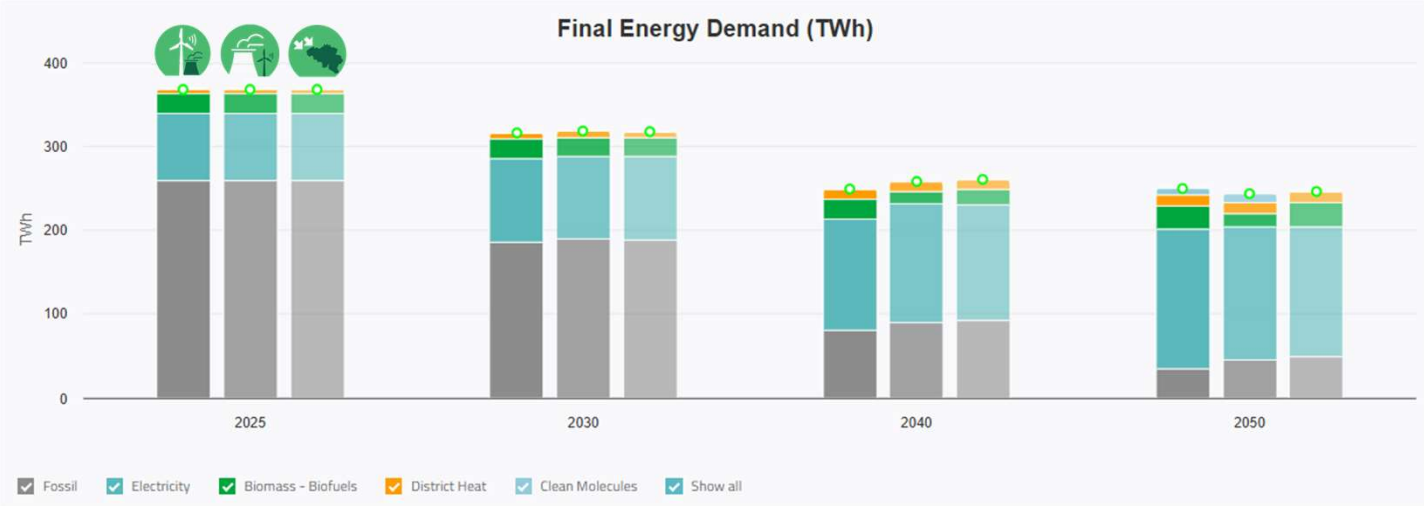
THIRD

Regardless of the scenario

Electricity demand more than

DOUBLES

In the 3 scenarios



Clean molecules: Hydrogen and its derivatives: such as ammonia, synthetic methane, methanol, and kerosene

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RESIDENTIAL & COMMERCIAL – FINAL ENERGY DEMAND

Starting today, an annual renovation rate of at least

4%

Is needed up to 2040, up from 1% today, particularly for buildings with label D or lower

From 2030 onwards,

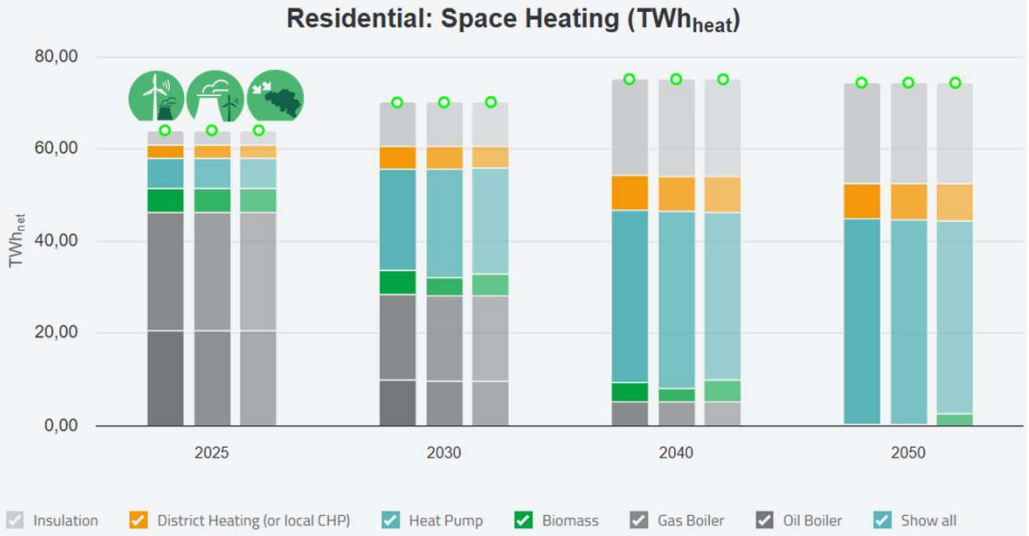
NO NEW INVESTMENTS IN FOSSIL BOILERS

Is cost-optimal.

By 2040, we should aim for a

COMPLETE PHASE OUT

Of oil heating in the buildings sector



RESIDENTIAL & COMMERCIAL – FINAL ENERGY DEMAND

By 2030, we should aim for

36%

Of buildings heated by electrical heat pumps, up from less than 10% today.

And 7% connected to district heating

Biomethane, if available in larger quantities, could

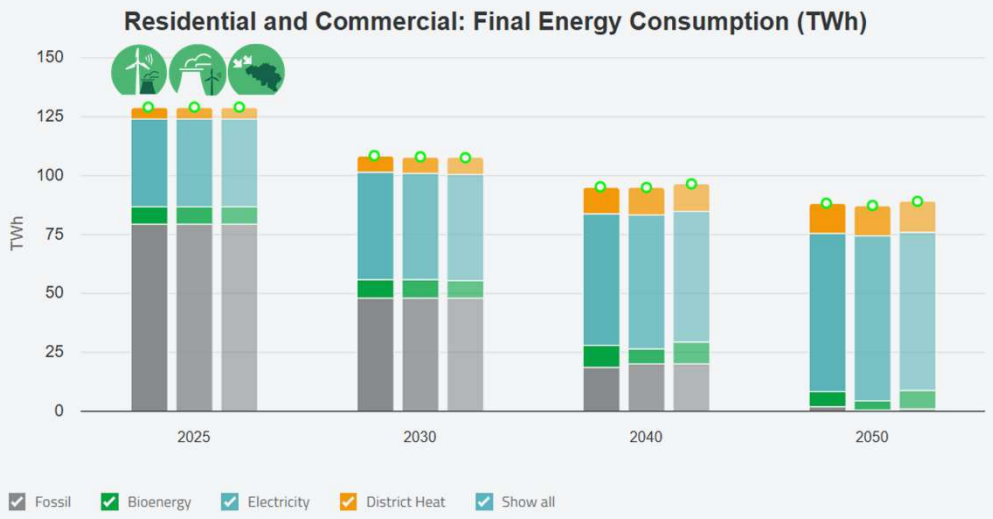
SUPPORT THE TRANSITION

Reaching net-zero in large cities where individual heat pumps or district heating is hard to realize in the short term

Electricity demand strongly increases with an additional

12 TWh

By 2050 due to projected increase in data centers



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DOMESTIC TRANSPORT – FINAL ENERGY DEMAND

Electric vehicle sales need to double the next 3 years to reach

60%

Market share by 2030 and reach 2 million EV's on the road

Road transport fully

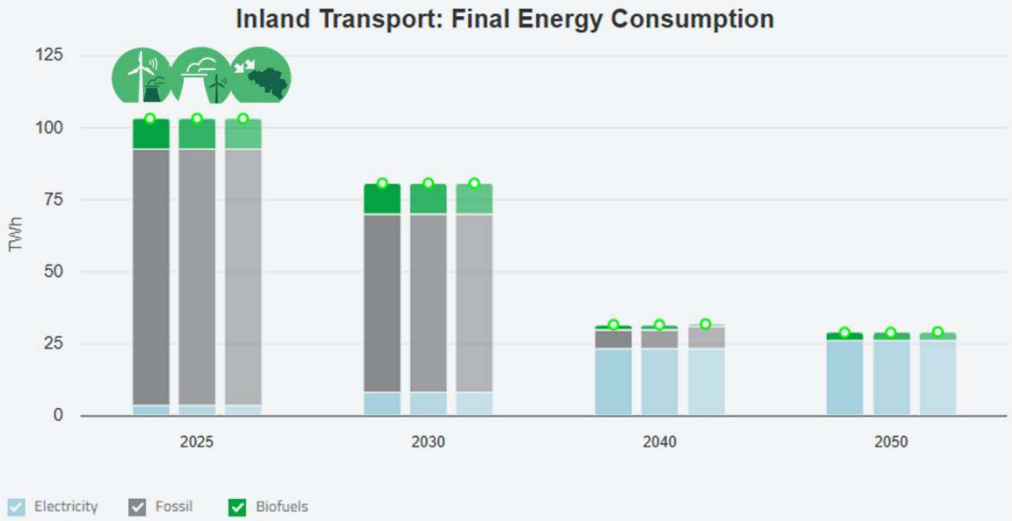
ELECTRIFIES

By 2050 in all scenarios

By 2050, at least

1.5 MILLION

Charging stations are needed, of which 50% is smart and 25% offer vehicle-to-grid services



