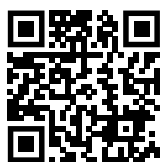


EDF NET ZERO SCENARIO



POWERING CARBON
NEUTRALITY IN EUROPE BY
2050

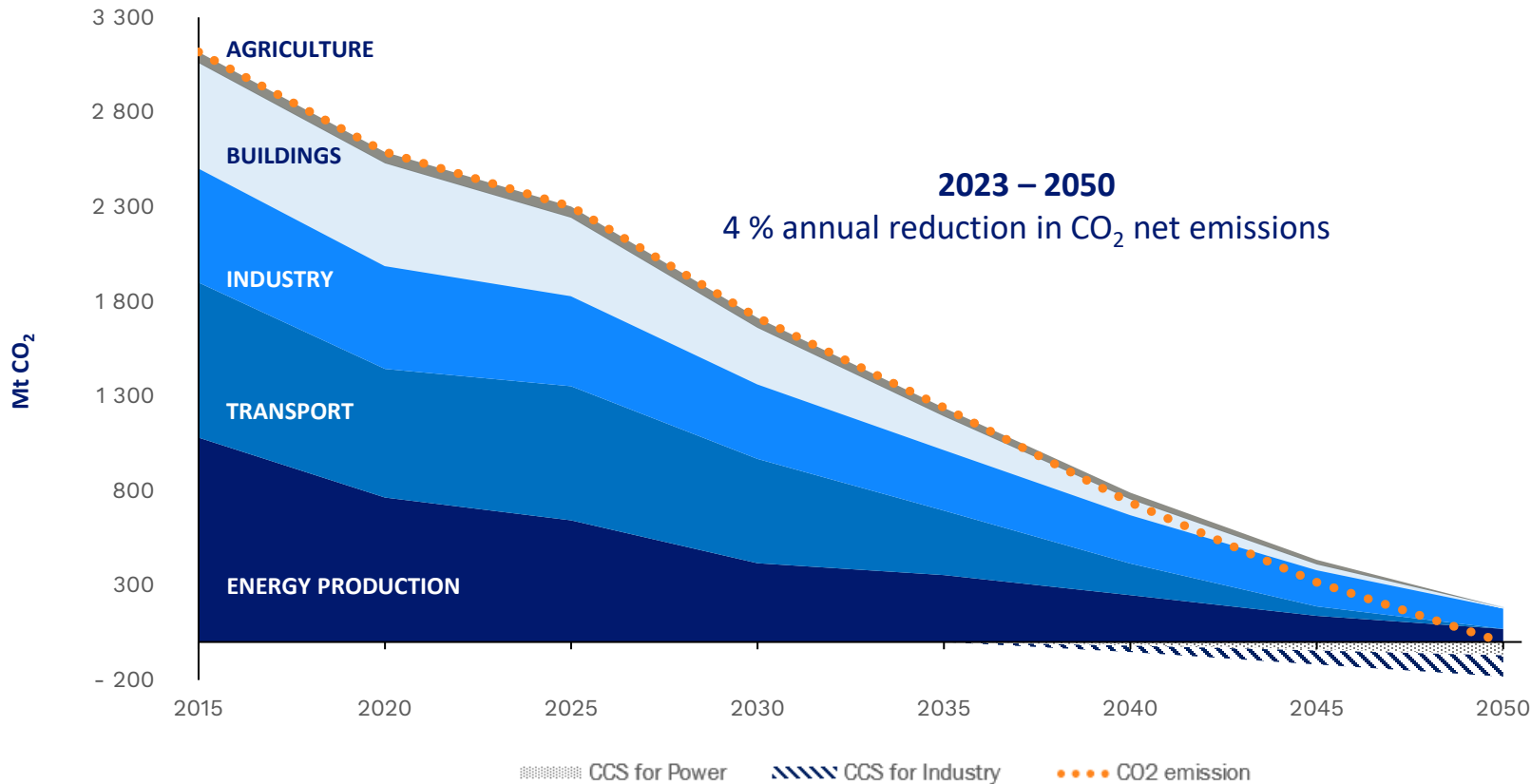


A PATHWAY TO REACH CARBON NEUTRALITY IN 2050



Total CO₂ net emissions

1990 : 3 900 Mt CO₂



REDUCTION IN FINAL DEMAND

-40% final energy demand vs. 2021

DIRECT ELECTRIFICATION

+60% power demand vs. 2021
57% electricity share in 2050

DECARBONIZED PRODUCTION

Wind and solar production **x6** vs 2021
120 - 150 GW nuclear capacity

FLEXIBILITY NEEDS

x2 - 3 at all time scales

EDF NET ZERO SCENARIO: OPTIMIZING THE PATH TO EUROPEAN NET ZERO 2050



CLIMATE NEUTRALITY BY 2050 A DECARBONIZATION STRATEGY BASED ON 2 PILLARS

Reduce final energy
demand



Decarbonize total energy
supply



Multi-energy modelling for 15 western European countries

Efficient multi-energy mix, taking into account:

- **Feasibility constraints** (physical, technological, societal)
- **Breakthrough technologies** (CCS, e-fuels) based on our **assessment** of innovation prospects

Efficient electricity mix :

- Based on an **hourly supply-demand balance analysis**
- Taking into account **security of supply** requirements

