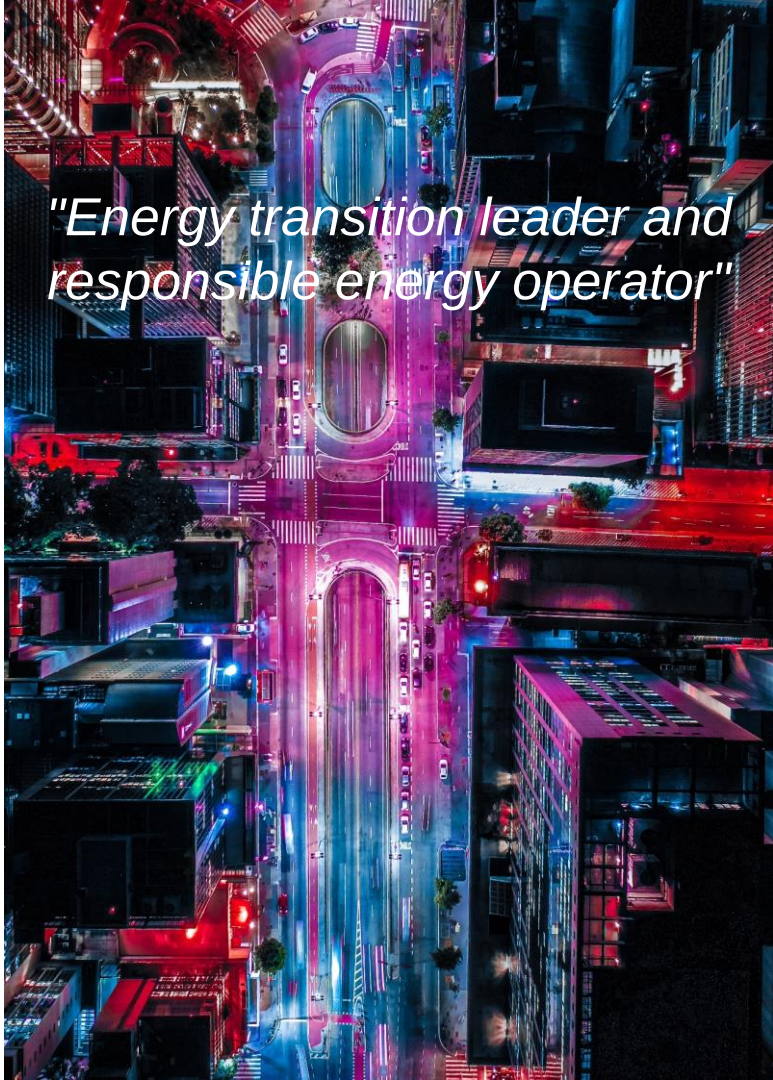
# THE ENERGY INDUSTRY CHALLENGES TOWARDS A NET ZERO ECONOMY




18th IAEE European conference

# GLOBAL CONTEXT

## 3 GLOBAL CRISES IN THE PAST 3 YEARS

**SANITARY CRISIS**
COVID-19

**2 M people** — **Died in Europe** since the beginning of the pandemic

**-8.9 %** — **GDP drop in Italy** in 2020

**3+ years** — Duration of **global supply chains disruptions**

**GEOPOLITICAL CRISIS**
UKRAINE WAR

**-80 %** — **Russian gas flowing to Europe** in September 2022 vs 2016-21 avg

**10 X** — **Gas price increase** in the past year (250 c€/smc august avg)

**8 X** — **Electricity price increase** in the past year (540 €/MWh august avg)

**ENVIRONM. CRISIS**
CLIMATE CATASTROPHES

**7 M people** — Impacted by unprecedented **floods in Bangladesh**

**18 M people** — **Suffering hunger in Africa** due to unprecedented drought

**-30 %** — **Ice loss on Italian mountains** in the past 60 years; complete disappearance by 2100

**All these instabilities are creating potentially irreversible changes in the energy and economic system at a global scale; to face them, EU and USA have enacted wide policy packages that invest in the energy transition**