PATHS 2050

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INDUSTRY – FINAL ENERGY DEMAND

By 2030, fossil fuels still account for

67%

Of the final energy demand of industry

By 2050, fossil fuels (natural gas) account for

25-40%

Of the final energy demand of industry, depending on the access to CO_2 storage

By 2050, electricity demand increases by

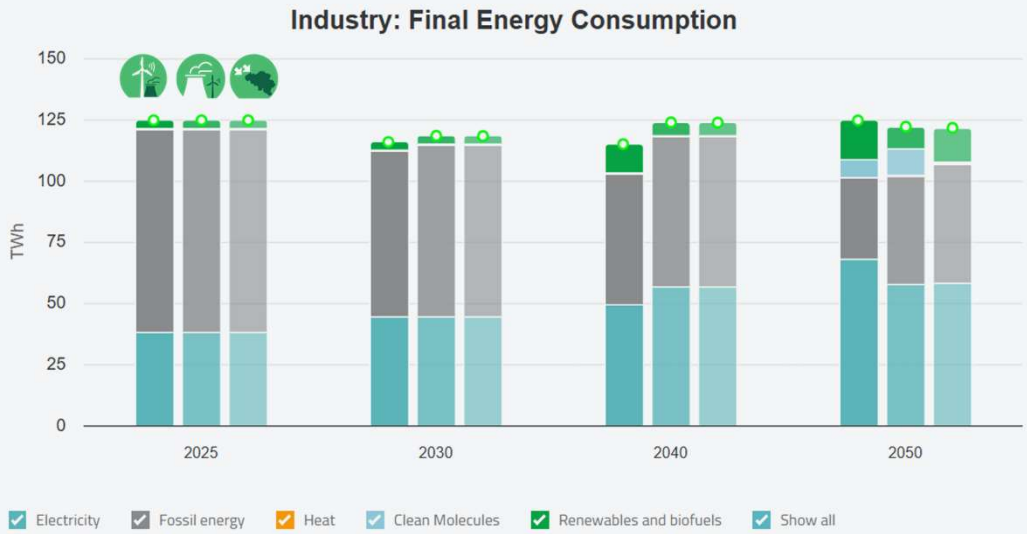
50-80%

Amounting to 57-67 TWh, depending on the scenario

By 2050, biomass use reaches

12 TWh

Partially combined with CCS, leading to negative emissions



PATHS 2050

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INDUSTRY – FEEDSTOCK

By 2050, fossil feedstock remains at

90 TWh

Ammonia will be fully imported

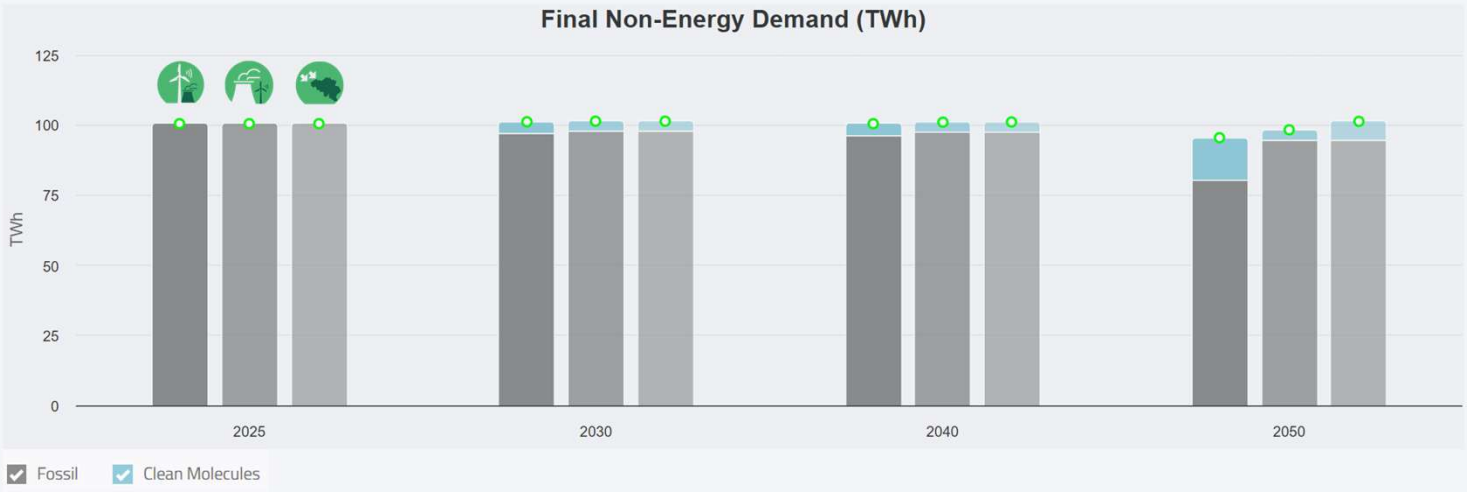
>2040

In Rotors and Imports

In Rotors, e-methanol feedstock reaches

9 TWh

Reducing fossil feedstock use by 14 TWh



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INDUSTRY – CHEMICAL SECTOR DEEP DIVE

