We are *not on track* **to meet the Paris Agreement's objectives.** What should we do?

World Energy Markets
Observatory 2024 | 26th Edition

Capgemini

IN COLLABORATION WITH

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Energy in the Regions

Regions

Europe
North America
Middle East
Africa
South East Asia

Countries

Germany
UK
France
Italy
Netherlands
Switzerland
Poland
Turkey
Spain
Sweden
Belgium
Norway

China
India
Japan
South Korea
Indonesia
Australia
Saudi Arabia
USA
Canada
Mexico

Europe

Region: European Union in 2023 (EU27 states)

449 Million

POPULATION

$25.5 Trillion

GDP

Energy

2023 total energy consumption: **1651 Mtoe**

Primary energy consumption declined for the 2nd year in a row in EU: -4.2%

Natural gas

Total gas production: **204.3 bcm**

Total gas consumption: **463.4 bcm**

Environment

European Union (EU) saw a decrease in carbon dioxide (CO_2) emissions from energy, which was about 2.5 billion metric tons in 2023.

In Q4 2023, EU economy greenhouse gas emissions were estimated at 897 million tonnes of CO_2-equivalents (CO_2-eq), a 4.0% decrease compared with the same quarter of 2022 (935 million tonnes of CO_2-eq).

Renewable energy

EU Total Electricity production in 2023: 3805 TWh

Share of wind in electricity generation: **16%**

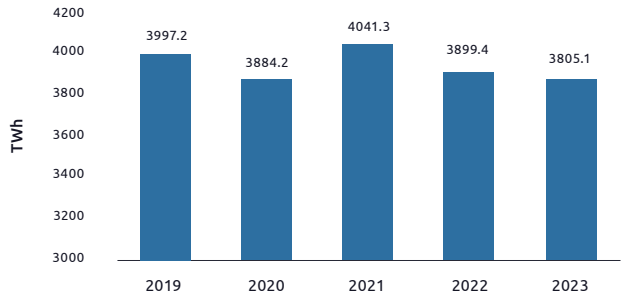
Share of solar in electricity generation: **8%**

Share of hydro in electricity generation: **17%**

2023 added Wind capacity: **15.3 GW**

2023 added Solar capacity: **54.7 GW**

Electricity production



Network

- In 2023, Europe's investment in power grids reached € 55 Bn, with a greater share of spend on digitalization and upgrading high-voltage transmission networks.
- On 28 November 2023, the EU Commission launched a Grid Action Plan, to modernise Europe's electricity grid and prepare for the renewables-based electrification of the energy system.
- The Commission estimates that €584 Bn in investments are necessary for the electricity grids in this decade

Electric vehicles (EVs)

- According to IEA, new electric car registrations reached nearly 3.2 million in Europe, in 2023, increasing by almost 20% relative to 2022, but slowing down in some countries in 2024.
- There has been an increase in the sales share of European countries, led by Norway at 95%, Sweden at 60%, the Netherlands at 30%, France at 25%. While the sales share for electric cars fell from 30% in 2022 to 25% in 2023.
- Europe is one of the biggest markets after China, where the electric light commercial vehicles (LCV) market leapt by 60% to reach almost 150,000.
- In Europe, electric truck sales increased almost threefold in 2023 to reach more than 10,000 (>1.5% sales share).

Energy players

Power: Centrica, CEZ, E.ON, EDF, EDP, Enel, ENBW, ENGIE, Fortum, Iberdrola, Naturgy, Ørsted, RWE, SSE, Uniper, Vattenfall

Oil and gas: BP, Eni, Equinor, Repsol, Shell, TotalEnergies

Regional highlights

- In 2023, wind & solar combined accounted for 24% of all electricity production in EU; the investment in renewables generation totalled about €110 Bn, an increase of more than 6% from the previous year.
- In February 2024, the European Investment Bank (EIB) approved €1.6 Bn for new energy investment to scale up renewable energy generation and strengthening electricity distribution networks to enable increased use of renewable energy.
- Electricity generated from Nuclear energy produced 735.9 TWh and accounted for 19.3% of the EU electricity generation in 2023.
- European Commission adopted the net zero Industry Act in June 2024, to bolster the manufacturing of clean technologies, with the objective of meeting 40% of the EU's deployment needs by 2030 and reducing today's reliance on imports.
- EU's gas imports from Russia decreased from 45% in 2021 to 18% in June 2024. In the first quarter of 2024, EU imported most of its petroleum oils from the USA, Norway, and Kazakhstan, and most of its natural gas from Norway and Algeria.

North America

Region: North America

513.4 Million
POPULATION

$33.1 Trillion
GDP

Electricity Consumption

2022: 4,661 TWh

2023: 4,623 TWh

Natural Gas

Total gas production: 1261.1 bcm

Total gas consumption: 1104.8 bcm

Environment

Total CO_2 equivalent emissions from energy, process emissions, methane, and flaring: 6289.3 million tons of CO_2 equivalent

2023 Energy-related CO_2 emissions: 5649.1 Mn tons of CO_2 equivalent compared to 5792.4 Mn tons in 2022 (2.5% decline)

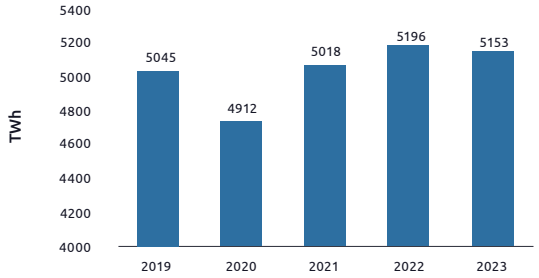
Electricity Generation

Total Electricity generation in 2023: **5153 TWh**

USA's Renewables Share of Electricity generation: **21.7% (973.6 TWh)**

Canada' s Renewables Share of Electricity generation: **66.5% (421.2 TWh)**

Electricity production (North America)



Network

- In October 2023, Biden Administration announced $3.46 Bn for 58 projects to strengthen grid reliability and resilience across 44 states, sparking a combined public-private investment of $8 billion, and bringing more than 35 gigawatts of new renewable energy.
- In October 2023, as part of the President's Investing in America agenda, the U.S. Department of Energy announced up to a $1.3 billion commitment in three transmission lines crossing six states
- In March 2024, Government of Canada announced a $16.7 Mn federal investment for a project by Ontario's power grid operator that will strengthen its electricity grid operations.
- $494 Mn investment in Mexico's distribution networks in 2024 expected, which includes smart grid projects like remote operation and automation in networks, scaling of the measurement to advanced meter infrastructure, management of the energy balance for the electricity market

Electric vehicles (EVs)

- North America experienced an almost threefold increase in the number of electric heavy-duty vehicle OEMs between 2020 and 2023, from 16 to 45
- At the end of 2023, North America accounted for 20% of fuel cell electric vehicles (FCEVs) worldwide.
- In April 2024, Honda Motor Co., Ltd announced that it plans to build a comprehensive EV value chain in Canada with an approximate investment of CAD$15 billion to strengthen its EV supply system and capability to prepare for a future increase in EV demand in North America.
- Between August 2022 and March 2023, major EV and battery makers announced cumulative post-IRA investments of at least $52 billion in North American EV supply chains.

Major energy players

United States: NRG Energy, Duke Energy, Southern Company, Pacific Gas & Electric, NextEra Energy, American Electric Power, Exelon, Edison International, Consolidated Edison, Sempra Energy, FirstEnergy, AES

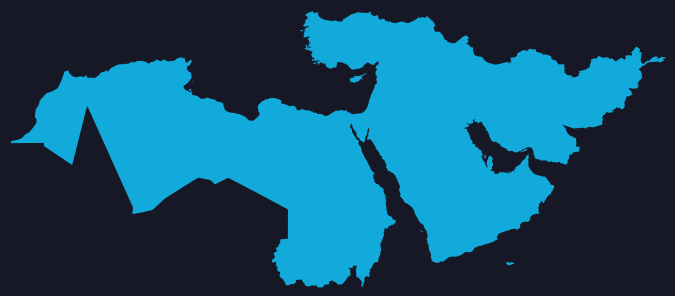
Canada: Hydro-Québec, BC Hydro, Hydro One, Ontario Power Generation, ENMAX, TransAlta.

Mexico: PEMEX, CFE (Commission Federal de Electricidad), Iberdola Mexico, Sempra Infrastructure, Naturgy Mexico, AES Mexico, TC Energy Mexico

Region highlights

- In North America, green hydrogen is projected to drive most of the growth in the short and long term, spurred by recent government support, while electrified transport is projected to account for around 30 percent of demand growth to 2030.
- In the United States, investment in clean energy increases to an estimated more than $300 billion in 2024, 1.6 times the 2020 level and well ahead of the amount invested in fossil fuels.

