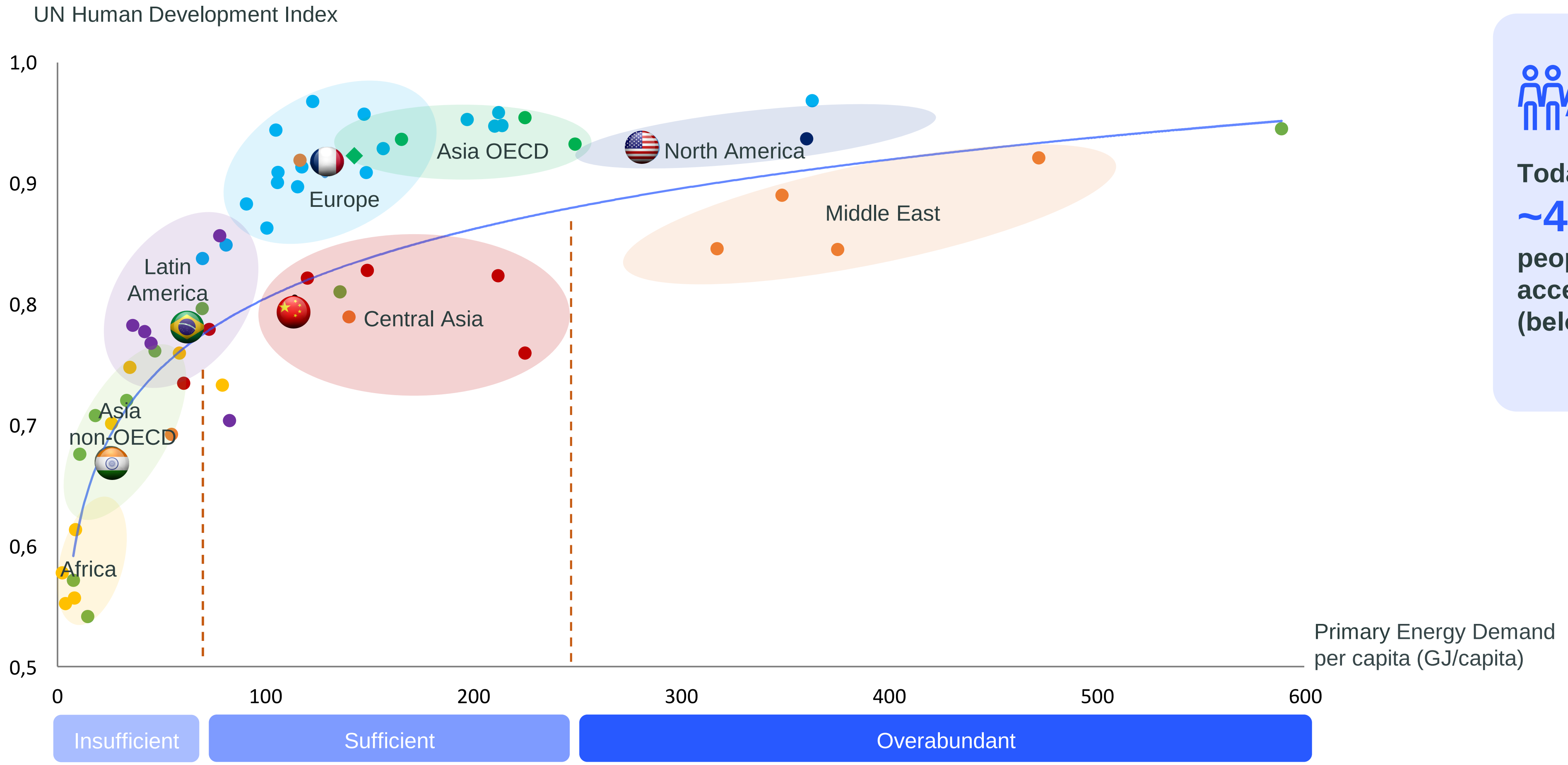

Neptune Floating Storage and Regasification Unit (FSRU) – Turkey

TotalEnergies

# TotalEnergies Energy Outlook 2025

November 4th, 2025

# Energy access is essential to human development




**Today**

**~4.6 bn**

**people lack access to energy (below ~70 GJ/capita)**



*Sources: HDI: UN data, TPED: Energy Institute & Our World in Data, Population: Oxford Economics, graph adapted from Smil (2017)*

TotalEnergies

PART 1

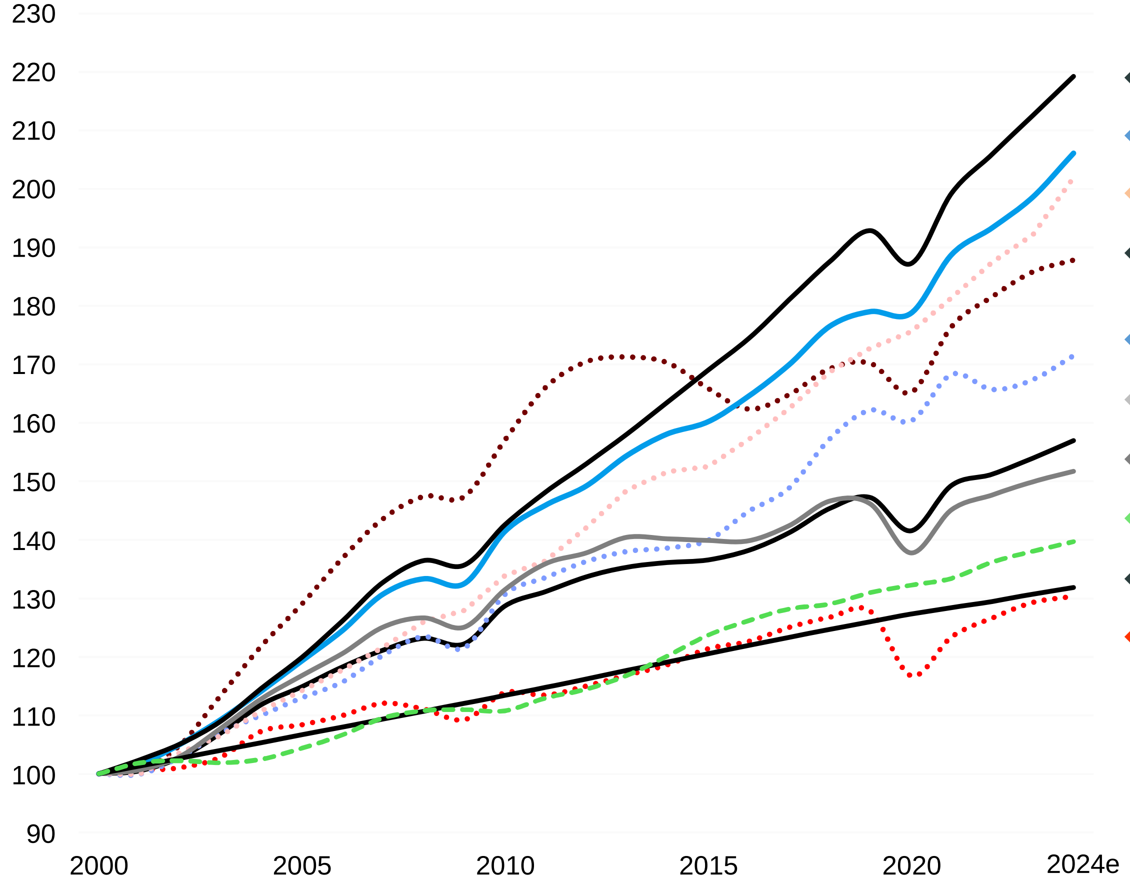
# Looking back: what has happened since the 2015 Paris Agreement

# Evolution of global energy indicators since 2000

## Primary energy demand grows slower than GDP as $CO_2$ emissions start to decouple

### Evolution since 2000

2000=100




### Compound Annual Growth Rates (CAGR)

| | 2000-2024e | 2023-2024e |
|---|---|---|
| GDP | 3.3% | 3.2% |
| Electricity demand | 3.1% | 4.3% |
| Renewable energy supply | 3.0% | 5.8% |
| Coal demand | 2.7% | 1.0% |
| Natural gas demand | 2.3% | 2.7% |
| Total primary energy demand | 1.9% | 2.2% |
| $CO_2$ emissions | 1.7% | 0.8% |
| Energy efficiency | 1.4% | 1.0% |
| Population | 1.2% | 0.9% |
| Oil products demand | 1.1% | 0.8% |



*Source: Oxford Economics, Enerdata, IEA "Global Energy Review 2025"*

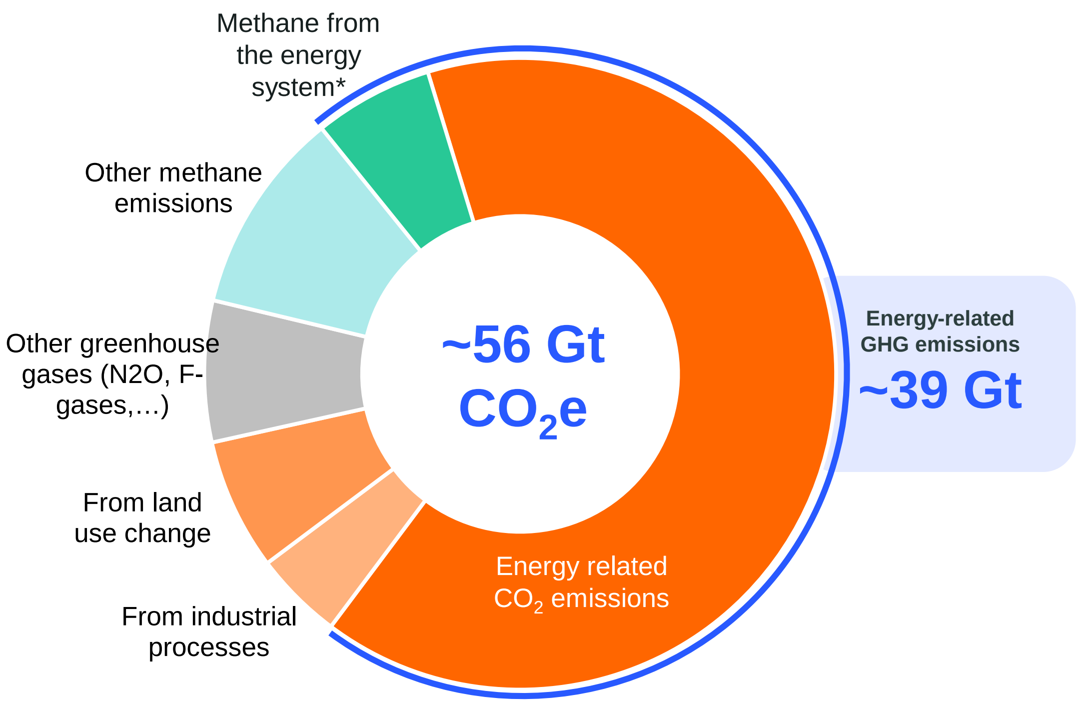
ENERGY AND EMISSIONS

# Global and Energy-related GHG emissions

## Coal in electricity generation is the single largest source of emissions

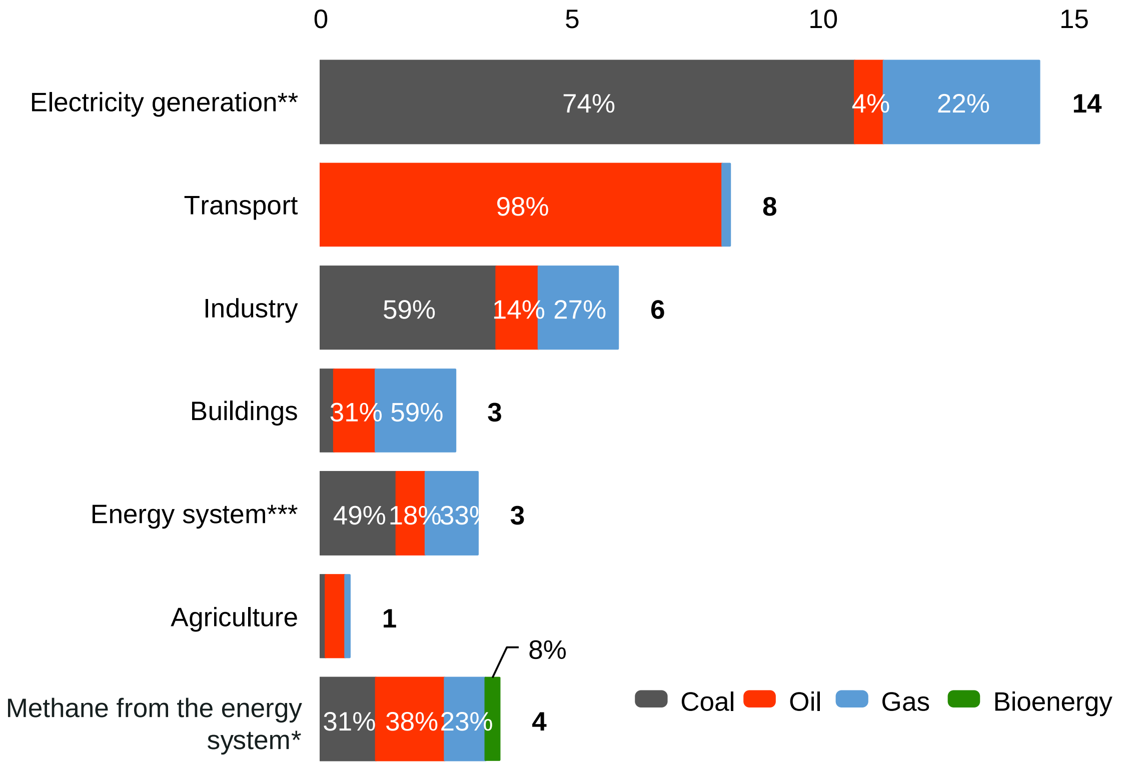
### Global anthropogenic GHG emissions in 2023