**FF55 / RepowerEU**
750 b€

**Inflation Reduction Act**
430 b$

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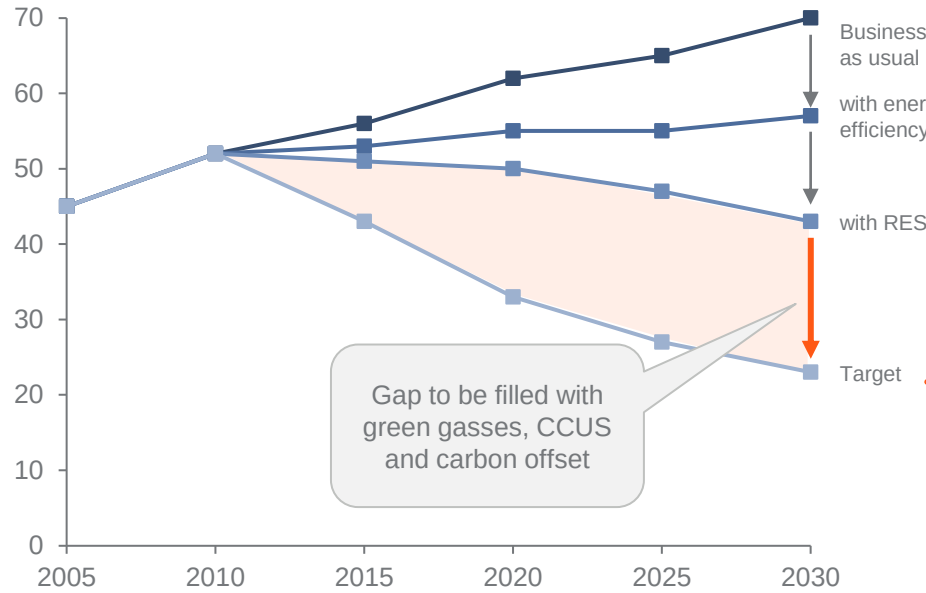
# CO2 TARGETS AND POSSIBLE ABATEMENT LEVERS

## REDUCE AND REMOVE EMISSIONS

### Global GHG emission reduction by levers

(GtCO2 per year)




**Energy efficiency**

Reduction of carbon emissions through increased energy efficiency, covering industrial technology, supply-side technology & transport

**Renewable energy**

Shift toward low or clean power sources. Electrification of end-uses & processes, using clean power as e- source

**Green gasses**

For remaining emissions that cannot be electrified (technical and/or cost reasons), replace energy source with clean fuels

**CCS CCUS**

CO2 capture and storage (in geological formations) or use in products and processes to reduce emissions and remove CO2 that cannot be avoided

**Carbon offset**

Taking advantage of natural sinks that absorb and store CO2 as part of the natural cycle (plants, soil, oceans)

**Energy Efficiency & RES alone will not be sufficient to achieve GHG emissions targets, CCUS will be a necessary lever to achieve a low carbon economy**