Middle East



Region: Middle East - (Iran, Iraq, Israel, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Other Middle East)

258 Million
POPULATION

$3.4 Trillion
GDP

Electricity Generation

Total electricity generation (2023): 1463.4 TWh

- Iran: 382.9 TWh
- Iraq: 139.4 TWh
- Israel: 77.2 TWh
- Kuwait: 88.3 TWh
- Oman: 44.3 TWh
- Qatar: 54.4 TWh
- Saudi Arabia: 422.9 TWh
- United Arab Emirates: 165.0 TWh
- Other Middle East: 89.1 TWh

Renewable energy

Renewables generation in Middle East: 41.3 Twh

(Israel- 8.1 Twh, United Arab Emirates-13.8 Twh, Saudi Arabia-5.8Twh, Iran- 2.1 Twh, Oman- 1.6Twh)

Energy-related CO_2 emissions (2023): 2258.3 Mn tons CO_2 (2.3% increase) compared to 2207.4 Mn tons in 2022

- Iran: 683.6 million tons CO_2
- Iraq: 168.2 million tons CO_2
- Israel: 65.5 million tons CO_2
- Kuwait: 93.9 million tons CO_2
- Oman: 85.1 million tons CO_2
- Qatar: 132.5 million tons CO_2
- Saudi Arabia: 620.4 million tons CO_2
- United Arab Emirates: 287.2 million tons CO_2
- Other Middle East: 121.8 million tons CO_2

Electric Vehicles and charging

- Israel: EV car sales of 65,000 in 2023, with 4200 charging points which are publicly available slow and 710 which are publicly available slow
- Qatar: Qatar General Electricity and Water Corporation aims to set up 600 to 1,000 electric vehicle charging stations by 2025 and 2030
- Saudi Arabia: EV sales in Saudi Arabia reached 1,500 in 2023
- UAE: Nearly 35,000 electric vehicles were sold in UAE in 2023, with 261 charging stations

Major Energy players

- Iran: National Iranian Oil Company, Pars Oil and Gas Company, Isfahan Refinery
- Qatar: QatarEnergy, Qatar General Electricity and Water, Qatargas
- Saudi Arabia: Saudi Aramco, MARAFIQ Power And Water Utility Company for Jubail And Yanbu, ACWA Power Co, Saudi Electricity Company
- UAE: ADNOC, TAQA, Dubai Electricity and Water Authority

Recent Developments

- **Iran:** The Iranian government has unveiled a plan to develop 15 GW of solar PV capacity, which is expected to require a private sector investment of US$8.3 billion, in three phases
- **Iraq:** In August 2024, The Ministry of Electricity of Iraq and Siemens have reached an agreement on the development of five 1.5 GW combined-cycle gas turbine (CCGT power projects in Iraq, with a combined capacity of 7.5 GW.
- **Israel:** The country's Ministry for Energy and Infrastructure has stated that for the first time in history, most electricity in Israel was produced from renewable sources with renewable energy accounting for 51% of total production in March 2024.
- **Kuwait:** Kuwait targets 17 GW of renewable capacity and 25 GW of green hydrogen production capacity by 2050. Under its New Vision 2035, Kuwait aims to generate 15% of its electricity from renewables by 2030.
- **Oman:** The United Arab Emirates (UAE) and Oman have signed an investment agreement worth $31.85 billion for an industrial and energy mega-project, which includes renewable energy initiatives (solar, wind), as well as green steel production facilities.
- **Qatar**: The Qatar General Electricity and Water Corporation (Kahramaa) has unveiled Qatar's National Energy Strategy, under which the country targets 18% of renewable energy in the power mix by 2030. The strategy also aims to add up to around 200 MW of distributed solar generation by 2030 to enable more localized power generation and reduce strain on centralized grid infrastructure.
- **Saudi Arabia:** In June 2024 ,The Saudi Power Procurement Company (SPPC) has signed power purchase agreements for three new solar photovoltaic projects with a combined capacity of 5.5 GW, as part of Saudi Arabia's National Renewable Energy Program.
- **UAE:** The UAE Energy Strategy 2050 aims to triple the contribution of the renewable energy and invest AED 150 to AED 200 billion by 2030. In the first phase, which runs till 2030, the strategy aims to increase the installed clean energy capacity from 14.2 GW to 19.8 GW by 2030 and surge the share of installed clean energy capacity in the total energy mix to 30% by 2030.

Africa

Region: Algeria, Egypt, Morocco, South Africa, Eastern Africa, Middle Africa, Western Arica, and other northern and southern Africa

1.48 Billion

POPULATION

$2.8 Trillion

GDP

Electricity Generation

Total Africa electricity generation (2023): 902.9 TWh

- Algeria : 85.9 TWh
- Egypt: 220.1 TWh
- Morocco: 42.2 TWh
- South Africa: 224.4 TWh
- Eastern Africa: 127.9 TWh
- Middle Africa: 45.3 TWh
- Western Africa: 99.0 TWh
- Other Northern Africa: 52.0 TWh
- Other Southern Africa: 6.1 TWh

Renewable energy

Renewables generation in Africa : 56.7 Twh

(Algeria: 0.6 TWh, Egypt: 10.9 TWh, Morocco: 8.6 TWh, South Africa:18.4 TWh, Eastern Africa: 13.1 TWh, Middle Africa: 0.7 TWh, Western Africa: 2.7 TWh, Other Northern Africa: 0.7 TWh Other Southern Africa: 0.8 TWh)

Energy-related CO_2 emissions (2023): 1335.1 Mn tons CO_2 (0.7% decrease) compared to 1344.5 Mn tons in 2022

- Algeria : 144.7 million tons CO_2
- Egypt: 232.1 million tons CO_2
- Morocco: 69.1 million tons CO_2
- South Africa: 425.0 million tons CO_2
- Eastern Africa: 116.8 million tons CO_2
- Middle Africa: 52.2 million tons CO_2
- Western Africa: 189.9 million tons CO_2
- Other Northern Africa: 89.6 million tons CO_2
- Other Southern Africa: 15.7 million tons CO_2

Electric Vehicles and charging

- South Africa: EV sales of 1,080 in 2023, with 300+ fast and slow charging points
- South Africa's Free State province is taking a major leap towards electric mobility with a $234 million investment in the world's first network of solar-powered electric vehicle charging stations.

Major Energy players

- South Africa: Eskom, Sasol, PetroSA, Exxaro
- Morocco: TAQA Morocco S.A., ONEE
- Nigeria: Seplat Energy, NNPC
- Egypt: Middle East Oil Refinery (MIDOR), North Cairo Electricity Distribution Company

Recent Developments

- **Egypt:** Egypt targets $40 billion of investment in green hydrogen and renewable technology by signing seven memoranda of understanding with international developers in the fields
- **Morocco:** Morocco is aiming to significantly boost its energy output by investing $7 billion to add 9 gigawatts of capacity by 2027
- **South Africa:** By 2030, power generation in South Africa is expected to increase by more than 40%, rising from approximately 210 TWh currently to 300 TWh by the end of the decade
- **Nigeria:** Federal Republic of Nigeria has been approved a loan of $500 million for the first phase of the Economic Governance and Energy Transition Support Program (EGET-SP), a new program aimed at accelerating transformation of the country's electricity infrastructure and improving access to cleaner sources of energy
- **Algeria:** In March 2024, Algeria's National Electricity and Gas company (Sonelgaz) has signed 20 concession contracts with companies and consortia through its subsidiary Sonelgaz-EnR, for the installation of 3,000 MW of installed capacity.

Southeast Asia

Region: Southeast Asia (SEA) - (Hong Kong, Singapore, Malaysia, Philippines, Vietnam, and Taiwan)

0.7 Billion
POPULATION

$3.8 Trillion
GDP

Electricity Generation

Total electricity generation (2023): 960.6 TWh

- Hong Kong: 37.9 TWh
- Malaysia: 187.8 TWh
- Philippines: 119.0 TWh
- Singapore: 57.4 TWh
- Taiwan: 282.1 TWh
- Vietnam: 276.4 TWh

Renewable energy

Renewables generation in Southeast Asia : 207.7 Twh

(Hong Kong-0.4 TWh, Malaysia-36.0 TWh, Philippines-25.7 TWh, Singapore- 1.8 TWh, Taiwan-25.0 TWh, Vietnam-118.8 Twh)

Energy-related CO_2 emissions (2023): 1298.5 Mn tons CO_2 compared to 1216.2 Mn tons in 2022 (6.8% increase)

- Hong Kong: 65.9 million tons CO_2
- Malaysia: 284.7 million tons CO_2
- Philippines: 152.6 million tons CO_2
- Singapore: 224.4 million tons CO_2
- Taiwan: 265.5 million tons CO_2
- Vietnam: 305.4 million tons CO_2

EV Charging

- Hong Kong: 8,728 chargers (June 2024)
- Malaysia: 2,585 chargers (June 2024)
- Philippines: 338 charging stations (February 2024)
- Singapore: over 6,200 chargers (May 2024)

Major Energy players

- Hong Kong: CLP Group and Hong Kong Electric Company
- Malaysia: Tenaga Nasional Berhad, Malakoff Corporation Berhad, Sarawak Energy
- Philippines: Manila Electric Company (Meralco)
- Singapore: Singapore Power Ltd.
- Taiwan: Taiwan Power Company (Taipower)
- Vietnam: Vietnam Electricity Group (EVN)

Recent Developments

- Hong Kong: In a landmark partnership, Asia-Pacific & Japan (APJ) hyperscale data centre specialist, AirTrunk, has joined forces with Hong Kong's major power utility, CLP Power Hong Kong Limited (CLP Power), to facilitate the largest site-specific renewable energy certificate (REC) procurement in Hong Kong.
- Malaysia: The Government of Malaysia has outlined a plan to phase out coal-fired power plants, reducing their use by 50 per cent by 2035 and completely retiring them by 2044. At the same time, Malaysia is rapidly increasing its adoption of renewable energy, with a target to boost renewable energy capacity to 70 per cent by 2050.
- Philippines: The Philippines' Department of Energy (DOE) anticipates at least 4,164.92 megawatts (MW) of renewable and conventional power projects to come online in 2024. This will enhance the country's energy infrastructure and bolster the power supply and stability of the grid, as per the government agency.
- Singapore: Hitachi ABB Power Grids has been selected to deploy its innovative energy storage solution to support the development of Singapore's first Virtual Power Plant (VPP) project. The project, launched in 2019, is developed by the Energy Research Institute @ Nanyang Technological University, Singapore (ERI@N) and is jointly funded by Singapore's Energy Market Authority (EMA) and Sembcorp Industries (Sembcorp).
- Taiwan: Google and BlackRock have announced a significant partnership to advance solar energy in Taiwan. This collaboration involves a capital investment in New Green Power (NGP), a Taiwanese solar developer and BlackRock portfolio company, with the aim to develop a 1GW solar pipeline, accelerating the clean energy transition in Taiwan
- Vietnam: The Vietnamese government is moving forward with a new decree aimed at promoting the development of rooftop solar power for self-consumption. This initiative is part of broader efforts to boost clean energy sources and reduce reliance on the national grid.

