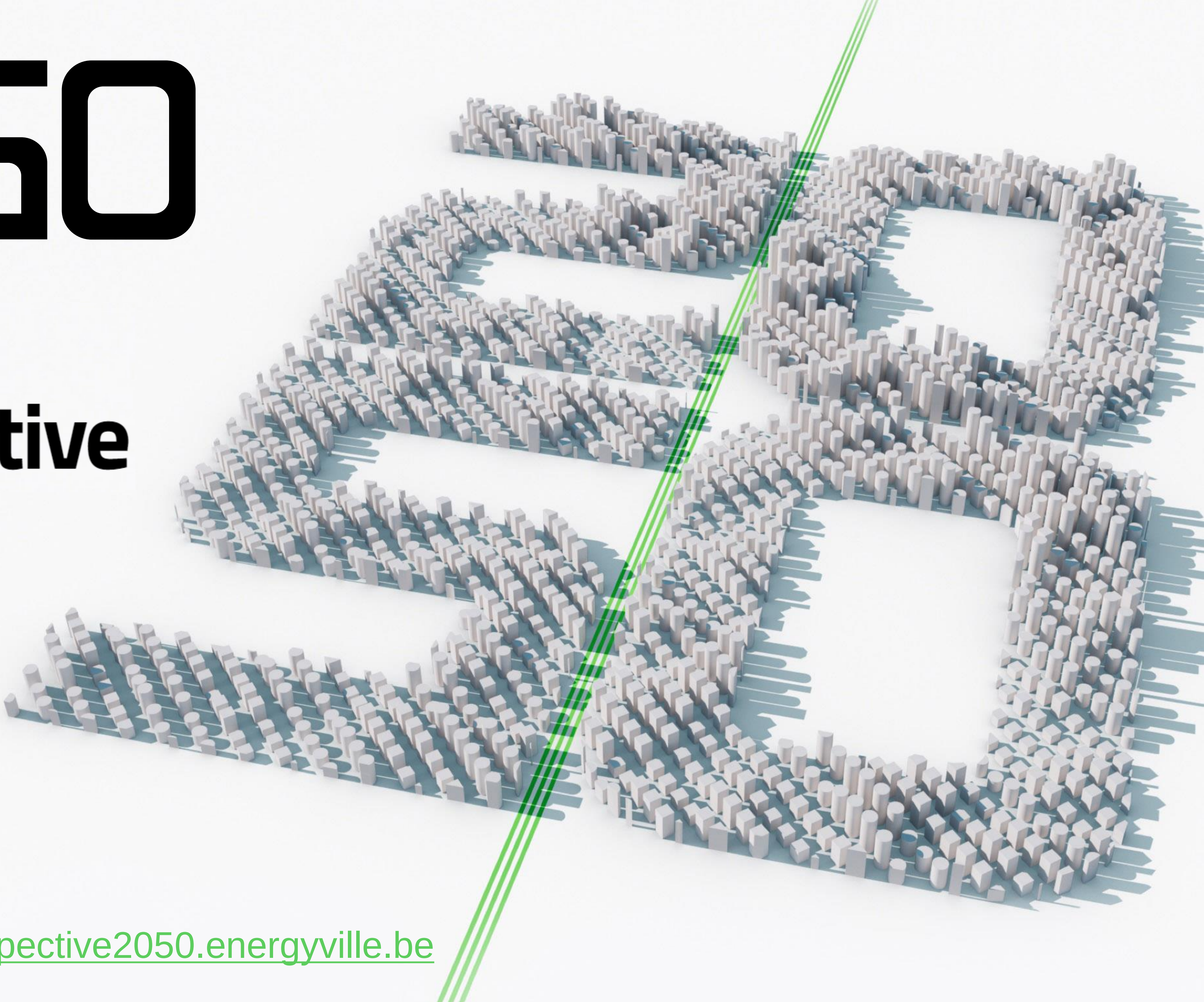
# How can Belgium become carbon neutral between now and 2050?

# PATHS 2050

# The Power of Perspective



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https://perspective2050.energyville.be

# What about 2023-2025?

- Unprecedented energy crisis in EU
- Origin of long-term energy system modelling – IEA ETSAP group and TIMES starts at the first oil crisis, 1978
    - Insights in 2030-2050 will not solve today's problems BUT
    - Will set a clear trajectory to make our energy system more robust



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# The EnergyVille TIMES Be model

- Setting a new benchmark
- 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 included, possible import of clean molecules included

- **Cost optimization from now to 2050**: gives insights into pathways to 2050 with intermediate 2030 milestones

- Reporting on **combustion and process scope 1 $CO_2$** emissions = 85% of Belgian GHG emissions today
  - Scope 2 emissions from imported electricity included but not reported in this project.
  - Bunker fuels for international maritime and aviation sector not included
  - No agricultural $CH_4$ or $N_2O$ emissions

EPOC 2030-2050

BREGILAB

Procura

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# The 3 scenarios to net-zero 2050

febeliec
federation of belgian industrial energy consumers

## Electrification

- Direct access to additional 16 GW of offshore wind potential
- Allow new SMR technology > 2045 compliant with EU taxonomy

+

## Central

- ➢Industrial product demand stable
- ➢Population growth → buildings, transport
- ➢Technical renewable potential: 104 GW rooftop PV, 20 GW onshore, 8 GW offshore wind
- ➢Interconnection from 6,5 GW to 13 GW by 2040
- ➢Set of net-zero options for all sectors
  - Energy efficiency
  - Electrification
  - Clean molecules
  - CCS/CCU options

+

## Clean Molecules

- Lower cost range of hydrogen/molecule import – 2050 : 1,7 €/kg $H_2$
- Limited access to $CO_2$ storage: 5 Mton/y

$CO_2$

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# Total final energy demand Belgium