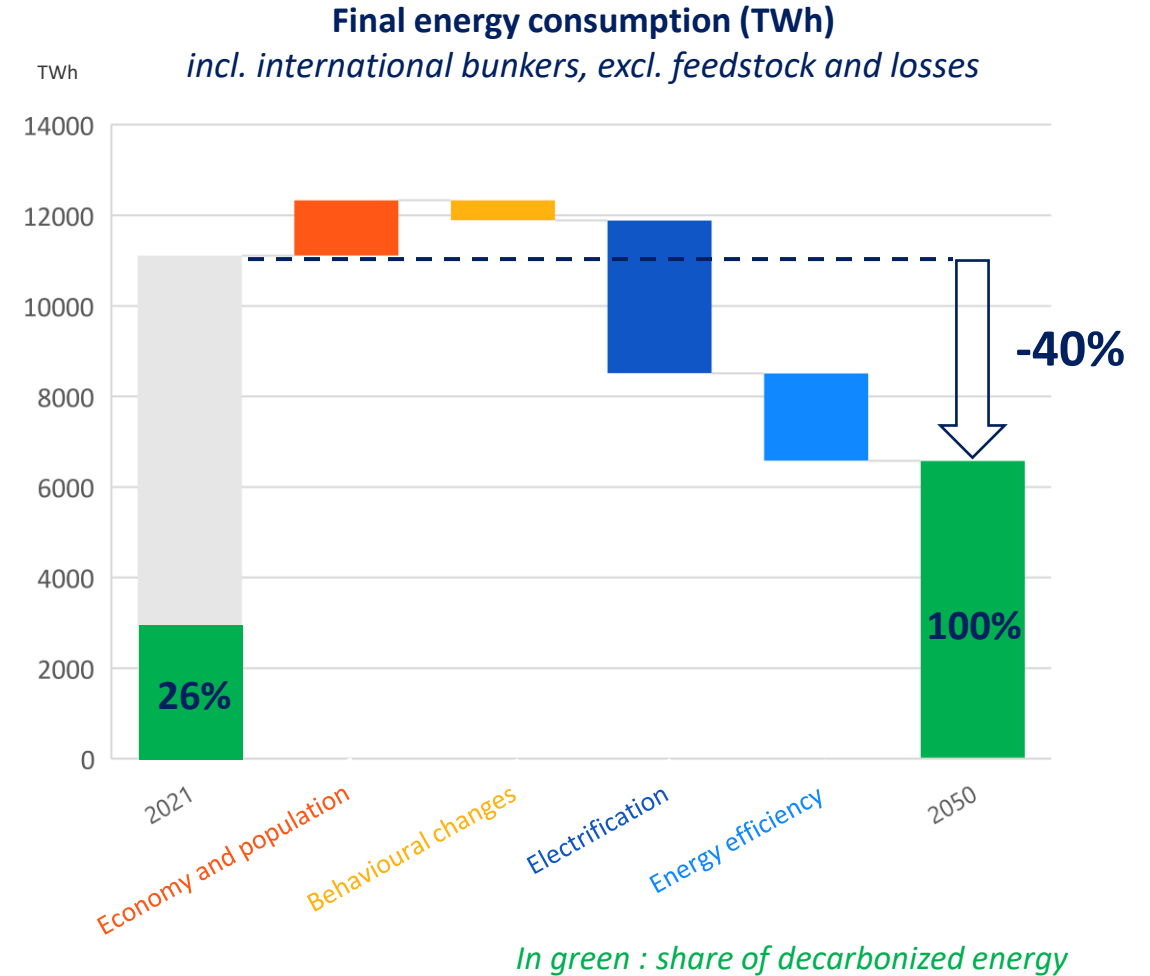
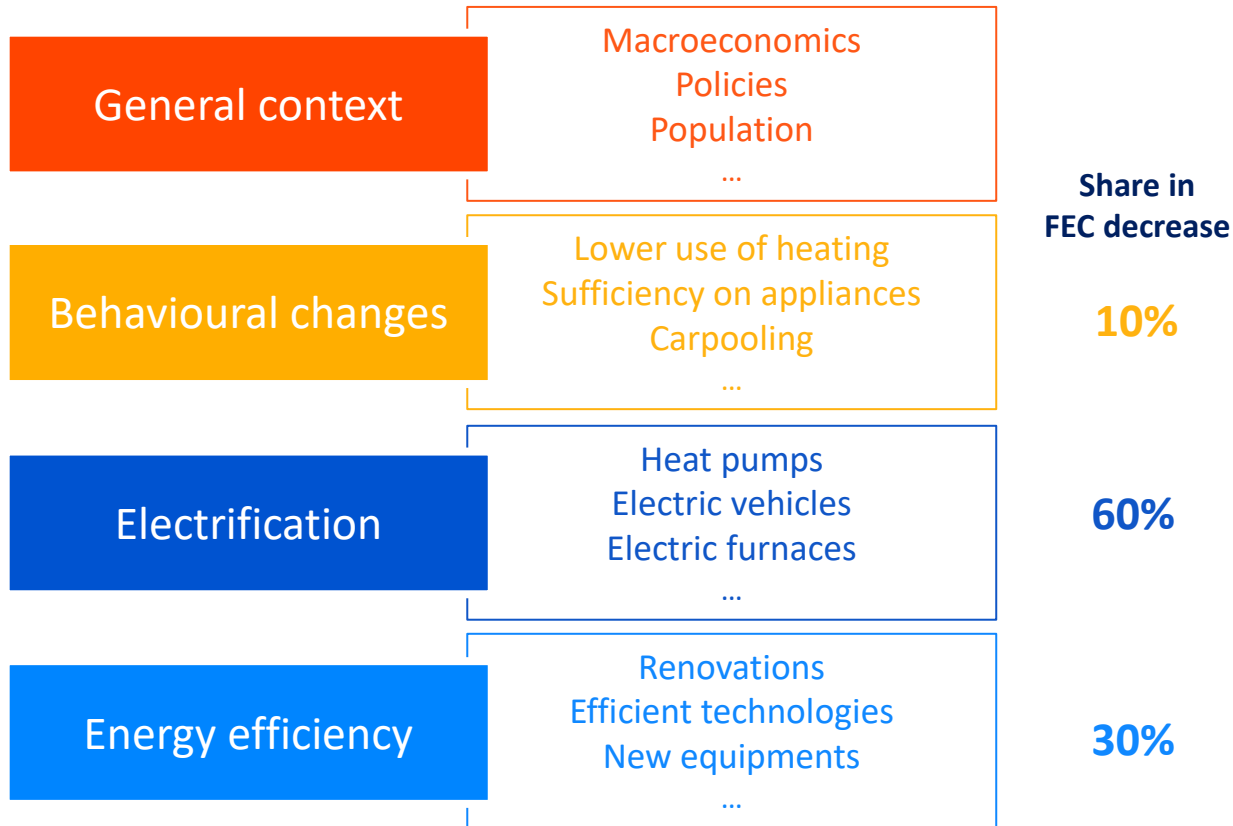
Optimization based on welfare maximization, cost minimization and system resilience



Our scenario provides an economically efficient pathway towards climate neutrality in 2050, taking into account the feasibility constraints in the various dimensions of the European energy sector's transition.



4 components in final energy consumption (FEC) evolution



Electrification is the key driver to reduce greenhouse gas emissions and final energy consumption.

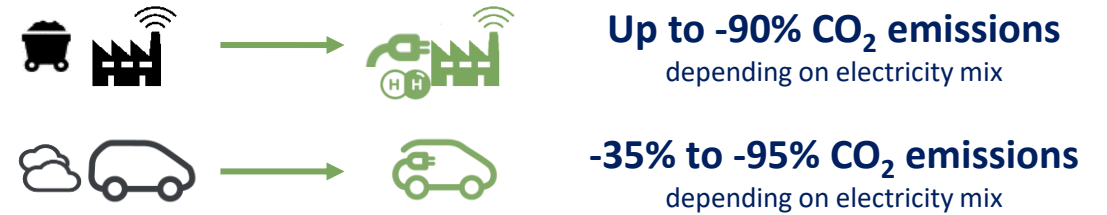
ELECTRIFICATION PRIORITIES



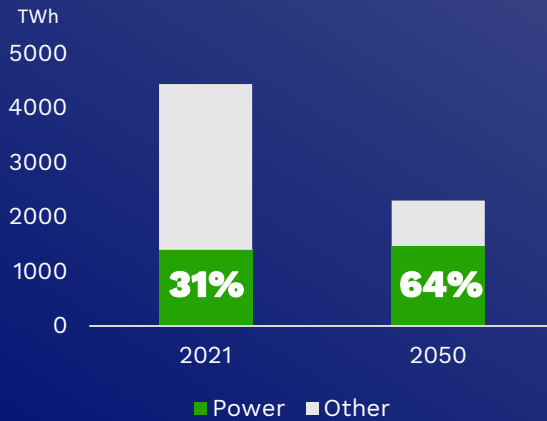
Electrification reduces energy consumption



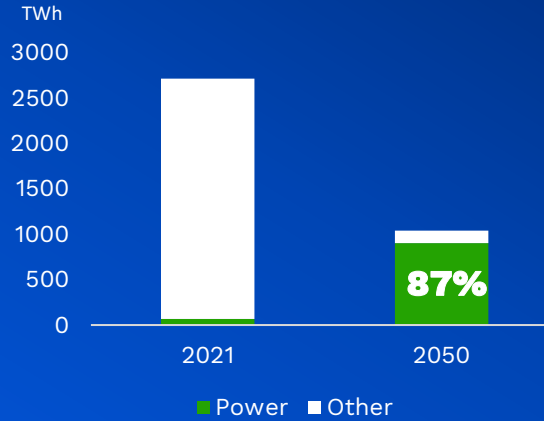
Electrification reduces CO₂ emissions (scope 1&2)