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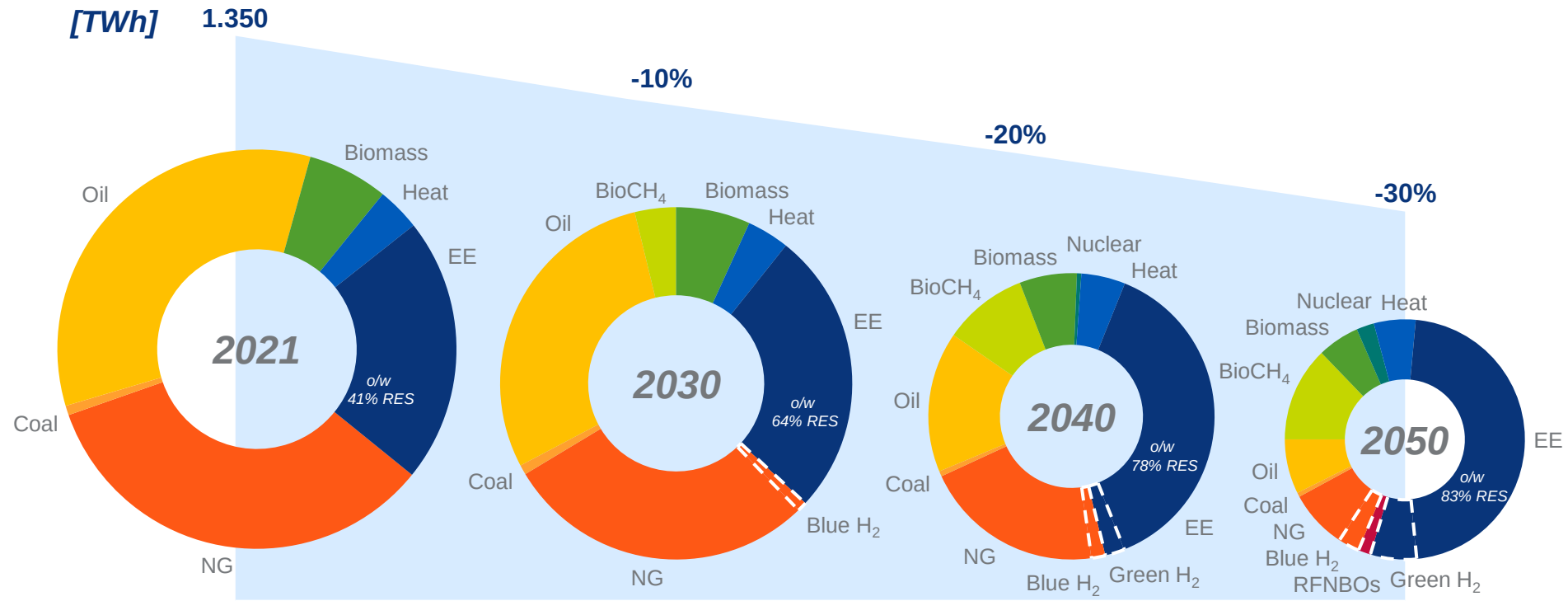
# DECARBONIZATION PATHWAY