**Final energy demand decreases by a**

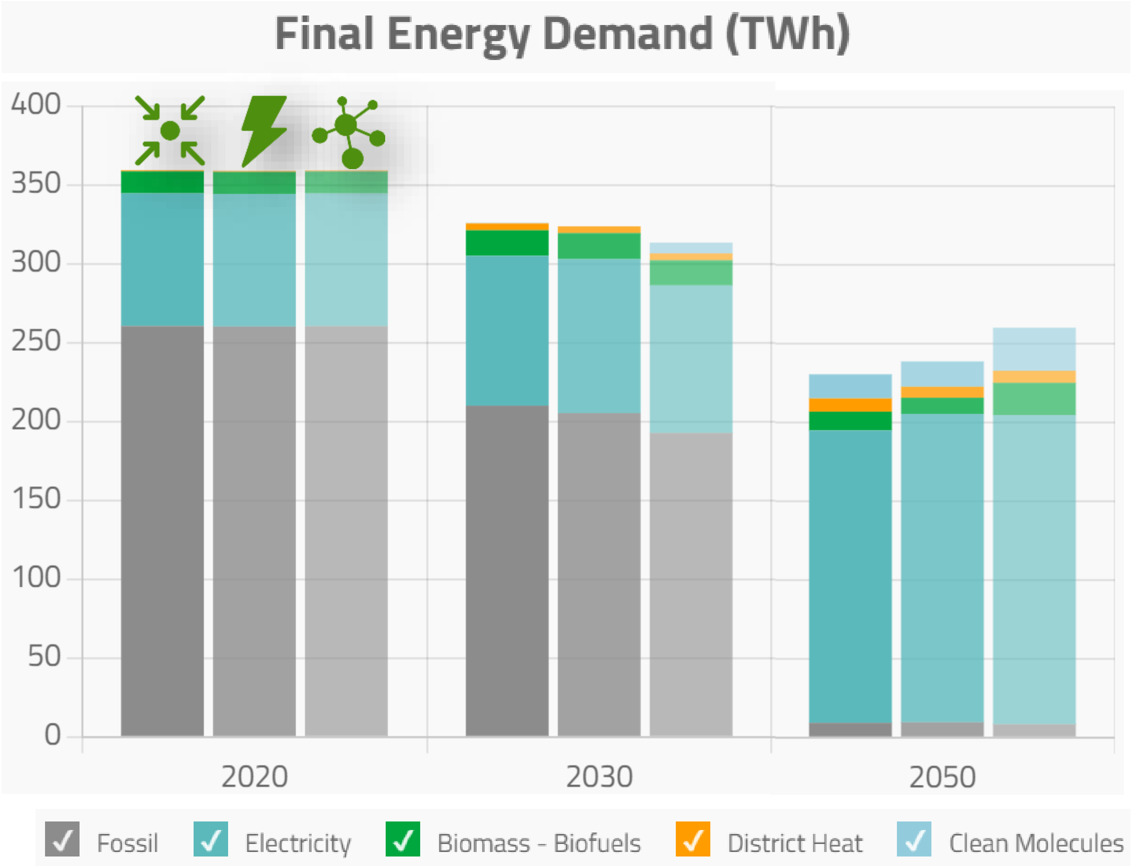
# third

regardless of the scenario.

**Electricity demand more than**

# doubles

in the 3 scenarios.

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# Residential & commercial – final energy demand

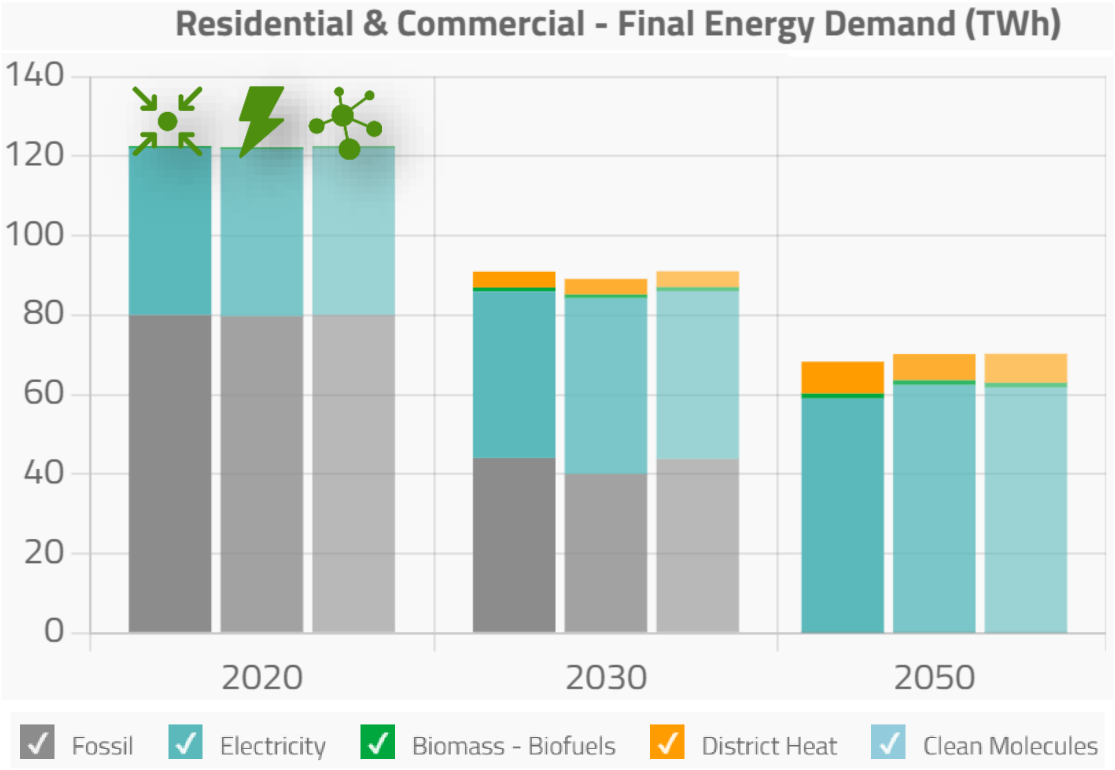
## Renovation & electrification

By 2030, renovation, insulation and
**fuel oil phaseout**
realise 50% $CO_2$ reduction

By 2030, heat pumps are installed in
**1,5 million**
residential homes and commercial buildings.

By 2050, district heating (8TWh) fulfills the demand of at least
**800.000 homes**
based on geothermal and waste heat.

By 2050, heat pumps with water buffers and electric water heaters provide
**flexibility**
to a highly renewable electricity system.

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# Transport – final energy demand

## Electrification

By 2030, investing in more than

**2 million**

electric person vehicles would be cost effective and puts us on track to net-zero 2050.

By 2050, electrification leads to an efficiency improvement of

**76%**

Total energy demand decreases from 100 TWh today to 34 TWh.

