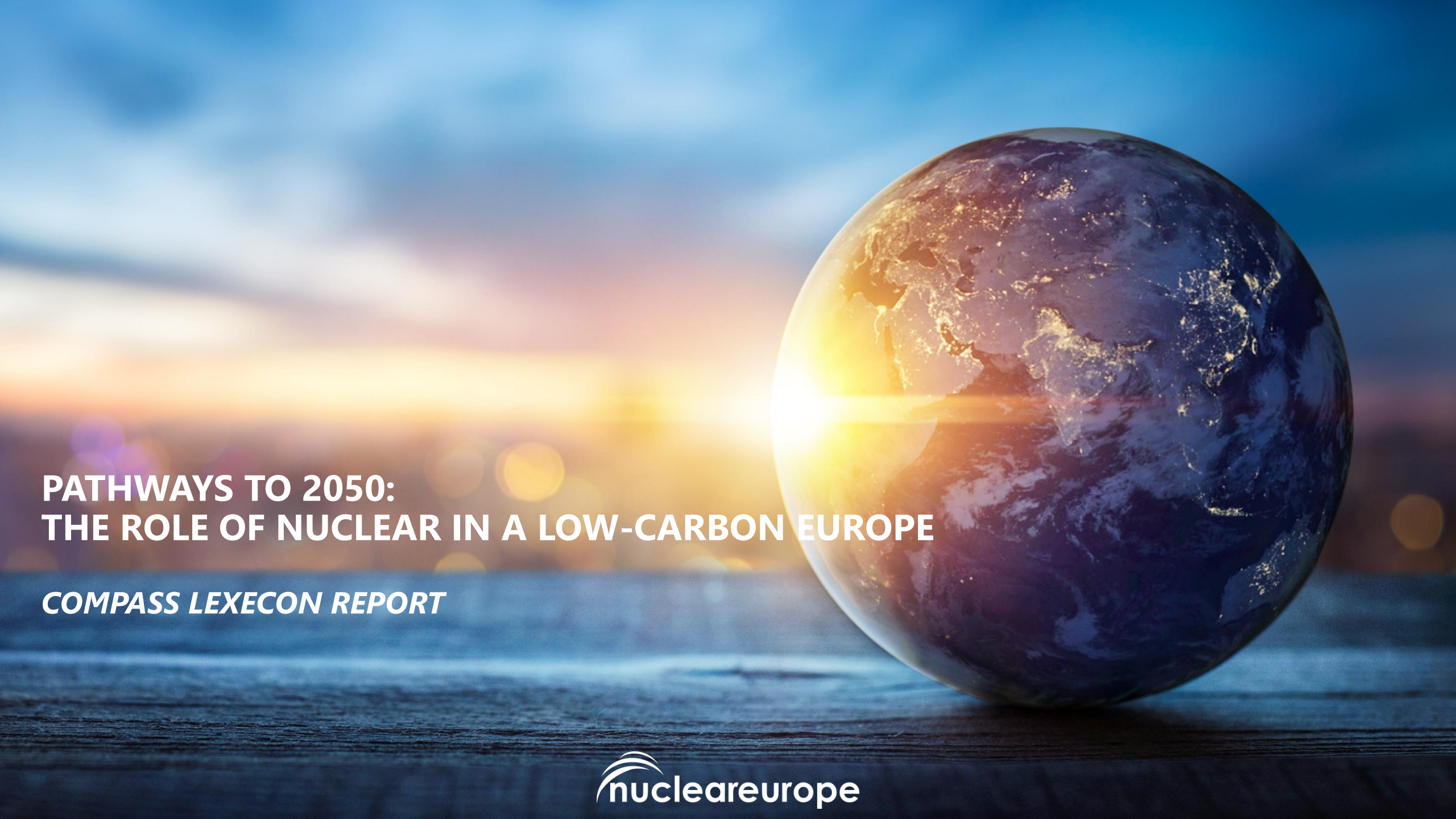

PATHWAYS TO 2050:
THE ROLE OF NUCLEAR IN A LOW-CARBON EUROPE

COMPASS LEXECON REPORT

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What does nuclear contribute to the EU's economy?

99 Nuclear reactors in operation in the EU

1 million jobs

€ 100 billion/year

24% of the electricity Production (2023)

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Key conclusions

More nuclear will enable

- Faster decarbonisation
- Lower energy system costs in the long-term
- Security of supply in a flexible energy system
- Lower dependence on hydrogen imports
- Greater industrial competitiveness in the EU

With all of these benefits extending well beyond 2050!

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Methodology

Nuclear & the Energy Trilemma

Decarbonisation & sustainability

- Role of nuclear in ensuring credible, secure & cost-efficient decarbonised electricity mix

Security of supply

- Role of nuclear in meeting growing electricity demand driven by electrification

Affordability & competitiveness

- Role of nuclear (Long-term operation & new build) in avoiding lock-in of fossil fuels and CO_2 emissions