## FINAL ENERGY CONSUMPTION BY SOURCE

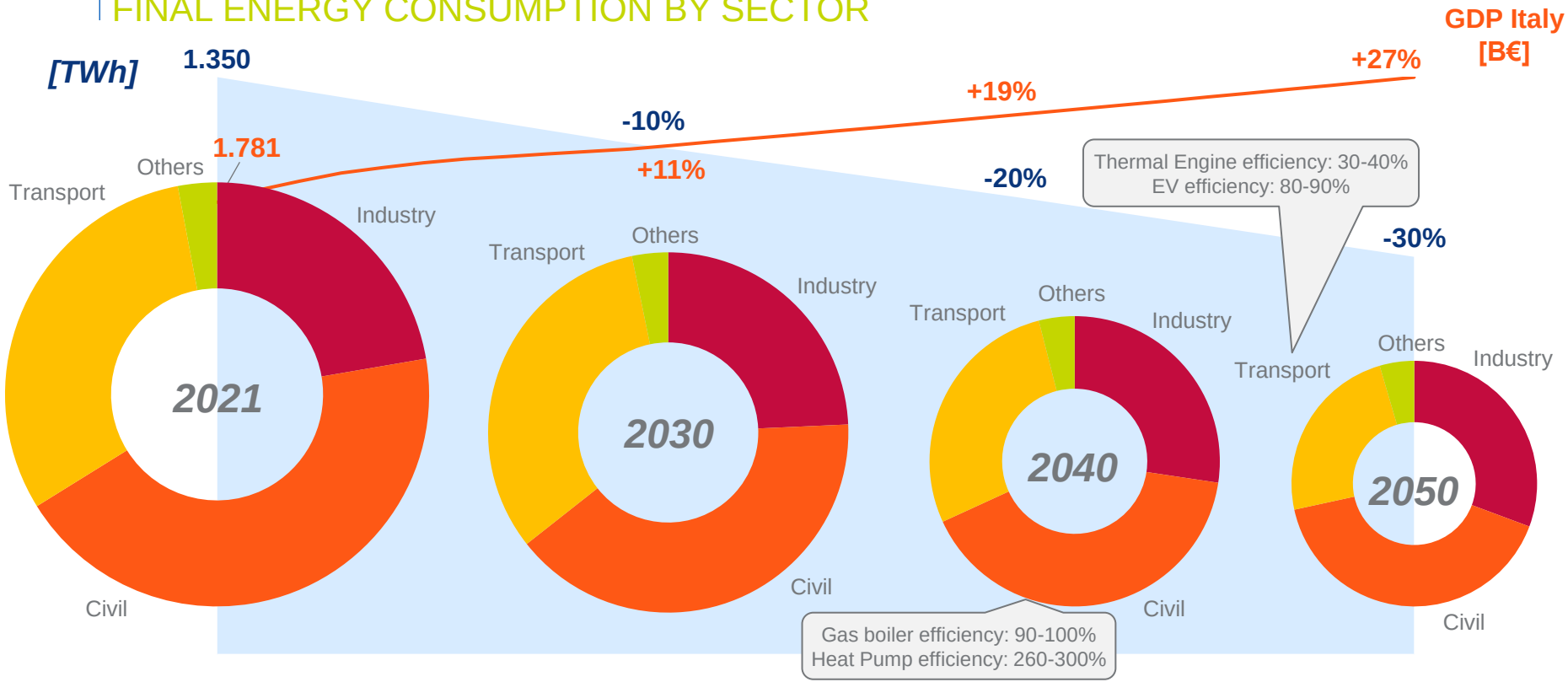



**Reduction of final energy consumption through electrification by RES, energy efficiency and fuel shifts (from fossils to biomethane and H2)**

**The energy transition allows to increase energy independence, thus improving Italian energy security**

# DECARBONIZATION PATHWAY

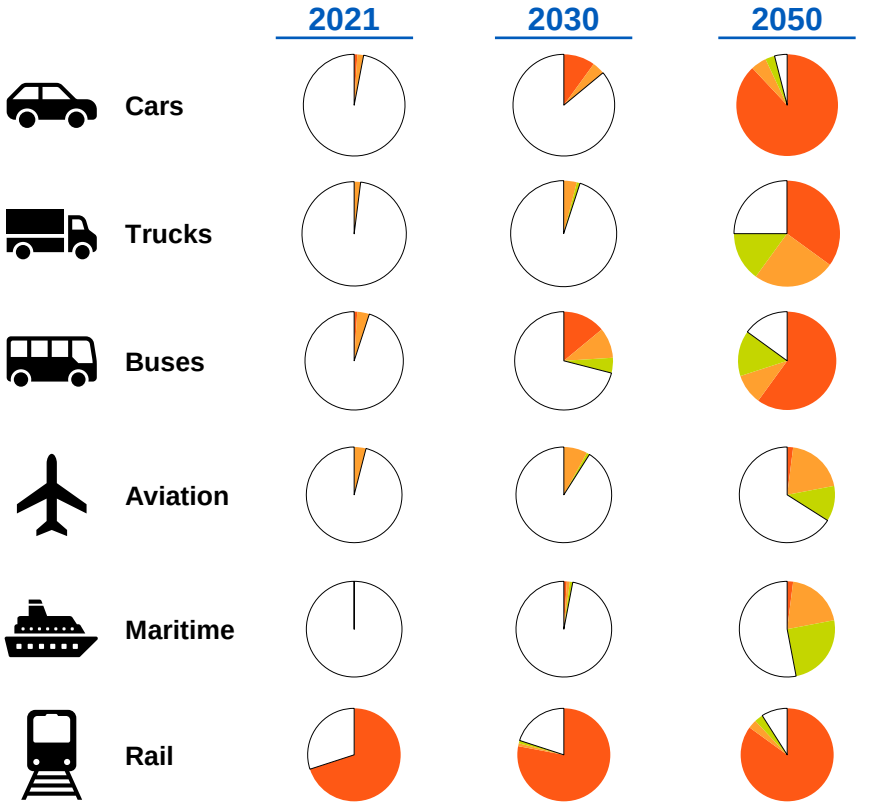
## FINAL ENERGY CONSUMPTION BY SECTOR




**Great challenge: maintain a GDP of 0,8%/year (average annual growth rate b/w 2022 and 2050) while decreasing the total energy needed, thus decoupling growth rate and energy consumption**