$GtCO_2e$




### Global energy-related GHG emissions in 2023

$GtCO_2e$




*GHG: GreenHouse Gases*
*Sources: IEA, Enerdata, UNEP, CITEPA, EDGAR, TTE internal analysis*
** Includes methane emissions from the production and transport of fossil fuels and bioenergies*
*** Includes heat combined with power*
**** Includes energy sector own use, transport losses and energy transformation*

ENERGY AND EMISSIONS

# Recent trends across regions

## Emissions have grown less than energy demand since 2015

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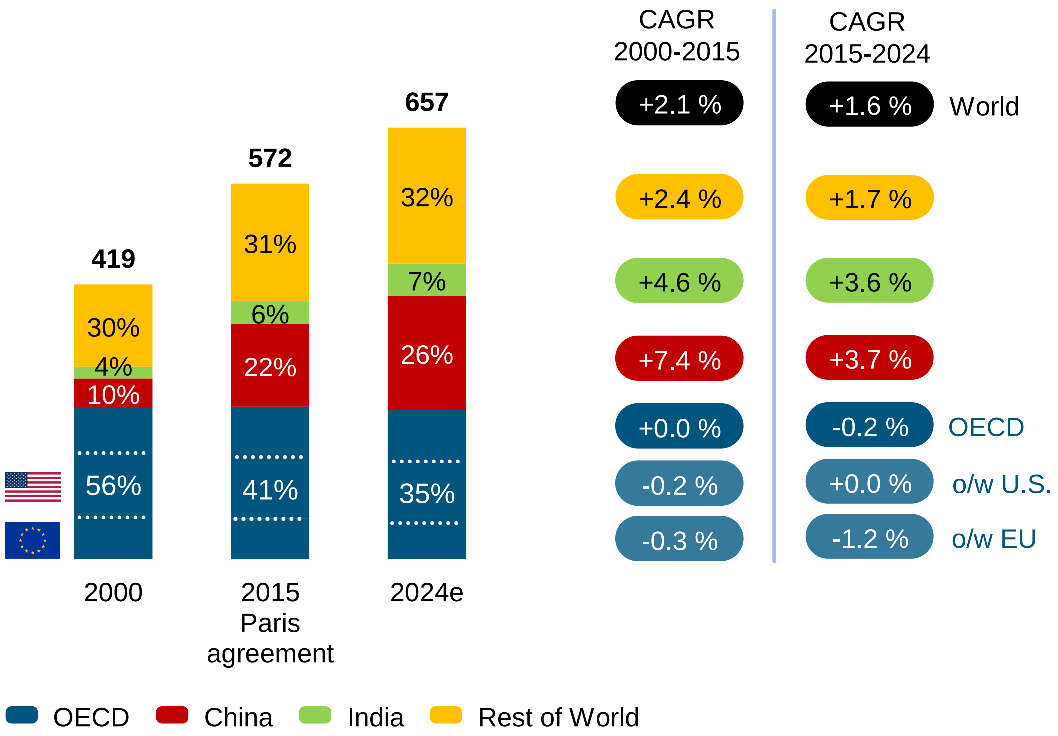
### Total Primary Energy Demand (TPED) growth

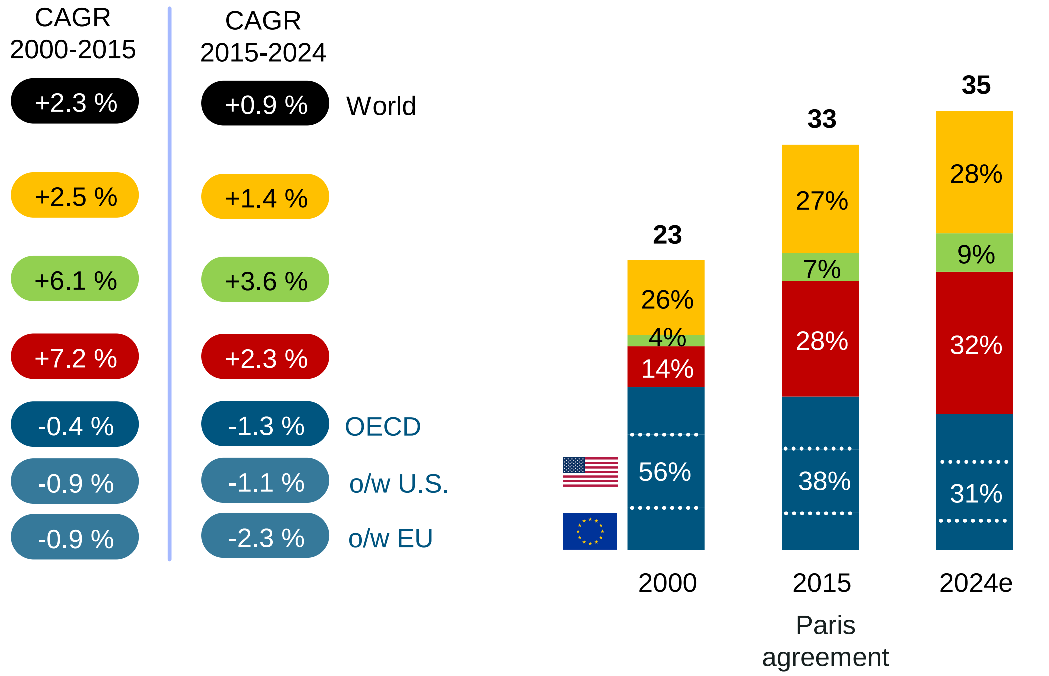
EJ




**Energy demand in OECD countries has broadly remained flat since 2000, while China, India, and the Rest of World have grown from less than half to almost two-thirds of global energy demand.**

### Energy-related $CO_2$ emissions evolution

$GtCO_2$




**Emissions growth has slowed markedly since 2015. The OECD share of global emissions has declined from more than half in 2000 to around one-third in 2024.**



*Source: Enerdata, TTE internal analysis*

Part 1 Looking back

Part 2 Looking ahead

COUNTRY FOCUS

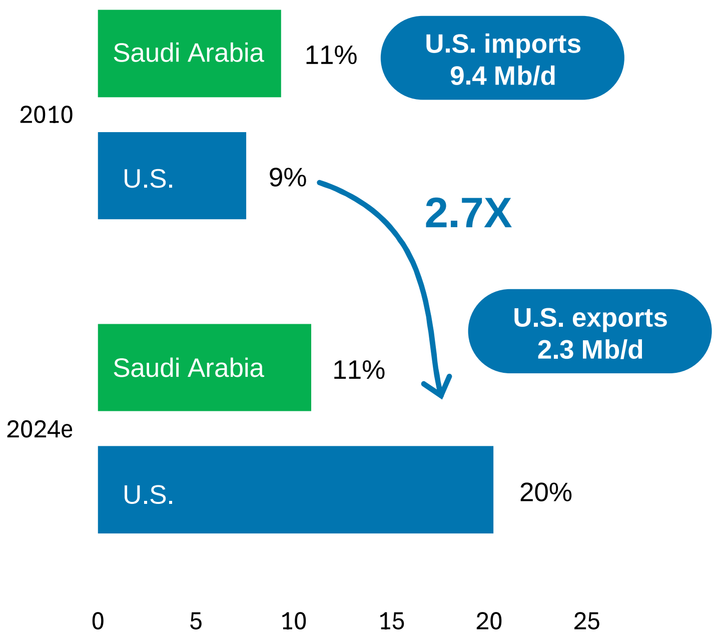
# The United States

## Between 2015 and 2025, the U.S. has become a net exporter of oil and gas

TotalEnergies

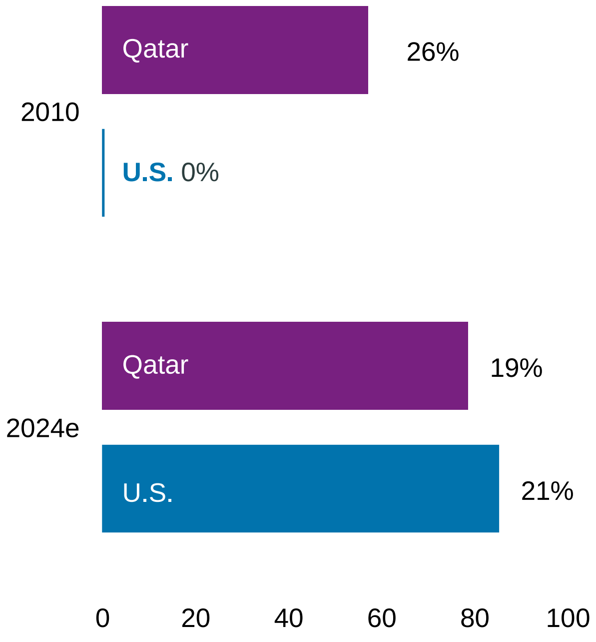
### Oil products* production by region

Mb/d, % of global production



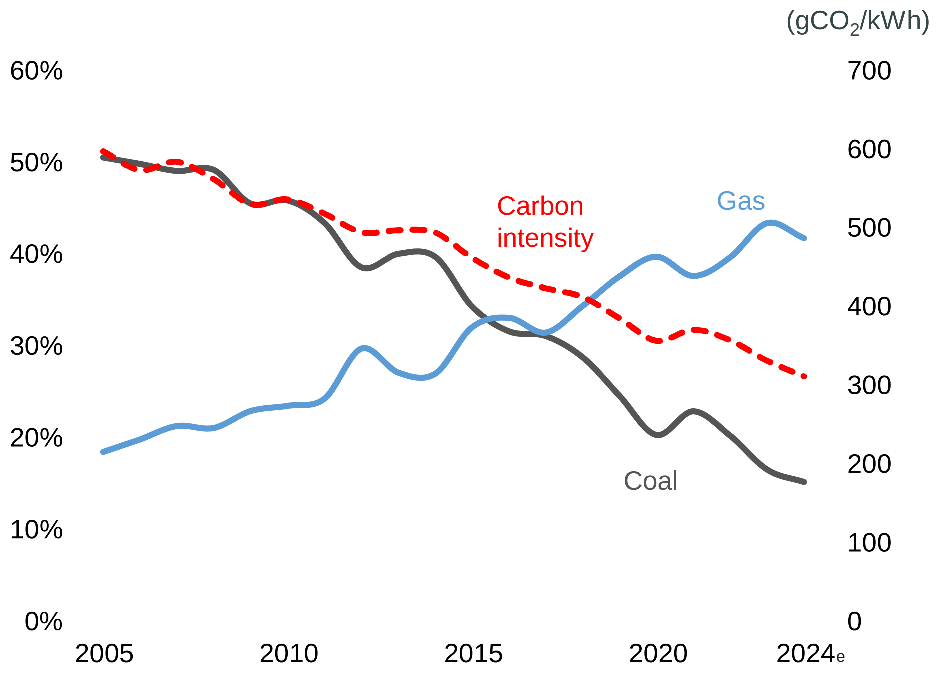

### LNG exports by region

Mtpa, % of total supply




### Fuel shares and emissions of the U.S. electricity mix

% of fuel (left) and carbon intensity (right)




**The U.S. became net exporter of gas in 2017, and of petroleum** products in 2020**

**The U.S. has reduced its emissions by 21% since 2005, out of which coal-to-gas switching in electricity generation accounts for 85%**



** Oil products supply includes crude oil, condensate, NGL and biofuels*

*** Petroleum products include crude oil, condensate, unfinished oils and refined products*

*Source: Enerdata, TTE internal analysis*

COUNTRY FOCUS

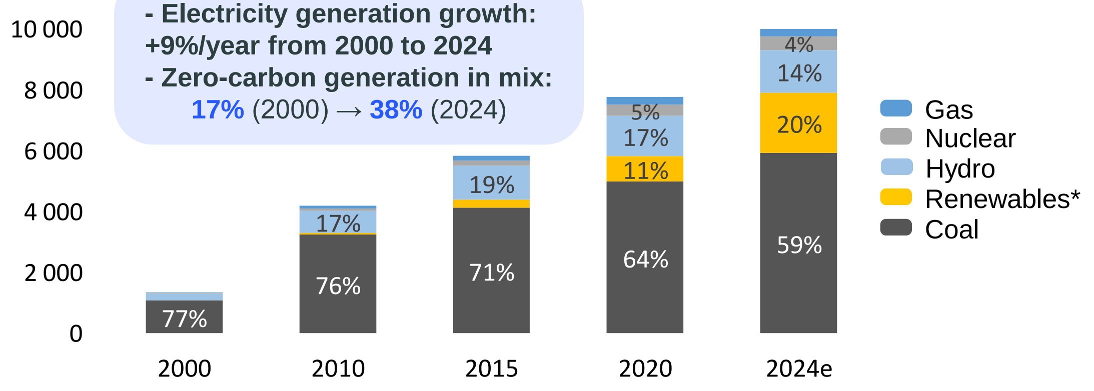
# China

## The rise of clean energy superpower

TotalEnergies

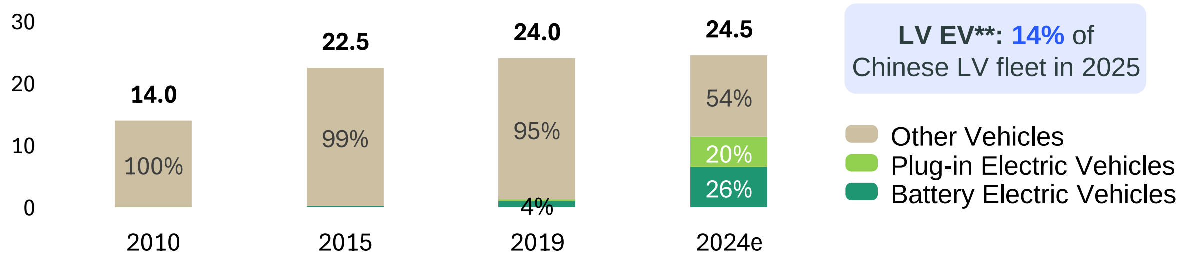
### Electricity supply in China by fuel, 2000-2024e