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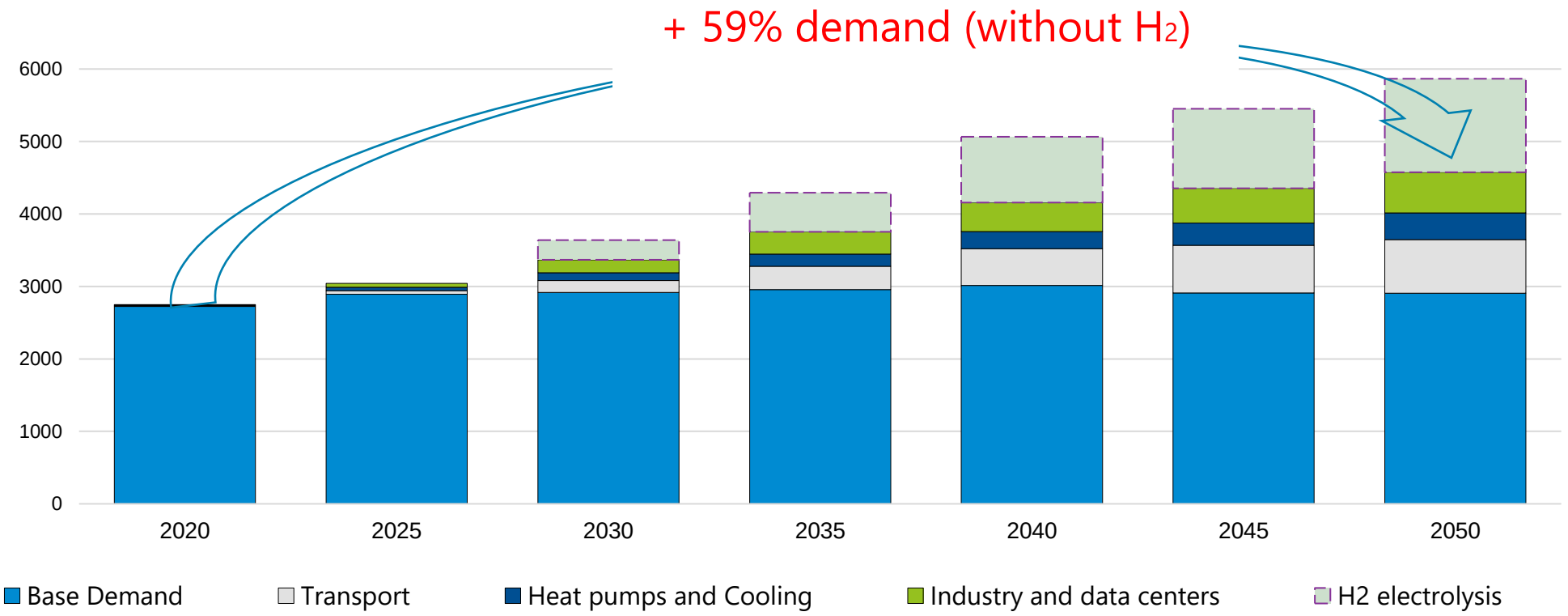
Assumptions

Common Assumptions	Electricity demand = ENTSO-E Ten-Year Network Development Plans (TYNDP) 2024
	Commodity prices = IEA World Energy Outlook 2023 & Compass Lexecon modelling
	Technology costs = EC Technology Assumptions 2024
Differentiated Assumptions	Renewable installed capacity = Based on TYNDP (2030) & optimised based on least cost and potential (beyond)
	Thermal & flexible installed capacity = Optimised to ensure security of supply
	Hydrogen electrolyser demand = TYNDP projections for European hydrogen production

Aggregated power demand is expected to increase….



Aggregated power demand, EU27 - 2020-2050 [TWh] (based on ENTSO-E TYNDP 2024 Distributed Energy scenario)

…… with greater demand for flexibility

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Three nuclear scenarios….

#100GW

Business as usual

100 GW of installed nuclear capacity in the EU

#150GW

Nuclear Alliance target

150 GW of installed nuclear capacity in the EU

#200GW

Change in paradigm

200 GW of installed nuclear capacity in the EU

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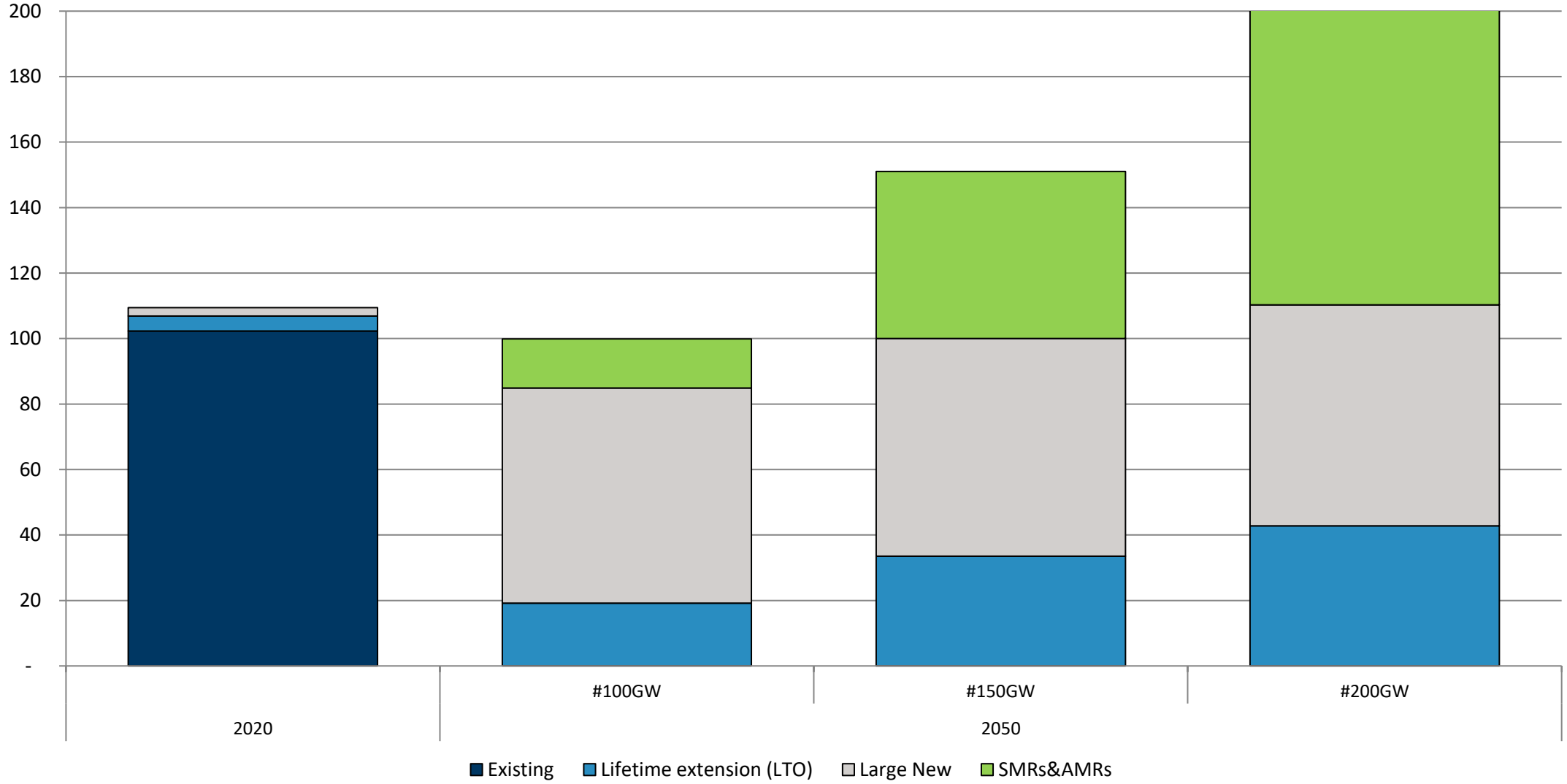
…. composed as follows