Country Cards

Germany

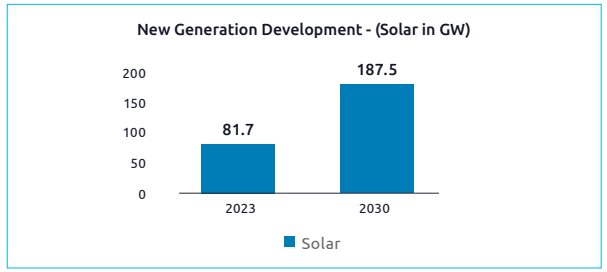
The German energy market is undergoing **significant transformation through three major trends: power plant strategy, grid expansion, and smart meter rollout.** These elements **collaboratively foster a cohesive and sustainable energy system by ensuring a reliable green energy supply, integrating renewable sources, and enhancing efficiency and transparency.** Together, they foster the transition towards a sustainable energy future and support the **achievement of climate goals.**

The German electricity market has **three key roles:**

- **Power Generators:** Produce electricity, major players include RWE, Uniper, EnBW, LEAG and Vattenfall
- **Electricity Suppliers:** Buy and sell electricity to consumers, major players include E.ON, EnBW, Vattenfall, EWE, RheinEnergie
- **Grid Operators:** Manage electricity infrastructure, balancing supply and demand. Major players (TSOs) are TenneT, Amprion, 50Hertz, TransnetBW, and various DSOs.

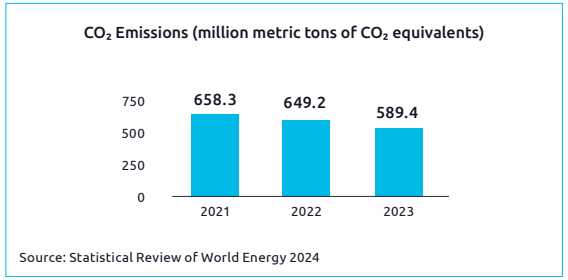
Source: IRENA 2024

Source: Source: Companies' annual reports 2023

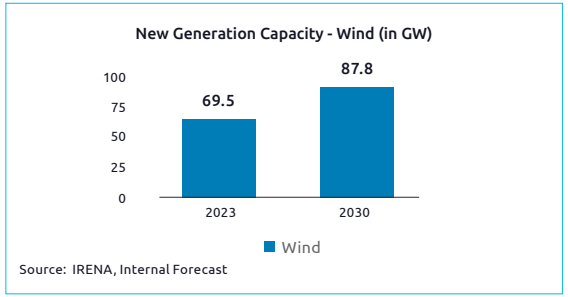


Regulatory Authorities in Germany:

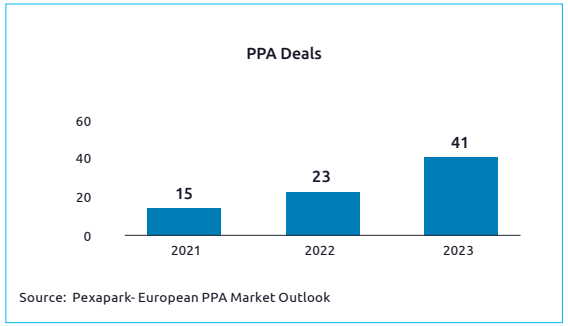
- **Bundesnetzagentur (BNetzA)** oversees Germany's grid infrastructure, including energy grids, and promotes competition by ensuring non-discriminatory access. EnWG Amendment 1 (2023) grants BNetzA increased responsibility for the hydrogen network and its financing.
- **The Federal Ministry for Economic Affairs and Climate Action (BMWK)** supervise energy policy and the energy sector.
- **The German government** drives for a further increase in renewable energy supply by introducing new laws like the Building Energy Act (GEG) and the German Supply Chain Act (LkSG).



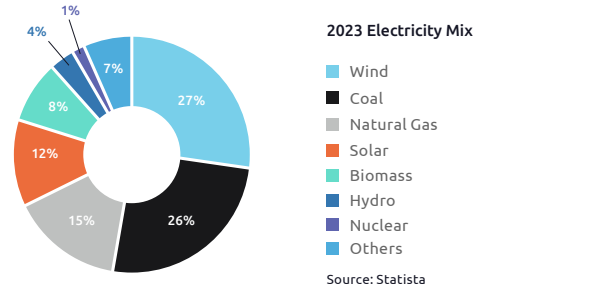
Source: Statistical Review of World Energy 2024



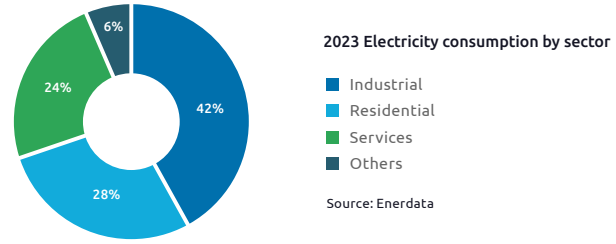
Source: IRENA, Internal Forecast



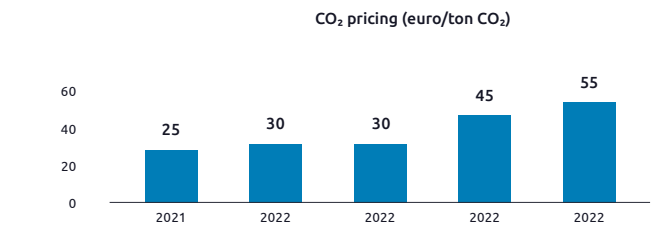
Source: Pexapark- European PPA Market Outlook



Source: Statista



Source: Enerdata



Source: DEHSt

Sources: 1 – BMWK, 2 – Bloomberg, 3 - Bundesnetzagentur; 4 – S&P Global
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EnWG-Novelle-1 verabschiedet - wichtige Neuregelungen zur BNetzA, zum Wasserstoff-Kernnetz, Nutzen statt Abregeln und Schwerlasttransporten - IHK Braunschweig

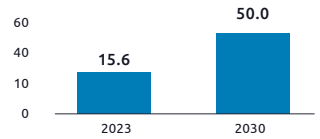
UK

- One of the new UK Government's key energy pledges from the 2024 general election is the creation of Great British Energy, which will own, manage and operate clean power projects
- The new UK government intends to invest £8.3 billion of funding into this new, publicly owned green power company
- Together with Great British Energy, it will work to 'turbocharge' the UK Government's target to deliver clean power by 2030

The Office of Gas and Electricity Markets (Ofgem) regulates the monopoly companies which run the gas and electricity networks. It is governed by the Gas and Electricity Markets Authority (GEMA).

Major review (Review of Electricity Market Arrangement) into Britain's electricity market design launched by the UK government to radically enhance energy security and cut costs of electricity for consumers in the long term

New generation capacity- Solar (In GW)



Source: IRENA , Solar Power Portal

The National Grid runs the transportation (transmission and distribution) of electricity. The price of electricity is determined by retail and wholesale market. **Wholesale electricity prices are not regulated.**

The "big six" energy companies operating in the UK are British Gas, EDF Energy, E. ON, npower, Scottish Power, and SSE.

The UK's energy sector has mostly been privatized since the 1990s.