TWh



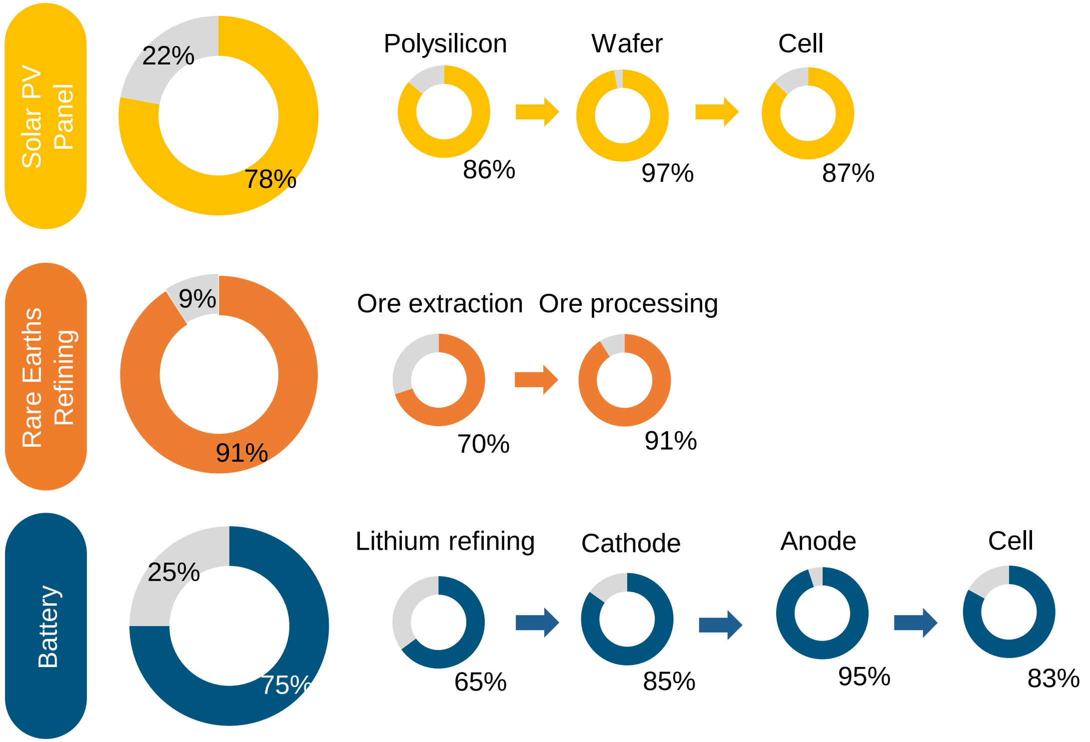

### Light Vehicle sales in China

Millions




### China's market shares of new supply chains

% of China vs. rest of the world in 2024e***




**China accounted for more than half of global renewables capacity and EV additions in 2024**

**China is dominant in most global clean energy supply chains – but facing domestic overcapacity challenges**

** Renewables include Solar PV, Wind and Biomass*
*** LV (Light Vehicles), EV (Electric Vehicles) = BEV (Battery Electric Vehicle) + PHEV (Plug-In Hybrid Electric Vehicle)*
**** Sources: IEA, BNEF, TTE internal analysis*

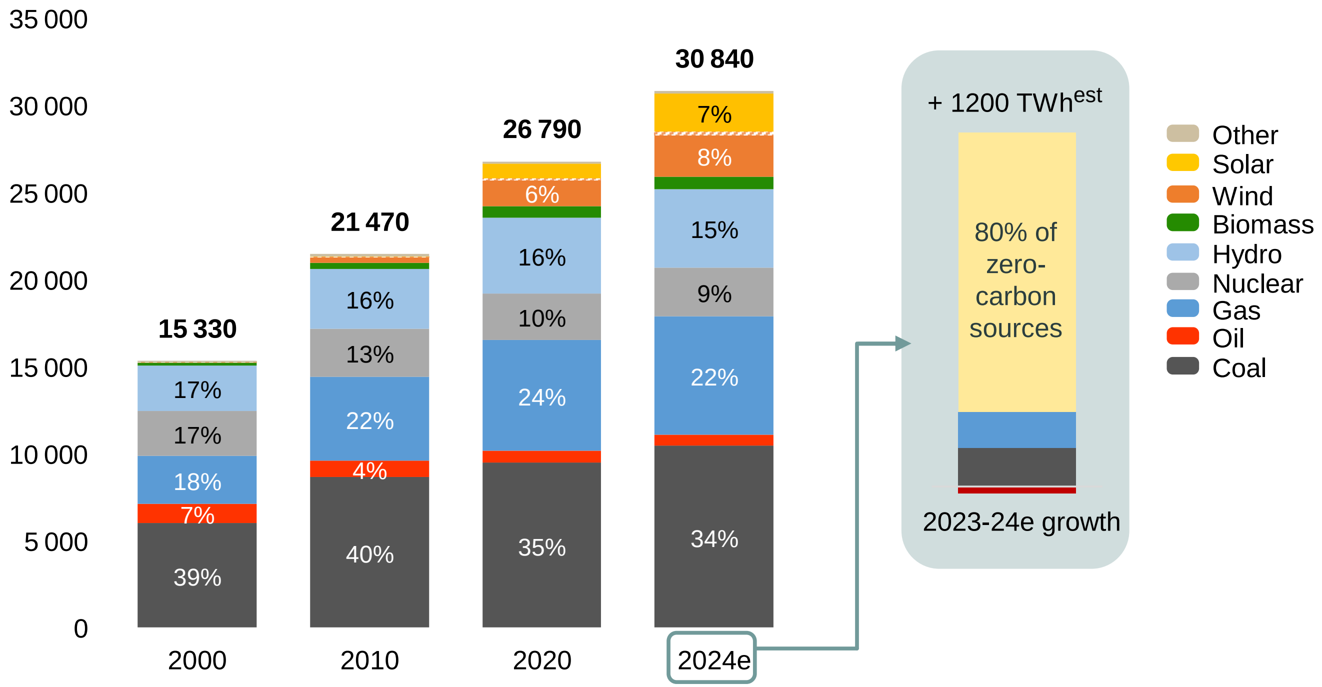
TECHNOLOGY

# Electricity generation mix

## Energy security and affordability supported by coal in emerging countries, with $CO_2$ intensity reduction driven by renewables and increased coal efficiency

### World electricity generation by fuel*

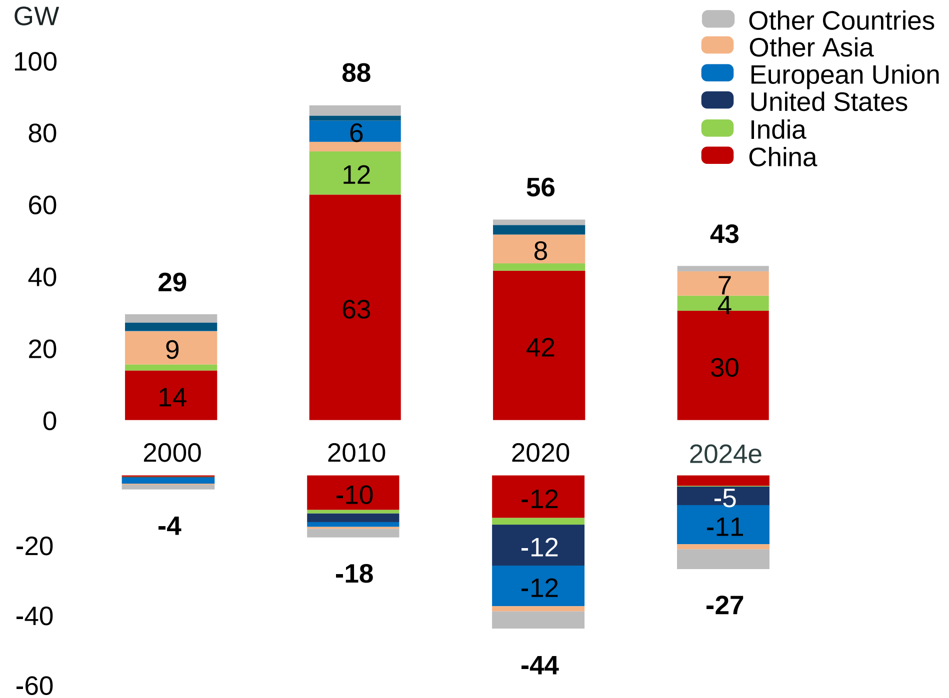
TWh




**2020-2024: Power generation emissions increase from 8.1 to 14.6 Gt $CO_2$, with carbon intensity falling from ~530 to ~470 g $CO_2$e/kWh****

### Coal-fired generation capacity annual additions and retirements***

GW




**More efficient new coal power plants: average carbon intensity from ~940 to ~900 $gCO_2$e/kWh since 2000** - Load factor from 62% to 51%**

Sources: * TTE internal analysis, Enerdata, IEA
** Ember
*** Global Energy Monitor

Part 1 Looking back
Part 2 Looking ahead

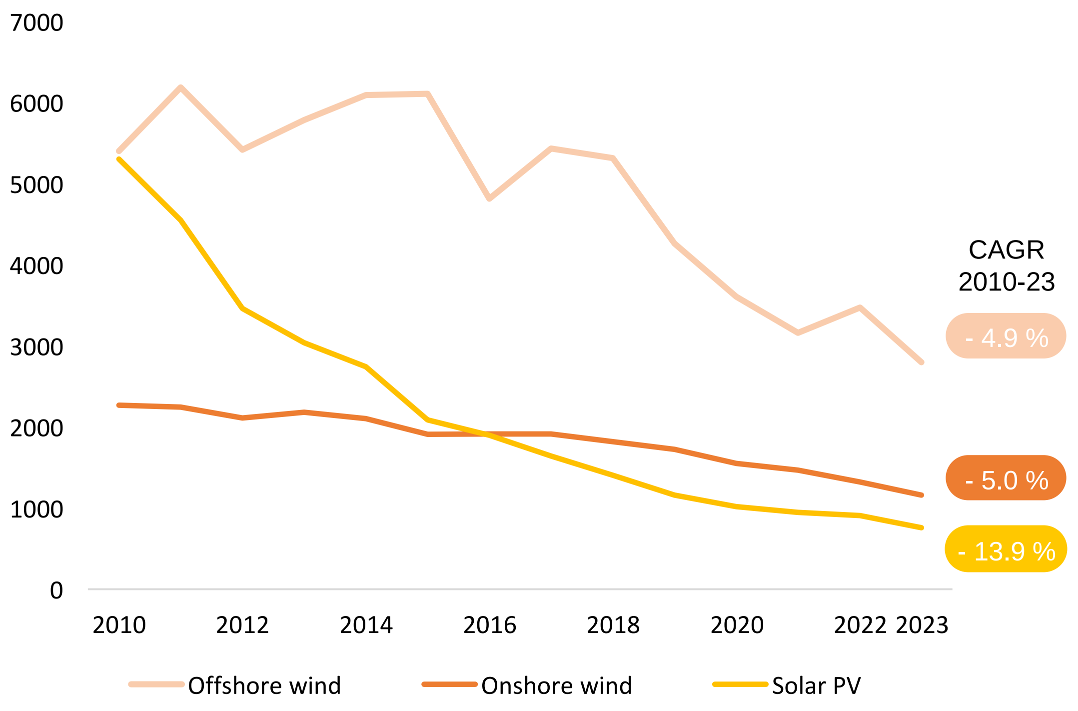
TECHNOLOGY

# Cost of producing 24/7 reliable electricity

## While costs have fallen sharply, solar PV remains more expensive than natural gas for delivering 24/7 reliable electricity

### Cost of wind and solar capacity*

$/kW (2010-2023)