Final energy use

INCREASES

Mainly due to energy intensity of CCS

Electrification of the naphtha crackers leads to

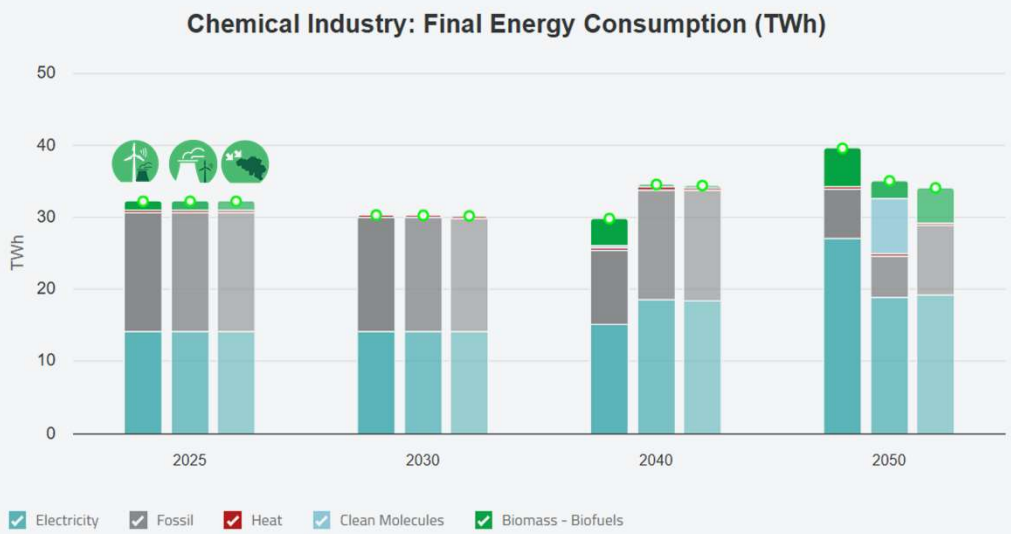
9 TWh

Additional electricity demand in Rotors

By 2050, local hydrogen production in Reactors

8 TWh

Could be used for ammonia production and some high temperature heat processes



INDUSTRY – STEEL SECTOR DEEP DIVE

By 2030, primary steel CO_2 intensity decreases by

30%

To reach -95% by 2050
from 1,7 tCO2/t steel today

By 2030, the use of natural gas could more than

DOUBLE

Due to a partial shift to a Direct Reduced Iron process

By 2050, biomass use increases to

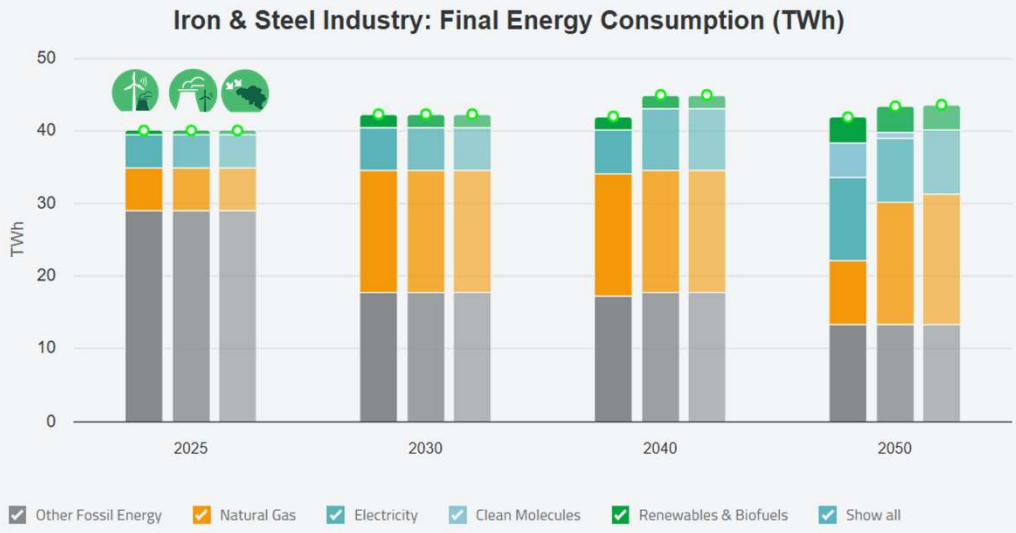
4 TWh

For charcoal and bio-ethanol production

By 2050, in Rotors, hydrogen use amounts to

5 TWh

Replacing natural gas partially in the DRI process and limiting CCS to 3 Mton/a



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CO_2 EMISSIONS

By 2030, Belgian CO_2 emissions are reduced by

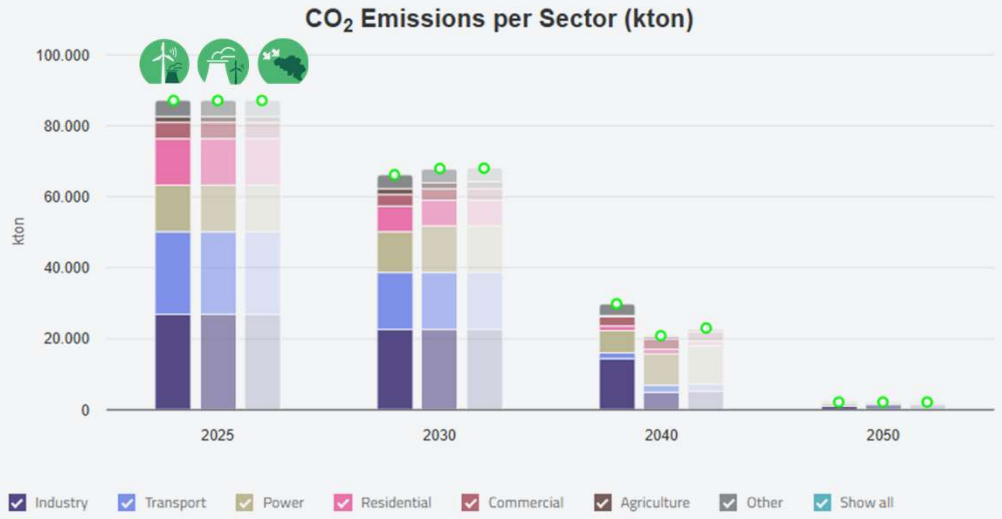
45%

Compared to 1990 levels

By 2040, a CO_2 reduction of

75-83%

Should be reached to be on track for net-zero by 2050



CARBON CAPTURE UTILISATION & STORAGE

By 2030, Carbon Capture and Storage could reduce CO_2 emissions by

2-4 Mton/a

In the chemical & cement sector

By 2040, Carbon Capture and Storage needs scaling up to

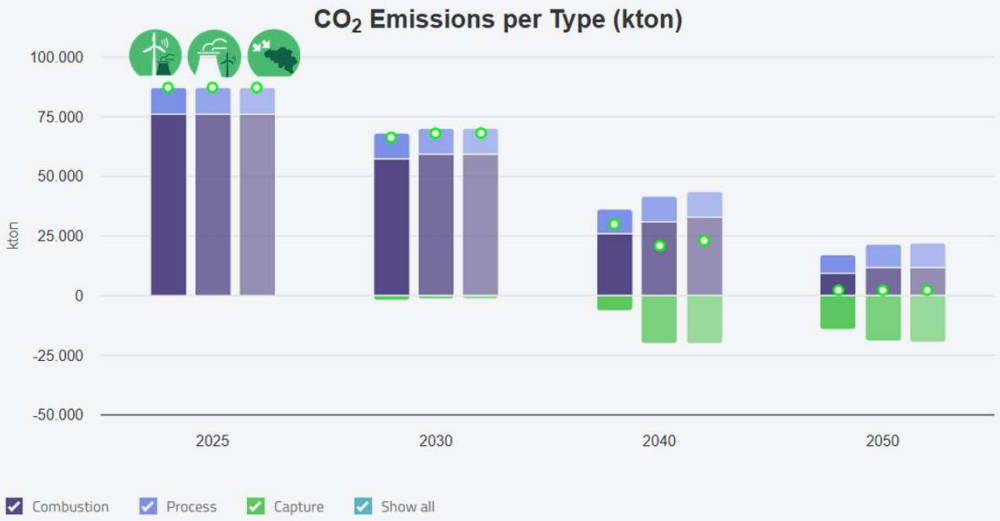
20 Mton/a

In the steel, chemical, cement, lime and glass sectors

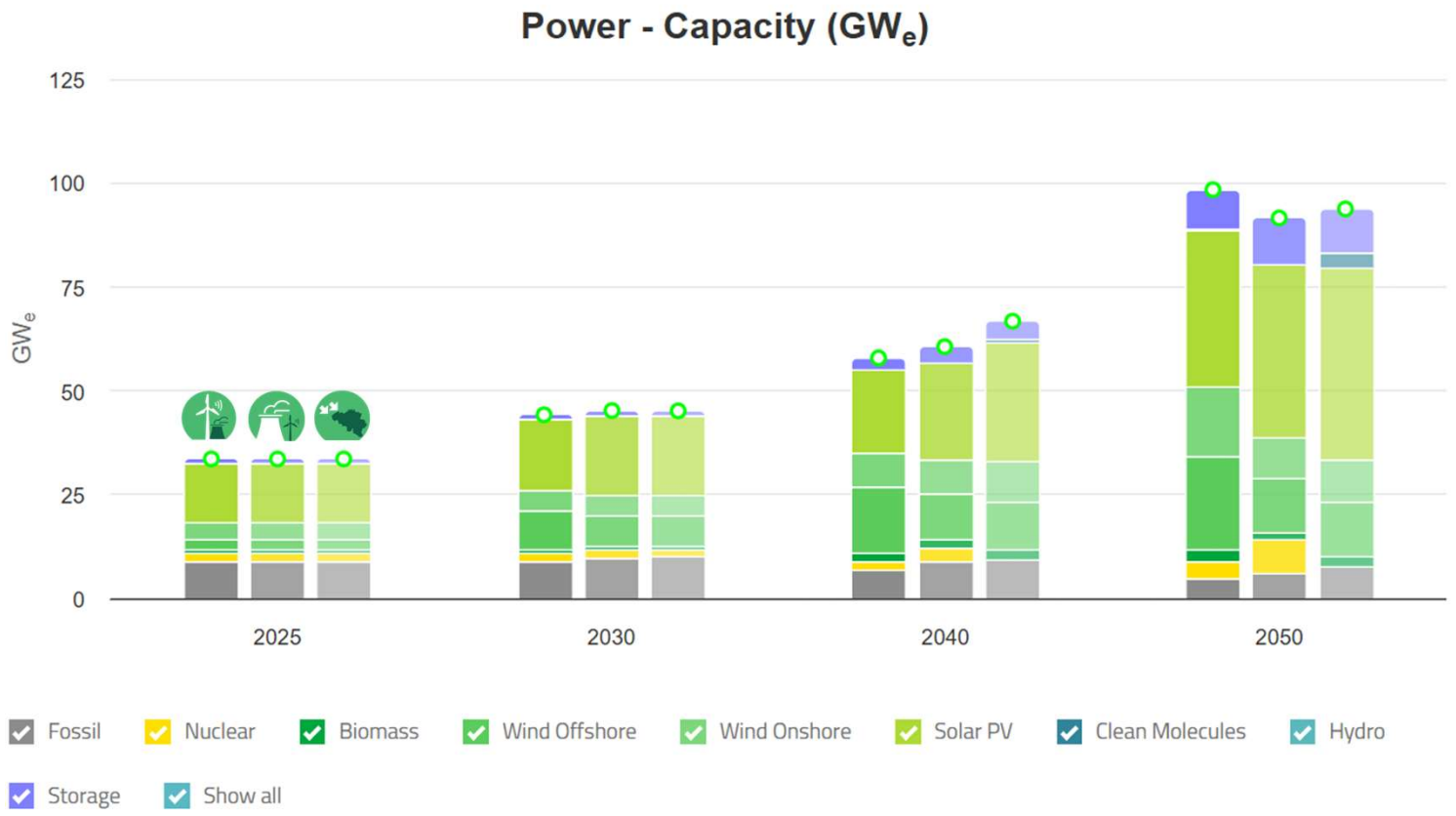
In Rotors, access to affordable electricity and a cap on CO_2 storage leads to

9 TWh

Of e-methanol production for a methanol-to-olefins and -aromatics production



POWER SECTOR – CAPACITY (incl. STORAGE)