Sources:
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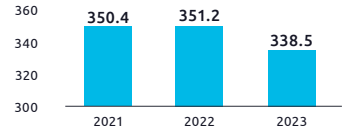
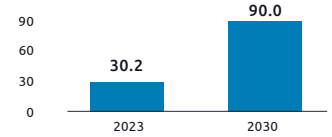
CO_2 emissions (million tons of CO_2 equivalents)



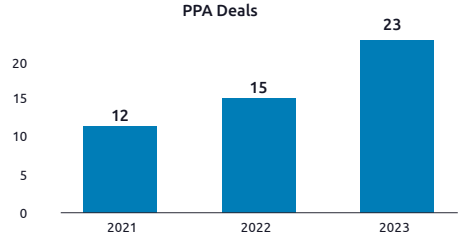
Source: Statistical Review of World Energy Data 2024

New generation capacity- Wind (In GW)

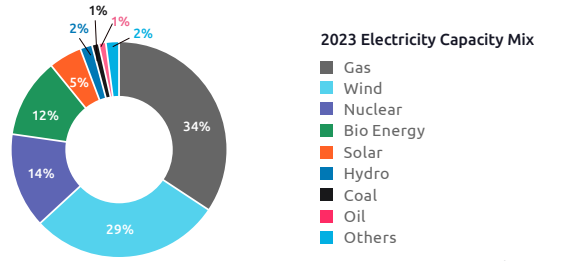


Sources: IRENA, Wind Europe

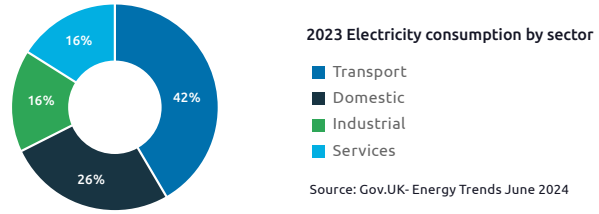
PPA Deals



Source: Pexapark- European PPA Market Outlook

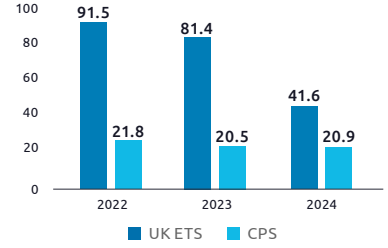


Source: Gov.UK- Energy Trends June 2024



Source: Gov.UK- Energy Trends June 2024

CO_2 pricing (euro/ton CO_2)



Source: The World Bank

France

- To meet its EU targets, France will need to triple its use of renewable power and reduce its energy consumption by a third by 2035, France's electricity Transmission and System Oerator RTE has stated in its 2030-2035 energy outlook
- With an annual estimation of €70 billion in investment opportunities, France is aiming to become a leader in Europe's green industry
- France electricity mix is already decarbonized (~40g of CO_2 per kWh), thanks to nuclear energy

EDF is the leading producer of low-carbon electricity with 93% of their electricity production decarbonized in 2023. Réseau de Transport d'Electricité (RTE) is the only transmission system operator, and Enedis, operates 95% of the metropolitan electric grid.

Total Energies SE is the biggest supplier of energy in France, with EDF and Engie.

Most French electricity is sourced from nuclear power stations (~70%+), however, a growing number of suppliers offer options from renewable sources.

In 2023, France had an **electricity capacity of 149.3 GW**, and electricity consumption of France is **estimated to be 411 TWh**

France was the biggest net exporter of power in Europe in 2023, due to low demand and the return of much of the country's nuclear fleet.

According to analysis by Montel group, **France exported almost 50TWh more than it imported in 2023** having become a net importer in 2022 for the first time in more than 40 years.

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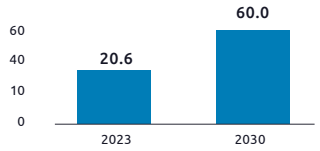
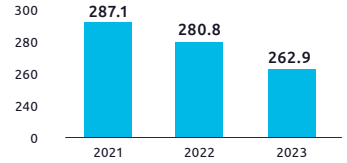
New Generation Capacity- Solar (In GW)

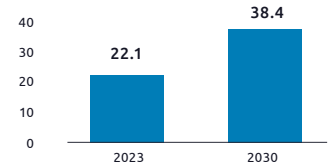


CO_2 Emissions (million metric tons of CO_2 equivalents)



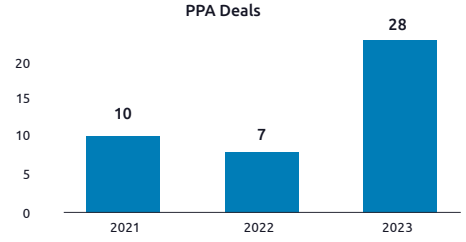
Source : Statistical Review of World Energy Data 2024.
Better nuclear fleet availability in 2023

New Generation Capacity - Wind (in GW)

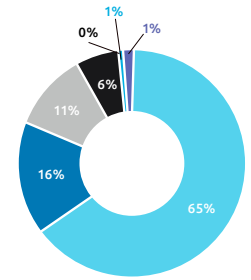


Source: IRENA, Internal Forecast

PPA Deals



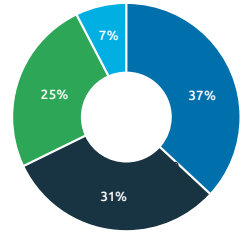
Source: Pexapark- European PPA Market Outlook



2023 Electricity Capacity Mix

- Nuclear
- Wind and Solar
- Hydro
- Natural Gas
- Oil
- Coal
- Others

Source : Statistical Review of World Energy Data 2024

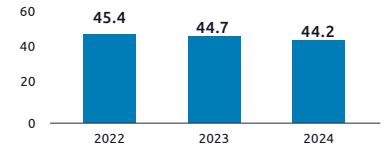


2023 Electricity consumption by sector

- Domestic
- Services
- Industry
- Others

Sources: Enerdata

CO_2 pricing (euro/ton CO_2)



Source: The World Bank

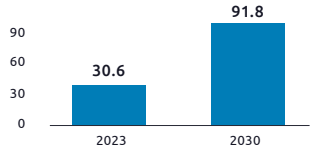
Italy

- **Italy is considering a significant shift in its energy policy with the creation of a new company focused on the development of small nuclear reactors. Discussions are ongoing with Ansaldo Nucleare, Enel and Newcleo about the potential development of the plan.**
- **The Italian government approved a plan worth €27.4 billion to promote green investments and ease the cost of energy for the industrial sector. The plan is expected to trigger investments in renewable power production and energy security.**

Terna is an electricity transmission system operator that owns virtually all the Italian National Transmission Grid, responsible for operating and managing the national electricity transmission grid. Terna also handles dispatching of electricity throughout Italy.[1]

2023 Development Plan: Terna has introduced the 2023 development plan where one of the main features is introducing the hyper grid network. This will leverage the technologies of the HVDC (High Voltage Direct Current) transmission system to achieve the energy transition and security targets.[2]

New generation capacity- Solar (In GW)



Source : Terna

Italy inches towards reversing a nuclear energy ban as Italy plans to draft, by early 2025, rules to allow the use of new nuclear power technologies. In its energy and climate plan (PNIEC), nuclear power could meet up to 11% of domestic energy demand in 2050.

Italy has retained key expertise in the sector. State-controlled utility Enel has agreed with France's EDF to develop four reactors in Italy. Enel operates nuclear power stations in Spain and energy major Eni is investing in a project to develop a nuclear fusion reactor in the United States.

Sources:
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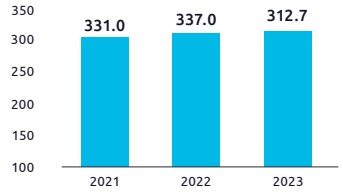
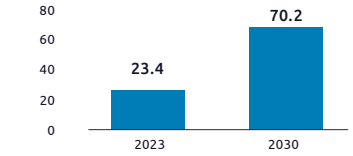
CO_2 emissions (million tons of CO_2 equivalents)



Source: Statistical Review of World Energy Data 2024

New generation capacity- Wind (In GW)



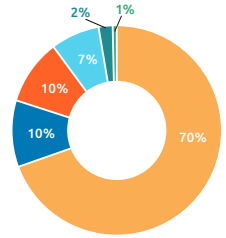
Source: Terna

Carbon Tax

In Italy, a proper carbon tax has never been introduced. They are trying to follow the European Union Emission Trading System (ETS).

In 2021, this covered 36.2% of GHG emissions. In total, 81.8% of the emissions were subject to a positive Net Effective Carbon Rate in 2021 under ETS.

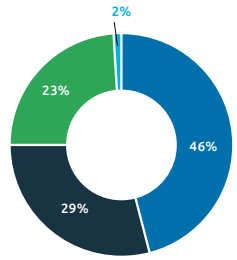
Sources: Science Direct, Reuters



2023 Electricity Mix

- Thermal
- Hydro
- Solar
- Wind
- Geothermal
- Pumping

Source: Terna

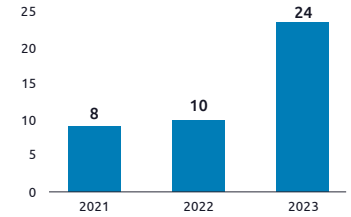


2023 Electricity consumption by sector

- Industrial
- Tertiary
- Households
- Agriculture

Sources: Statista

2023: Total PPA Deals



Source: Pexapark- European PPA Market Outlook

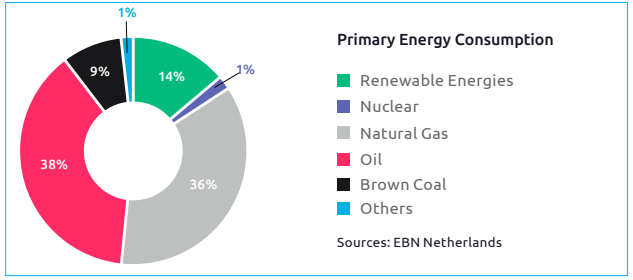
Netherlands

- With hydrogen expected to play a major role in Netherlands' 2050 energy outlook, the government has reserved €9 billion of the climate fund until 2030 to accelerate demand and supply of hydrogen
- The second biggest technology investment from the government remains in nuclear energy with €5 billion reserved in the climate fund ahead of budget allocated to energy infrastructure

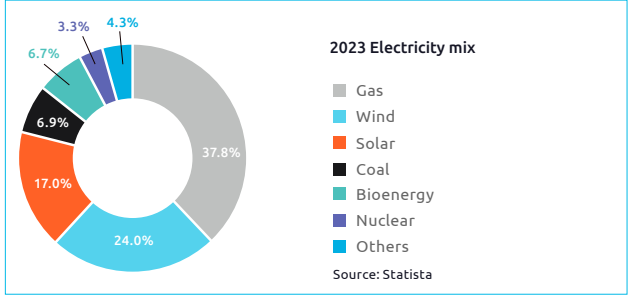
The Dutch government has set targets of **27% of all energy to come from renewable sources by 2030 and 100% by 2050.**

The Authority for Consumers and Markets is and independent regulator responsible for the regulation of the energy sector in the Netherlands.