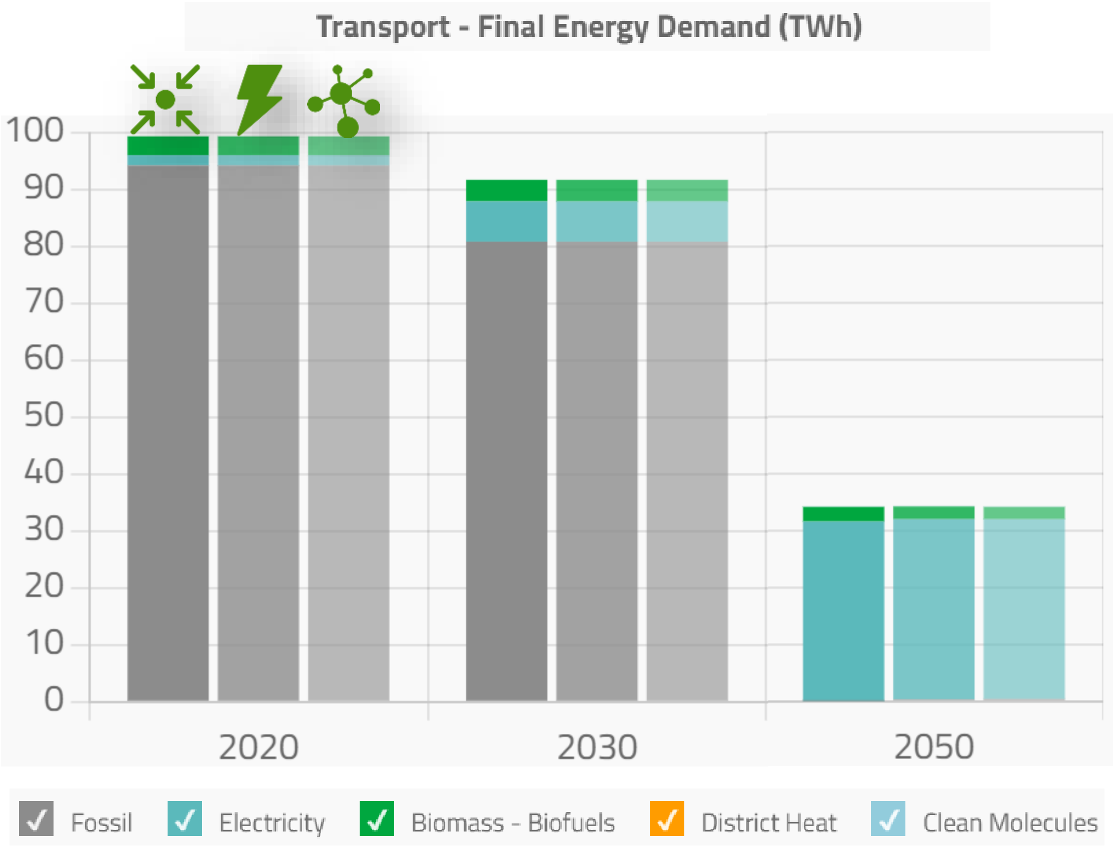
By 2050 our road transport is

**fully electrified**

By 2050, at least

**1,1 million**

smart charging stations (average 7,5 kW peak) are needed to provide demand flexilibility.



# Industry – final energy use

## Electrification & limited use of clean molecules

**Until at least 2030, fossil fuels remain**

**dominant**

in the industry as final energy demand.

**By 2050, electrification of industrial processes leads to an increase of**

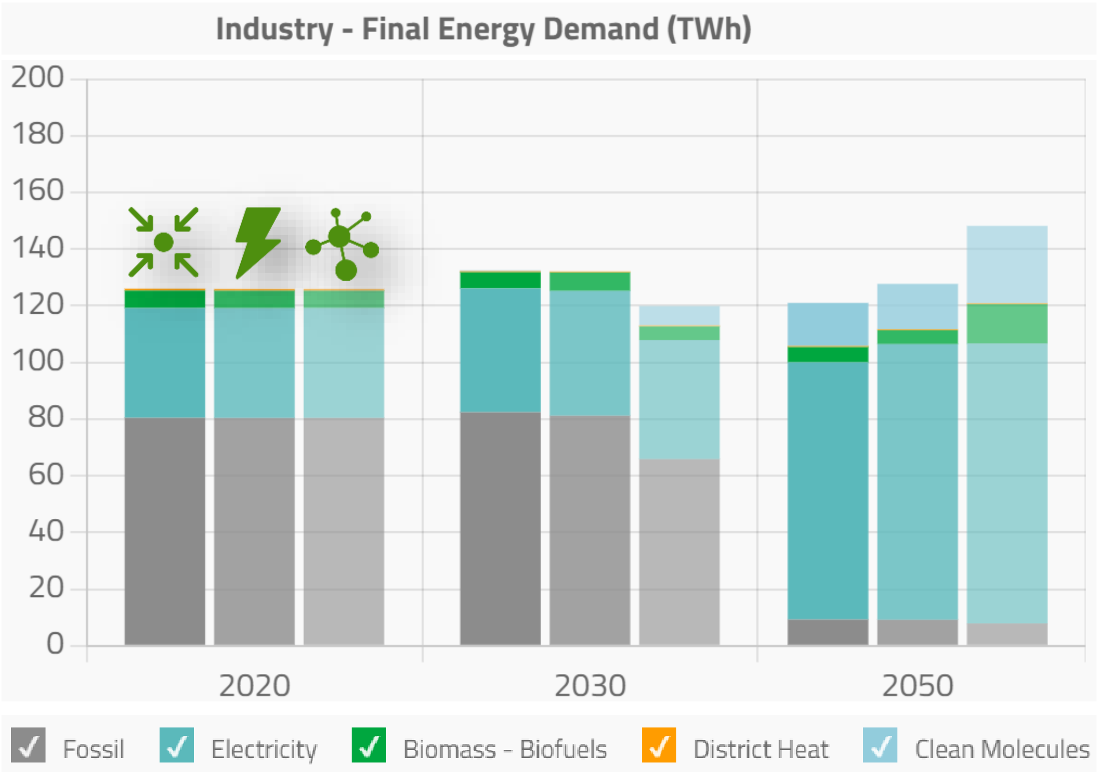
**x 2**

the current electricity demand in all scenarios.

**By 2050, clean molecules amount to**

**21-25 %**

of the final energy demand in industry.