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Modelling approaches

Total energy system costs

Capital expenditure (CAPEX)
Operational expenditure (OPEX)
Fuel costs
Network costs

Electricity system approach

Modelling perimeter impacted by the different levels of nuclear development limited to the electricity system

Higher nuclear capacity assumed not to impact any other energy vector, so does not impact electricity demand

Energy system approach

Modelling perimeter impacted by the different levels of nuclear development includes broader European energy system

E.g. higher nuclear capacity is assumed to substitute low-carbon H_2 imports, by allowing more domestic production in the EU

Nuclear benefits

More nuclear enables faster decarbonisation

#150GW nuclear will save around 430 $MtCO_2$

More nuclear will allow for faster decarbonisation, avoiding up to 430Mt of CO_2 emissions by 2050

Additional nuclear capacity could halve CO_2 emissions compared to the EU 2030 targets

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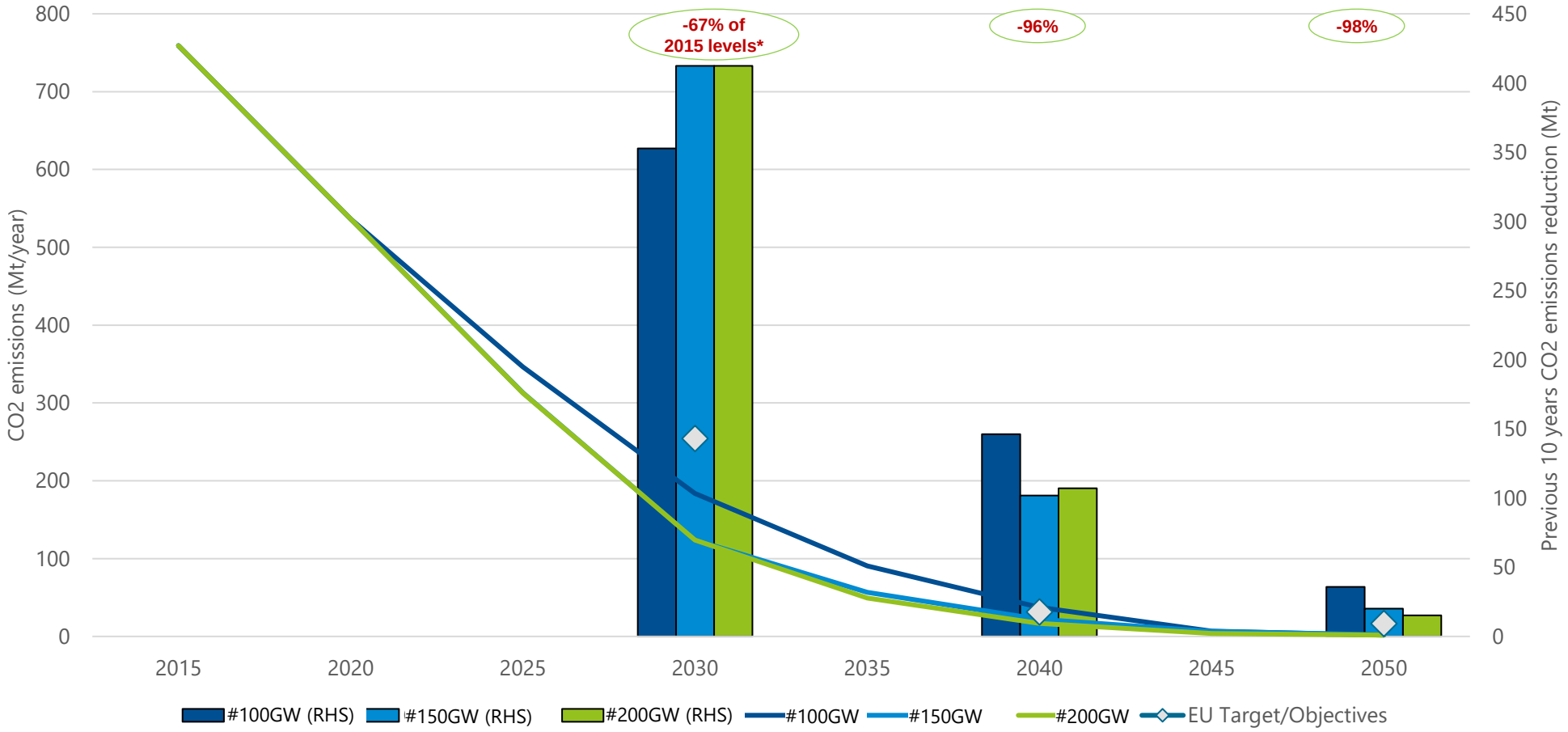
More nuclear enables faster decarbonisation