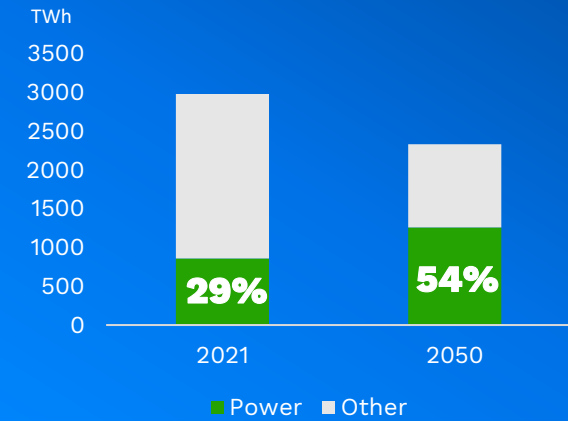
BUILDINGS* (TWh)



TRANSPORT* (TWh)



INDUSTRY* (TWh)



x10

Number of residential heat pumps



x23

Number of electric vehicles



x1.5

In direct electricity consumption in the industrial sector



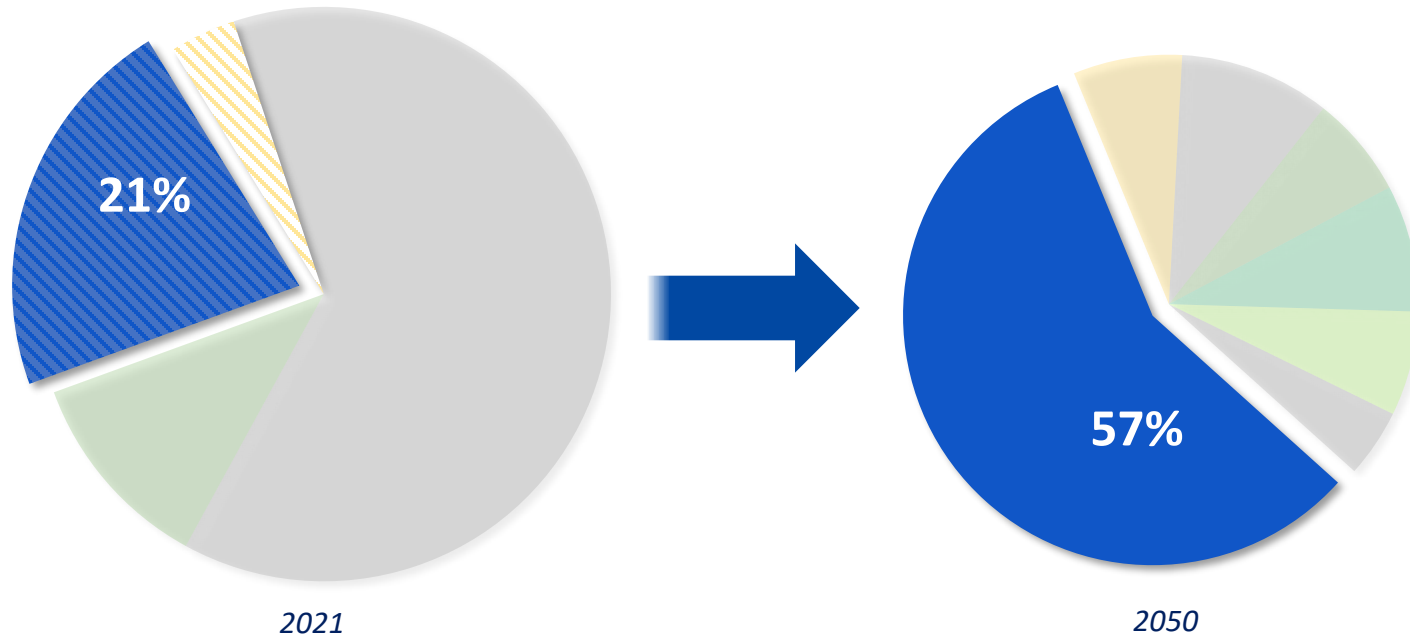
The key priorities are the massification of electrification in transport, buildings, as well as the acceleration in industry because of the risk of staying locked with fossil fuels.

*Final energy consumption excl. international bunkers for transport

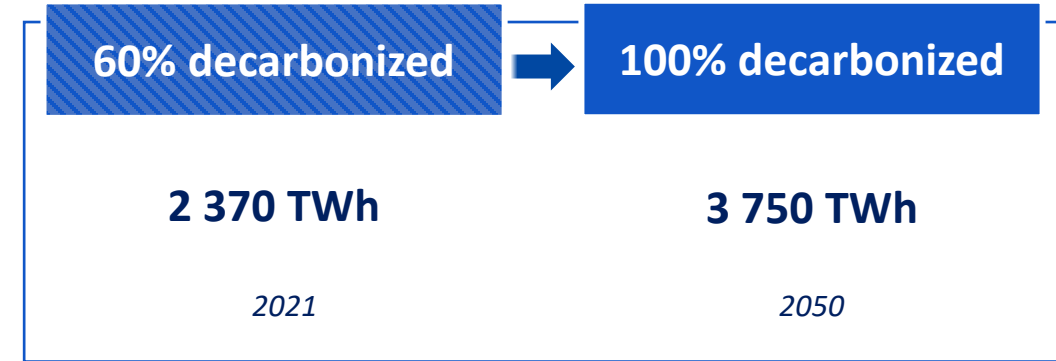


Final energy consumption

incl. international bunkers, excl. feedstock and losses



ELECTRONS

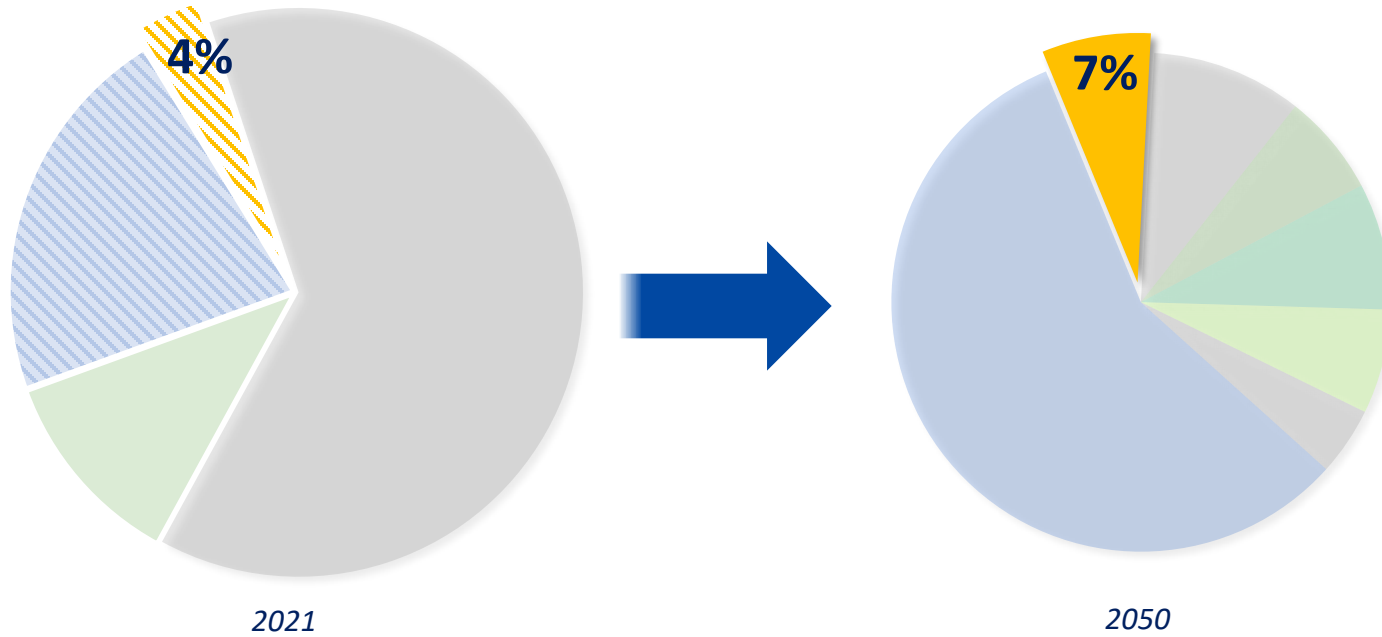


■ Electricity ■ Fossil fuels ■ Solid biomass ■ Bioliquids ■ Biogas ■ e-fuels ■ Heating Networks