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# Industry – $CO_2$ emissions

## Carbon capture & storage

By 2030, Carbon Capture and Storage (CCS) removes

**17 Mton**

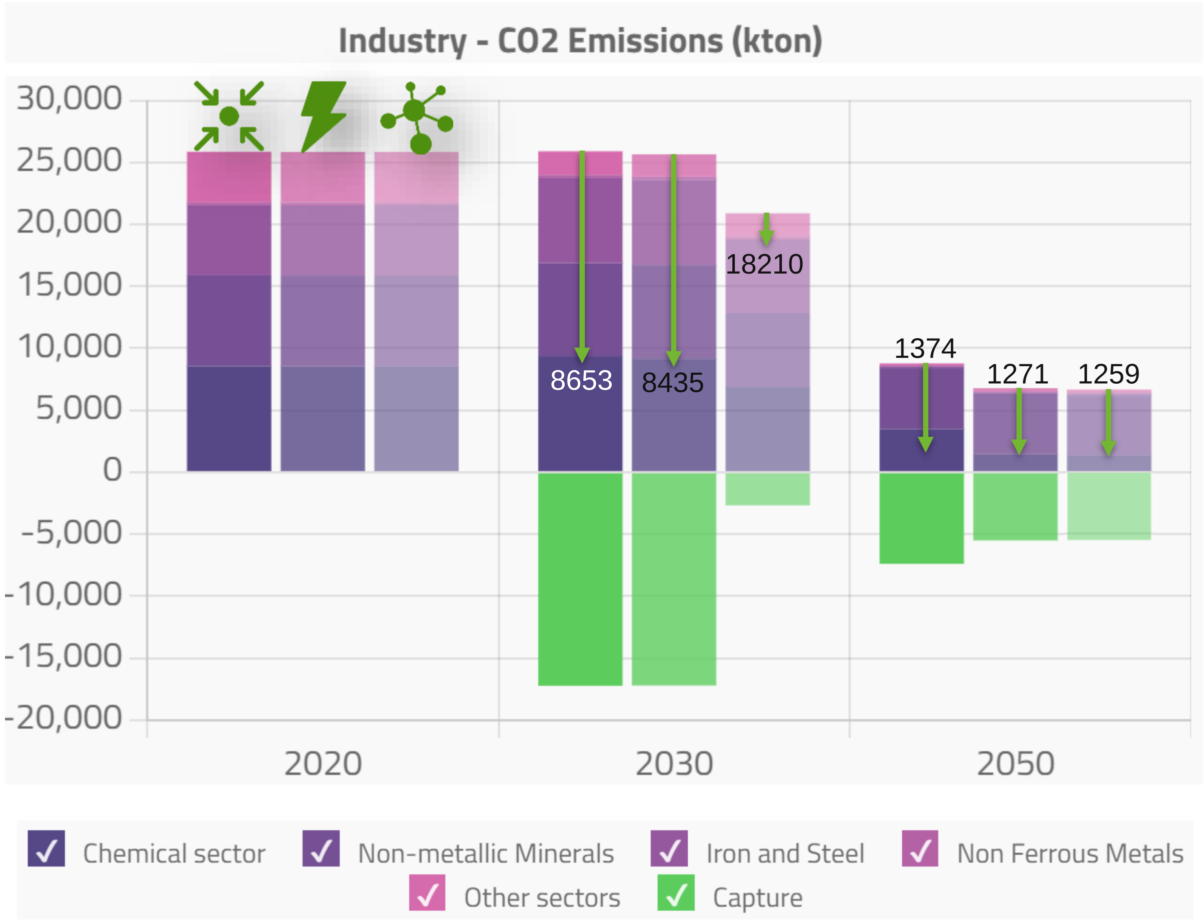
of $CO_2$ emissions from the atmosphere.

By 2050, CCS is limited to

**7,4 Mton**

and applied in cement, lime, high value chemicals.

- Clean Molecules, limited storage access (5 Mton/y)
  - Delayed reduction path
  - Carbon capture & *utilisation* in 2050



# Power sector - Capacity

**By 2030, Solar PV capacity needs to increase**

**x 4**

up to >20 GW in all scenarios,
to be on track to net-zero 2050.

**By 2030, wind onshore and offshore**

**x 2**

as no regret in all scenarios.