Electricity system emissions and emission targets (in Mt)

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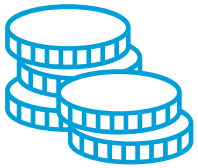
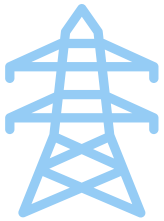
More nuclear lowers cost in long term

#150GW nuclear will save €390bn in total energy system costs



More nuclear will drive down EU electricity prices throughout the energy transition



An energy system with more nuclear will be more cost efficient (significant infrastructure savings – 280GW)

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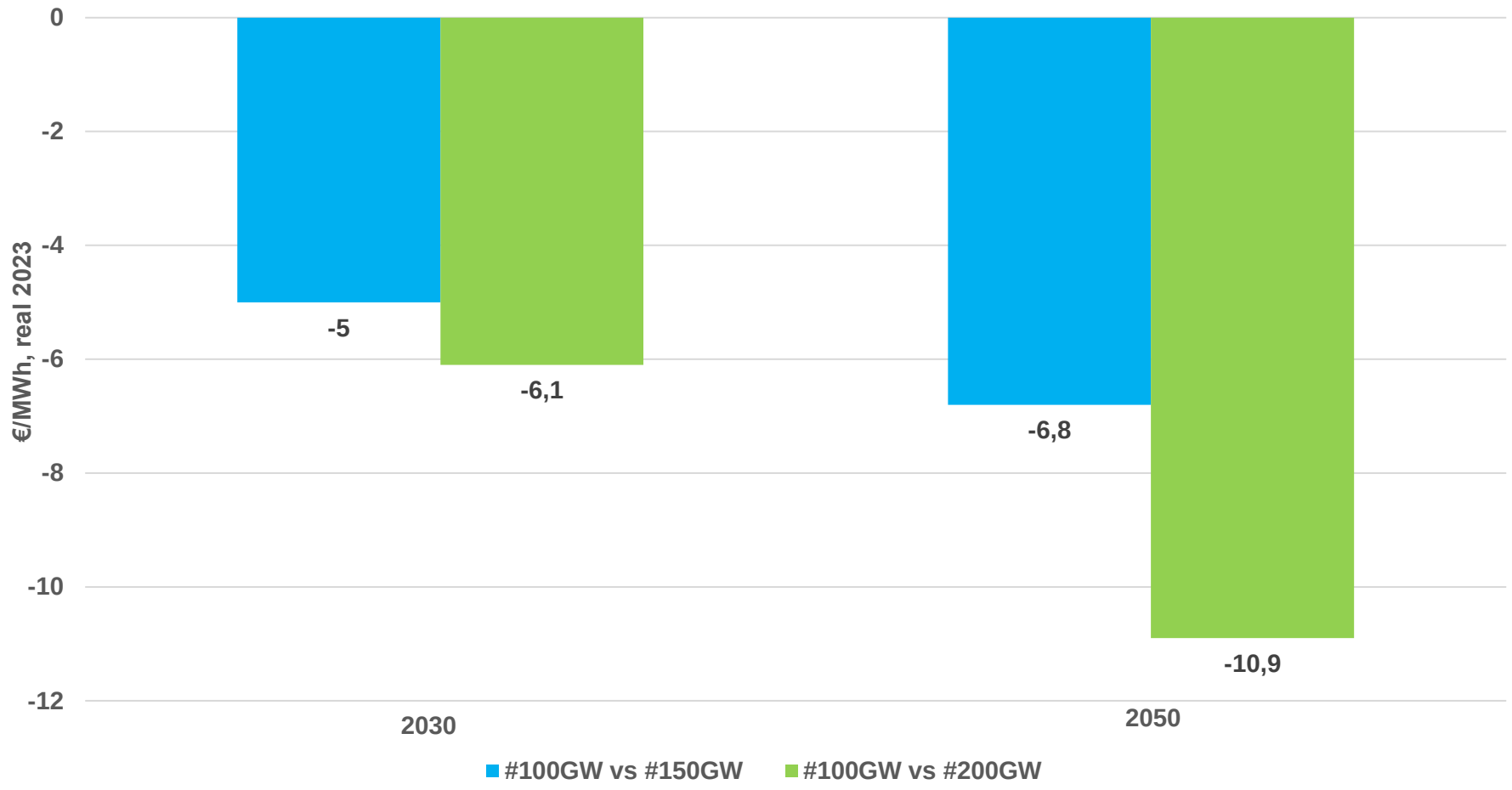
More nuclear drives down EU energy prices….