POWER SECTOR – RENEWABLE CAPACITY

By 2030, offshore wind capacity should increase to

7-9,3 GW

In Belgian territorial waters and with direct access to far offshore

Up to 2030, new PV installment rate should be at least

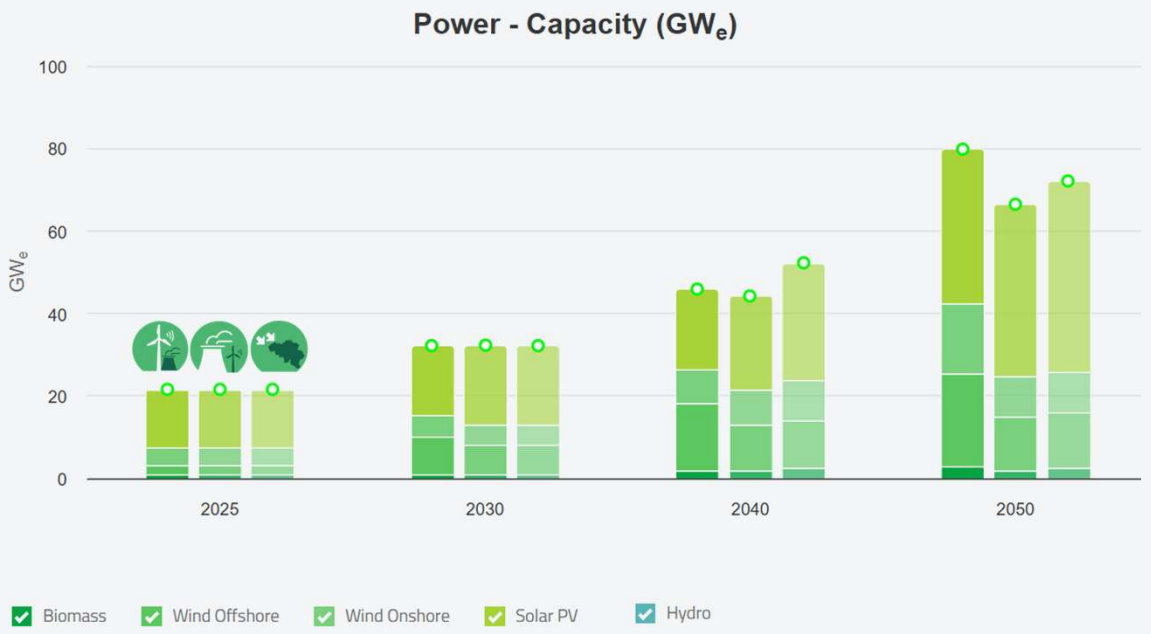
1 GW/a

To reach a capacity of 17-19 GW

By 2050, PV and wind growth leads to

65-80 GW

Of renewable capacity



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POWER SECTOR – THERMAL CAPACITY & STORAGE

By 2030, gas based capacity (CHP and CCGT) amounts to

9-10 GW

Requiring new investments

From 2040 earliest, new nuclear can become part of the energy system

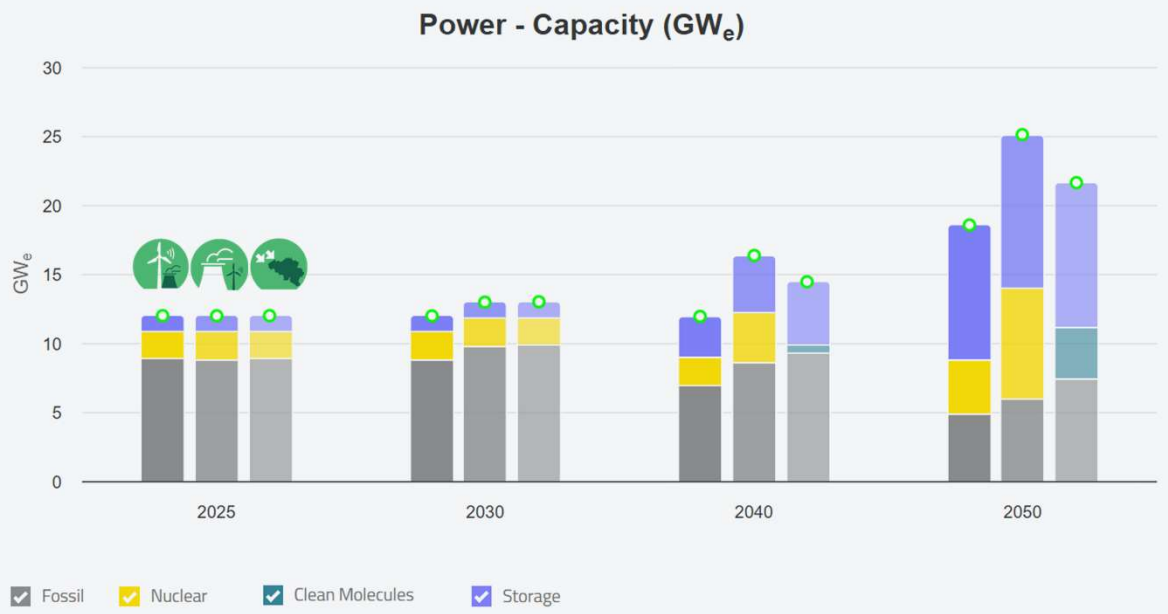
4-8 GW

As large-scale EPR or more flexible SMR reactors.

By 2050, batteries and vehicle-to-grid offer

8,5-10 GW

Of storage and flexibility to the electricity system



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POWER SECTOR – GENERATION & NET IMPORT