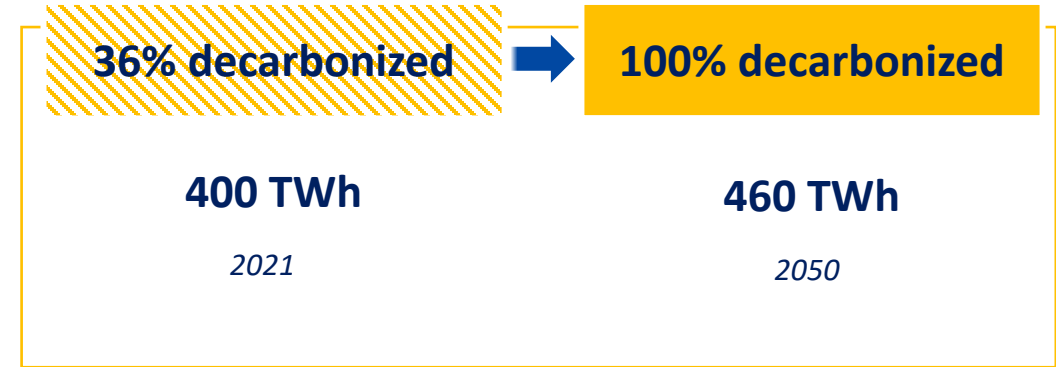


Final energy consumption

incl. international bunkers, excl. feedstock and losses



HEATING NETWORKS

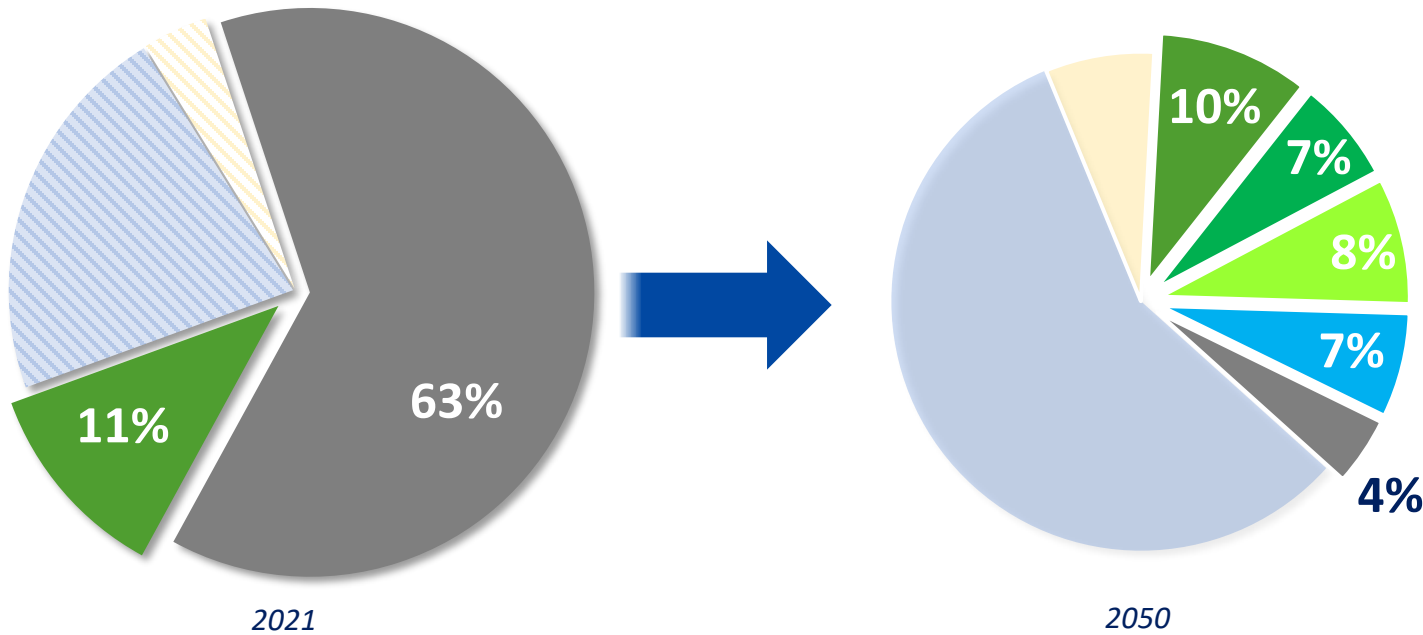


■ Electricity ■ Fossil fuels ■ Solid biomass ■ Bioliquids ■ Biogas ■ e-fuels ■ Heating Networks



Final energy consumption

incl. international bunkers, excl. feedstock and losses



MOLECULES

Biofuels

Limited Resources

Relevant uses in home/industry heating & maritime/aviation

1 250 TWh
2021

1 650 TWh
2050

H₂ and e-fuels

High energy requirement
Low-carbon CO₂ supply

Relevant uses in international transport and industry as feedstock

420 TWh*
2050

* + 180 TWh for feedstock

Fossil fuels + CCS

Risk of fossil lock-in
To be coupled with CCS

Relevant uses mainly in industry (process & combustion)