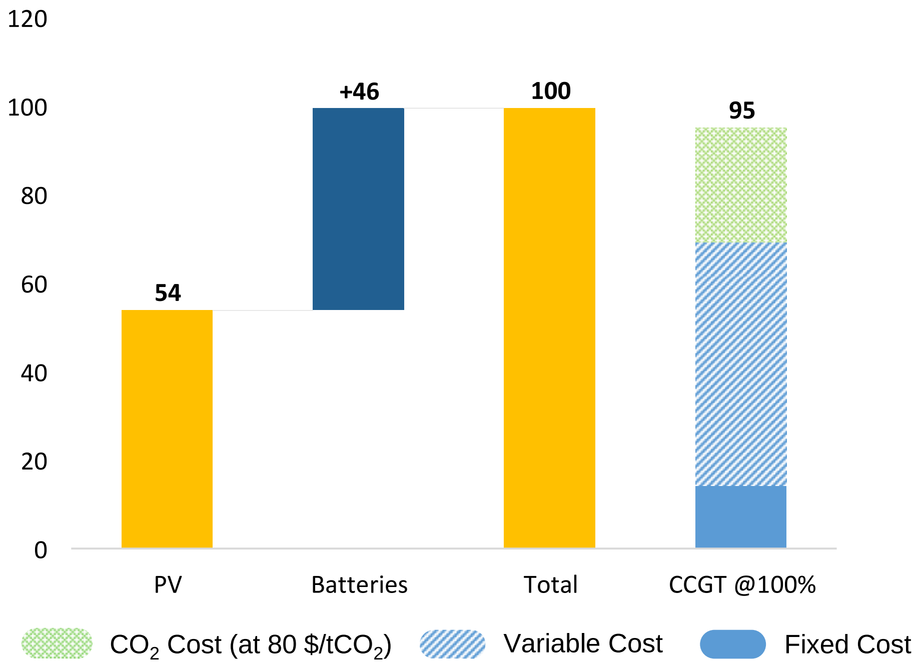



*Note: The total installed costs represent the total cost of completing a project (including project development costs, grid connection, equipment, installation, civil engineering, contingency, etc.)*

### Cost of a 24/7 reliable electricity – EU example**

PV (20%) + Batteries (80%)

$/MWh




**$CO_2$ pricing is essential for decarbonizing the electricity grid**

*Note: Cost estimates refer to newly installed capacities in EU27 countries in 2025*

*Sources: * IRENA, "Renewable Power Generation Costs in 2023"*
*** Internal calculations based on average assumptions derived from Wood Mackenzie, IHS, and BNEF*

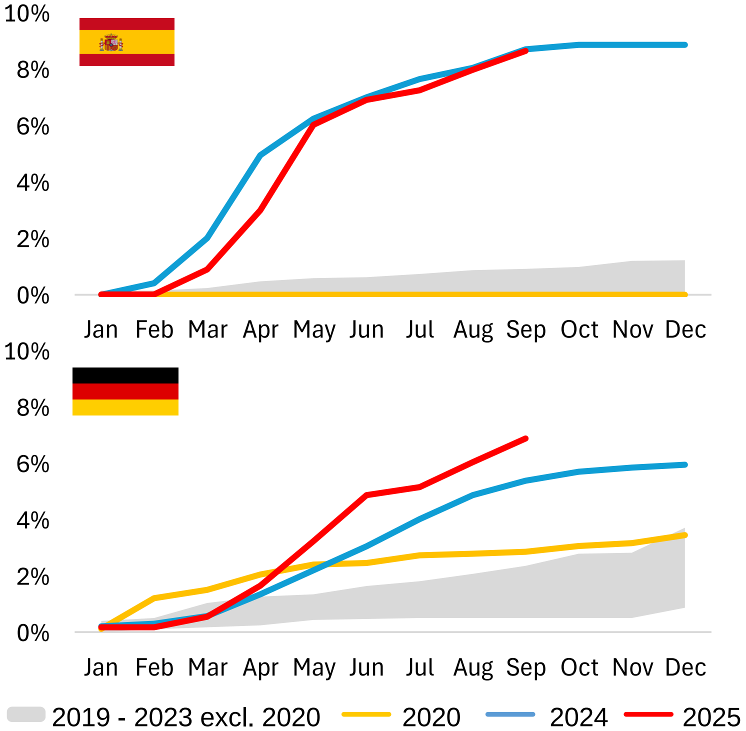
TECHNOLOGY

# System transformation required to integrate renewables

## Effective renewables deployment now limited by the absorption capacity of the electricity system

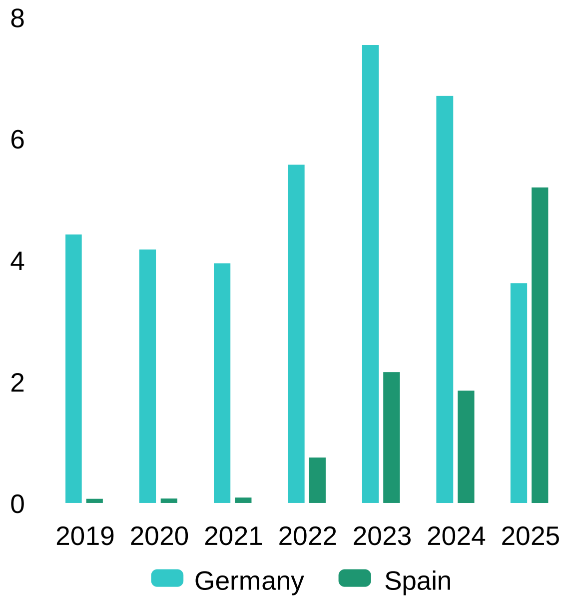
### Frequency of negative electricity prices*

Share of annual hours with negative prices



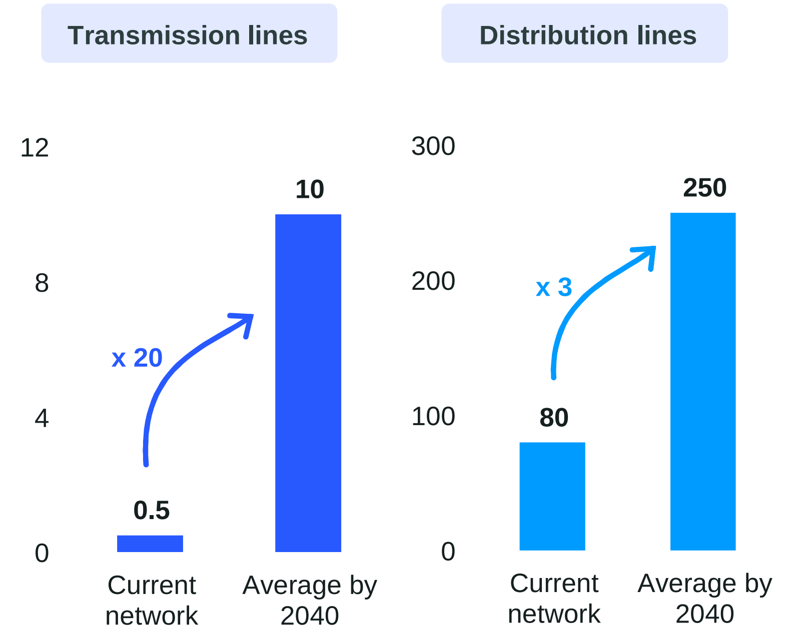

### Annual variable renewables technical curtailment**

TWh




### Annual network buildout required for Europe's energy transition***

Thousand kilometer of new lines per year




**Massive deployment of demand flexibility and storage capacities is needed**

**Expansion of transmission and distribution networks, along with transformation in planning and operation, is required**

*Sources: * ENTSO-E transparency platform, TTE internal analysis*
*** IEA, Renewables 2025 (Variable renewables refer to solar PV and wind) and TTE internal analysis*
**** Compass Lexecon for CurrENT (2024) based on ENTSO-E Distributed Energy Scenario, BNEF ETS (2025), TTE internal analysis*

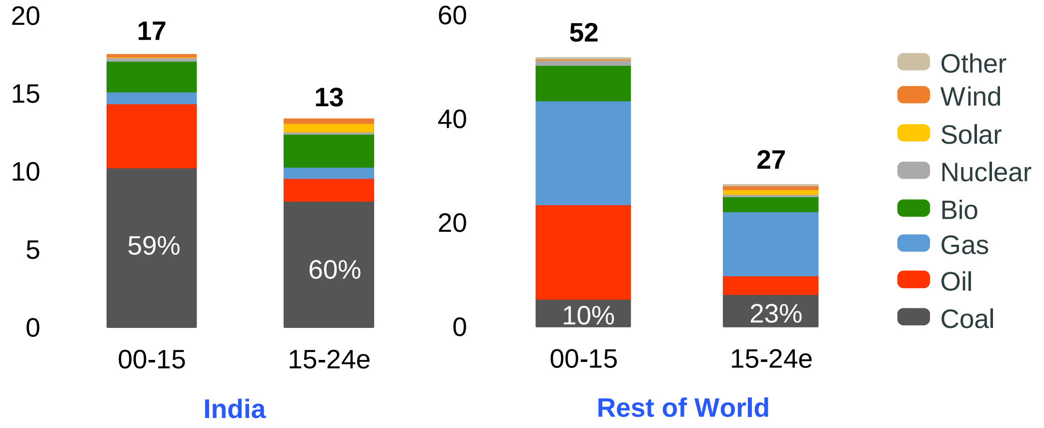
POLICIES

# Affordability and security vs. transition

## Throughout the world, priority is given to energy security and affordability

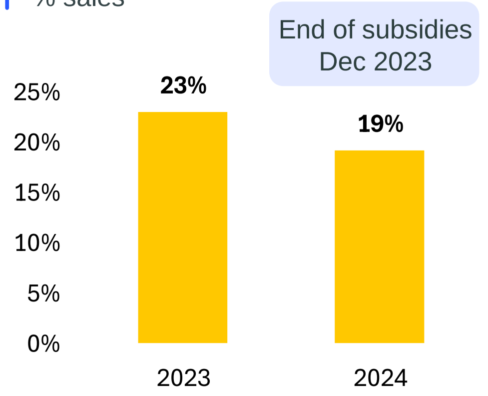
### TPED growth by fuel – India & Rest of World*

EJ



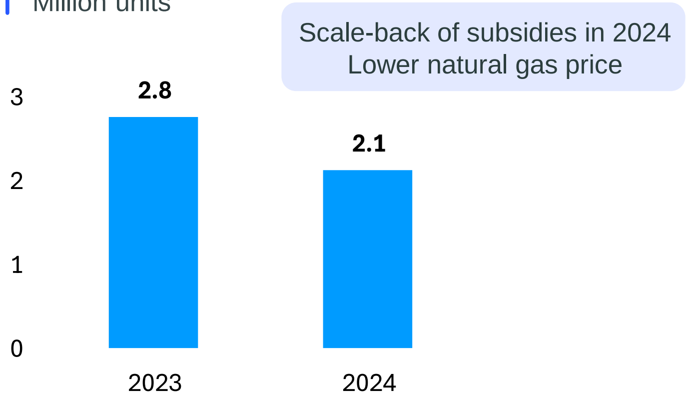

### EV sales in Germany**

% sales




### Heat pump sales in EU***

Million units




**India & Rest of World**

- **Coal use rebounded after 2016, as energy demand growth was largely met by local and affordable coal**
- **Limited Progress on North-South energy partnerships**
  - **Just Transition Energy Partnerships have been launched for South Africa ($8.5 bn) and Indonesia ($20 bn)**
  - **The $100 bn per year climate finance goal was met in 2022, 2 years behind target**

**OECD countries**

- **Limited willingness to pay a “green premium” makes subsidies the main policy tool, though their continuity is uncertain in a tight fiscal context**
- **When regulations and mandates are used instead, they often trigger political backlash**

*Sources: * Enerdata, TTE internal analysis*
*** TTE internal analysis*
**** European Heat Pump Association, considering 13 EU countries representing ~85% of EU heat pump market*