By 2050, electricity generation in Belgium

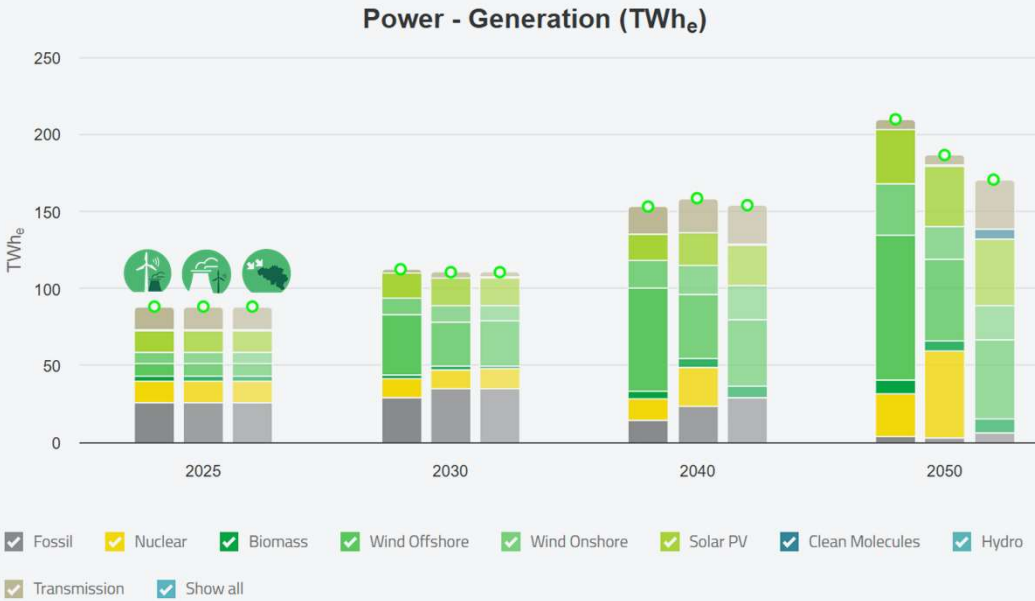
doubles

and reaches 139 - 200 TWh

Belgium remains net importer of electricity

6 – 30 TWh/a

By 2050 in Rotors/Reactors vs Imports scenario



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FLEXIBILITY NEEDS - SUPPLY

By 2050, battery storage amounts to

6 – 7,3 GW

To provide storage and flexibility to the electricity system

By 2050, vehicle-to-grid services amount to

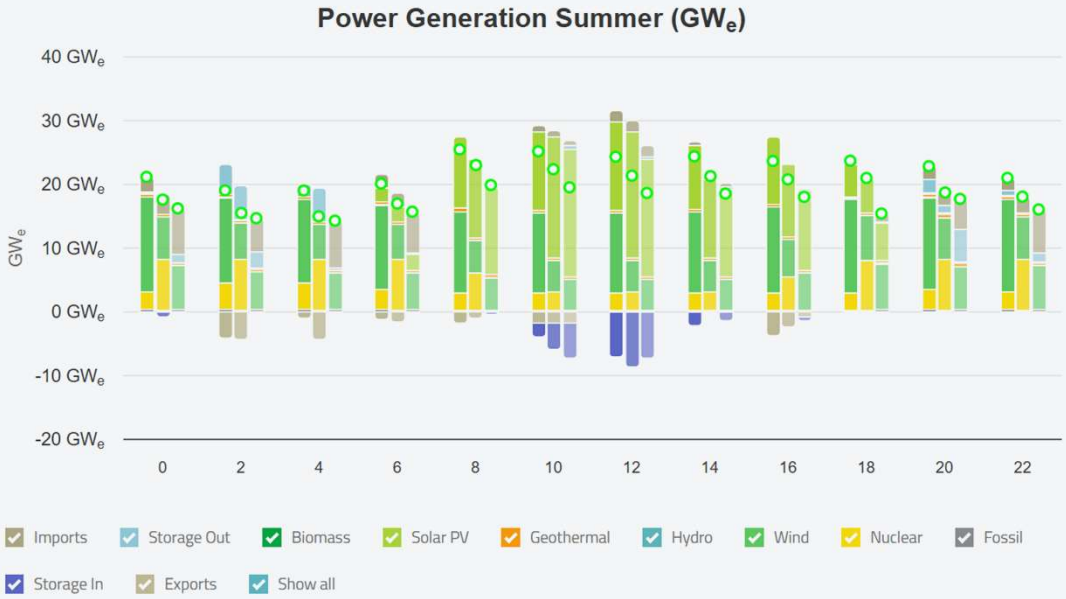
2,5 GW

Providing flexibility to the electricity system

Nuclear, advanced modular reactors, should provide

flexibility

By ramping up and down during the day



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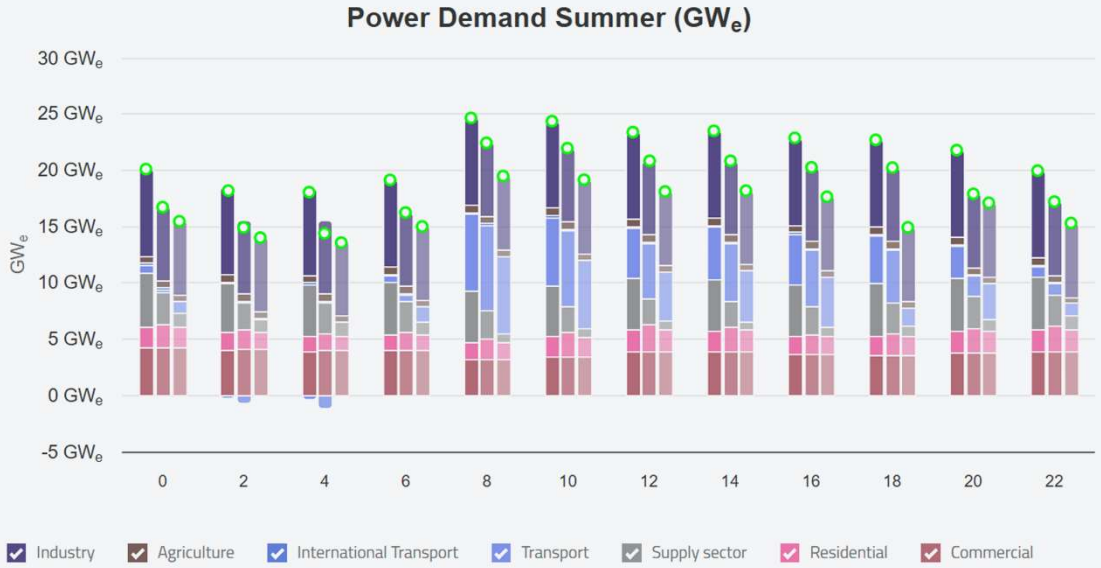
FLEXIBILITY NEEDS - DEMAND

By 2050, smart charging of cars can bring

7 GW

Of flexibility to the electricity system



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CLEAN MOLECULES SUPPLY - DEMAND

By 2050, clean molecule import amounts to

69 – 100 TWh

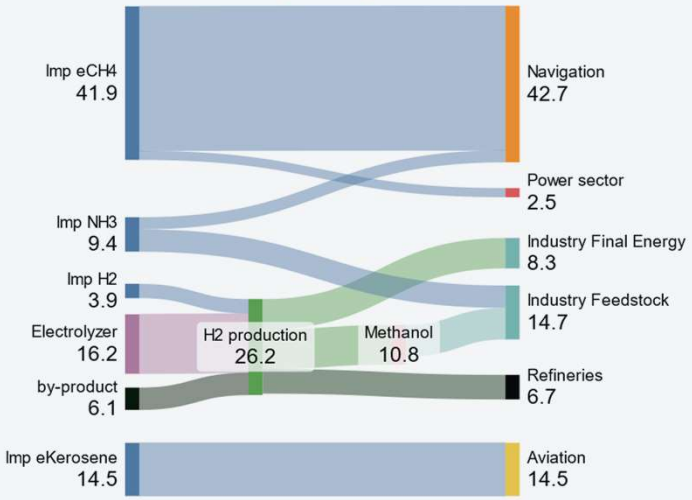
Including e-methane, ammonia, and e-kerosene, mainly driven by international navigation and aviation

Limited access to carbon storage could lead to

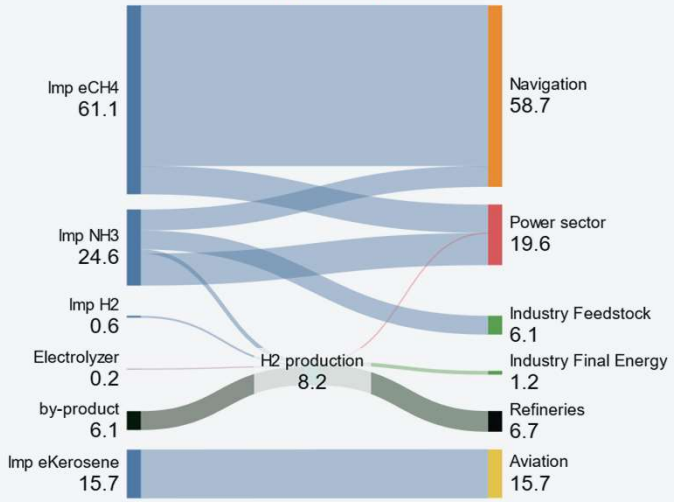
9 TWh

Of e-methanol production, if affordable electricity is available as in Rotors

ROTORS scenario 2050 (TWh)



IMPORTS scenario 2050 (TWh)



COST COMPARISON OF THE MAIN SCENARIOS

The Rotors and Reactors scenario are more

CAPITAL INTENSIVE

Increasing large-scale domestic low-carbon electricity generation

The Imports scenario leads to higher

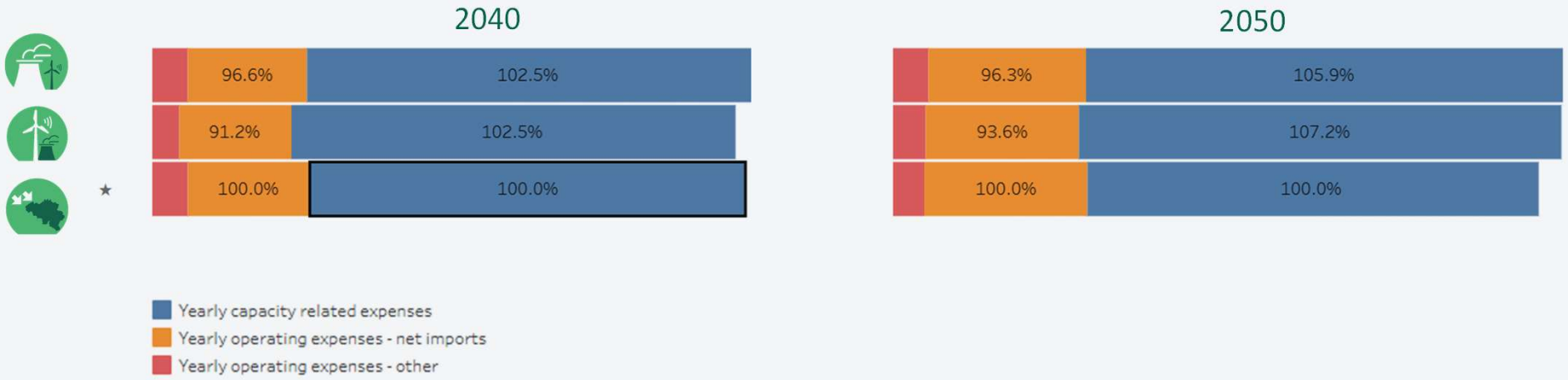
OPERATING EXPENSES

And a higher dependency on imports of molecules and electricity

Between 2040 and 2050, Rotors and Reactors require annually

12,5 b€

Investments in the electricity sector.



ELECTRICITY GENERATION COST

Early investments in the power sector lead to

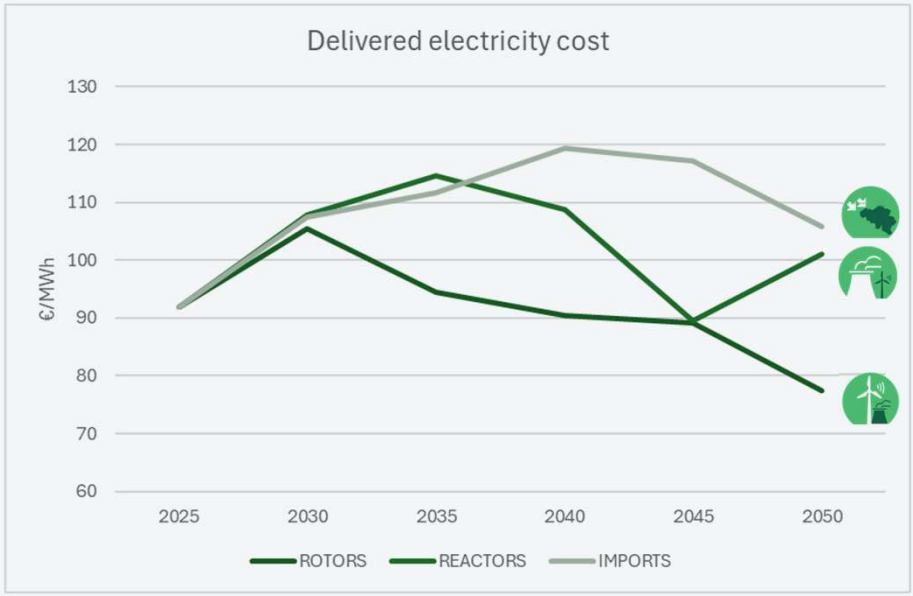
lower

Delivered electricity costs in the short and longer term

By 2050, Rotors could lead to the lowest delivered electricity cost

77 €/MWh

Due to the combination of more offshore wind and nuclear SMR



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SUMMARY

SUMMARY EVOLUTION MAIN ENERGY VECTORS & CCS

By 2030, natural gas use peaks in the power sector

42 – 50 TWh

To phase out by 2050 and being replaced by 3-8 TWh e-methane or other H_2 derivatives for peak operation