**By 2050 eFuel turbines grow to a capacity of**

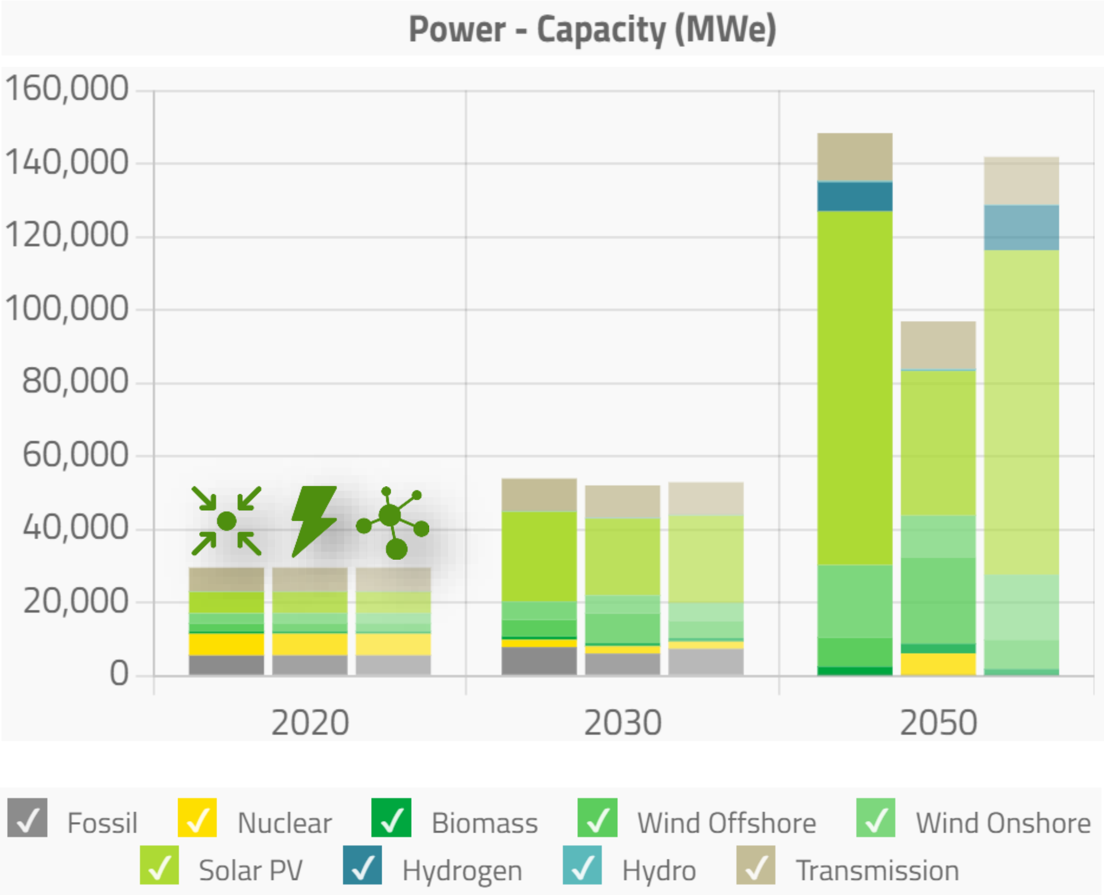
**8 GW**

in the Central scenario to
provide peak power.

**By 2050, additional 16 GW offshore and 6 GW nuclear SMR's**

**halves**

investments in solar PV and
onshore wind in Belgium.

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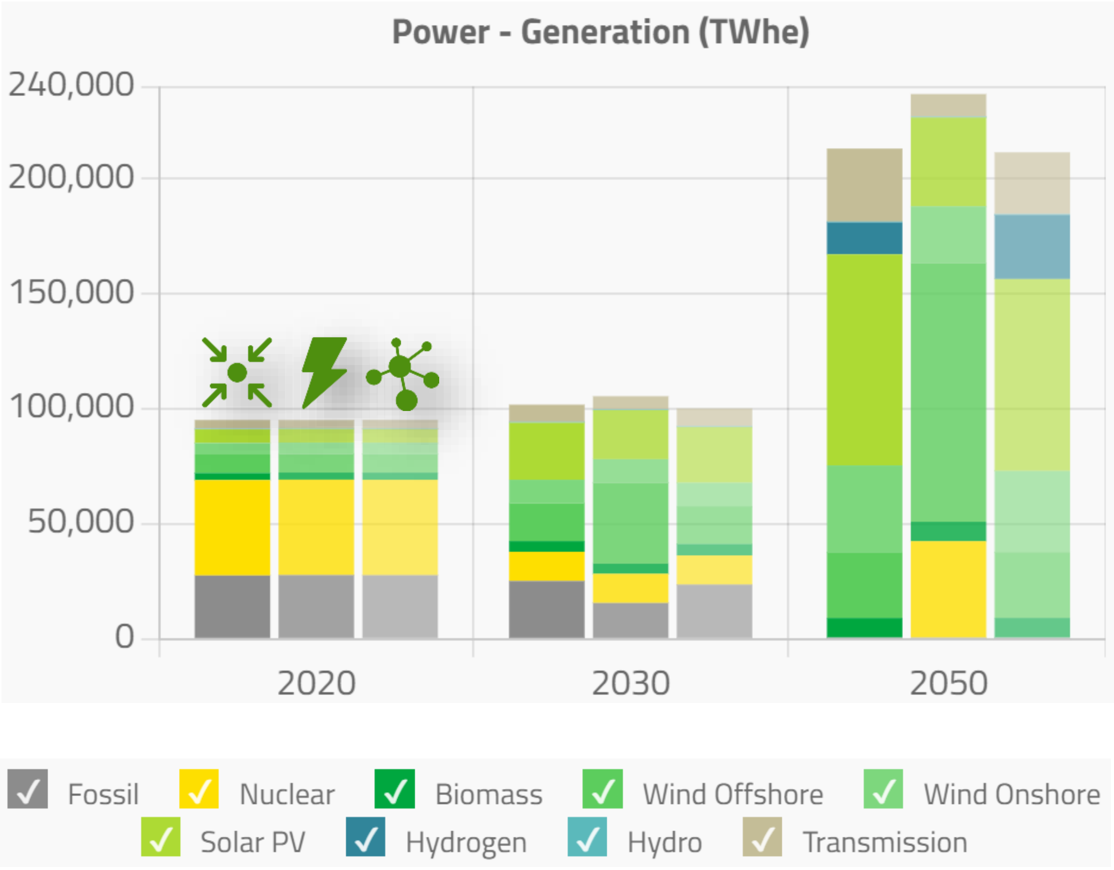
# Power sector - Generation

**From 2040 onwards the need for**

**flexibility of demand**

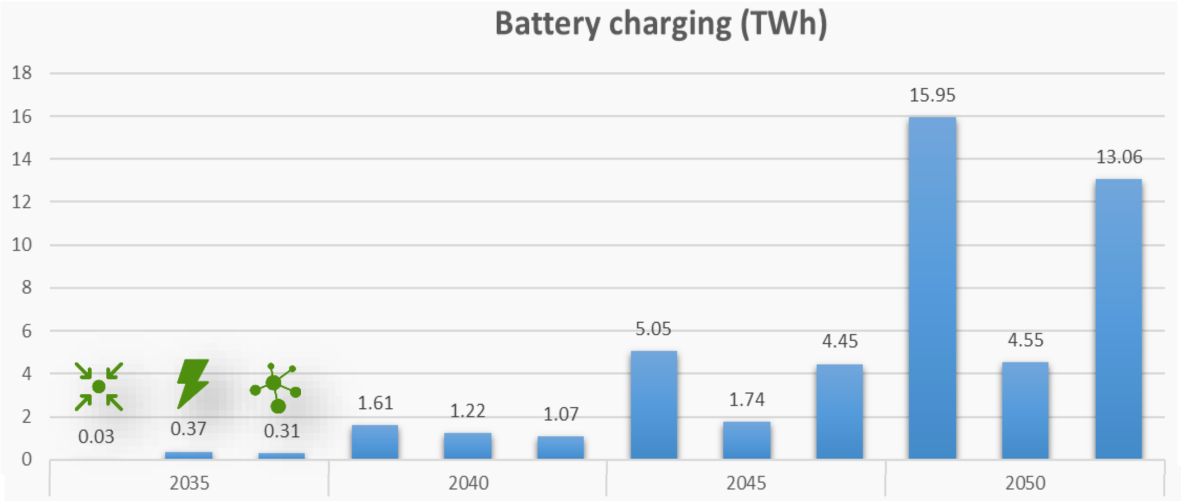
grows drastically: smart charging, heat pump with buffers, battery storage, hydrogen electrolysers.