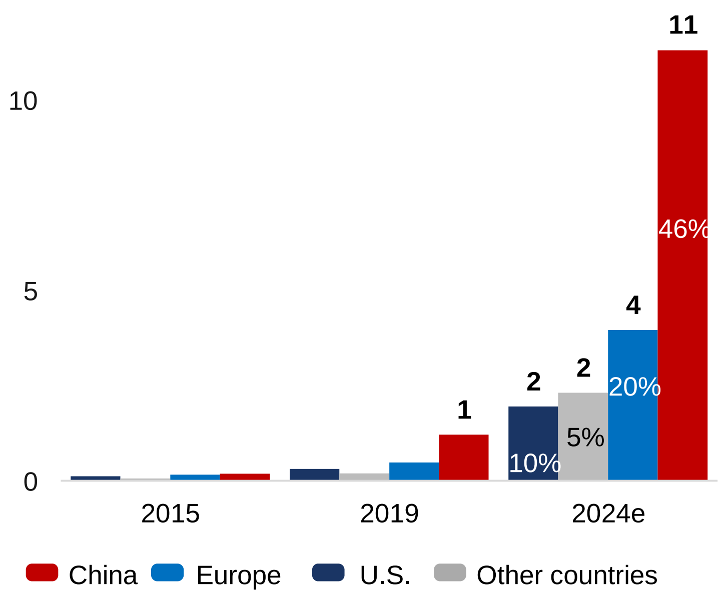
TECHNOLOGY

# Electric Vehicle penetration and performance

## Despite major technological progress and cost declines, barriers to widespread adoption remain

### Evolution of EV LVs sales*

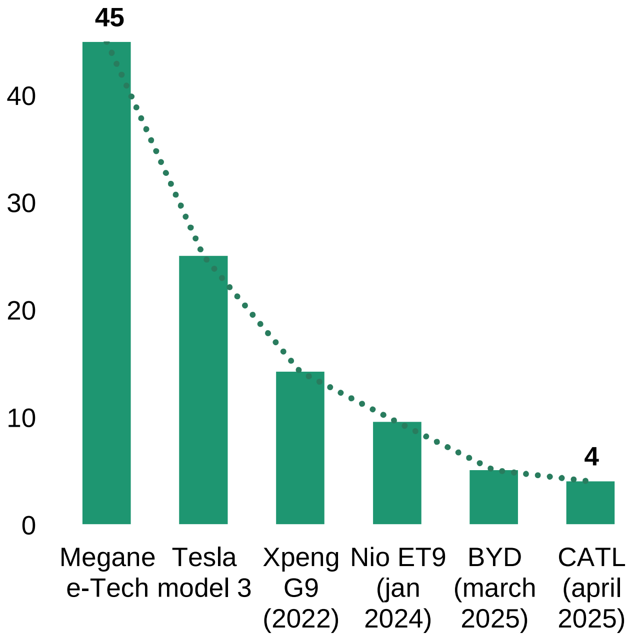
Millions, % of EVs in country LV sales




In 2024, **4% of cars in worldwide fleet** were electric

### Charging time to recover 300km of range

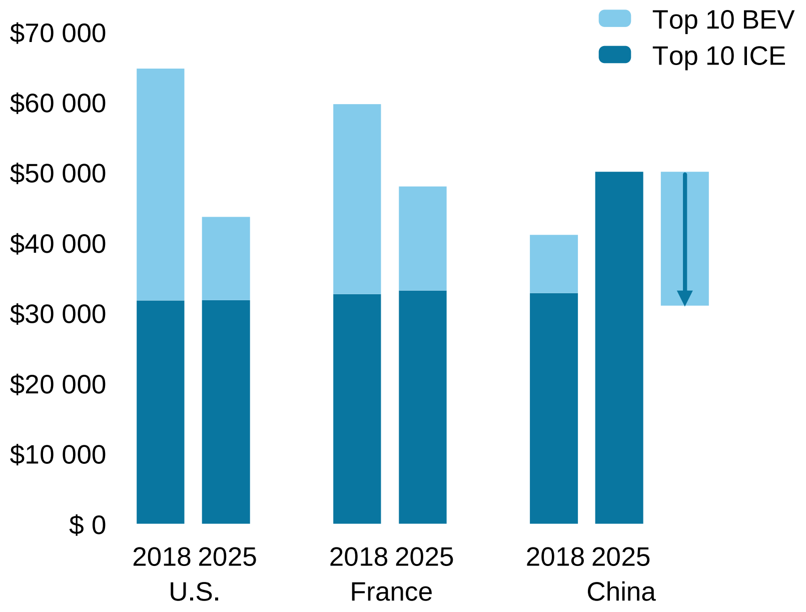
min




Widespread and affordable reduction in charging time would lift one barrier to adoption

### Average Prices for Top 10 Best-Selling BEV and ICE Models Across Regions and Years

2025$ Purchasing Power Parity (PPP)




In U.S. and France, most cars are sold on the used car market (over 70%); concerns over higher prices and battery life = key obstacles to EV adoption



** LV (Light Vehicles), EV (Electric Vehicles) = BEV (Battery Electric Vehicle) + PHEV (Plug-In Hybrid Electric Vehicle)*
*Sources: EV Volumes, Manufacturers data, TTE internal analysis*


The Yunlin offshore wind farm off Taiwan

PART 2

# Looking ahead

THREE SCENARIOS

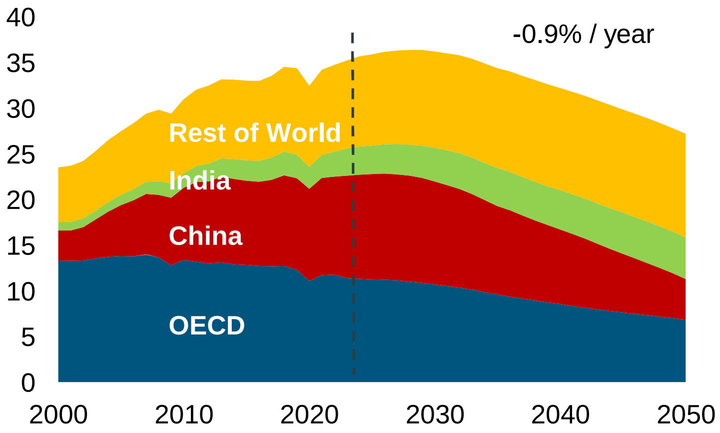
# Comparing emission pathways across the scenarios

TotalEnergies

## Trends

Emissions ($GtCO_2$*)

**Reference: assuming recent trends in policies and technologies hold**



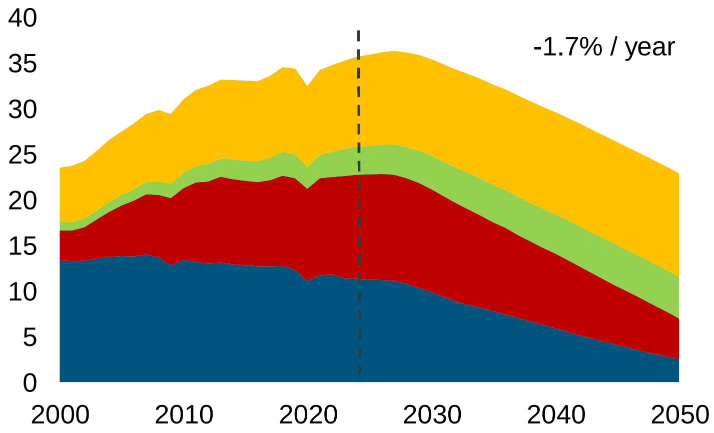

**If current trends hold, China advances toward its 2060 goal while OECD countries reduce emissions but fall short of their 2050 Net Zero targets. India and the Rest of World continue to develop with limited decarbonization**

**~ +2.6-2.8°C** by 2100**

## Momentum

Emissions ($GtCO_2$*)

**Goal-driven: OECD near Net Zero 50, China near Net Zero 60**



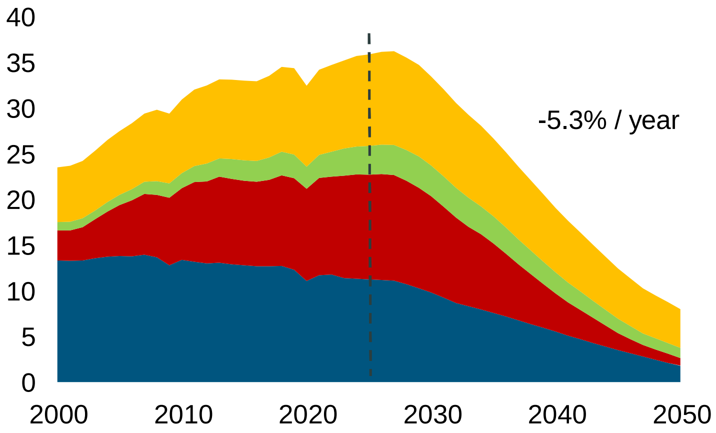

**OECD countries are closer to their 2050 Net Zero targets, and China to its 2060 goal. In India and the Rest of World, nearly half of energy demand growth is met by low-carbon sources**

**~ +2.2-2.4°C** by 2100**

## Rupture

Emissions ($GtCO_2$*)

**Goal-driven: well-below 2°C**




**Geopolitical fragmentation and tensions make this scenario out of reach as it would require a stronger international cooperation to stay well below 2°C: OECD countries and China need to support low-carbon growth in emerging economies**

**~ +1.7-1.9°C** by 2100**

Rest of World  India  China  OECD

**Our collective challenge is to accelerate global decarbonization without compromising growth in emerging and developing economies**



** $CO_2$ emissions related to energy combustion*
*** Temperature increases estimated at P66-P83, evaluation conducted by MIT*

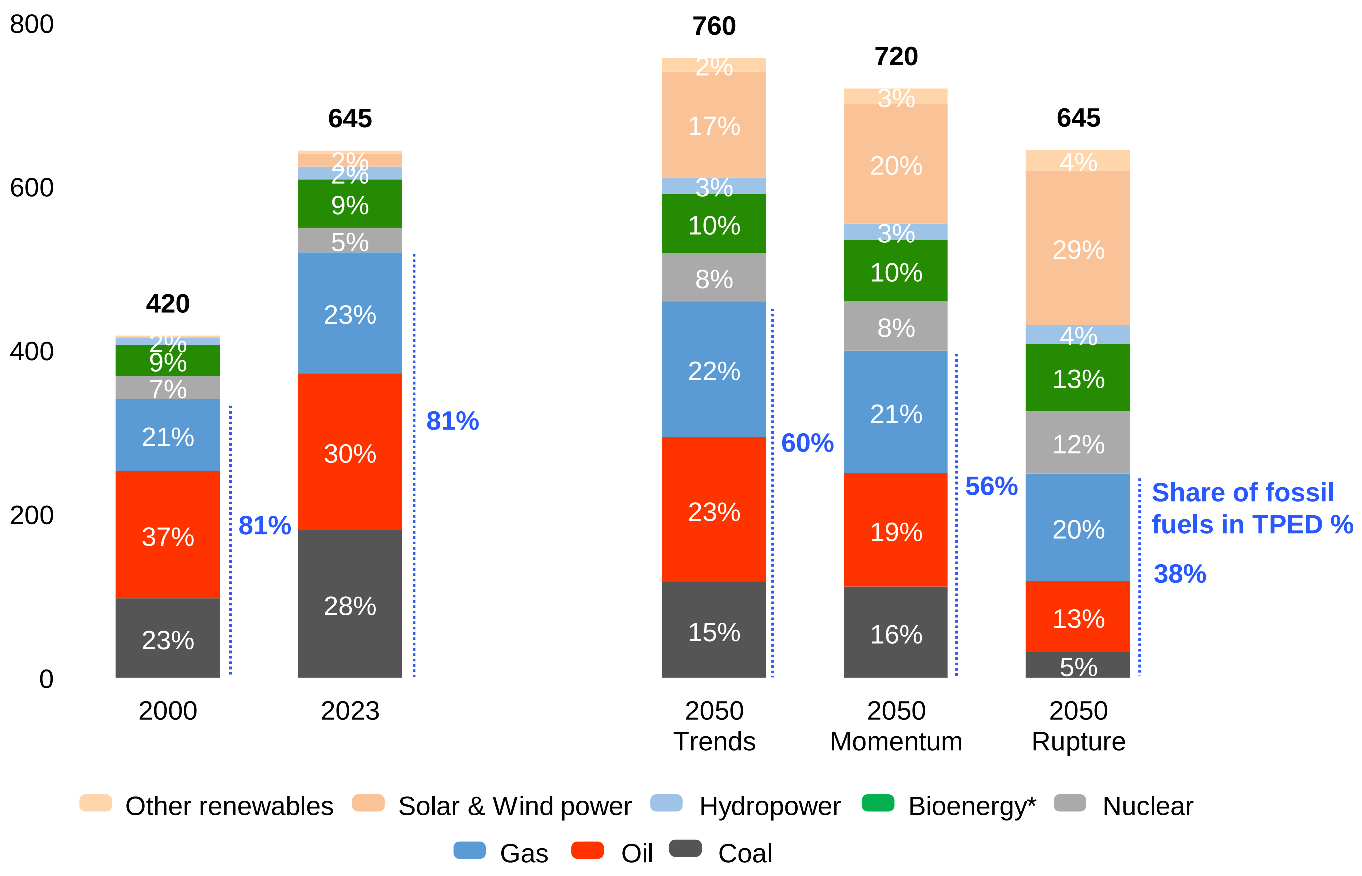
THREE SCENARIOS

# Primary Energy Demand in 2050

## From sustained transition to global transformation

### World Total Primary Energy Demand (TPED)

EJ




The *Trends* scenario assumes that Coal demand gradually declines, particularly in China's power sector. Governments policies supporting electric vehicle adoption remain in place (e.g., ICE 2035 ban in the EU).

The *Momentum* scenario assumes the 2050 targets set by the OECD countries and the 2060 targets set by China are met.

The *Rupture* scenario assumes significantly enhanced multilateral cooperation towards global decarbonization. Geopolitical fragmentation and tensions make this scenario out of reach.

Variable renewables expected to play a central role in electricity generation, which requires:

- a profound transformation of the operations of electricity systems
- massive investment in electricity grids

Gas maintains a stable share in the TPED, notably as an energy source in industry.