# FINAL ENERGY DEMAND – TRANSPORT

## DECARBONIZATION LEVERS




**~60%**
energy consumption reduction due to switch from thermal to electric engines

**2035**
Year in which only zero emissions cars & vans can be sold

**3 Millions**
Domestic wall-boxes present in 2030 in Italy (~55% EV)

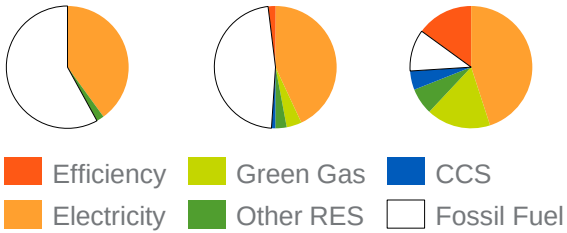
**150,000**
Public charging stations present in 2030 in Italy

**The main decarbonization lever for road transport is electrification**
**On the other hand, in maritime and aviation RFNBOs and biofuels will play a major role**

# FINAL ENERGY DEMAND – INDUSTRY

## DECARBONIZATION LEVERS

| | 2021 | 2030 | 2050 |
|---|---|---|---|
| Electrification | 40% | 44% | 53% |
| Efficiency | | -2% | -15% |
| Green Gases | 0% | 4% | 20% |
| CCS | 0% | 2% | 7% |




**120 kton**
Green $H_2$ in industry in 2030

**2 Mton**
$CO_2$ captured and stored in 2030 in the industrial sector

**1 bcm**
Biomethane used in industry in 2030 (~500 MW CHP)

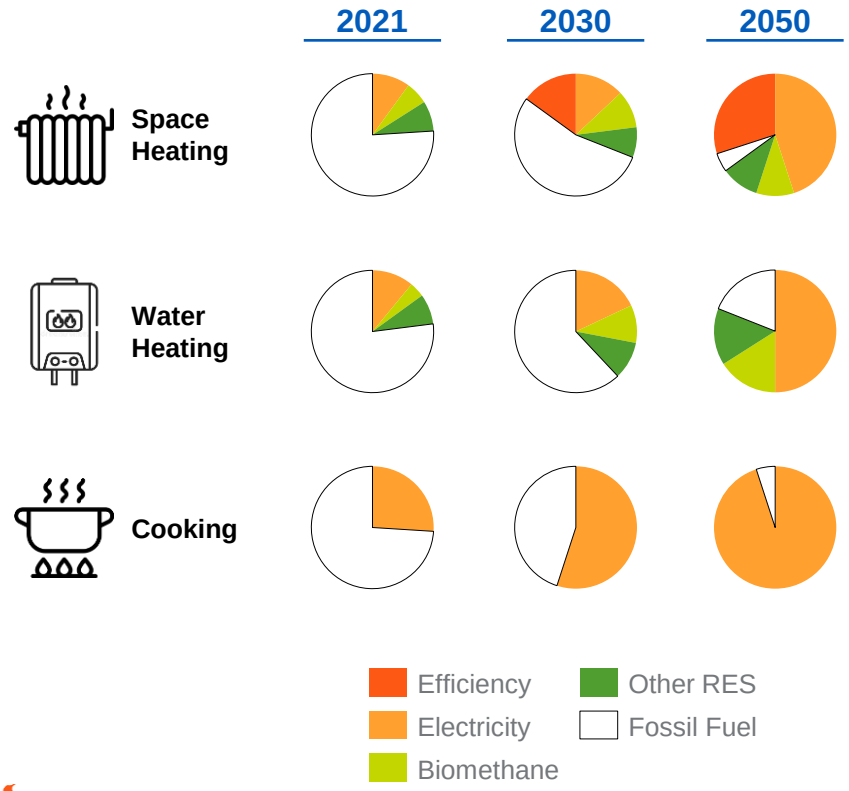
**5000**
Industrial heat pumps sold in the next 10 years[1]

**Green gases and CCS will enable the decarbonization of Hard to Abate processes, namely in chemical, cement and steel industries**