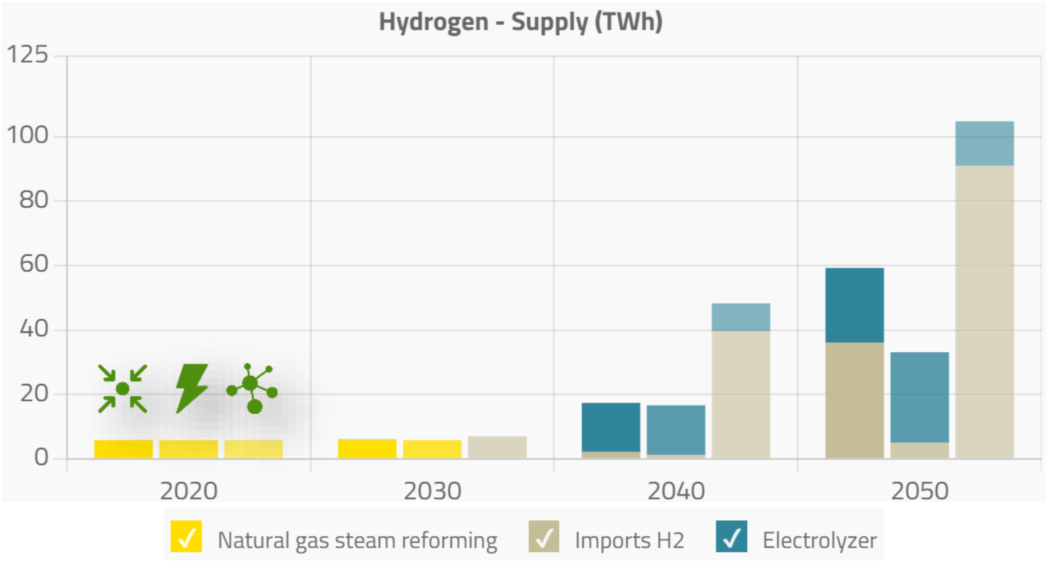


# Flexibility needs in the energy system

- Growing from 2040 onwards, by 2050
  - Central: 18,8 GW
  - Electrification: 5,6 GW
  - Clean Molecules: 13,5 GW

- Balance between Belgian production and import 2050
  - Central: 13,2 GW → 23 TWh Belgian production - 36 TWh import
  - Electrification: 8,2 GW → 28 TWh Belgian production – import limited to 5 TWh
  - Clean molecules: 10,4 GW → 13,7 TWh Belgian production – 91 TWh import




TIMES Be optimizes for the minimal amount of battery capacity needs at national level.
The model does not take local grid issues or short term balancing/frequency control needs into account

Excluding international aviation and maritime transport

# Fit-for-55 by 2030 ?

**Evaluation limited to $CO_2$ emissions**

- No policy projection or prognosis
- Belgian $CO_2$ emissions 1990: **120 Mton** $CO_2$ emissions excluding net $CO_2$ from LULUCF
- Central scenario 2030: **52 Mton**
  → **reduction of -57%**


**Buildings**
- Renovation & insulation
- 1,5 M heat pumps

**Transport**
- Smart charging infrastructure
- 2 M electric vehicles

**Green $H_2$**
- Penetration very low

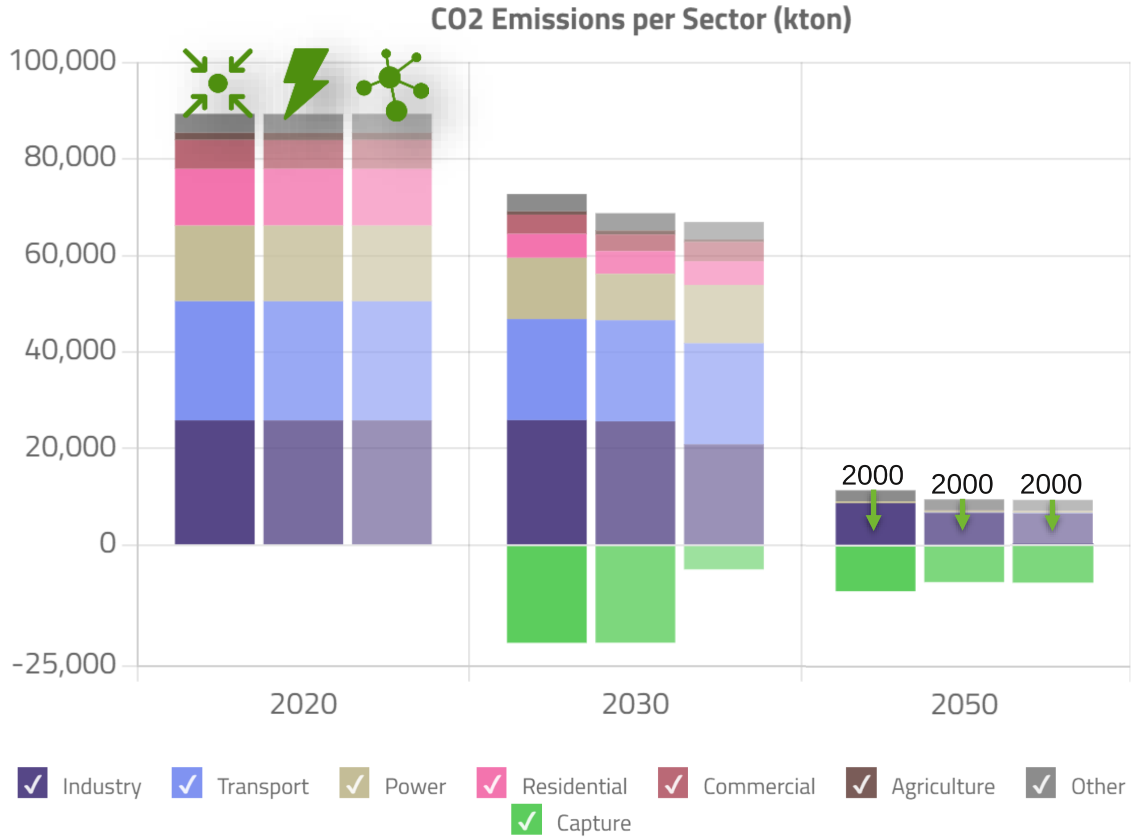
**Industry**
- 20 Mton/y Carbon capture & storage