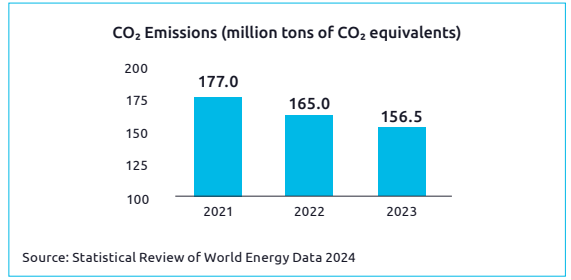
TenneT, the system operator, is the sole party accountable for overseeing the high-voltage grid (ranging from 110 kV to 380 kV) in the Netherlands



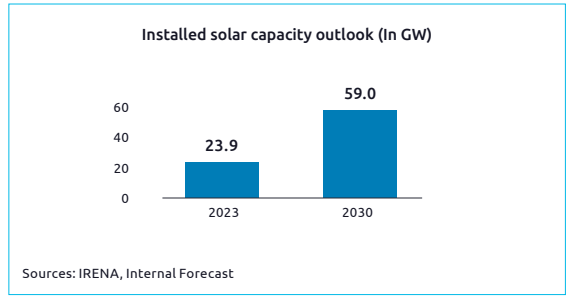
Sources: EBN Netherlands



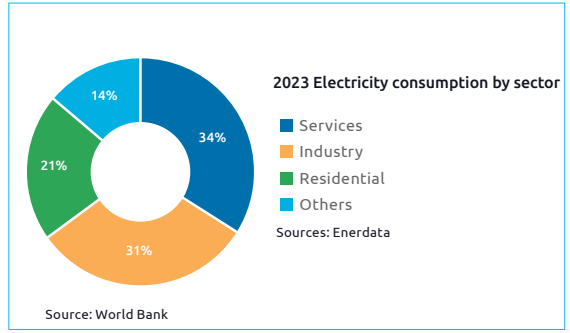
Source: Statista



Source: Statistical Review of World Energy Data 2024

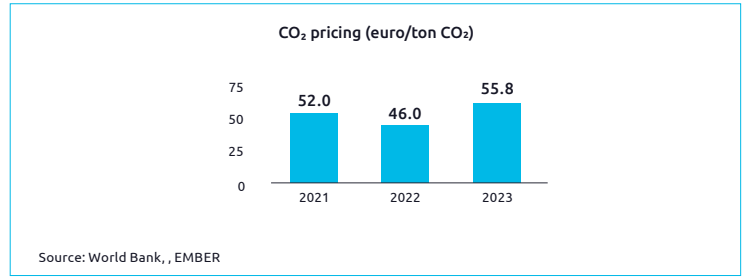


Sources: IRENA, Internal Forecast

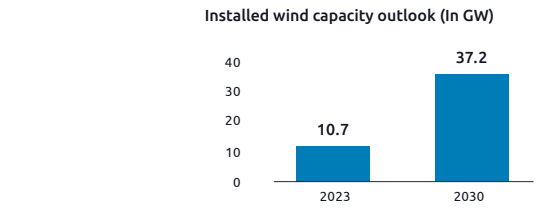


Sources: Enerdata

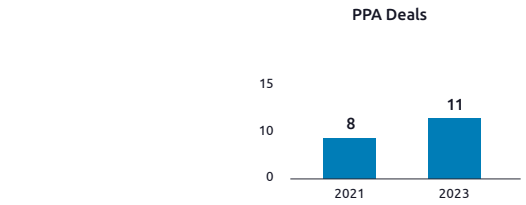
Source: World Bank



Source: World Bank, , EMBER



Sources: IRENA, Internal Forecast



Source: Pexapark- European PPA Market Outlook

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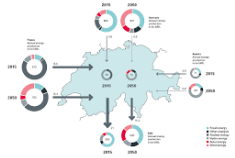
Switzerland

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



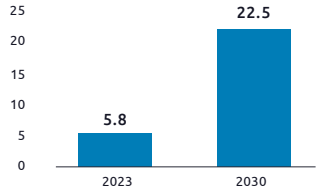
mall Landustrie SGS CTU aspo

As of December 2023, there are currently 705 hydropower power plants in Switzerland that have a capacity of at least 300 kilowatts (generator). Large-scale hydropower plants (capacity greater than 10 MW generator) account for 90.6% of Switzerland's total hydropower production. Further, Swiss utilities are increasingly investing in new technologies related to batteries and hydrogen

ElCom is Switzerland's independent regulatory authority in the electricity sector, which is responsible for monitoring compliance with the Swiss Federal Electricity Act and the Swiss Federal Energy Act. It also monitors electricity supply security and regulates issues relating to international electricity transmission and trading.

The **Federal Act on a Secure Electricity Supply from Renewable Energy Sources** was approved by Parliament which lays the foundations for a rapid expansion of Switzerland's energy production from renewable sources such as hydropower, solar, wind and biomass. It also introduces a mandatory hydropower reserve.

New generation capacity- Solar (In GW)

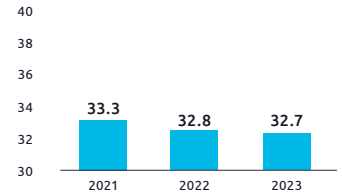


Source: IRENA, Internal Forecast

The Federal Council of Switzerland negotiates electricity agreements with the EU to secure allow full access for Switzerland to the single market for electricity and ensure cooperation in this sector with the EU in the future.

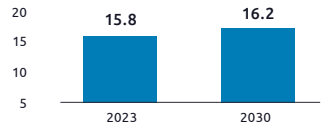
According to a new report from the Swiss Energy Foundation (SES), Switzerland is only able to rely on its own sources of energy for 29.7% of the year, before the country import resources from abroad.

CO_2 emissions (million tons of CO_2 equivalents)



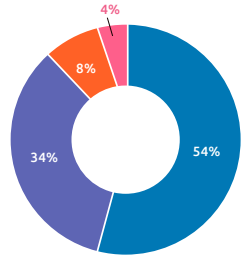
Source: Statistical Review of World Energy Data 2024

New generation capacity- Hydro (In GW)



Source: IRENA, Internal Forecast

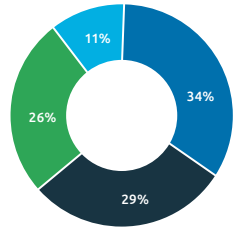
To date, there have been very few opportunities for PPAs in Switzerland as electricity is mainly produced from a mix of nuclear and hydropower and there are very few large-scale wind and solar installations in the country. Switzerland did not have PPA capacity until 2021



2023 Electricity mix

- Hydro
- Nuclear
- Solar
- Fossil Fuels

Source: Low-carbon Power

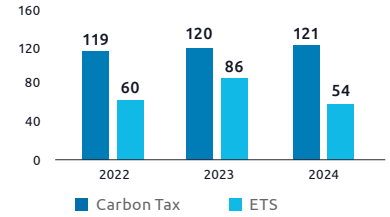


2023 Electricity consumption by sector

- Residential
- Industrial
- Services
- Transport and Others

Source: Statista

CO_2 pricing in (euro/ton CO_2)



Source: The World Bank

Sources:
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Poland

Energy Regulatory Office

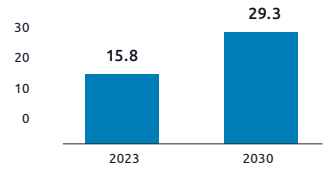
PAA PAŃSTWOWA AGENCJA ATOMISTYKI

- **Poland plans to increase its renewable power capacity through the development of offshore wind farms. By 2027, Poland expects 6 GW power capacity to be generated by offshore wind.**
- **EBRD extends financial package of up to PLN 126.1 million to support renewable energy capacity in Poland developed, constructed and operated by Eurowatt Green Energy Group**

The President of Energy Regulatory Office is a central body of state administration nominated based on the Energy Law. It is responsible for regulation in energy sector as well as promotion of competition

The National Atomic Energy Agency is another government regulatory body responsible for nuclear regulations. They conduct activities that are significant for ensuring nuclear safety and radiological protection.1

New Generation Capacity- Solar (In GW)



Source: IRENA

Polish government officials stated that they need a huge upgrade of its power grids to cope with the transmission of energy from renewable and nuclear sources.

They need to invest €112.5 billion in transmission and distribution grids by 2040. Poland's new energy strategy forecasts 74% of energy coming from zero-emission sources, including renewables and nuclear power.