6 870 TWh
2021

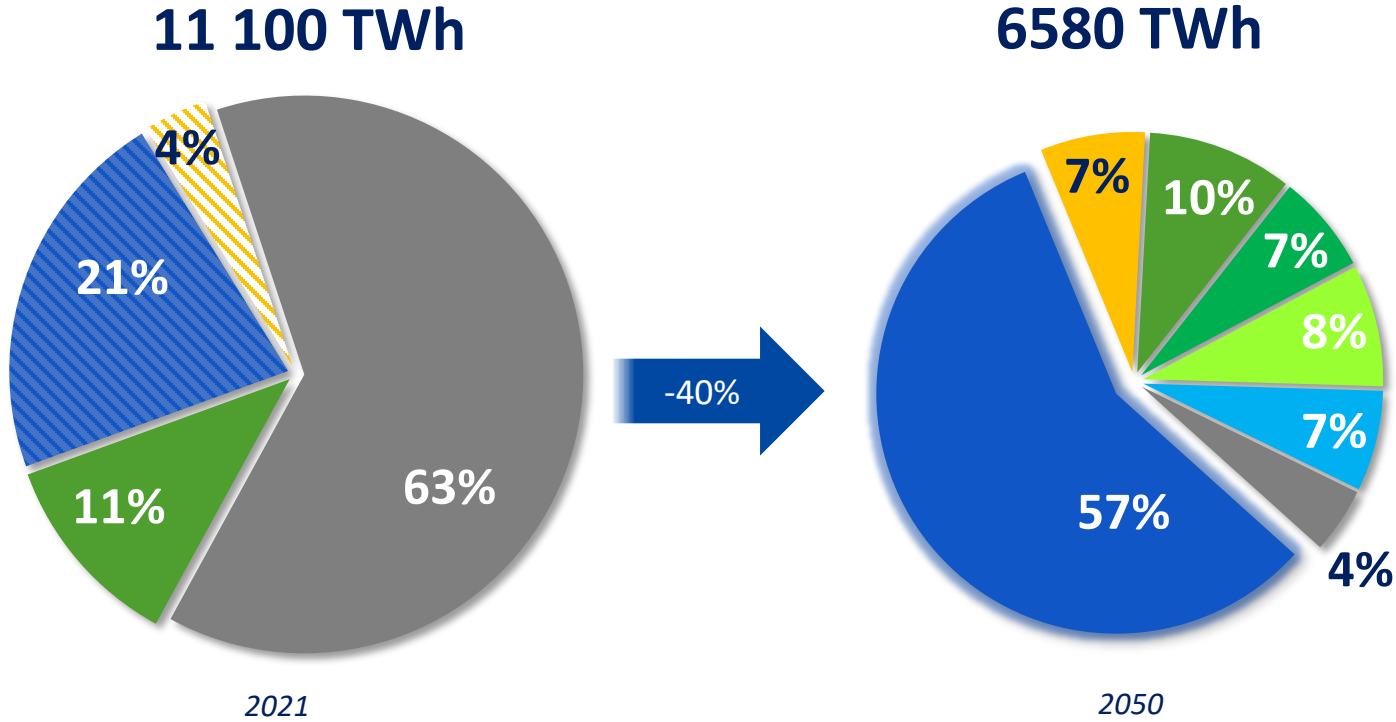
290 TWh
2050

■ Electricity ■ Fossil fuels ■ Solid biomass ■ Bioliquids ■ Biogas ■ e-fuels ■ Heating Networks

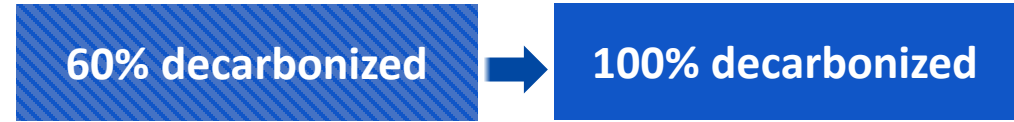


Final energy consumption

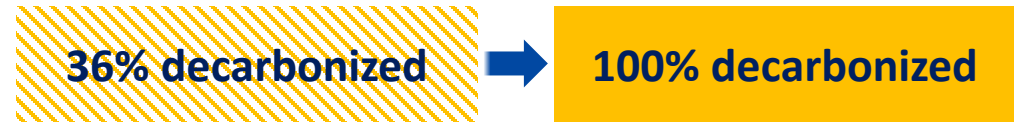
incl. international bunkers, excl. feedstock and losses



ELECTRONS



HEATING NETWORKS



MOLECULES

Biofuels	H ₂ and e-fuels	Fossil fuels + CCS
Limited Resources Relevant uses in home/industry heating & maritime/aviation	High energy requirement Low-carbon CO ₂ supply Relevant uses in international transport and industry	Risk of fossil lock-in To be coupled with CCS Relevant uses mainly in industry (process & combustion)

■ Electricity ■ Fossil fuels ■ Solid biomass ■ Bioliquids ■ Biogas ■ e-fuels ■ Heating Networks



The share of electricity in the energy mix increases to 57% in 2050.
All energy vectors are 100% decarbonized.
Biofuels, hydrogen and derivatives will play an important role for hard-to-abate targeted uses (industry and international transport).

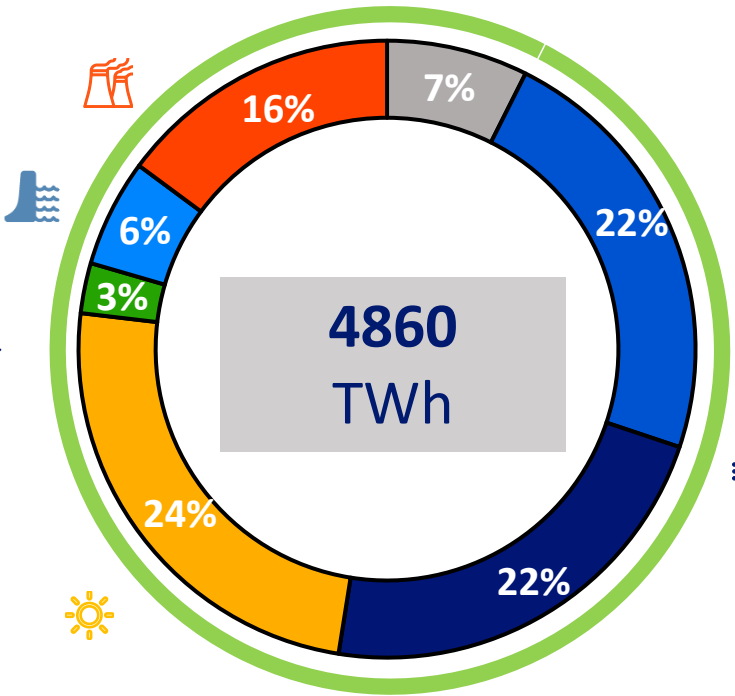
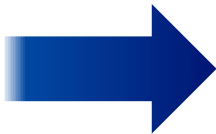
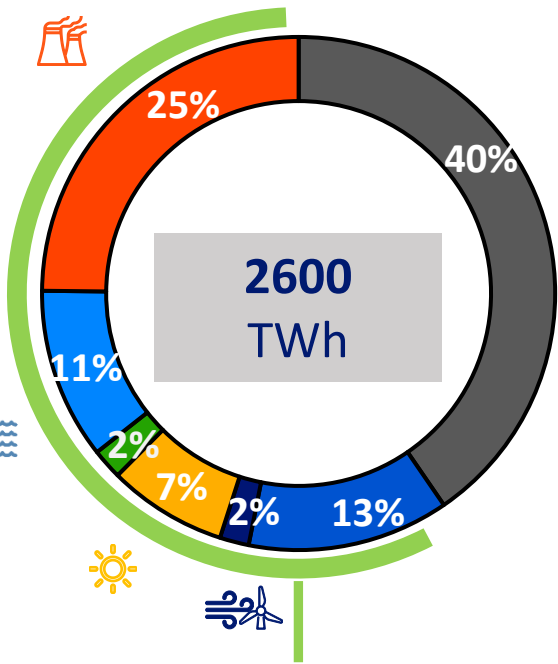


POWER MIX



EU Power mix 2021

EDF Net Zero Power mix 2050



x1.8 power production to cover the important level of total demand

100% decarbonized power mix

77% of renewables production in the power mix

60% decarbonized power production

** All the figures are given for EDF Net Zero geographical perimeter*

- Fossil
- Onshore
- Offshore
- Solar
- Bio & other renewables
- Hydro
- Nuclear
- Decarbonized Thermal