*Source: Enerdata, TTE internal analysis*

** Bioenergy includes biomass, waste, biofuels and biogas*

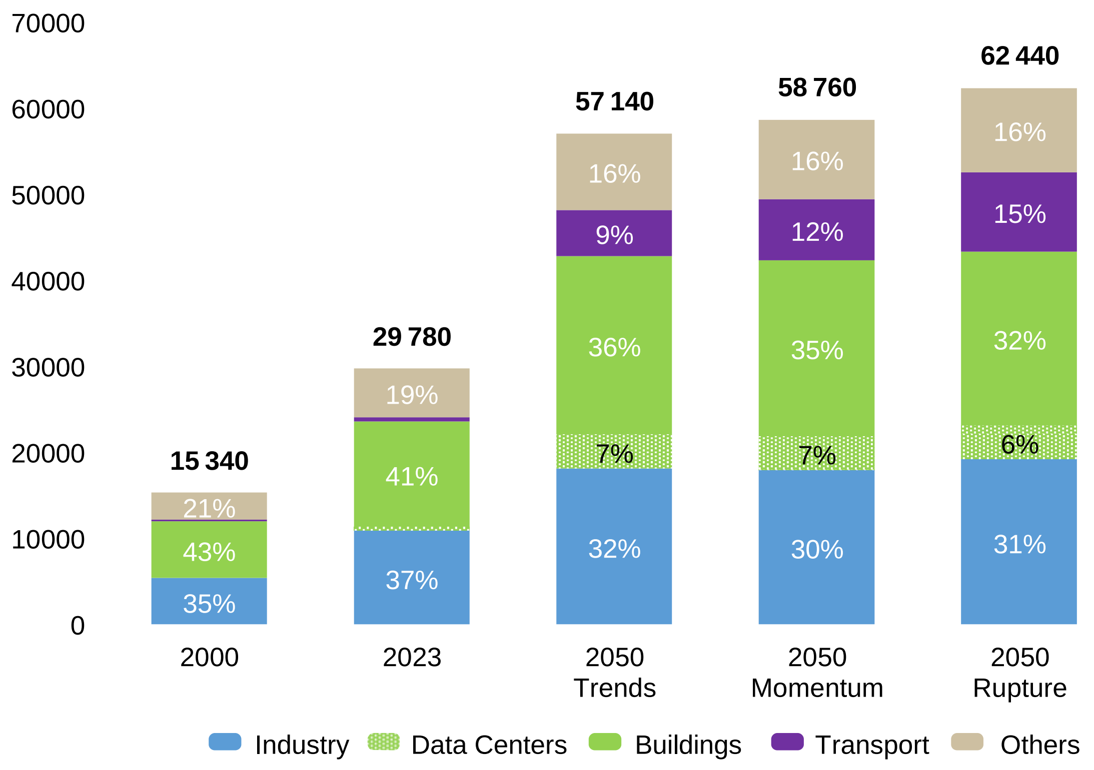
COMMON FEATURES

# Electricity demand by sectors

## In all scenarios, electricity demand increases, driven by new uses

### Electricity demand evolution by sectors

TWh, excluding $H_2$ production use




**Historically, electricity demand has been largely driven by GDP. In the future, new uses, in addition to economic growth, will further increase demand.**

**Transport : +5 000 TWh in *Trends*, mostly in China, Europe, and to a lesser extent the U.S.**

**Buildings:**
**+3 500 TWh for data centers,**
**mainly in the U.S. and China**
**+2 700 TWh for cooling,**
**mainly in India, the Middle East and Indonesia**

**In *Rupture*, electrification advances further across all sectors reaching 35% in industry compared to 29% in *Trends***

*Source: Enerdata, TTE internal analysis*

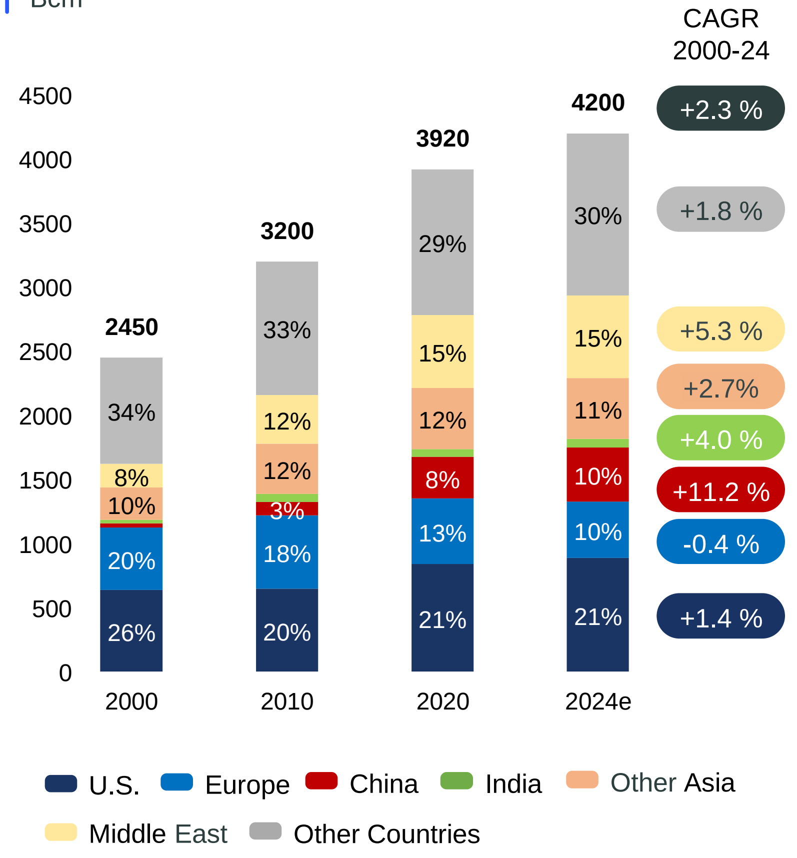
COMMON FEATURES

# Gas demand growth over the last 20 years

## Gas demand has increased across all regions and sectors, except in Europe

### Gas demand by regions

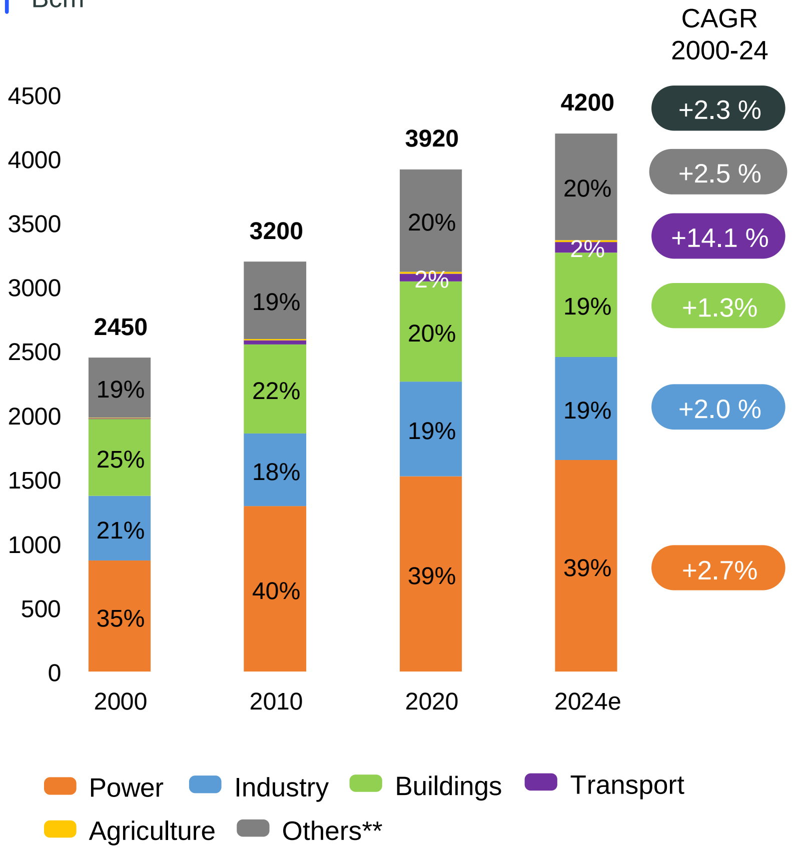
Bcm*




**Recent global gas demand growth mainly driven by China and the Middle East**

### Gas demand by sectors

Bcm*




**Recent gas demand growth led by electricity generation, in particular coal-to-gas switching in the U.S., and by industrial use**

** Bcm normalized at 36 MJ/m³*
*** Energy system uses (3/4), and non-energy uses (1/4)*
*Sources: Enerdata, TTE Trends 25*

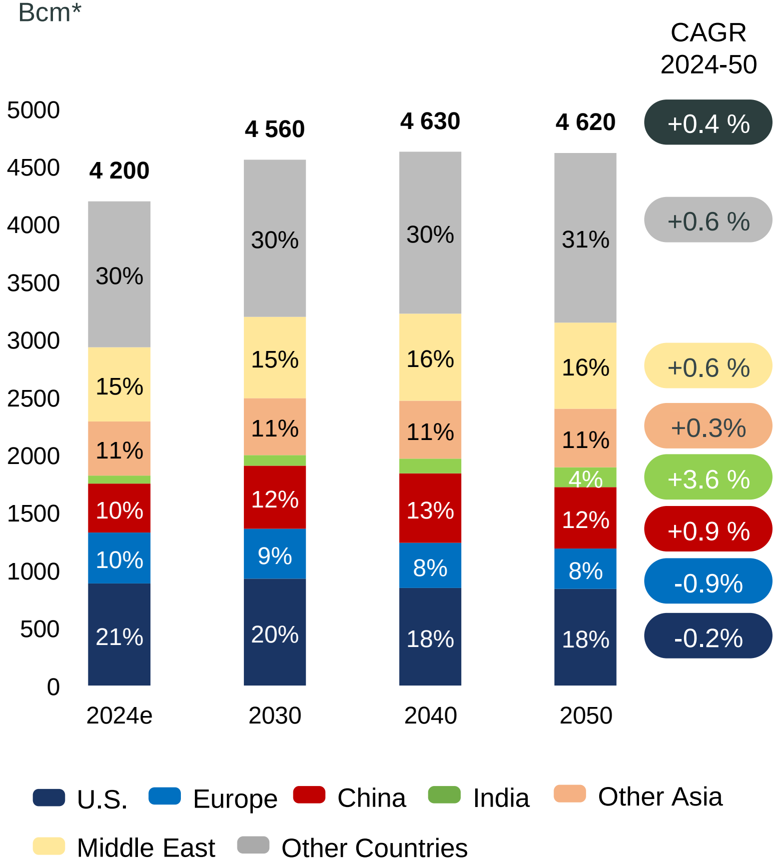
COMMON FEATURES

# Gas demand growth over the next 25 years

## Demand is expected to grow until the 2040s, then plateau

### Gas demand by regions, *Trends* scenario

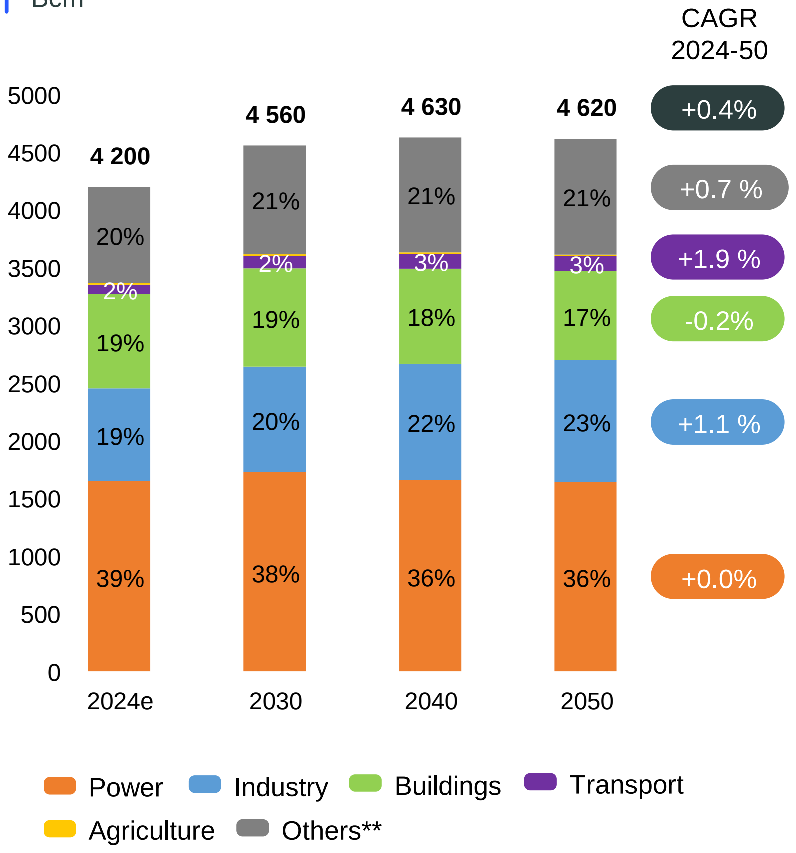
Bcm*




Expected global gas demand growth underpinned by China, India and the Rest of World, offsetting a slight decline in OECD countries

### Gas demand by sectors, *Trends* Scenario

Bcm*




Expected gas demand growth led by industry, supported by economic growth and coal-to-gas switching to reduce air pollution

* Bcm normalized at 36 MJ/$m^3$
** Energy system uses (3/4), and non-energy uses (1/4)
Sources: Enerdata, TTE Trends 25