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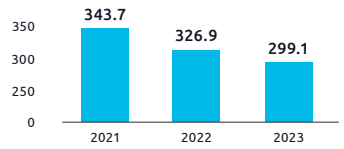
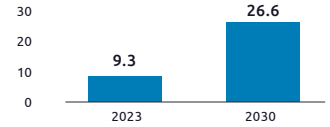
CO_2 Emissions (million tons of CO_2 equivalents)



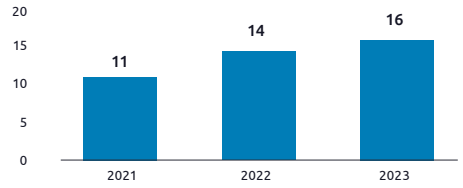
Source: Statistical Review of World Energy Data 2024

New Generation Capacity - Wind (in GW)

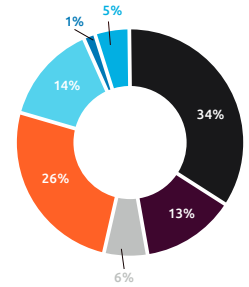


Source: IRENA

PPA Deals



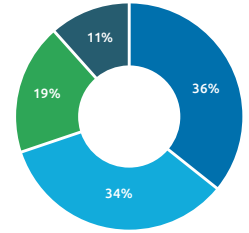
Sources: Pexapark



2023 Electricity Mix

- Coal
- Lignite
- Natural Gas
- Solar
- Wind
- Hydroelectric
- Others

Source: Statista

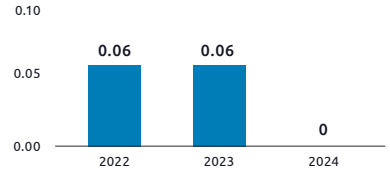


2023 Electricity consumption by sector

- Industry
- Services
- Household
- Transport

Source: Enerdata

CO_2 pricing (euro/ton CO_2)



Source: World Bank

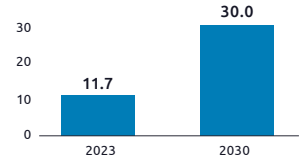
Turkey

In May 2024, Turkey and the World Bank signed an agreement for $1 billion program to support renewable energy expansion efforts,. The program is expected to help establish and expand Turkey's market for distributed solar energy and pilot a program for battery storage.

The energy market in Turkey is primarily governed by The **Ministry of Energy and Natural Resources (MENR)**, which has been responsible for supervising market activities and determining the energy and natural resources requirements.

The **Energy Market Regulatory Authority (EMRA)**, is the main regulatory authority for the electricity, natural gas, oil, and liquefied petroleum gas markets. The **General Directorate of Energy Affairs (EIGM)**, acts as the main policy-making body, takes measures regarding energy policies, and coordinates programs

New Generation Capacity- Wind (In GW)



Source: IRENA, Internal Forecast

Türkiye's transmission lines connect to 21 distribution grids operated by private companies. These 21 distribution grid companies operate approximately 71,000 Km of distribution lines. One of the aims of distribution system operators (DSOs) or electric distribution companies (DISCOs) is to increase the efficiency of the existing grids by either replacing the old transformers or lines and/or installing smart grid systems

Türkiye has a semi-liberalized and moderately regulated market. Energy Exchange Istanbul (EXIST) is Türkiye's electricity spot market, which manages day-ahead and intraday markets where 40% of electricity is traded among 854 market participants

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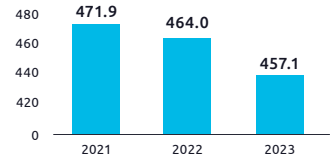
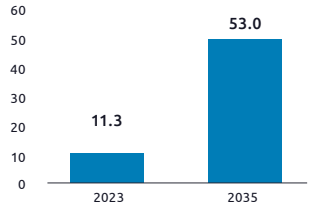
CO_2 Emissions (million tons of carbon dioxide)



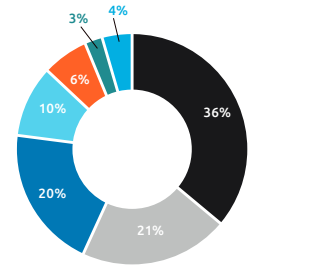
Source: Statistical Review of World Energy 2024

New Generation Capacity - Solar (in GW)



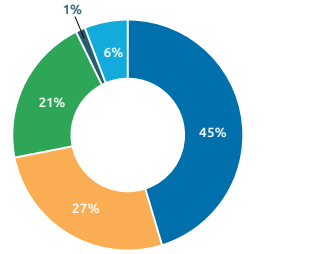
Sources: IRENA, Ember

Electricity mix chart



Source: Statista , Statistical Review of World Energy 2024

2023 Electricity consumption by sector



Sources: Enerdata

Public Utilities	Private Utilities
• EUAS, Electricity Generation Corporation is the major state-owned electricity generation company in Turkey.	• Major private utilities include: - ENKA - Enerjisa Enerji - Zorlu Enerji
• EUAS holds **20% share of the total market.**	• Share of private sector in electricity generation increased to **80%.**

Carbon Pricing: ETS

Turkey has been preparing for the use of carbon pricing instruments to help achieve its mitigation targets with efforts gathering pace in 2023.

These include the submission of an Updated First NDC, which has explicit references to the Turkish Emission Trading System (TR ETS), and an announcement from the Directorate of Climate Change (DoCC) during COP28 that a pilot ETS is planned to launch in October 2024 with the publication of the National Allocation Plan

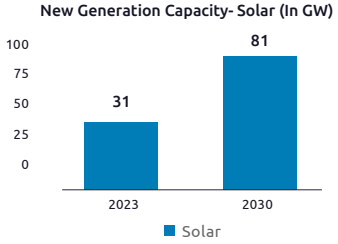
Sources: World Bank Group= Carbon pricing dashboard

Spain

- **The European Investment Bank is providing a €1 billion loan to Iberdrola to co-finance the construction of the 22 renewable energy plants in Spain, Portugal and Germany, in a deal signed in June 2023**
- As of July 2024, the Spanish government has approved subsidies worth **almost €800 Mn for major green hydrogen projects.**
- **Amazon Web Services aims to invest €15.7 billion in Spain, expanding their existing cloud region there and investing in almost 600MW of renewable energy projects**

Red Eléctrica de España, SA (REE) is the sole TSO for the Spanish electricity system. Spain's Long-Term Decarbonization Strategy (ELP 2050) will reduce greenhouse gas (GHG) emissions by 90% by 2050. The two largest companies represent 43% of electricity generation in Spain. **These are Iberdrola (24%) and Endesa (19%).**

Enagas is the operator of Spain's network of gas pipelines and LNG terminals and was, in December 2023, designated as the country's provisional hydrogen transmission network operator (HTNO).



Source: IRENA, Global Energy Monitor

The Official Journal of the European Union has adopted the Delegated Act on Projects of Common Interest (PCI), which includes the **H2Med and the Spanish Hydrogen Backbone** projects, giving them access to the advantages linked to PCI status.

These projects are also partially managed by Spain's gas grid operator Enagas.

In parallel to the development, Spain is working on the regulatory framework for its green hydrogen sector, part of which involves the re-establishment of a National Energy Commission (CNE), which is in the process of demerging from the Market and Competition Regulator (CNMC).

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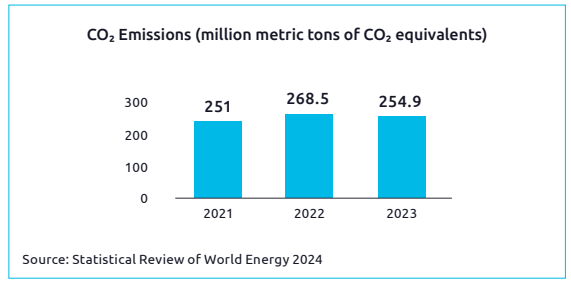
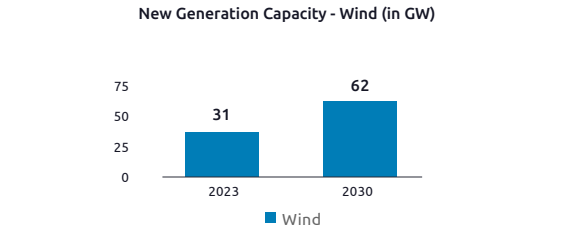
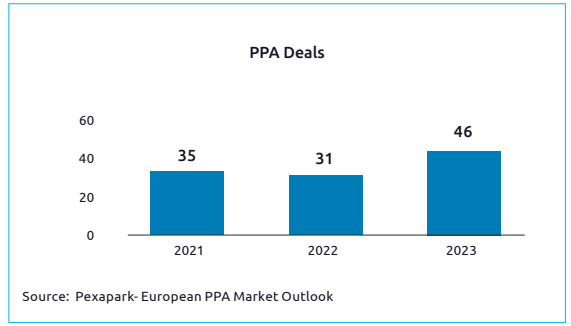
Spain approves 800 million euros of subsidies for green hydrogen projects | Reuters



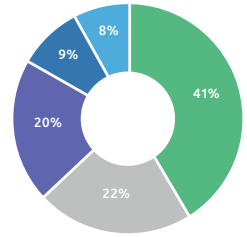
Source: Statistical Review of World Energy 2024



Source: IRENA, Global Energy Monitor



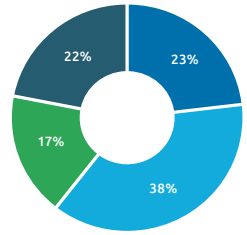
Source: Pexapark- European PPA Market Outlook