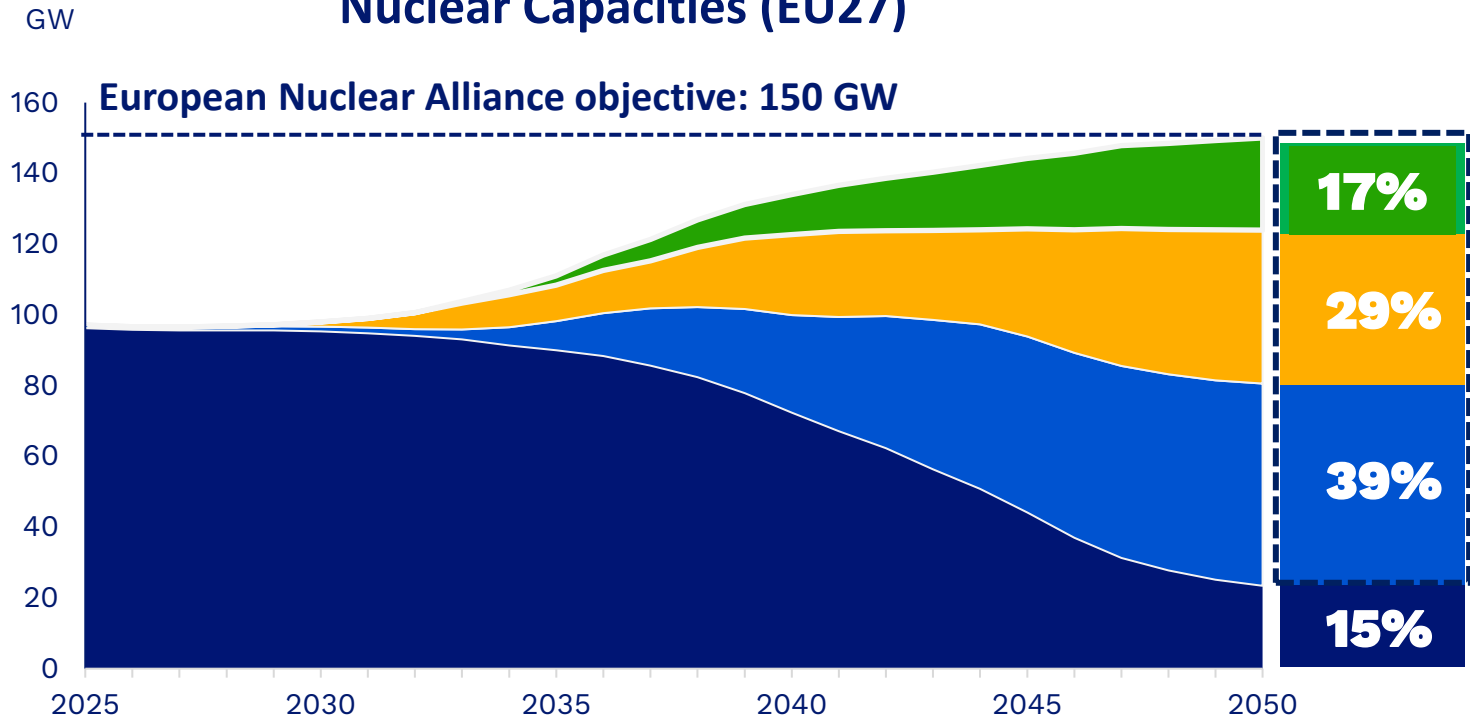


By 2050, the European power mix is made up entirely of decarbonized generation, comprising renewables incl. hydropower, nuclear and decarbonized thermal assets.





Nuclear Capacities (EU27)



By 2050, up to **85%** of nuclear capacity come from Long-Term Operations (LTO) or new build

<p>RECOMMENDED ADDITIONAL LEVERS</p> <ul style="list-style-type: none"> • Long-Term Operations / New Nuclear
<p>EXPECTED ADDITIONAL LEVERS</p> <ul style="list-style-type: none"> • Long-Term Operation of existing fleet over 60 years • New nuclear programs: large units or SMR
<p>NEW NUCLEAR CAPACITIES already announced</p> <ul style="list-style-type: none"> • Large Nuclear Units (> 1 GW) • Small Modular Reactors (< 500 MW)
<p>EXISTING CAPACITIES up to 60 years old</p>



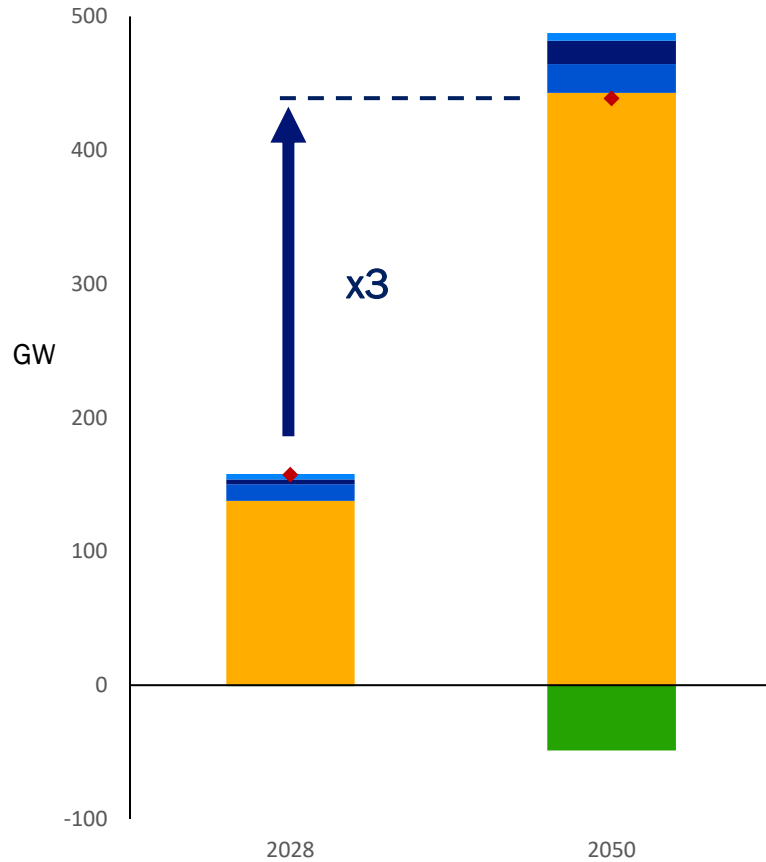
Nuclear power makes a major contribution to EU decarbonization, as a decarbonized, energy-dense and dispatchable technology. Nuclear New Build and LTO will represent 85% of 2050's nuclear capacity and should be an industrial priority.

POWER FLEXIBILITY NEEDS



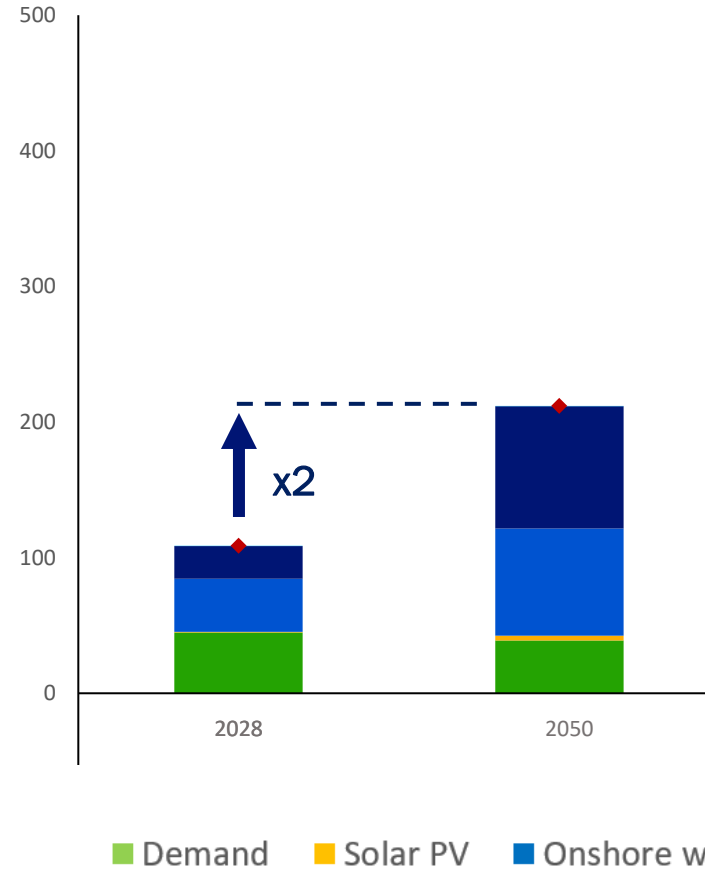
Intra-day power flexibility needs breakdown

The daily variability of solar production is the main driver of flexibility needs.