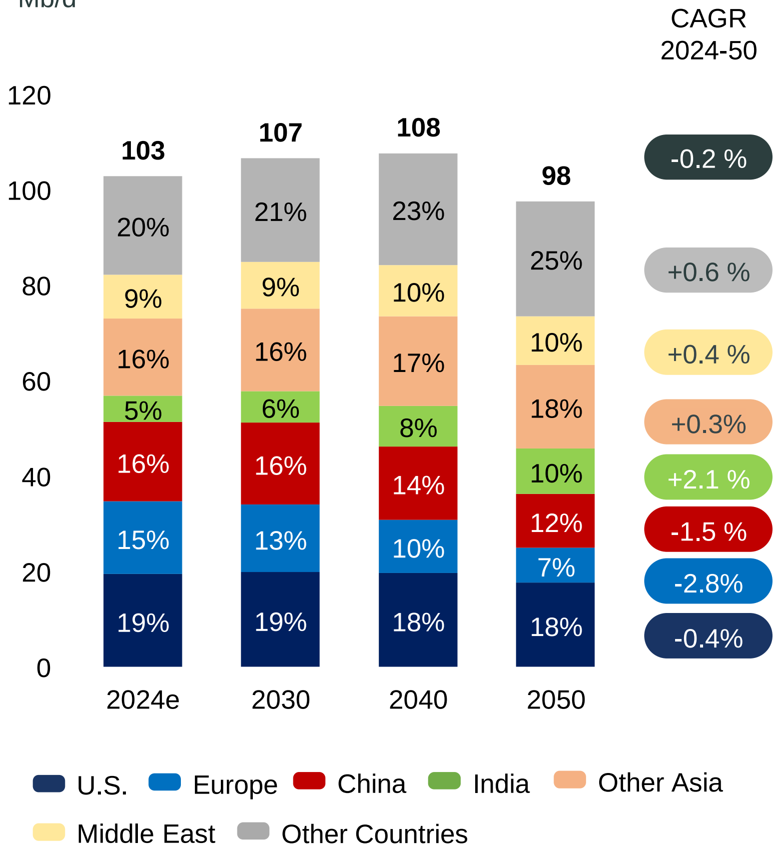
COMMON FEATURES

# Oil products demand growth over the next 25 years

## Demand is expected to remain stable until 2040, then slowly decline

### Oil products* demand by regions, *Trends* scenario

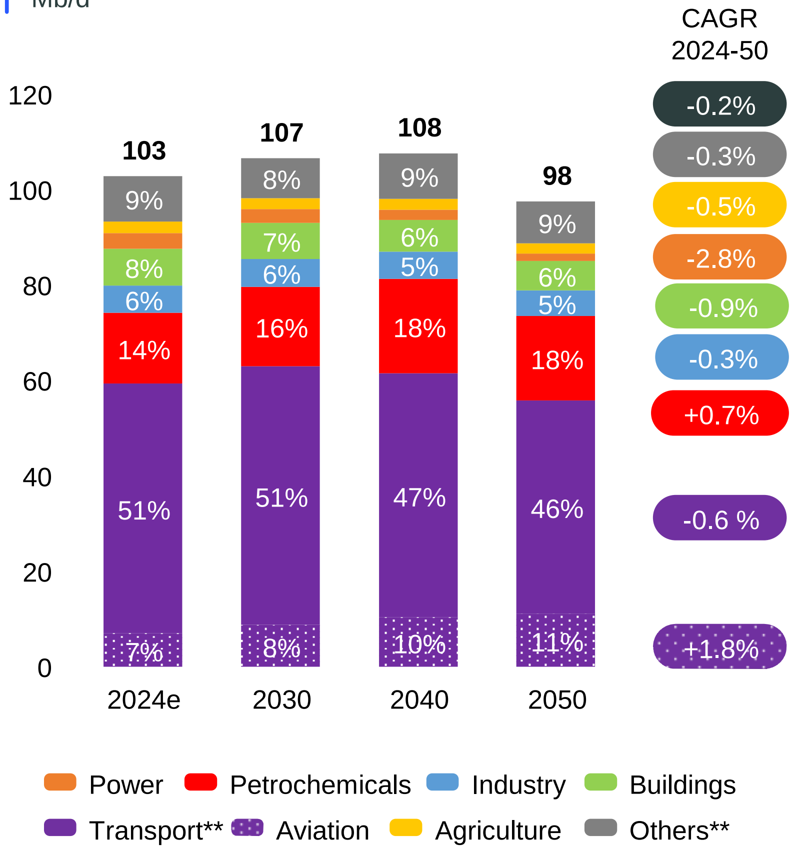
Mb/d




**India is the primary growth driver of global demand, along with the Middle East and Other Asia, offsetting decline in Europe and China**

### Oil products* demand by sectors, *Trends* scenario

Mb/d




**Demand from aviation and petrochemicals grows over the period. Post-2040, EV penetration leads to a slow decline**

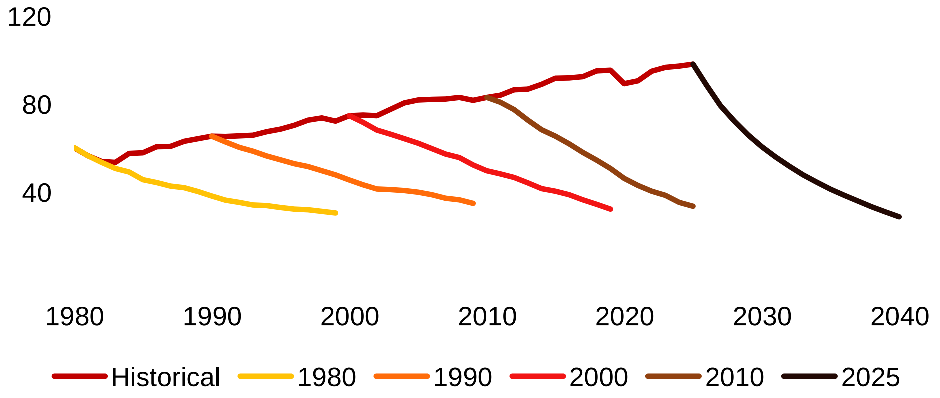
* Oil products include all refined products and biofuels
** Transport : Aviation excluded; Others: Non-energy uses (2/3), and energy system uses (1/3)
Sources: Enerdata, TTE Trends 25

COMMON FEATURES

# Oil & Gas fields natural decline - an update from the IEA

## IEA analysis shows new field developments are needed across all scenarios

### Oil production with no investment from given year
Mb/d

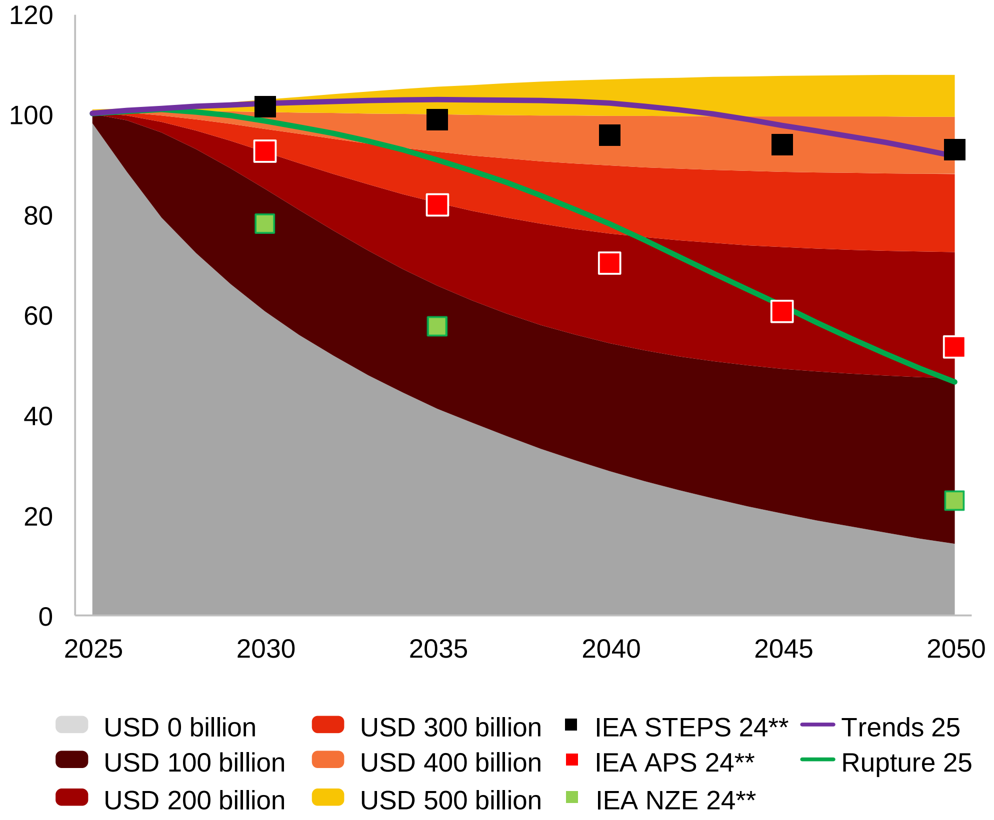



**IEA***

**"Natural decline rates are becoming steeper" (…) reflecting "the higher reliance today on unconventional sources and changes in the mix of conventional production" (more deep offshore fields)**

**"Nearly 90% of annual upstream oil and gas investment since 2019 has been dedicated to offsetting production declines rather than to meet demand growth."**

### Oil production under varying average annual upstream Investment levels and demand benchmarks
Mb/d




**"The oil and gas industry needs to run fast just to stand still"**
***– IEA****

*Source: * IEA, "The Implications of Oil and Gas Field Decline Rates" (2025)*
*** IEA, World Energy Outlook 2024, Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS), Net Zero Emissions by 2050 Scenario (NZE)*

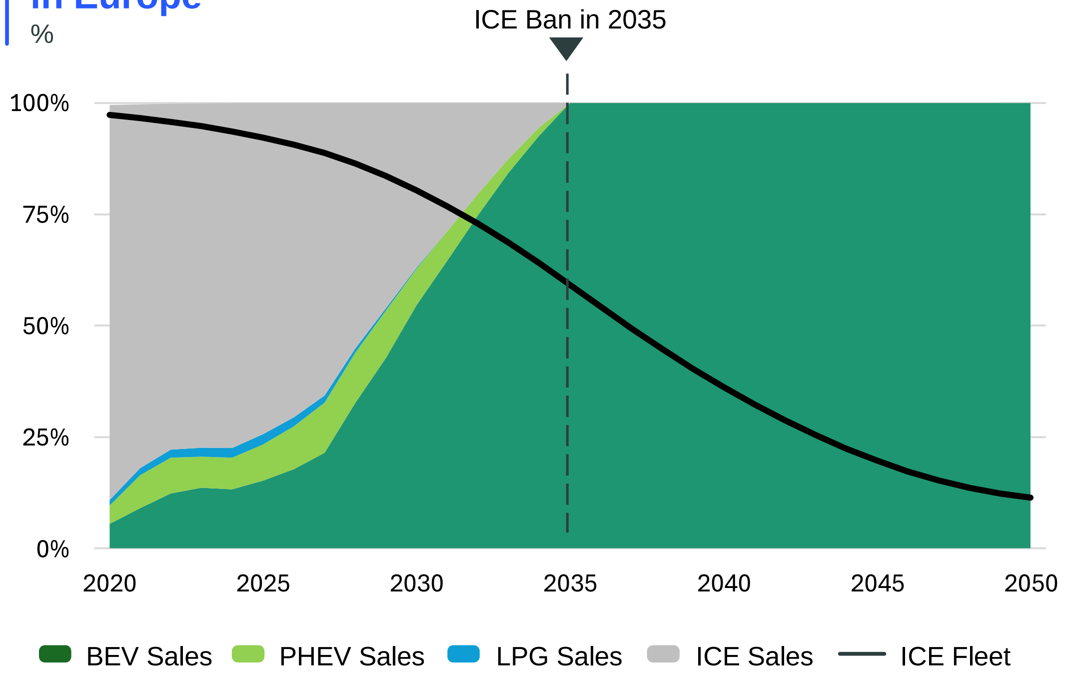
COMMON FEATURES

# Energy systems inertia

## Transforming energy systems takes decades

### Light Vehicles fleet and sales share evolution by technology in Europe*

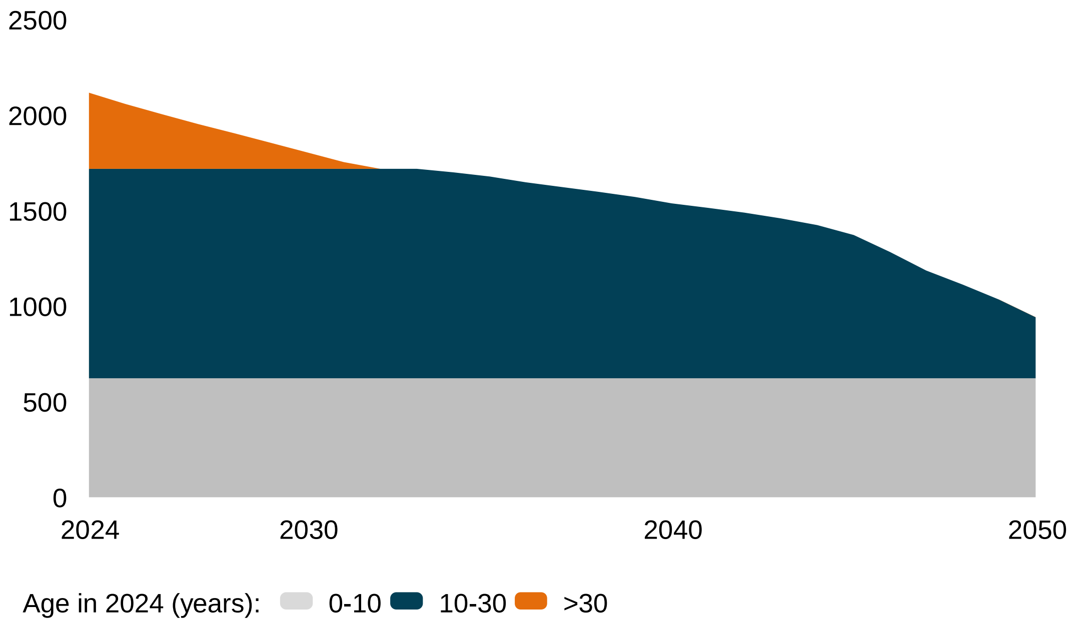
%




**Around 20 years**
**are needed to fully renew the vehicle fleet after a complete transition to BEV sales**

### Capacity evolution of existing coal power plants**

GW




**As coal-fired plants operate for 40 years on average, even with a ban on new coal plants from 2025, more than a third of existing capacity would still be in operation by 2050**