**Power**
- Solar PV x4
- Wind onshore & offshore x2

# $CO_2$ emissions Belgium

- Net-zero 2050 for Belgium ≠ zero emissions in 2050
  - Full implementation of fossil fuel phaseout, electrification, clean molecules
  - Carbon capture processes are ≈90% efficient
  - Hardest to abate processes

- 98% reduction, remaining **2 Mton** will have to be removed by different means, such as BioEnergy Carbon Capture and Storage (BECCS) or Direct Air Capture (DAC)



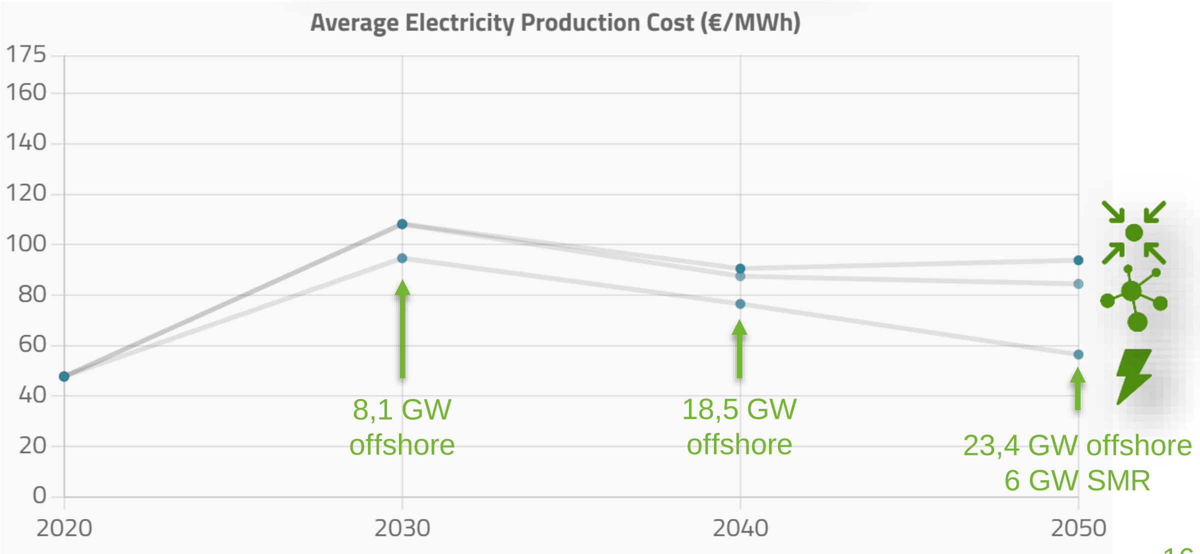
# Average electricity generation cost

- Central scenario leads to average production costs of 94 €/MWh
- Offshore wind + SMR leads to lowest generation cost of 56 €/MWh

Facilitating direct access to

**far offshore wind**

for Belgium drastically lowers electricity and system costs from 2030 onwards.

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# Annual costs per period

## Comparison with scenario without climate ambition

**Annual costs increase by**

**11,7 - 21 billion €**

by 2050, when net-zero is reached.

**Annual costs increase to**

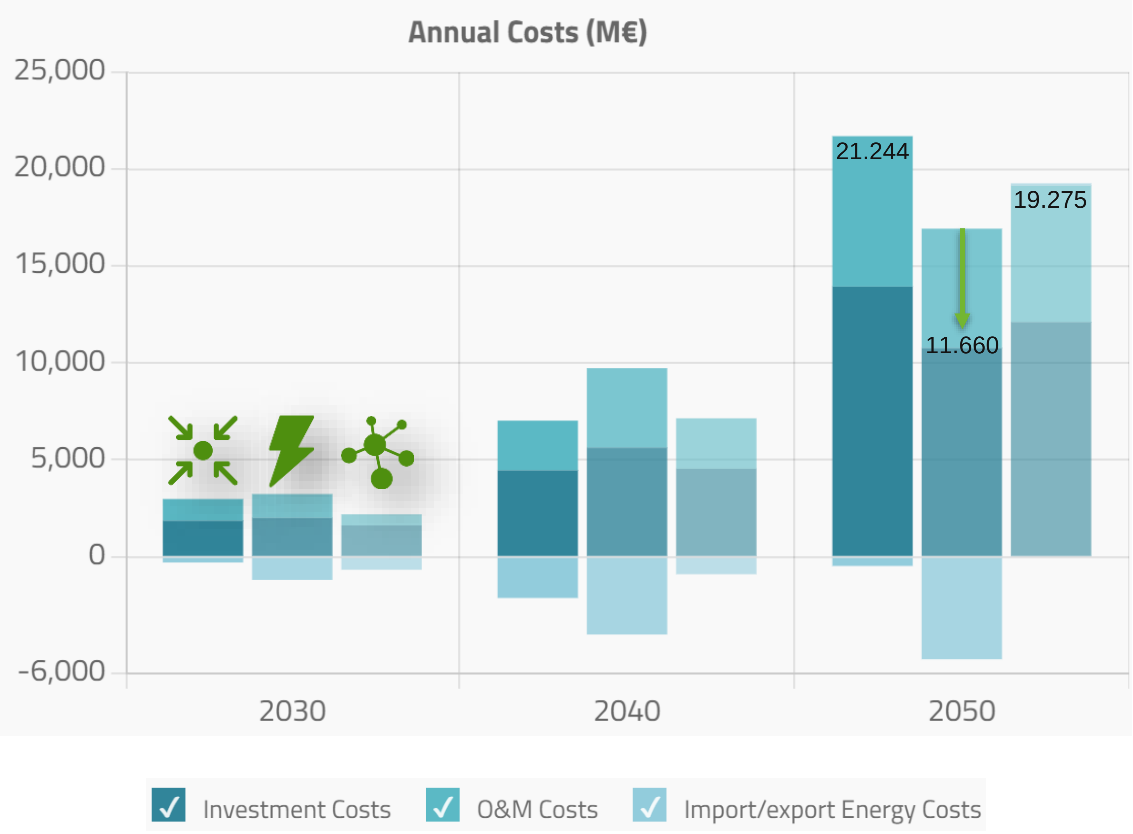
**2-4%**

of Belgium's GDP (reference 2021) when net-zero is reached.