Differences in the levelised cost of generation - energy system approach (in €/MWh, real 2023 / year)

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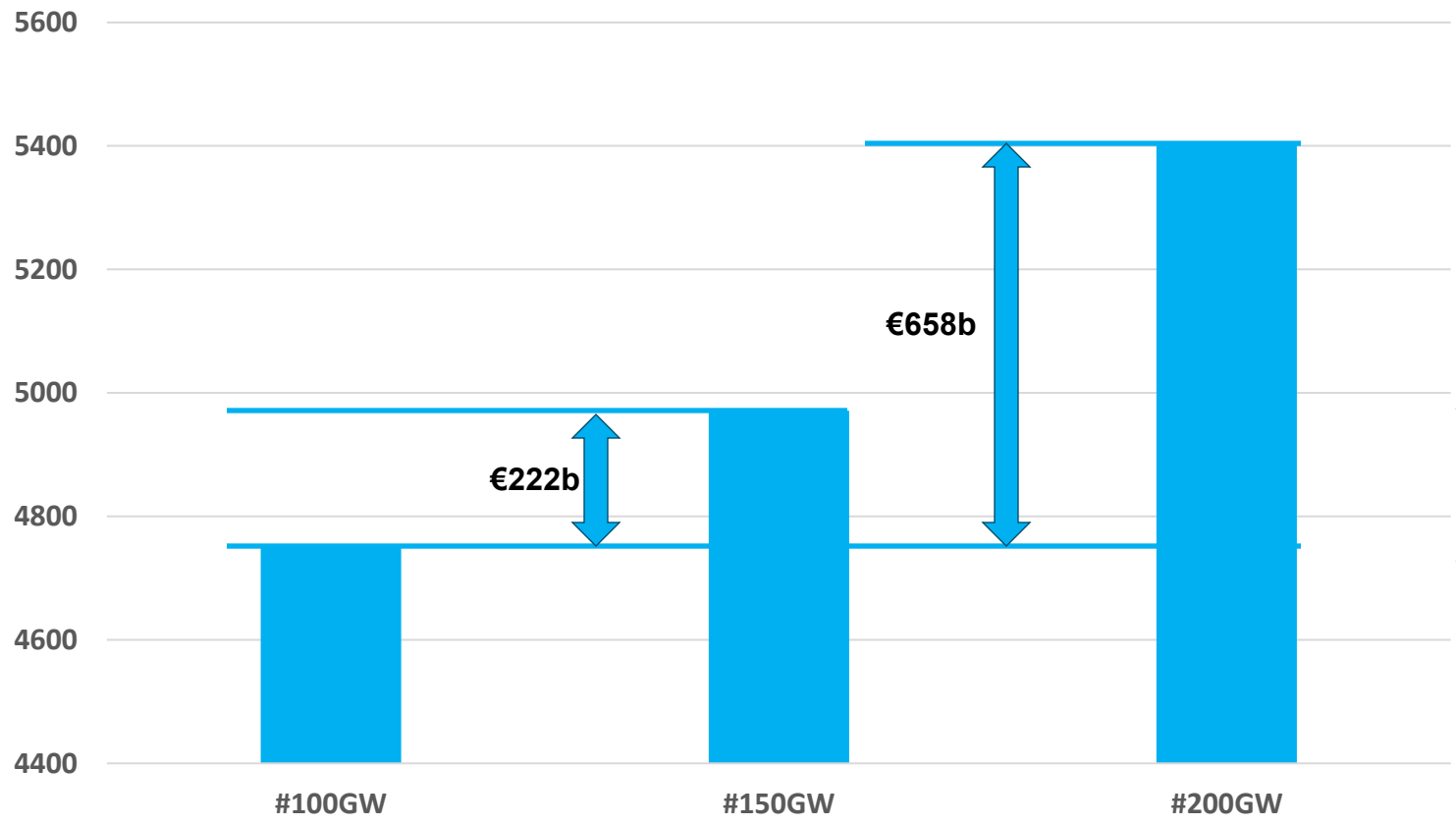
… & leads to greater residual asset value in 2050…



Under the #200GW & #150GW scenarios nuclear new builds will have a longer lifetime than other clean technologies, thus inducing investments significantly beyond the modelling horizon.

Residual value, #100GW vs #150GW&#200GW difference in 2050 (in bn€, real 2023)

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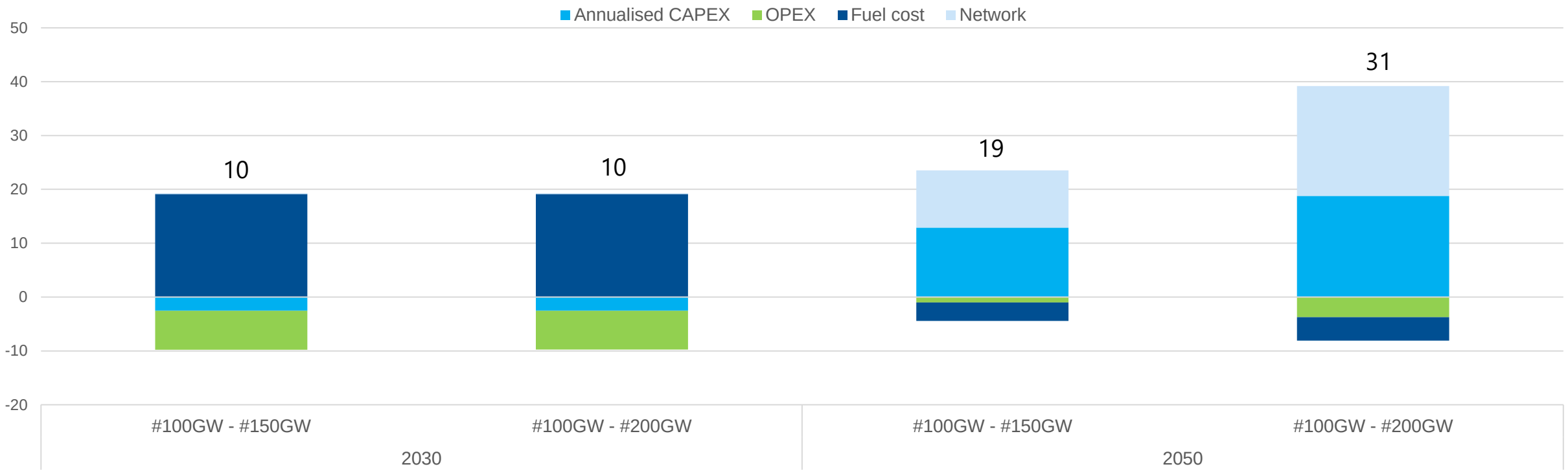
...with lower total system costs in the long-term