(1) *Considering 10% of total boilers sold >250kW (~5000 units/y)*

# FINAL ENERGY DEMAND – CIVIL

## DECARBONIZATION LEVERS




In 2021 Italy second country in EU for heat pump sales

**3 M**
Households with heat pumps for space heating in 2030[1] (+2 vs today)

**1,5 M**
Households with rooftop PV plants in 2030 (+0,5 vs today)

**0,7 bcm**
Gas reduction in the civil sector by 2030

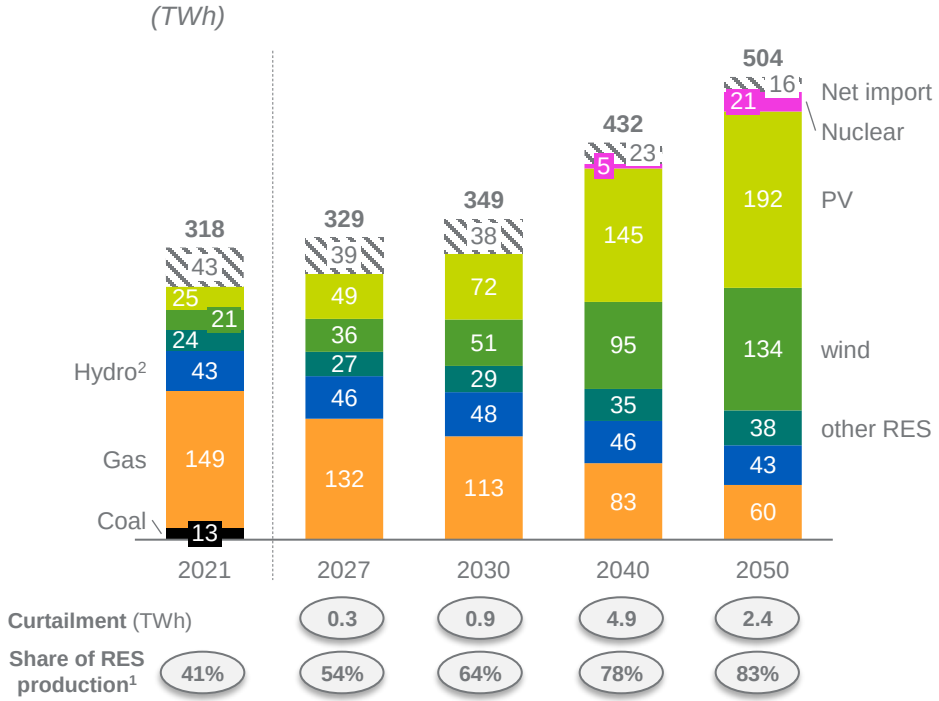
**1 M**
Renovated buildings By 2030[2]

**Households will become more energy independent thanks to local RES production coupled with storage (e.g., EVs) and smart-connected appliances**