By 2050, natural gas use decreases to

21 – 35 TWh

As final energy demand, mainly remaining in industry

By 2050, the use of e-methane import amounts to

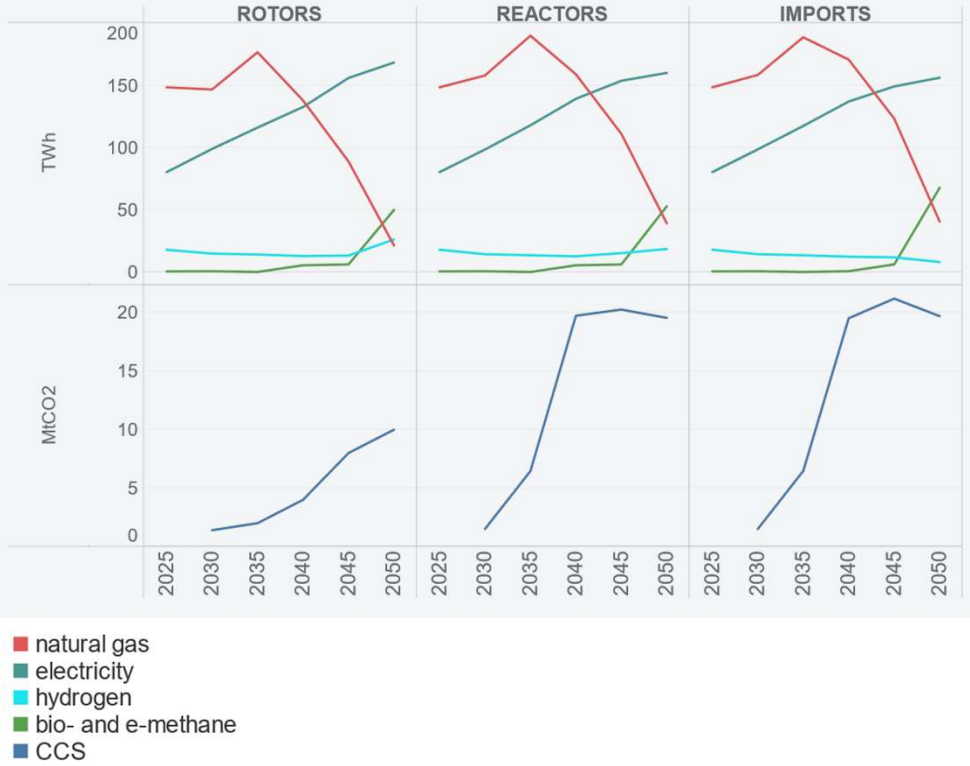
43 – 59 TWh

For international navigation and more limited for the Power sector

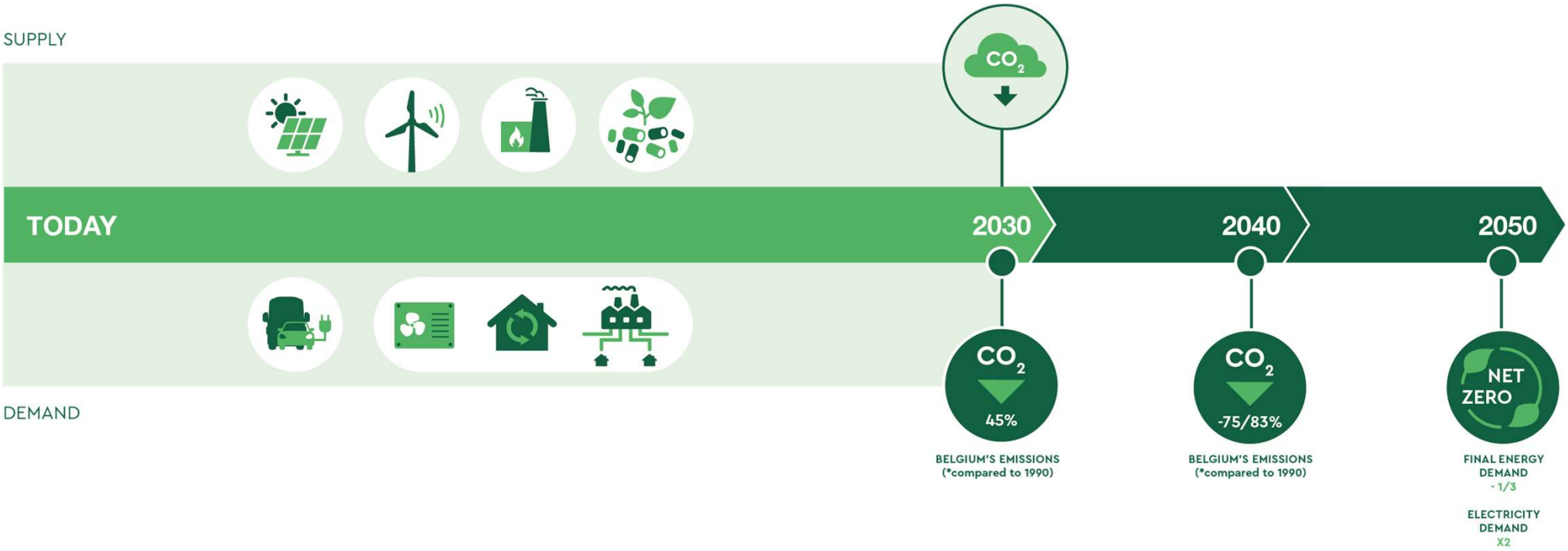
By 2040, Carbon Capture and Storage needs scaling up to

20 Mton/a

In the steel, chemical, cement, lime and glass sectors in Reactors & Imports



SHORT TERM RECOMMENDATIONS BY 2030



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MEDIUM TERM RECOMMENDATIONS - FROM 2030 TO 2040