Total yearly cost benefits in the #150GW and #200GW vs #100GW (in € billion, real 2023 /year)

Compared to the #100GW scenario, **between 2030 and 2050 50 GW of additional nuclear capacity** could lead to a system cost benefit of **€310bn.**

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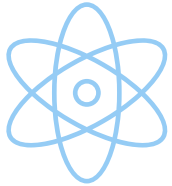
More nuclear supports security of supply

#150GW nuclear can reduce gas consumption by about 180 bcm

More nuclear will support security of supply in an increasingly flexible energy system



Thanks to additional nuclear capacity, the EU will be less reliant on energy sources such as natural gas

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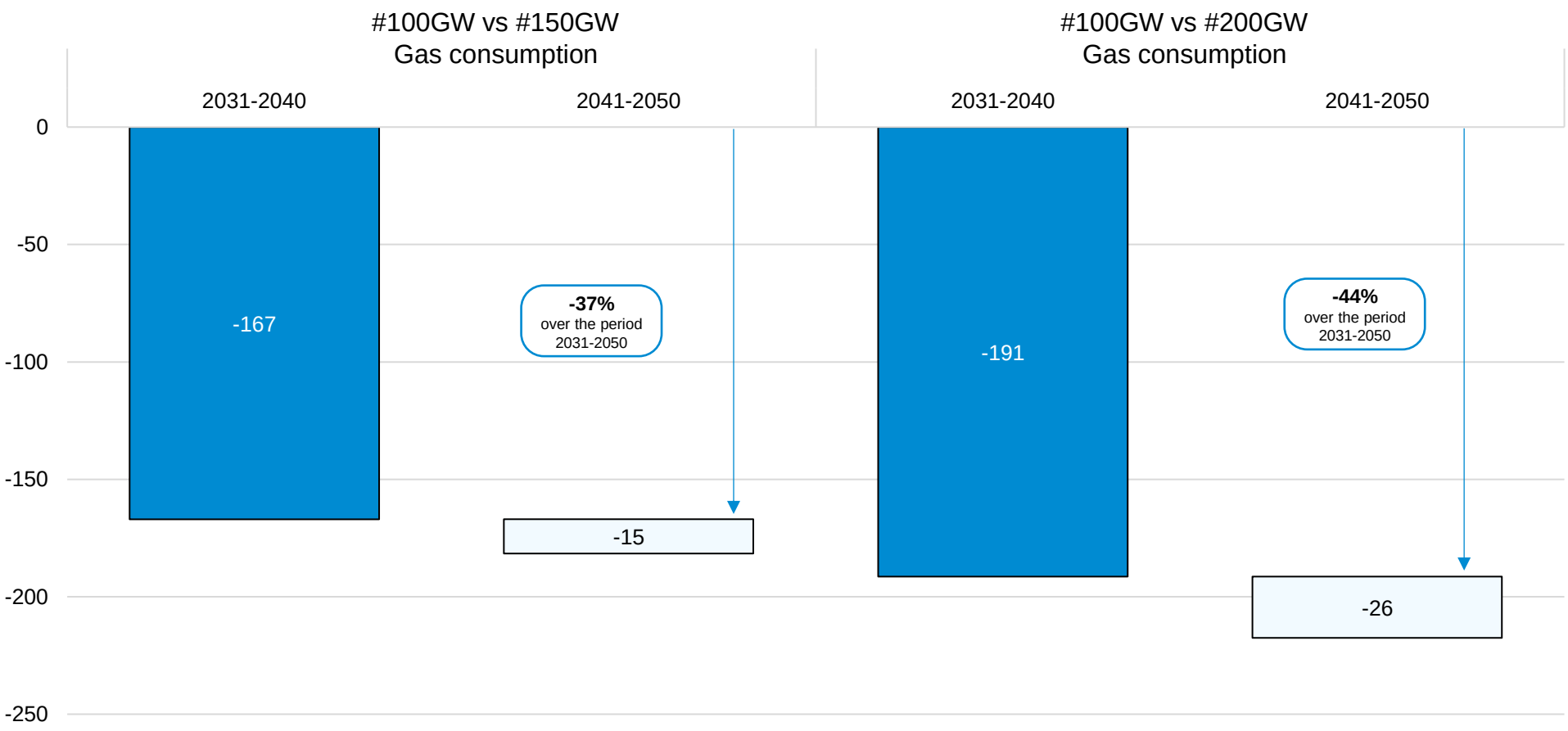
More nuclear supports security of supply



More nuclear reduces dependence on clean H_2 imports

#150GW nuclear could reduce EU dependence on hydrogen imports by up to 33%

Producing clean hydrogen in Europe would generate savings of around €83bn between 2030-2050