*(1) 20% of total households (2) 8% of total residential buildings*

# ELECTRICITY GENERATION MIX

## MAIN RESULTS



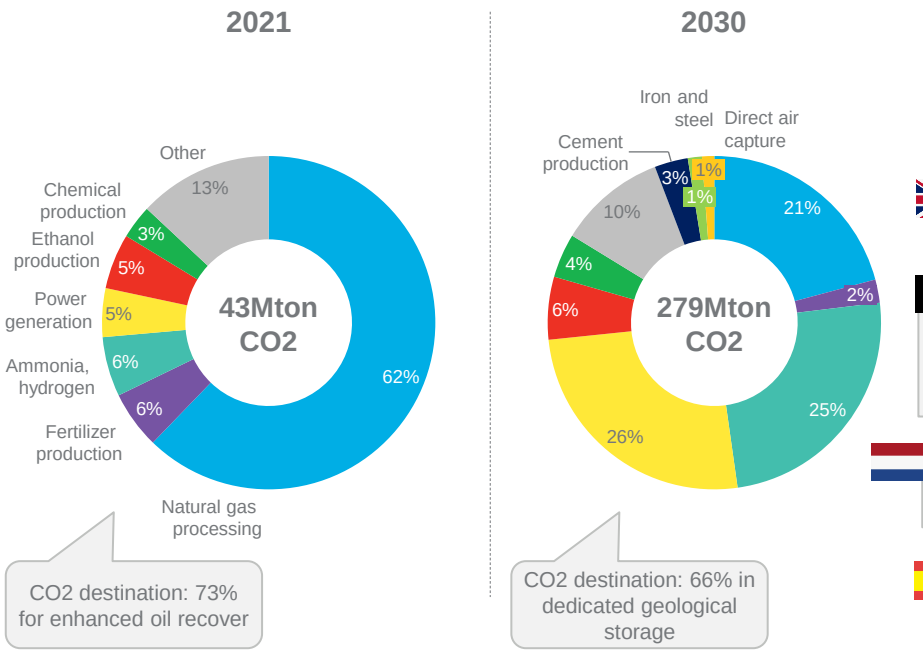

**Growth in electricity demand will be mainly covered by increasing RES, but thermo gen will continue guarantee system adequacy**

*(1) Share of on National production (2) Including pumping*

# DECARBONIZATION OF THERMO FLEET IN ITALY

## EU TARGETS AND CO2 PRICE PUSH TOWARDS A LOW CARBON PRODUCTION

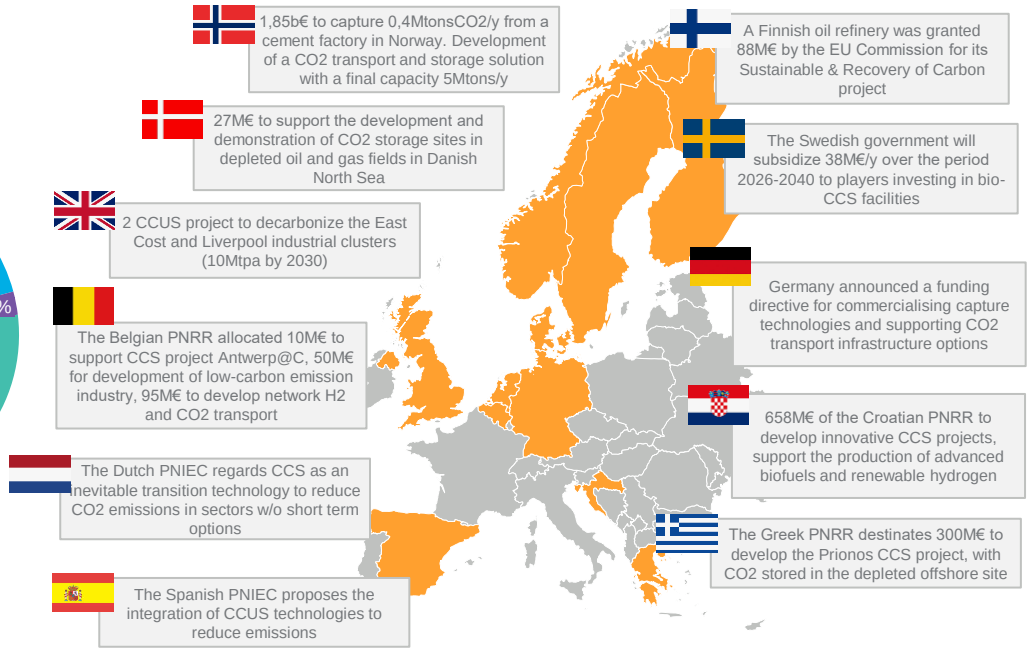
### CO2 capture by source - evolution @2030[1] (%)




CO2 destination: 73% for enhanced oil recover

CO2 destination: 66% in dedicated geological storage

### CCS projects in Europe




**CCS is available, scalable, competitive and safe technology to accelerate the decarbonization path, with 38 currently existing project in EU**

*Source: Bloomberg*

# NEW NUCLEAR TECHNOLOGY

## SMR AVAILABLE STARTING FROM 2030

### Gen II

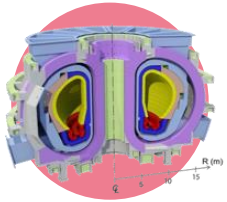
Almost all nuclear reactors in operation. Life-extension (from 40 to 60-80 years)