2023 Electricity Mix

- Renewables
- Natural Gas
- Nuclear
- Hydro
- Others

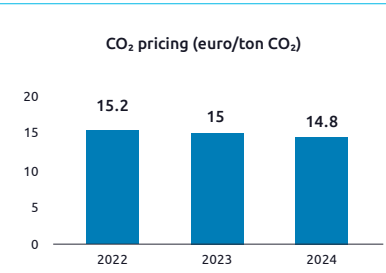
Source: Statistical Review of World Energy Data 2024



2023 Electricity consumption by sector

- Industrial
- Transport
- Residential
- Commercial and Services

Source: Various sources, internal analysis



Source: World Bank

Sweden

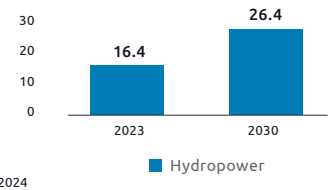
Sweden has a national energy policy target of 100% fossil-free electricity generation by 2040; the installed capacity of wind power is likely to grow by 14 GW and Solar power to grow by just under 8 GW between 2020 and 2030

The main regulator for the energy industry in Sweden is the Swedish Energy Agency

The agency has submitted a proposal for strategic priorities in energy research and innovation for 2025-2028

Seven Swedish cities have signed a joint declaration on climate neutrality with cities in Spain and Romania

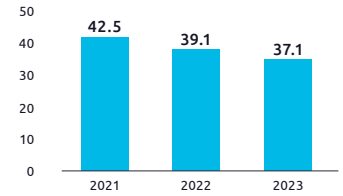
New Generation Capacity (Hydropower in GW)



Source : IRENA 2024

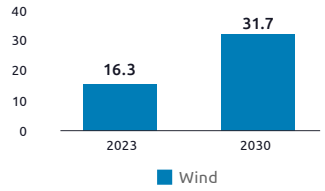
- Recently, Swedish government announced their plans to invest over SEK 1Bn ($97 Mn) in 2025 to expand fossil-free electricity production including plans for an investment of more than $9 Mn in pilot and demonstration nuclear power projects.
- In Nov 2023, Sweden announced a **plan for long-term nuclear energy investment** to double electricity production in 25 years.

GHG Emissions (million tons of CO_2 equivalents)



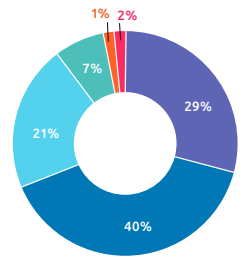
Source: Statistical Review of World Energy 2024

New Generation development (Wind in GW)



Source: IRENA 2024

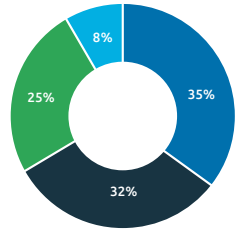
- Vattenfall and Swedish industry majors join forces on new energy investment. Sweden is planning for up to **12 new nuclear reactors by 2045**, which could cost around **SEK 400 Bn ($39 billion)** to build, with the government offering to share some of investment risks.
- E.ON presented its first network development plan, to guide the development of the electricity network during 2025–2034. A further minimum of **SEK 23 Bn** is to be invested until 2027.



2023 Electricity Mix

- Nuclear
- Hydro
- Wind
- Biofuel
- Solar
- Fossil Fuels

Source : Low-carbon Power

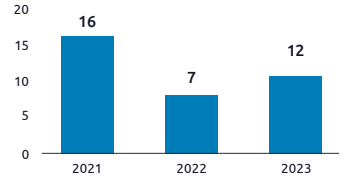


2023 Electricity consumption by sector

- Industry
- Household
- Services
- Others

Sources: Enerdata

2023: Total PPA Deals



Source: Pexapark

CO_2 pricing ($/tCO₂e)

Source: Worldbank

Sources:
Electricity mix
https://lowcarbonpower.org/region/Sweden
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Belgium

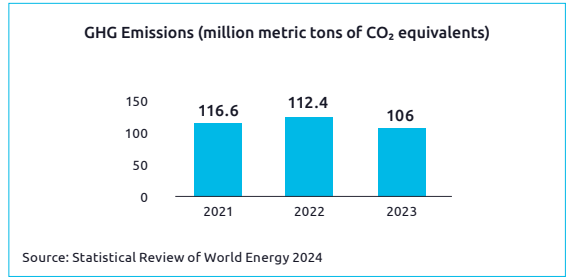
In 2023, total annual wind and photovoltaic generation in Belgium reached an all-time high (21.5 TWh or + 23%), accounting for 28.2% of the electricity mix, more than half (66.5%) of the energy mix for 2023 comprised nuclear and gas-powered generation. A new quarter-hour record of 8,078 MW was set on 29 May 2023, corresponding to 93% of total consumption.

- The main regulator for the energy industry in Belgium is the **Commission for Electricity and Gas Regulation (CREG)**, is responsible for ensuring transparency and competition in the electricity and gas markets
- In a recent, **CREG approved Elia's revised tariff proposal** for the 2024-2027. This is part of their ongoing efforts to regulate and stabilize energy prices in Belgium
- **Elia Group** is a transmission system operator that owns and operates high-voltage electricity transmission systems in Belgium and Germany
- **RESA** is the main operator of electricity and gas distribution systems in the province of Liège (Belgium)

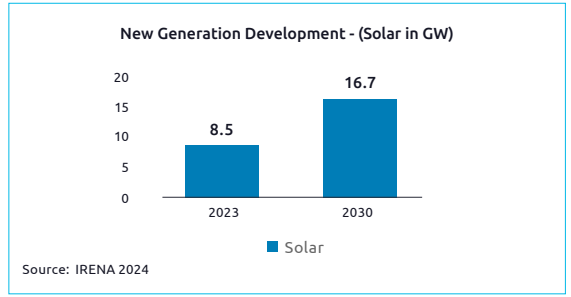
- **RESA** and the **European Investment Bank** (EIB) announced the signing of a **€190 Mn** loan agreement needed to implement the first part of the operator's industrial plan for **2023-2026**
- **RESA's industrial plan** for 2023-2026 **focuses on modernizing, strengthening, and digitizing** the regional electricity grid to enhance supply security and reduce climate impact
- The Belgian federal government launched the **Energy Transition Fund call for 2023**, which is broadly able to support investment in three areas:
  - Renewable energy and biofuels
  - Nuclear energy
  - Supply security and network

- S&P Global forecasted the EU carbon price in a range of **€80.8-95.50/ $mtCO_2e$** across 2024.
- In 2024, global **carbon pricing revenues reached a record $104 billion.**
- There are now **75 carbon pricing instruments** in operation worldwide.

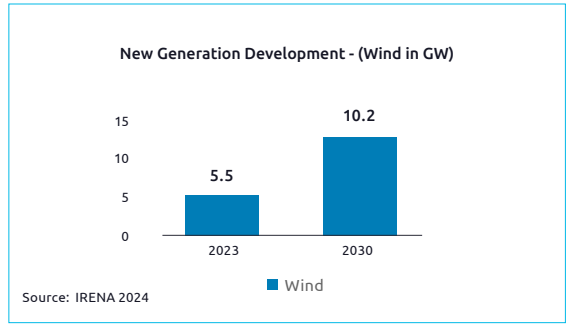
Sources:
CO_2 emissions:
https://www.energyinst.org/statistical-review
Electricity Mix: Elia Group:
https://www.elia.be/en/news/press-releases/2024/01/20240108_electricity-mix-2023-belgian-renewable-generation-reaches-all-time-high-while-consumption
Electricity consumption by sector:
https://www.enerdata.net/estore/energy-market/belgium/
New Generation Capacity:
https://www.mckinsey.com/id/our-insights/how-to-power-indonesias-solar-pv-growth-opportunities
Carbon pricing:
https://www.worldbank.org/en/news/press-release/2024/05/21/global-carbon-pricing-revenues-top-a-record-100-billion
https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/122823-bearish-eu-carbon-prices-to-continue-in-2024-on-lower-power-emissions-oversupply
Other sources:
https://be.fi-group.com/en/creg-approves-electricity-tariffs-for-2024-2027/
https://www.elia.be/-/media/project/elia/shared/documents/press-releases/2024/20240108_electricity-mix-2023-belgian_en.pdf
https://www.eib.org/en/press/all/2024-030-belgium-eib-and-resa-work-together-for-an-inclusive-energy-transition
https://www.deloitte.com/be/en/services/tax/blogs/belgian-federal-government-launches-energy-transition-fund-call-for-2023.html



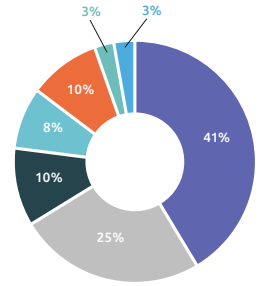
Source: Statistical Review of World Energy 2024