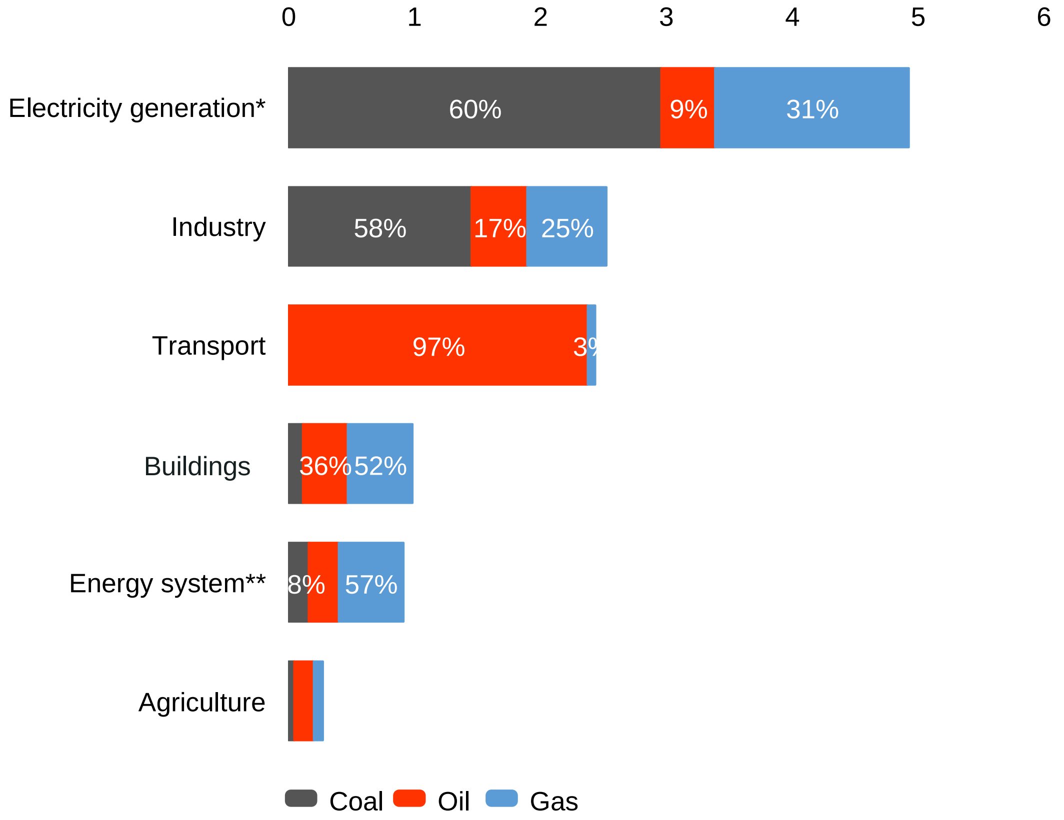
** BEV: Battery Electric Vehicle, PHEV: Plug-In Hybrid Electric Vehicle, LPG: Liquified Petroleum Gas Vehicle, ICE: Internal Combustion Engine,*
*** Source: Global Data, Energy Intelligence*

# Decarbonization beyond *Trends* in India & Rest of World

## Low-hanging fruits decarbonization opportunities are available

### Energy-related $CO_2$ emissions in 2023, in India and Rest of World

$GtCO_2$




**Coal-to-renewables and gas switching in existing electricity generation capacity could cut emissions by up to 2.4 $GtCO_2$ per year at a cost below \$60 per ton of $CO_2$ abated. Developing a reliable coal-free electricity system to support growth could avoid another ~2 $GtCO_2$ by 2050, at a similar cost**

**Electrifying 2- and 3-wheeler fleets could reduce emissions by around 180 $MtCO_2$ per year at a cost of ~\$50 per ton of $CO_2$ abated**

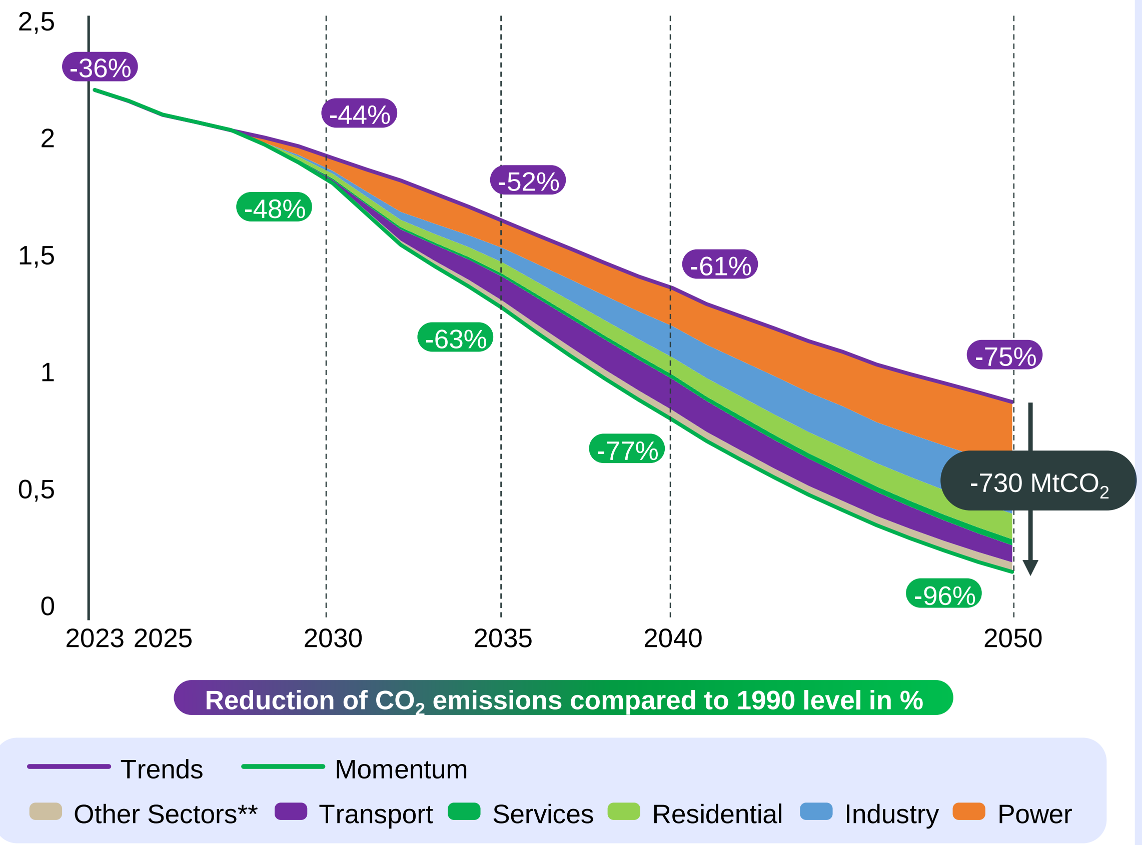
** Includes heat combined with power*
*** Includes energy sector own use, transport losses and energy transformation*
*Sources: IEA, Enerdata, UNEP, CITEPA, EDGAR, TTE internal analysis*

# From *Trends* to *Momentum* in Europe - gap analysis

TotalEnergies

## $CO_2$ Emissions* reduction between *Trends* and *Momentum* scenario in EU27

$GtCO_2$




**"Over 2011-2020 an average of €764 billion was invested in the EU each year to reduce GHG emissions (…). To reach the 2030 target, the Commission estimates that an additional €477 billion of green investment will be needed each year (…). In sum, total green investment of around €1.2 trillion each year, equivalent to 8.3% of 2023 GDP, is needed. "**

*Source: ECB "Green investment needs in the EU and their funding", 2025*

**39%**

**Coal phase-out:** Complete exit from coal before 2035 in *Momentum* vs. ~150 TWh remaining in 2050 in *Trends*

**CCS:** +50 $MtCO_2$ captured in *Momentum* vs. *Trends* from the power sector

**27%**

**Industry:** Higher electrification displacing coal and gas

**CCS:** +30 $MtCO_2$ additional capture from industry in *Momentum* vs. *Trends*

**19%**

**Buildings:** Greater electrification through heat pump deployment and improved energy efficiency, particularly better insulation

**10%**

**Transport:** Road transport leads decarbonization, driven by higher BEV penetration. Greater incorporation of SAF in aviation***



** $CO_2$ emissions related to energy combustion, excluding emissions from international trade*
*** Includes agriculture, transformations and losses of energy*
**** BEV: Battery Electric Vehicle, SAF: Sustainable Aviation Fuels*

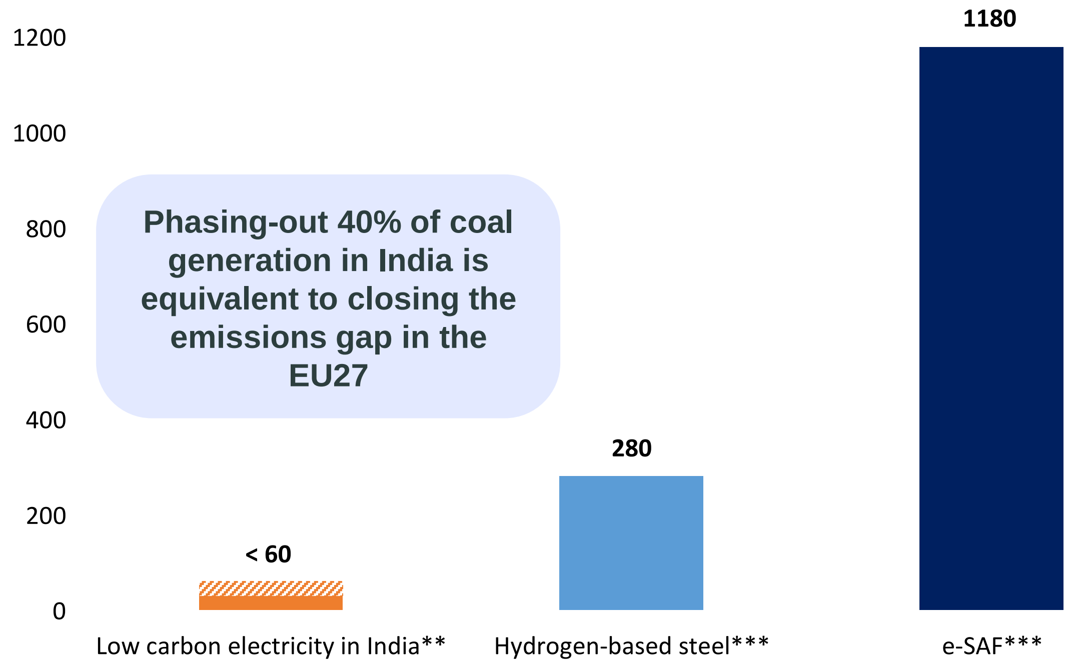
GOING BEYOND TRENDS

# Conclusion: a mindset change is required

## Capture the great carbon arbitrage*

### Abatement Costs

$/t$CO_2$




**Climate policy should focus on emissions, not energy sources**

**Prioritize the most efficient emission reduction actions** today, and direct limited funding toward where it delivers the greatest impact:

- Expansion of offset mechanisms: **Article 6 of the Paris agreement**
- The EU should authorize at least 20% offset (hence closing its emission gap), channeling finance to cost-effective decarbonization projects abroad

** The Great Carbon Arbitrage, Kleinnijenhuis A., Adrian T., and P. Bolton, INET Oxford University, 2022*
*** Incremental power system cost from Trends to Rupture in India in 2030, including electricity demand due to faster electrification of usages and coal-to-gas and renewables switching*
**** Source: Gollier, C. (2025). L'économie de l'(in)action climatique. PUF.*

La Perriere Multi-energy Park in Sainte-Suzanne – Reunion Island

# APPENDIX

THREE SCENARIOS

# From *Trends* to *Momentum* and *Rupture* – in 2050

## All decarbonization levers would have to be pushed further to remain well-below 2°C

| | Trends | Momentum | Rupture |
|---|---|---|---|
| **Strong electrification of end-use** | ~33% of final demand | ~36% | ~43% |
| **Deep decarbonization of electricity grid** | 30 740 TWh* (~54% of power generation) | 33 100 TWh* (~56%) | 40 500 TWh* (~65%) |
| **Energy efficiency acceleration**** | +1.9%/yr 2023-50 | +2.1%/yr | +2.5%/yr |
| **Sustainable mobility** | ~44% Zero Emission Vehicles in light vehicles fleet | ~55% | ~73% |
| | Sustainable aviation fuels (SAF) @ ~8% of demand | SAF @ ~24% | SAF @ ~54% (~41% biofuels,~13% e-Fuels) |
| **Gas going greener** | ~10% green gases*** in gas supply | ~14% | ~23% |
| **Increasing plastics' circularity** | ~18% of gross demand coming from recycled materials | ~30% | ~40% |
| **CCS to abate remaining emissions** | ~1.6 Gt (~6% $CO_2$ emissions) | ~2.8 Gt (~11%) | ~5.4 Gt (~40%) |
| **Support to India and Rest of World** | ~30% of non-fossil sources in primary energy demand (vs. ~44% in OECD countries) | ~30% (vs. ~64% in OECD countries) | ~54% (vs. ~64% in OECD countries) |

** Solar & wind – excluding renewable electricity generation for green $H_2$*
*** Energy efficiency is defined here as the decrease in primary energy required to produce 1$ of GDP*
**** Green gases include biogas and $H_2$, excluding $H_2$ share for liquid e-fuels production*

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