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REACHING NET-ZERO BY 2050 – RECOMMENDATIONS FROM 2040 TO 2050

PATHS 2050

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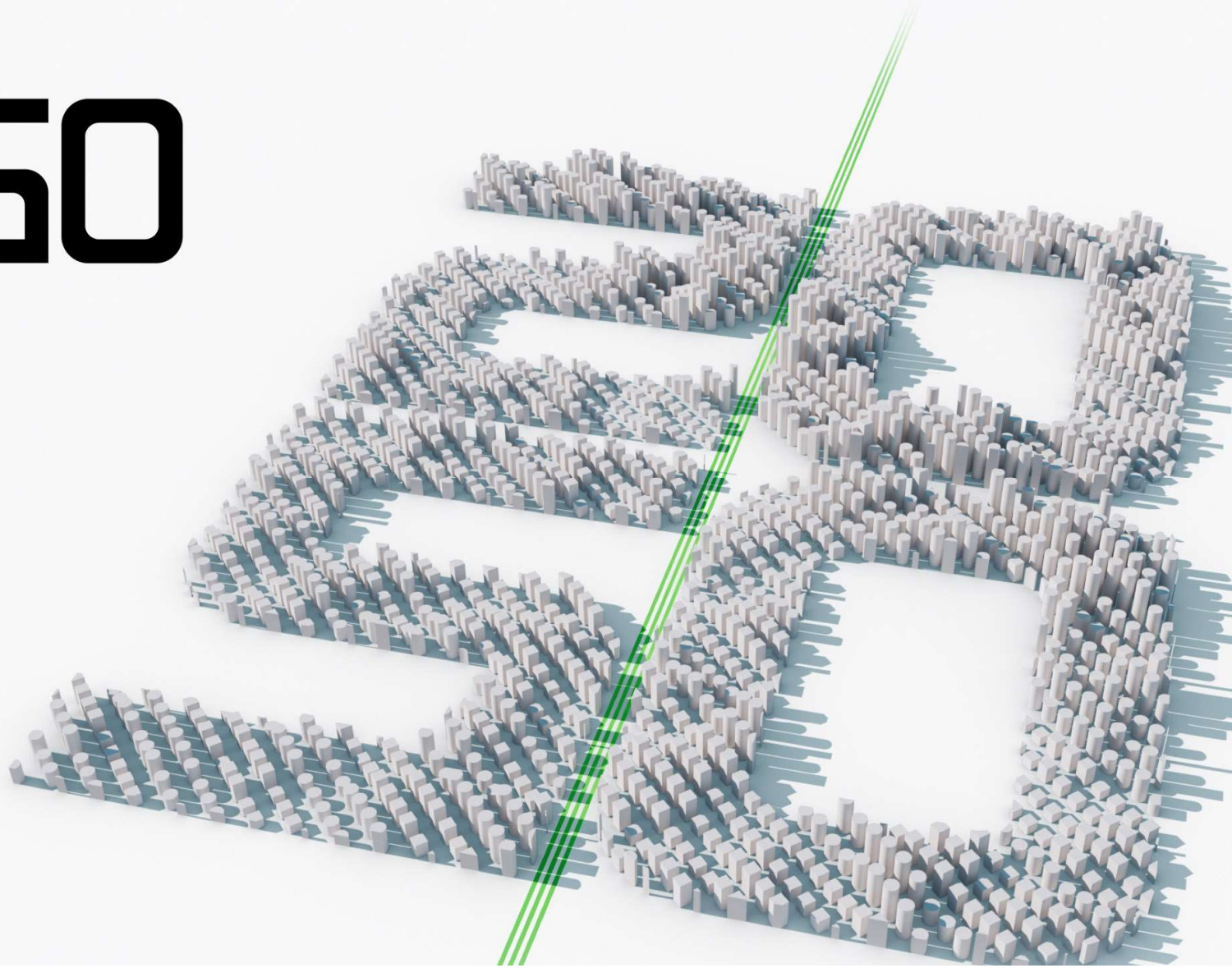
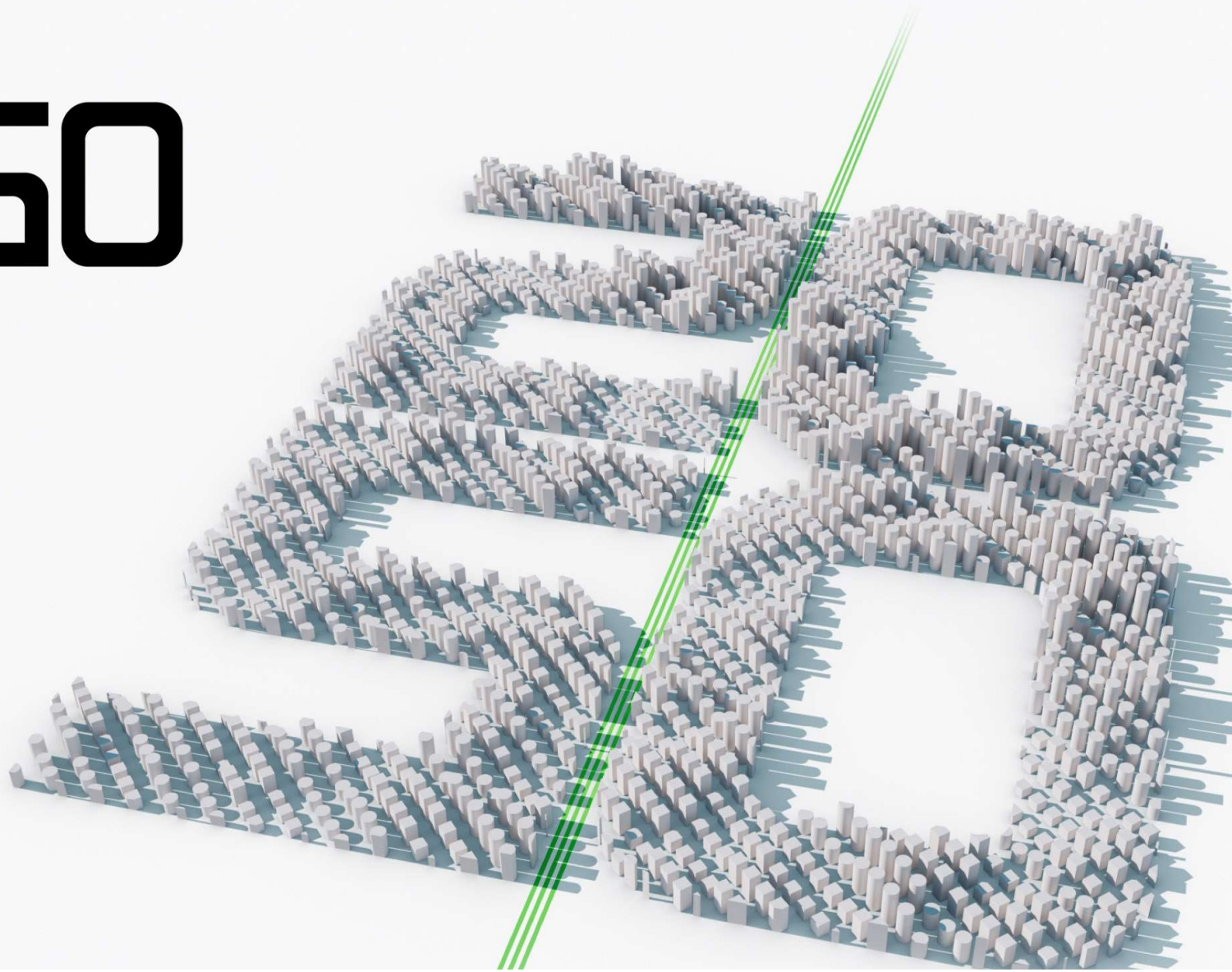
PATHS 2050

The Power of Perspective



PATHS 2050

Thank you!



1. **Tractebel** – SMRs: state of play
2. **Elia** – Flex@scale
3. **Energyville/Vito** – Paths 2025
4. **Florence School of Regulation** – developments at EU level

FLORENCE SCHOOL OF REGULATION

ROBERT SCHUMAN CENTRE

Electricity Market Design: Are we reforming the reform?

Prof Leonardo Meeus

Director Florence School of Regulation

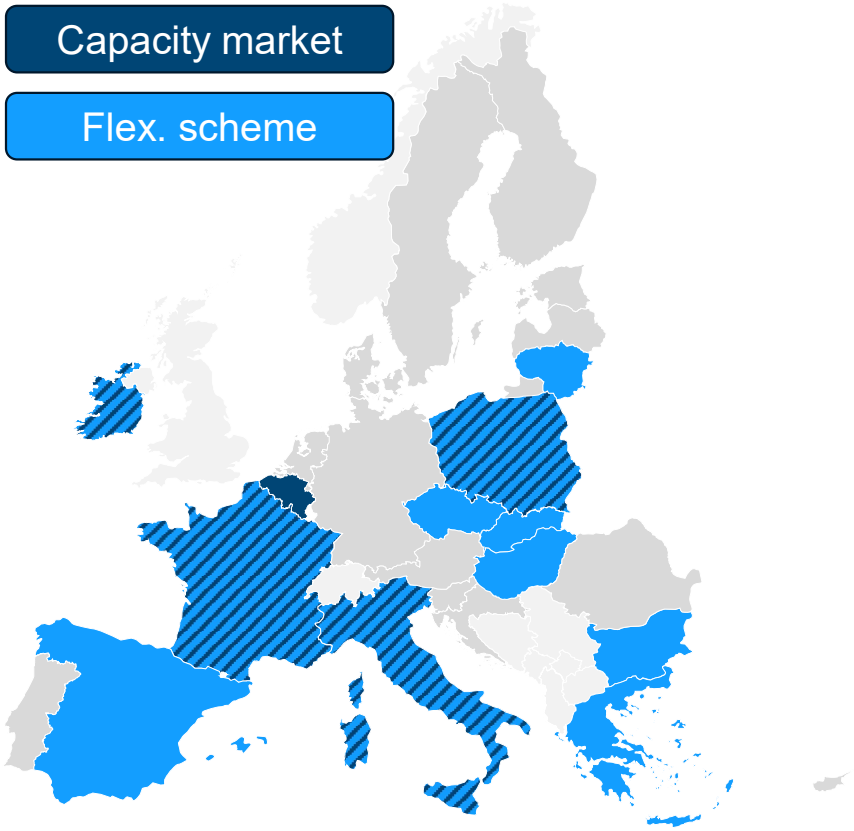
Loyola de Palacio Chair

www.eui.eu

Flexibility support schemes - developing fast

Capacity market

Flex. scheme



State Aid SA.64736 – RRF - Greece - Financial support in favour of electricity storage facilities

State Aid SA.102428 (2022/N) – Hungary
TCTF – RRF: Aid for energy storage facilities for the integration of weather variable renewable energy sources

State Aid SA.106554 (2023/N) – Slovakia
TCTF - RRF - Slovakia: Investment support for electricity storage

State Aid SA.104106 (2023/N) – Italy
Support for the development of a centralised electricity storage system in Italy

Aide d'État SA.107352 (2023/N) – France : mesure de soutien aux flexibilités décarbonées de court terme en France par appels d'offres.