Following the #150GW scenario can reduce reliance on clean hydrogen imports

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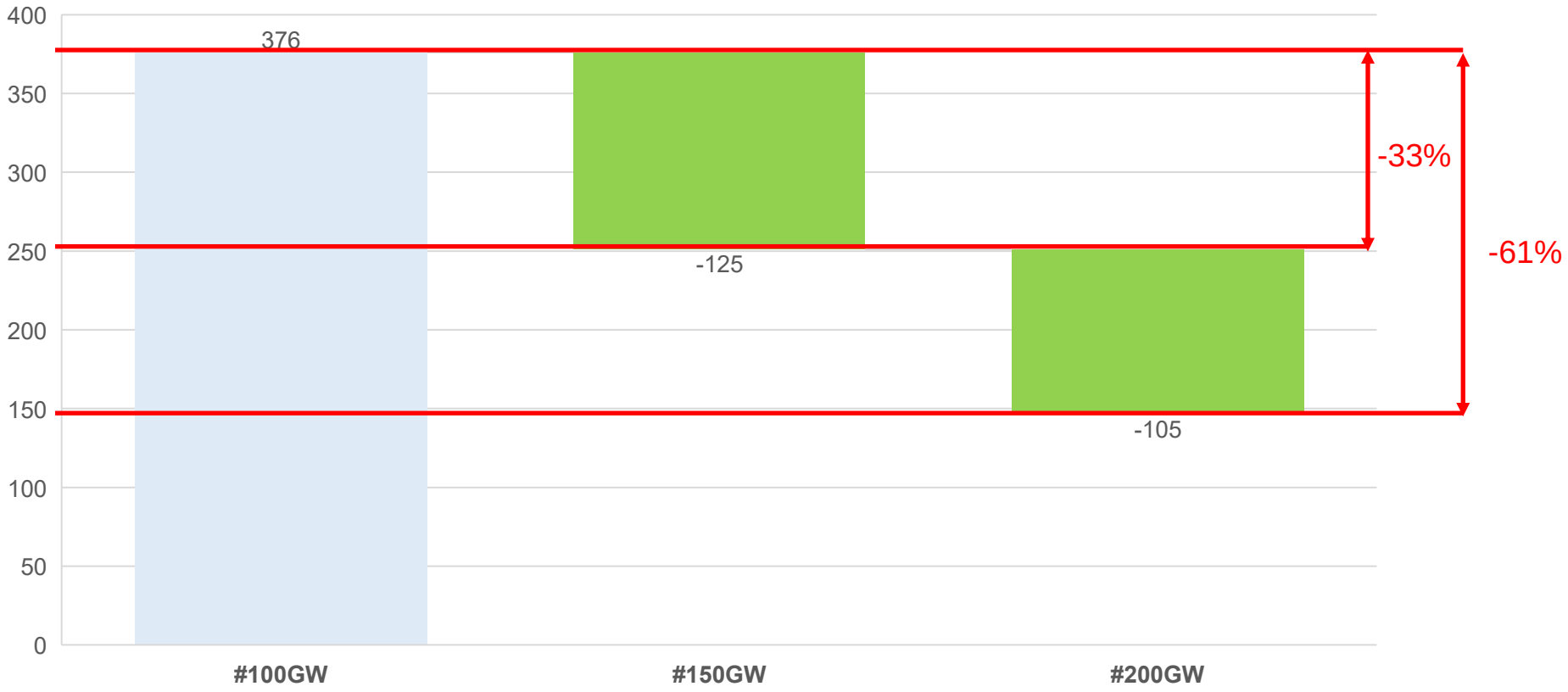
More nuclear reduces dependence on clean H_2 imports

With additional nuclear, clean H_2 imports would be replaced by domestic EU production between 2030-2050 (Mt) as follows:



Potential impact of additional nuclear installed capacity on imported clean H_2 (Mt)

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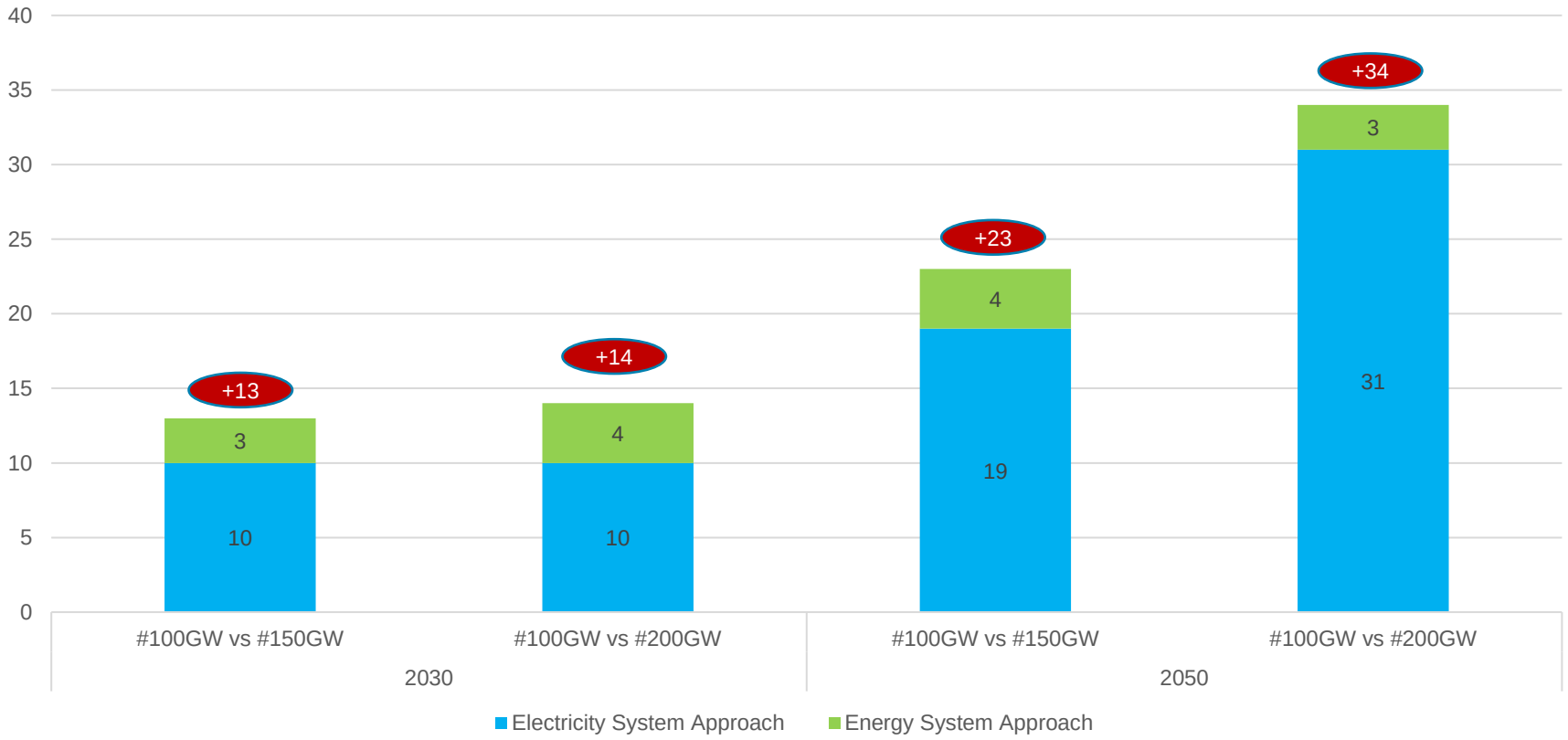
More nuclear brings greater cost benefits by supporting clean H_2 production