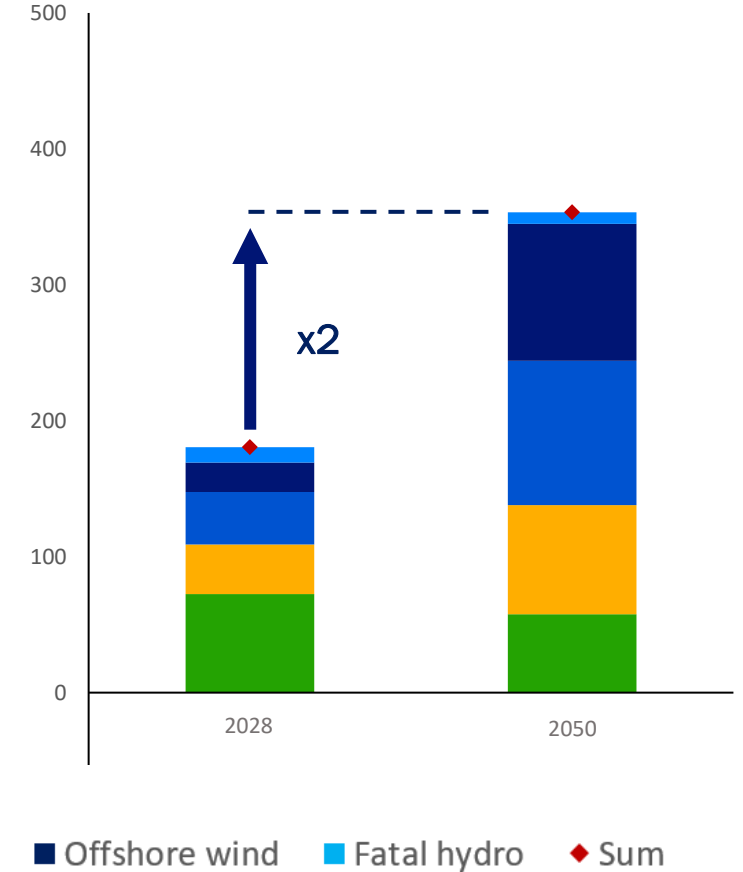
Weekly power flexibility needs breakdown

The weekly variability of wind production is the main driver of flexibility needs.



Seasonal power flexibility needs breakdown

The seasonal variability of renewables production and demand generates flexibility needs.



■ Demand
 ■ Solar PV
 ■ Onshore wind
 ■ Offshore wind
 ■ Fatal hydro
 ◆ Sum

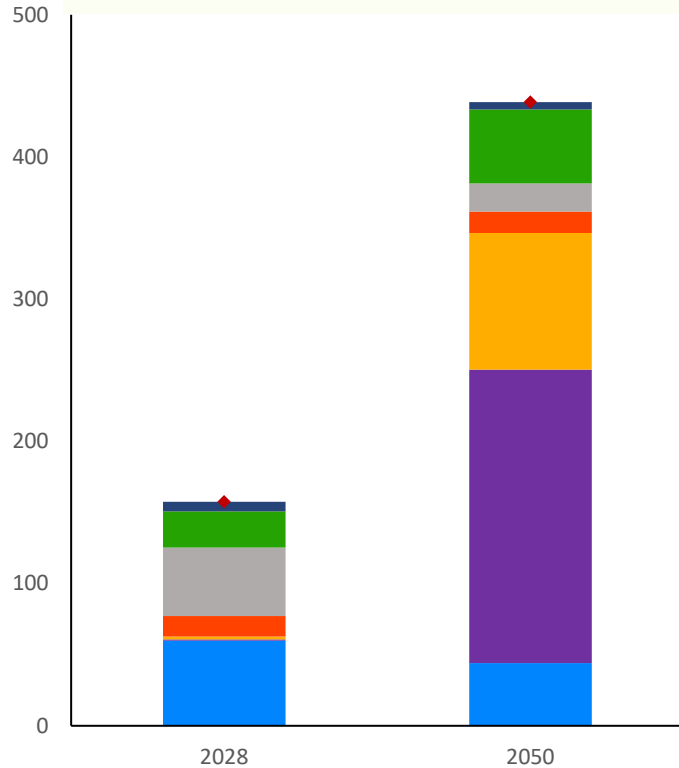
Flexibility needs of the power system increase over all time horizons due to the development of variable renewable energy sources.

POWER FLEXIBILITY SOURCES



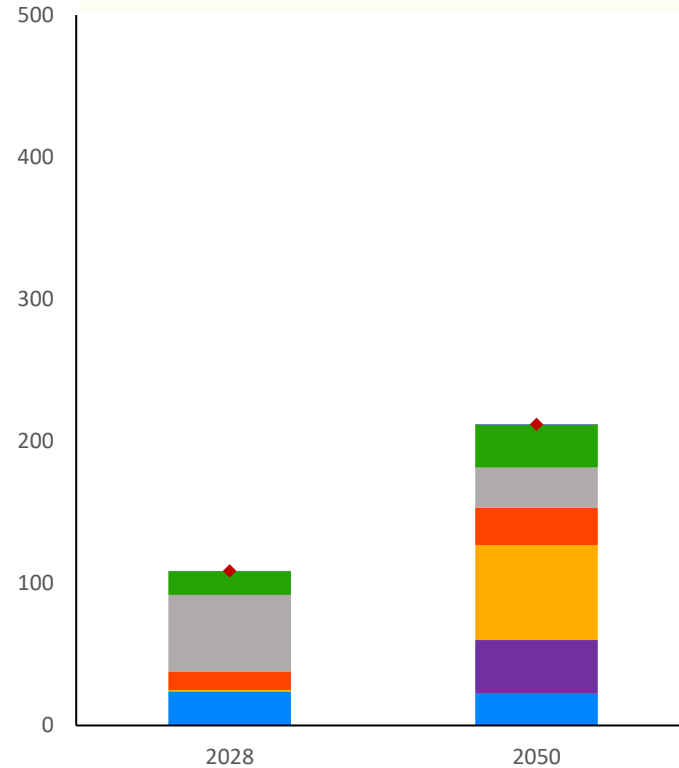
Intra-day power flexibility needs breakdown

Intraday flexibility needs will be mostly covered by demand-side management (e.g. EV smart charging) and daily storage assets (batteries)



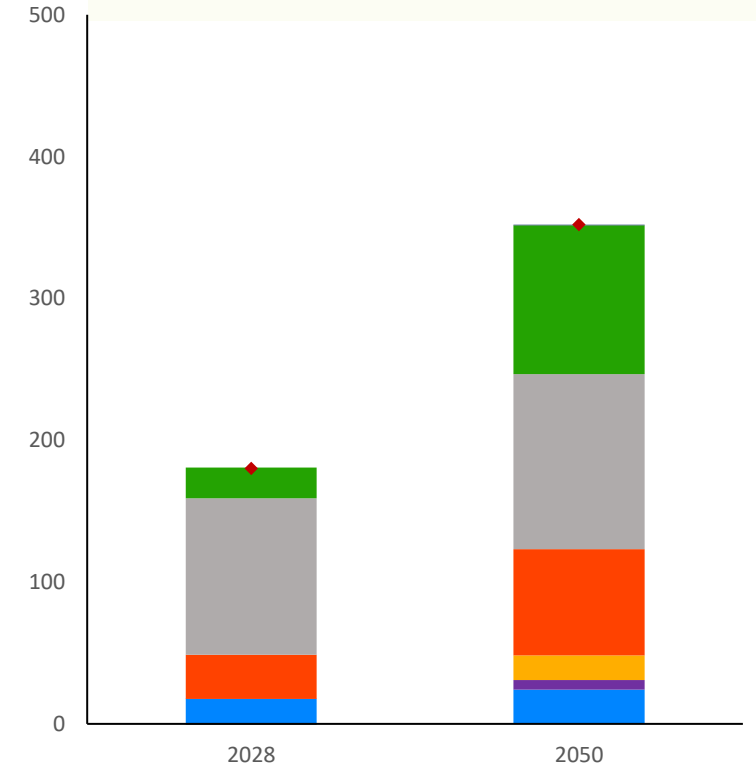
Weekly power flexibility needs breakdown

Weekly flexibility needs will be mostly covered by demand-side management, storage assets and decarbonized thermal fleet.