State Aid SA.112460 (2024/N) – Poland
TCTF – RRF: Support for electricity storage and related infrastructure

State Aid SA.114306 (2024/N) – Bulgaria
RRF and TCTF: State aid scheme to support the construction of stand-alone electricity storage facilities

State Aid SA.103068 – RRF – Spain: Support for innovative electricity storage projects

State Aid SA.115362 – Lithuania
TCTF: State aid scheme for investment support for electricity storage

State Aid SA.117215 (2025/N) – Czechia
TCTF: Support for energy storage

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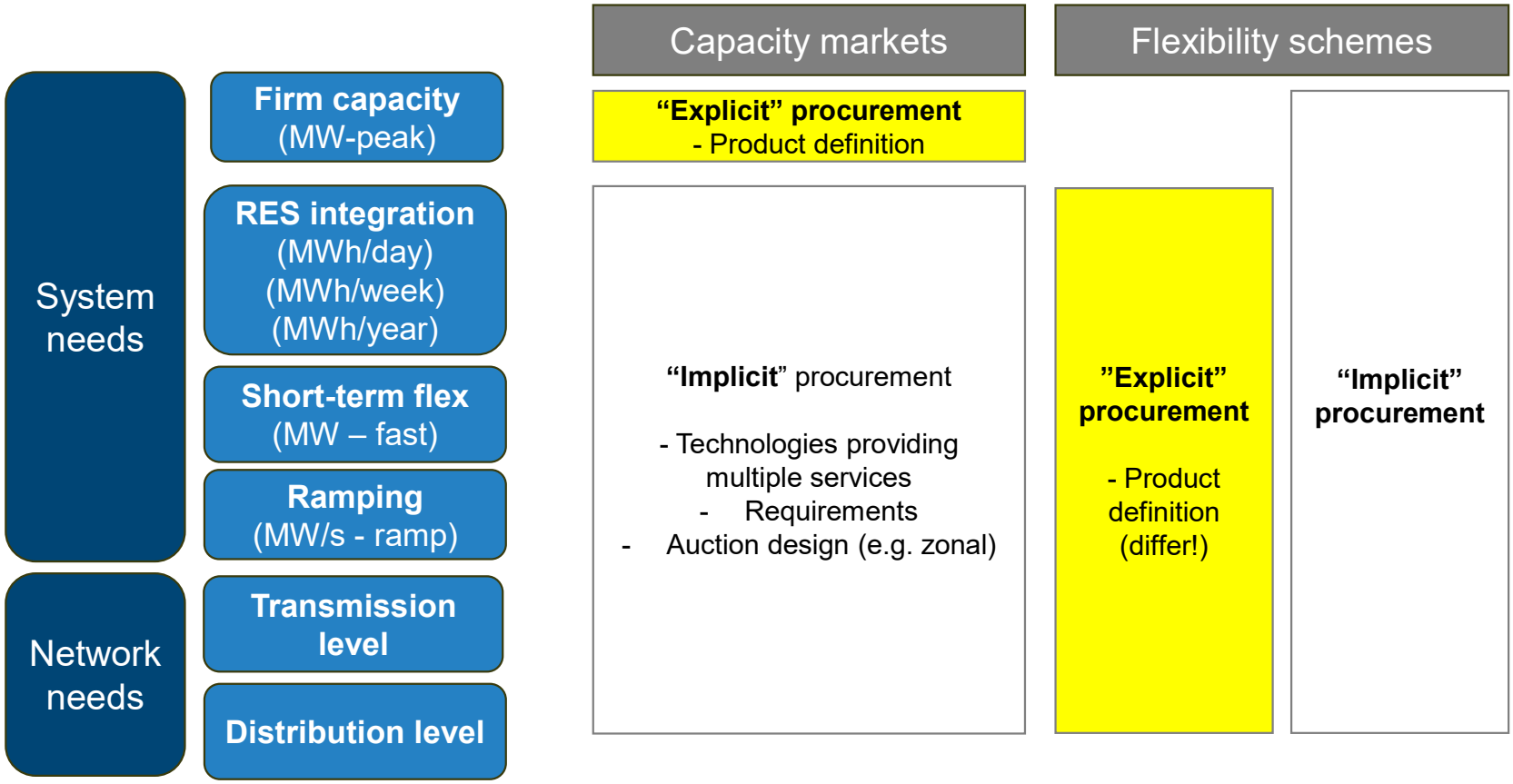
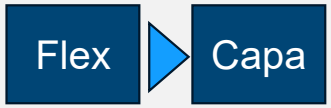
Flexibility and system needs - support schemes' perimeter



Taxonomy based on ENTSOE, EU-DSOentity draft FNA methodology

Open issue Coordination across products/instruments

Sequential auctions



Volume coordination

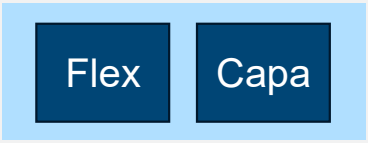
Volume deducted from CM auctions

Price coordination

Complement on CM auction price

Limitations?
- Implies selecting ”priorities” (what is procured first?)
- Limited cost efficiency
- Market complexity for technologies offering various services

Integrated procurement



Co-optimized multi-product auction

Examples?
- Not yet explicitly implemented in this context
- Well-known in other contexts (e.g. day-ahead and balancing capacity)

How ?
- A technology can offer one or several products (linked bids)
- Clearing minimizes total procurement costs considering each resources’ contribution to the different services

Carbon contract for difference

Bundesministerium für Wirtschaft und Energie

How CCfDs work in practice

So what does this actually mean? Here's a highly simplified example of two energy-intensive industrial companies: Company A uses conventional technology, has production costs of €10 for a product, and must additionally spend €5 on emission allowances for the carbon emissions generated in the production process. So the total production costs for the product are €15. As long as the carbon price is relatively low, the production using conventional technology in Company A is cheaper than in Company B, which uses a more expensive, greenhouse-gas-neutral technology and has production costs of €16. The carbon avoidance costs for Company B amount to €6. The state and Company B can now conclude a CCfD which offsets the difference between the market price for emission allowances and the carbon avoidance costs. In our example, this difference is one euro (six euros carbon avoidance costs minus five euros for the emission allowances). If the market price for emission allowances is lower than the carbon avoidance costs, the state pays the difference to Company B. If it is higher, Company B must pay the difference. In the case of energy-intensive industry, however, the avoidance costs are often far higher than the costs of emission allowances. In this case, CCfDs ensure that climate-friendly technologies can compete with conventional technologies. The advantage of a CCfD is that it takes account of a company's actual avoidance costs and its possibilities to pass them on on the market. If, over time, changes arise in the price of emission allowances, for example, or in the field of EU measures to prevent carbon leakage, the difference payments can be adjusted flexibly.

- CAPEX vs OPEX?
- Reference price, adjustment of the strike prices?
- Geography and technology scope?
- Length of contract?

EC simplification proposals in 2025

CBAM (Targeted Amendements)	Sustainability reporting (Omnibus)	Under assessment (REFIT)
• Headline: “90% of importers, only 1% of emissions under CBAM”, i.e. importers with less than 50 tonnes per year of iron and steel, aluminium, fertilizers, and cement • Other: simplified compliance for larger importers, recognition of carbon pricing in third countries, adjusted certificate purchase requirements	• Headline: “savings of €40 billion compliance costs by exempting 80% of companies previously under the Corporate Sustainability Reporting Directive (CSRD), i.e. companies with <1k employees • Other: Reporting timelines for both the CSRD and the Corporate Sustainability Due Diligence Directive (CSDDD) have been extended; Under the CSDDD, companies are now required to conduct environmental and human rights checks only on their direct suppliers, rather than across their entire supply chains.	• Renewable Energy Directive • Energy Efficiency Directive

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Simplification toolbox with different levels of ambition?

Plain Language	Cutting red-tape (standard cost model)	Cleaning up regulation	Governance
• Before (legalese):"The Member States shall take all appropriate measures to ensure compliance with the provisions set out herein." • After (plain language):"Member States must take the necessary steps to ensure this law is followed."	• Reducing the costs of complying with regulation • Filing forms, keeping records, reporting data, applying for permits or licenses	• Omnibus to amend, simplify, or repeal multiple legal acts at once (normally technical non-substantive changes or policy shifts) • Codification to bring together scattered legislation or case law into consolidated legal text	• Improve implementation by making rules easier to enforce at national level • Harmonization to reduce regulatory burden by factor 27 • Integration to avoid 27 solutions for a common problem by centralizing key powers

Are we reforming the reform?

Clean Industrial Deal Communication (Decarbonization Bank) Q1 2025	New State Aid Framework Communication Q2 2025	EIB Pilot offering financial guarantees for PPA offtakers Q2 2025	Recommendation on Network Charges Recommendation Q2 2025
Citizens' Energy Package (supplier switching, energy poverty, energy sharing) Q3 2025	Industrial Decarbonisation Accelerator Act Proposal Q4 2025	Guidance of CfD Design Communication Q4 2025	Guidance on promoting remuneration of flexibility in retail contracts Communication Q4 2025
Legislative action to revise EU energy security regulatory framework early 2026	Electrification Action Plan and European Grids Package Q1 2026	New Rules on Demand Response Q1 2026	Simplification

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Implementation of the electricity market reform

ACER assess need standard PPA contracts Oct 2024

EC assess streamlining CM Jan 2025

EC proposes CM assessment April 2025

ENTSO-E EUDSO propose flexibility needs methodology April 2025

EC assess barriers Forward markets Jan 2026

EC implementing act Forward markets July 2026

ACER asses peak shaving products outside price crisis 1 June 2025

Review Implementation Directive 2019/944 31 Dec 2025

EC assess barriers PPAs 31 Jan 2026

Review Implementation Regulation 2019/943 30 June 2026

EC assess impact Intraday cross-zonal gate closure time 1 Dec 2027

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Thank you.

Next meeting: 26/09/2025, 13 - 16u

Interested to present a topic: jessie.moelans@elia.be