Total cost benefits per approach, #150GW vs #100GW and #200GW vs #100GW scenarios (in € billion, real 2023 /year)

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More nuclear supports greater EU industrial competitiveness

#150GW nuclear will:	#200GW nuclear will:
Save around 430 $MtCO_2$	Save around 500 $MtCO_2$
Save €310bn in total power system costs	Save €450bn in total power system costs
Reduce gas consumption by about 180 bcm	Reduce gas consumption by about 220 bcm
Reduce dependence on hydrogen imports by up to 33%	Reduce dependence on hydrogen imports by up to 61%
Generate clean H2 production savings of around €83bn	Generate clean H2 production savings of around €125bn

Leading to greater EU competitiveness in a more climate friendly, affordable & secure energy system

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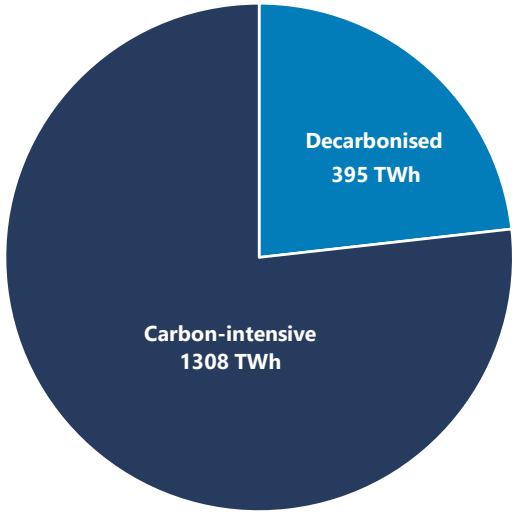
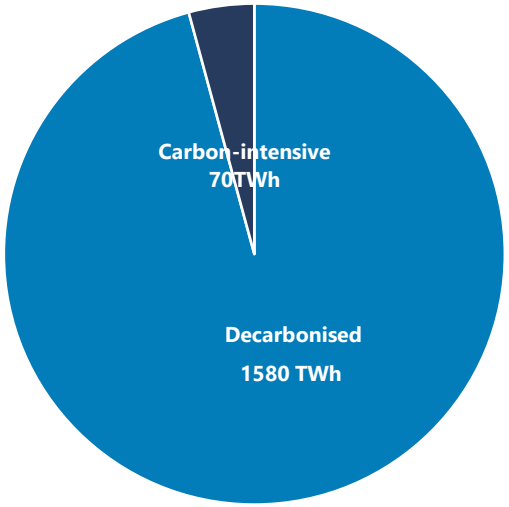
Nuclear heat potential

SMRs: Industrial heat decarbonisation potential

Industrial Heat – **1 703 TWh**
2021



Industrial Heat – **1 650 TWh**
2050



In 2021, only 23% of the 1 703 TWh of heat consumed by industry was decarbonised

Small Modular Reactors can contribute to the decarbonisation of industrial heat

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Expected 2050 demand from industries which could use heat from SMRs

288
TWh/year
Industrial Parks

338
TWh/year
Chemical Industry

218
TWh/year
Pulp & Paper

79
TWh/year
Metals sector

86
TWh/year
Non-metals sector

202
TWh/year
Food industry

Total 2050 projected heat demand for those industries: 1211 TWh

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SMR opportunities

- By 2050, the industrial sector is expected to need around **1580 TWh per year of decarbonised heat**.
- Of this, the industries which could benefit from the heat generated by SMRs (<1000°C) would need around **877 TWh** (covering around **72%** of their needs)
- This decarbonised heat demand would be the equivalent of over **130GW of installed SMR capacity**
- Whilst other technologies can also provide decarbonised heat, SMRs offer additional benefits including **supply and production cost stability**

Enabling recommendations

Key Enablers

Industry to render projects attractive for investors:

- Strong project management & implementation of lessons learnt
- Solid partnerships across the supply chain
- Attract more young people & build-up a skilled workforce

Policy makers to implement policies which encourage:

- Technology neutrality
- Long term & stable vision
- Access to financing
- Support for nuclear innovation
- A skilled workforce

Key Enablers

Input from industrial consumers on what their needs are

Streamlining of nuclear licensing processes across the Member States by regulators

Involvement of civil society in public engagement

Interaction with Trade Unions on skills, including re-skilling & upskilling potential


Thank you!
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