**Access to far offshore wind and SMR leads to**

**lowest**

annual costs increase to reach net-zero in 2050.

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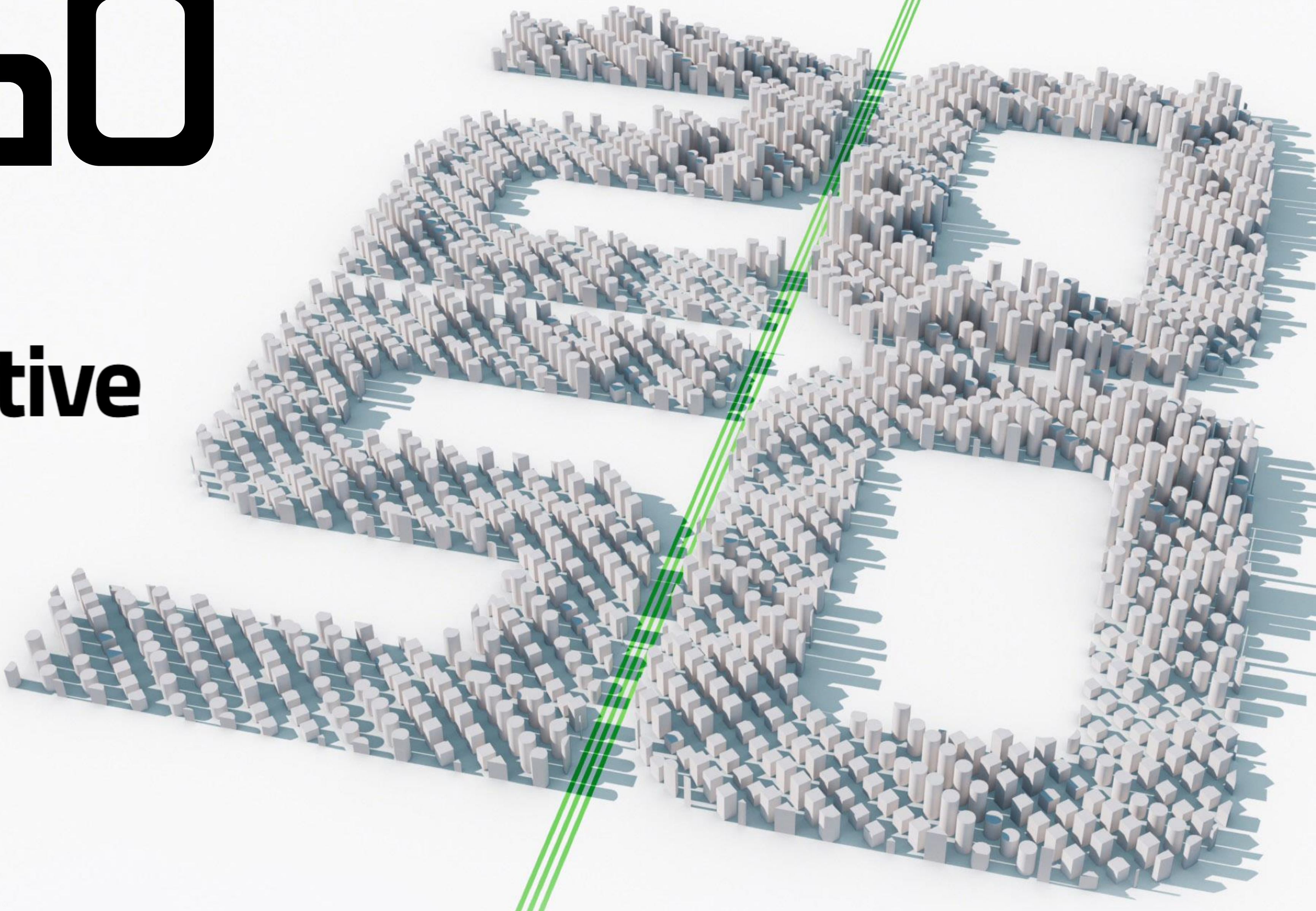
# Scenario overview table

## Power sector

| | Unit | 2030 | | | 2050 | | |
|---|---|---|---|---|---|---|---|
| **Capacity** | **GW** | **45.75** | **43.88** | **44.7** | **136.02** | **84.57** | **129.51** |
| Renewables | GW | 35.21 | 35.08 | 34.65 | 127.15 | 77.72 | 116.41 |
| Fossil | GW | 7.86 | 6.10 | 7.39 | 0.15 | 0.17 | 0.19 |
| Other | GW | 2.68 | 2.70 | 2.66 | 8.72 | 6.68 | 12.91 |
| Nuclear | GW | 2.00 | 2.00 | 2.00 | 0.00 | 5.97 | 0.00 |
| Other plants | GW | 0.68 | 0.70 | 0.66 | 0.70 | 0.71 | 0.68 |
| e-Fuel/H2 turbines | GW | 0.00 | 0.00 | 0.00 | 8.02 | 0.00 | 12.23 |
| Imports | GW | 8.88 | 8.88 | 8.88 | 13.03 | 13.03 | 13.03 |
| **Storage** (pumped hydro + batteries) | **GW** | **1.15** | **1.15** | **1.15** | **19.91** | **6.76** | **14.69** |
| **Emissions** | MtCO2eq | **12.67** | **9.61** | **12.07** | **0.39** | **0.39** | **0.39** |
| **Energy balance** | TWh | | | | | | |
| Net imports | TWh | 7.47 | 5.66 | 7.69 | 31.68 | 9.83 | 26.80 |
| Demand | TWh | 95.99 | 98.67 | 94.49 | 203.75 | 220.49 | 201.69 |
| Losses and own consumption | TWh | 5.84 | 6.83 | 5.69 | 9.33 | 16.29 | 9.76 |
| Generation | TWh | 94.36 | 99.84 | 92.48 | 181.40 | 226.95 | 184.64 |
| **Average generation cost** | €/MWh | **108.24** | **94.67** | **108.15** | **93.86** | **56.49** | **84.49** |

PATHS 2050

# The Power of Perspective



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