Seasonal power flexibility breakdown

For the seasonal horizon, flexibility needs will be mostly covered by nuclear and decarbonized thermal fleet.



■ Hydro
 ■ Batteries (inc V2G)
 ■ Demand response
 ■ Nuclear
 ■ Thermal
 ■ Variable RES
 ■ Others
 ◆ Sum

The needs will be mostly covered by :

- demand shifting/storage assets on shorter time scales ;
- nuclear, decarbonized thermal assets and interconnections on longer time scales.

A PATHWAY TO REACH CARBON NEUTRALITY IN 2050



Total CO₂ direct emissions on our 15 European countries scope

Priority actions and levers to reach -80% CO₂ emissions in 2040 would need to be significantly strengthened and complemented to reach -90%

EU ambitious electrification strategy.

Robust CO₂ prices, giving long-term visibility to investors.

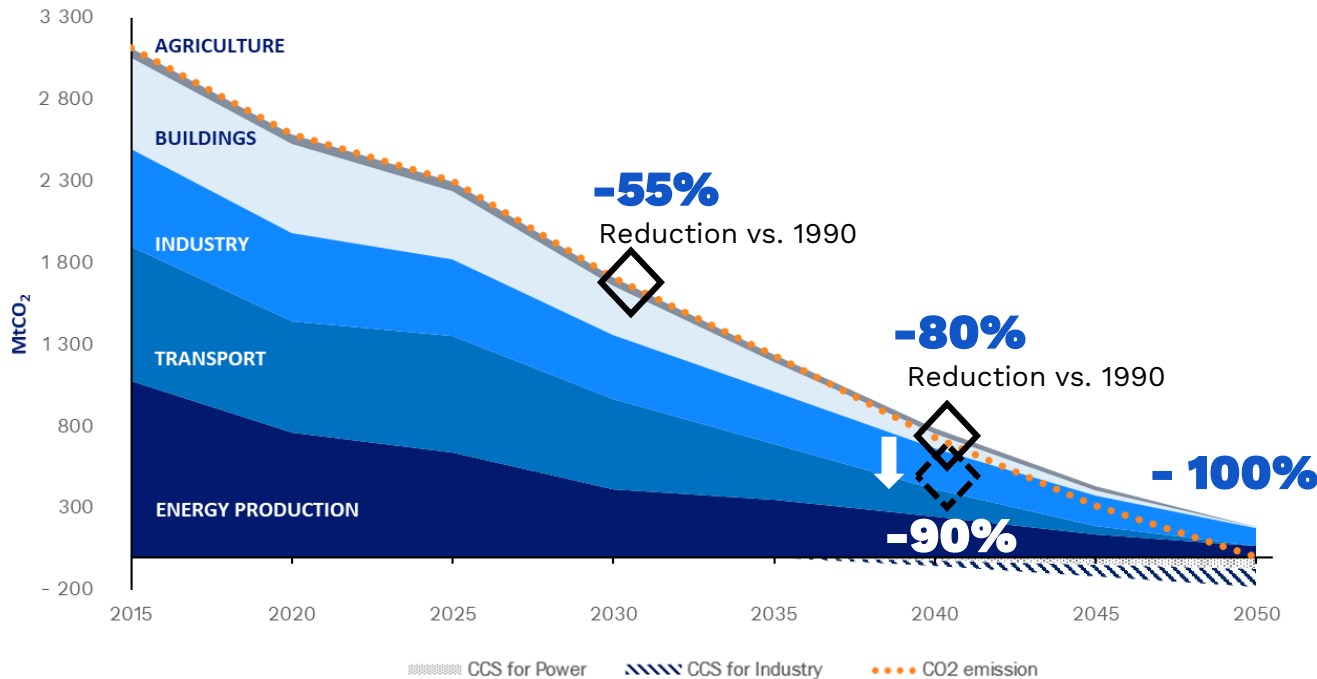
Technology-neutral legislation and fair access to EU funds for all zero- and low-carbon techs.

Reliance on Carbon Capture technologies on targeted uses.

Support to key EU industrial value chains to deliver the transition...

...While safekeeping the competitiveness of European industry and remaining mindful of the impact of the transition on the standard of living and way of life of European citizens

1990 : 3 900 Mt CO₂



Our optimized scenario reaches -80% emissions in 2040.

An objective of -90% emissions in 2040 requires significant additional efforts.



WHAT WOULD HAPPEN IF EUROPE REACHED 20% LESS ELECTRIFICATION IN 2050 COMPARED TO THE TARGET REFERENCE SCENARIO ?

**CARBON NEUTRALITY NOT
REACHED IN 2050 AND
DELAYED BY 10 YEARS**



A cumulative increase of
6000 Mt CO₂
between 2023 and 2050

**INCREASE OF EU POWER
SYSTEM COST**



Increases the power system costs
+ 20% increase

Weighs on EU public finances
+ 100 Bn€ of subsidies to renewables

**REDUCTION OF
EUROPEAN ENERGY
SOVEREIGNTY**



+ 60 bcm of gas



Not delivering on the electrification of the economy would delay carbon neutrality by 10 years, dramatically increasing the cost of the transition and jeopardizing European energy sovereignty.



ENERGY EFFICIENCY

-40%

FINAL ENERGY DEMAND VS. 2021

DIRECT ELECTRIFICATION

+60%

POWER DEMAND VS. 2021

57%

ELECTRIFICATION IN 2050

DECARBONIZED PRODUCTION

x6

WIND AND SOLAR PRODUCTION VS 2021

120 - 150 GW

NUCLEAR CAPACITY

FLEXIBILITY NEEDS

x2 - 3

AT ALL TIME SCALES

ROAD TO CARBON NEUTRALITY



DEMAND	<ul style="list-style-type: none">• Reduce final energy demand• Massive and smart electrification of all sectors<ul style="list-style-type: none">• Heat pumps installations• Large scale deployment of electric vehicles
SUPPLY	<ul style="list-style-type: none">• Renewable electricity massive development• Nuclear power lifetime extension and development of new capacities• Power Flexibility based on zero-carbon breakthrough technologies (storage & decarbonized thermal capacities)• Bioenergies, CCS and e-fuels for targeted uses
INFRASTRUCTURES	<ul style="list-style-type: none">• Investing in infrastructures to enable the transformation of the European energy sector• Strong priority on power grids and interconnections

REGULATORY

- Robust and predictable **carbon pricing** mechanisms is the keystone to shift towards decarbonized solutions and minimize the cost of transition.
- **Technology neutral** regulatory framework



Achieving carbon neutrality by 2050 requires urgent accelerations in demand, supply and infrastructures of the energy sector, as well as a clear and robust regulatory framework.

Thank you



EDF - 22-30 avenue de Wagram
75382 Paris Cedex 08 – France
SA au capital de 2 084 365 041 euros
552 081 317 R.C.S. Paris
www.edf.fr