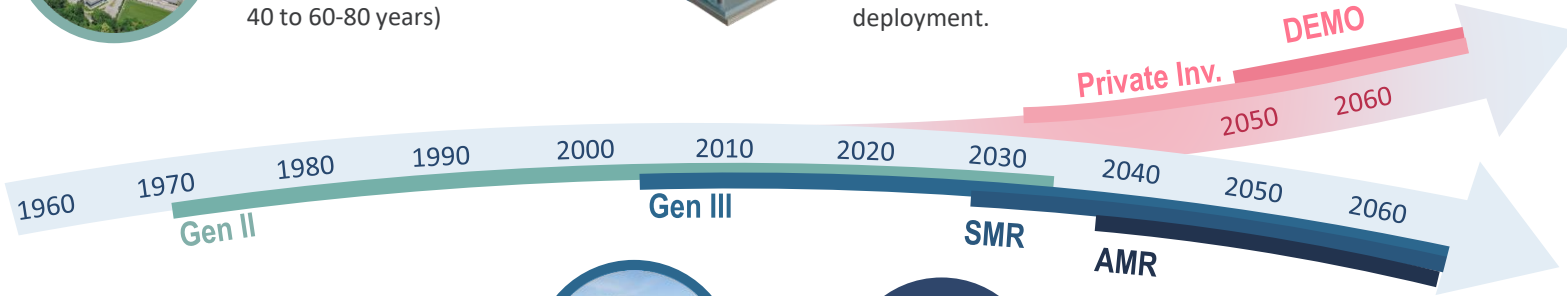
### SMR[1] Gen III+

Small size reactors (< 300 MWe), modular design & deployment.

### DEMO

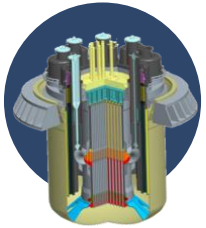
First-Of-A-Kind fusion reactor






### Gen III (Gen III+)

Some already in operation (Europe[3], China, UAE, S. Korea, Russia, India).
53 units under construction in the World



### AMR[2] Gen IV

Liquid metal or molten salts coolant.
Possibility to burn long-lived high-level radioactive nuclear waste.

*1) SMR = Small Modular Reactor 2) AMR = Advanced Modular Reactor 3) in Finland, Olkiluoto-3*

# NUCLEAR POWER ROLE

## ECONOMIC AND TECHNICAL PERFORMANCE OF DIFFERENT TECHNOLOGIES

| | CCGT<br>800 MW | CCGT+CCS<br>720 MW | PV<br>50 MW | Wind<br>50 MW | SMR<br>340 MW |
|---|---|---|---|---|---|
| *LCOE @2030 (€/MWh)* | 80-100 | 100-120 | 45<br>+50 for battery<br>+ grid development costs | 55<br>+50 for battery<br>+ grid development costs | 80 |
| *Load factor (%)* | 80 | 80 | 20 | 30 | 90 |
| *Lifetime (years)* | 40 | 40 | 30 | 30 | 60 |

Depending on gas and CO2 price

If baseload, otherwise LCOE increases

**Nuclear power is the cheapest solution to decarbonize the electricity system, if used baseload; its LCOE increases to >100 €/MWh if used as semi-baseload or peaker**

# NUCLEAR POWER ROLE

## ENVIRONMENTAL IMPACT OF DIFFERENT TECHNOLOGIES

| | CCGT 800 MW | CCGT+CCS 720 MW | PV 50 MW | Wind 50 MW | SMR 340 MW |
|---|---|---|---|---|---|
| *LCA GHG emissions[1] (gCO2/kWh)* | 390 (320 direct emissions, 70 other emissions) | 140 (50 direct emissions, 90 other emissions) | 37 + 50-100 for battery | 12-11 (onshore-offshore) + 50-100 for battery | 8 |
| *EROEI[2]* | 30 | 25 | 5 | 10 | 50 |
| *Land occupation (ha/GW)* | 10 | 15 | 1000 | 10000 | 16 |

In a RES-based world, we will need more and more energy to satisfy final energy demand

**In terms of energy efficiency, land occupation and GHG emissions, nuclear is far less impacting than thermo and RES technologies**

*(1) Life Cycle Assessment of Electricity Generation Options, UNECE, 2022 (2) EROEI: Energy Returned On Energy Invested*