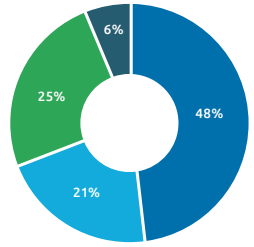
Source: IRENA 2024

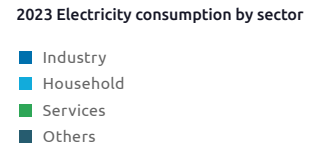


Source: IRENA 2024

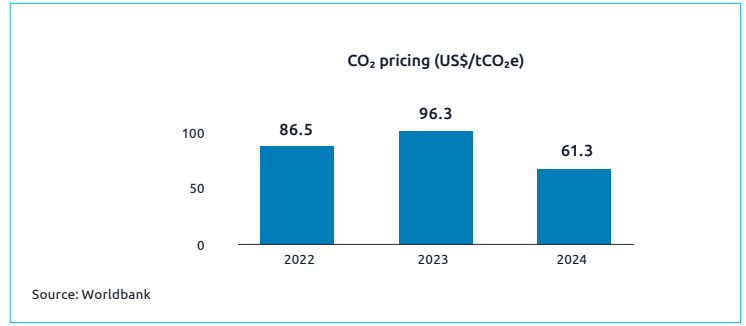


Source: Elia Group





Source: Enerdata



Source: Worldbank

Norway

- **Norway's oil and gas investments in 2024 are projected to hit $24 billion, driven by higher costs and ongoing field developments.**
- **Also in 2024, Statkraft, a Norwegian state-owned energy company plans to invest $4.1-$6.3 billion in Norwegian hydro and wind power upgrades, including 2.5 TWh of new wind power by 2030; Hydropower will see a 20% output boost, adding 0.3 TWh, with wind power doubling current production.**

The **Ministry of Energy** in Norway is responsible for facilitating a coordinated and integrated energy policy, with a focus on hydropower and petroleum activities

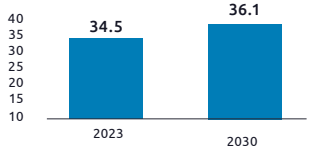
The **Norwegian Offshore Directorate**, under the Ministry of Energy, manages Norway's petroleum resources and oversees CO_2 storage, offshore wind, and seabed minerals

Norway's government is pushing for more renewable energy while maintaining hydropower and cooperating with the EU on decarbonization efforts

Amidst general public support for increased renewable power generation, municipalities have veto rights against new onshore wind developments which could hinder growth

NORWEGIAN OFFSHORE DIRECTORATE

New generation capacity- Hydropower (In GW)



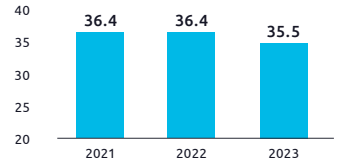
Source: IRENA, Statista

Norwegian electricity grid consists of three levels: the transmission grid (operated by Statnett), the regional grid, and the distribution grid. The transmission grid connects producers with consumers in a nationwide system. The regional grid often links the transmission grid to the distribution grid and may also include production and consumption radials carrying higher voltages. The distribution grid consists of the local electricity grids that normally supply power to smaller end users.

The state-owned transmission system operator(TSO), Statnett owns 98% of the transmission grid. The rest is owned by 13 regional grid companies and rented to Statnett.

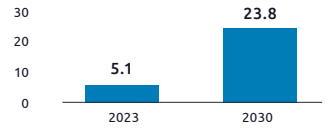
Sources:
https://www.energyinst.org/__data/assets/pdf_file/0006/1542714/EI_Stats_Review_2024.pdf
https://carbonpricingdashboard.worldbank.org/compliance/price
Political view & public view:
https://www.dnv.com/Publications/energy-transition-norway-2023-250141
https://energy.ec.europa.eu/events/6th-eu-norway-energy-conference-2023-10-24_en
https://reglobal.org/norways-energy-transition-report/

CO_2 emissions (million tons of CO_2 equivalents)



Source: Statistical Review of World Energy 2024

New generation capacity- Wind (In GW)



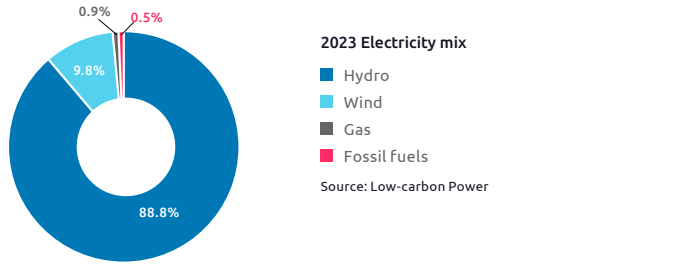
Source: IRENA, Internal Forecast

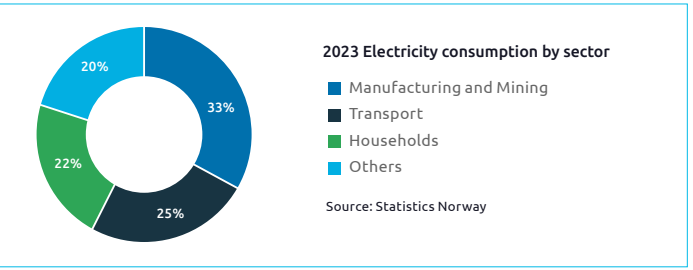
Ownership in the Norwegian Energy sector

Municipal, county, and central authorities own around 90% of Norway's electricity production capacity.

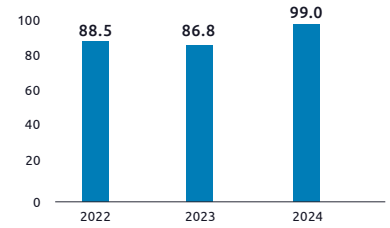
Statkraft SF, state-owned company owns around 35% of production capacity.

Sources:
Electricity mix and Electricity consumption by sector:
https://lowcarbonpower.org/region/Norway
https://www.ssb.no/en/energi-og-industri/energi/statistikk/produksjon-og-forbruk-av-energi-energibalanse-og-energiregnskap
The Ministry of Energy:
https://www.regjeringen.no/en/id4/
The Norwegian Offshore Directorate:
https://www.sodir.no/en/about-us/
Other:
https://oilprice.com/Latest-Energy-News/World-News/Norways-Oil-Investment-Set-for-Record-High-in-2024.html
https://oilprice.com/Latest-Energy-News/World-News/Oil-and-Gas-Investments-in-Norway-Set-for-Record-High-in-2024.html
https://www.dn.no/energi/statkraft/vindkraft/vannkraft/
statkraft-storsatser-pa-vind-og-vannkraft-i-norge-for-lite-mener-hoyres-nikolai-astrup/2-1-1580024
Norway's Statkraft to invest up to $6.6 bln in hydro, wind power | Reuters





CO_2 pricing (euro/ton CO_2)



Source: The World Bank

Sources:
New generation capacity- Hydropower:
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_RE_Capacity_Statistics_2024.pdf?rev=a58750 3ac9a2435c8df13e40081d2ec34
https://www.statista.com/statistics/1393788/forecast-hydropower-capacity-in-norway/

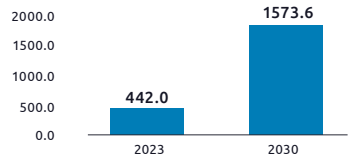
China

- **Clean energy contributed a record $1.6tn to China's economy in 2023 and China's investment in clean energy remains to be around $890B in 2023**
- **China unveils equipment renewal plan for energy sector; By 2027, China's equipment investment in key areas of the energy sector is expected to increase by more than 25% compared with 2023, according to the action plan jointly released by the NDRC and the National Energy Administration.**

Government agencies such as the **National Development and Reform Commission (NDRC) and the National Energy Administration** are primarily responsible for establishing policies and standards for the electricity sector.

These agencies are also responsible for overseeing the operation of the electricity market and regulating electricity prices

New Generation Capacity- Wind (In GW)



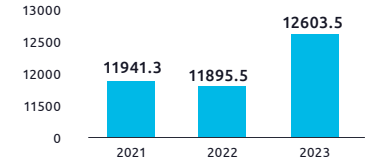
Sources: GlobalData, IRENA

Electricity grid in China is operated by the **State Grid Corporation of China in the North and China Southern Power Grid Co Ltd in the South**. State Grid covers about 26 provinces in eastern, central, and northern regions, while the latter covers five provinces in southern China.

Currently, China's power market is based primarily on provinces balancing electricity supply and demand, with thermal power playing a key role. Inter-provincial power transactions are governed by government contracts, which are based on prices that do not directly reflect actual supply or demand.

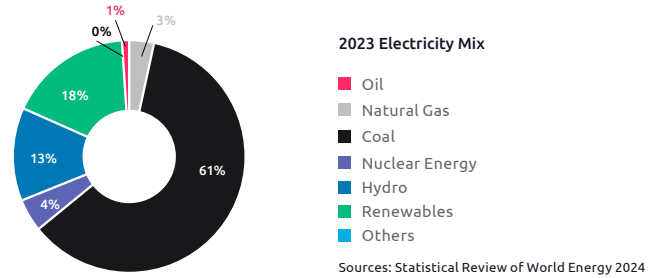
Sources:
CO_2 emissions + Electricity mix
https://www.energyinst.org/statistical-review
Electricity consumption by sector
https://www.enerdata.net/estore/energy-market/china/#:~:text=Power%20Consumption,and%2017%25%2C%20respectively).
CO_2 pricing
Carbon Pricing Dashboard | Up-to-date overview of carbon pricing initiatives (worldbank.org)
Enerdata
China's State Grid will invest US$70bn in grid network construction in 2024 | Enerdata
New gen capacity
https://www.globaldata.com/media/power/china-reach-2030-solar-wind-energy-target-five-years-ahead-schedule-says-globaldata/
https://www.statista.com/statistics/239093/CO2-emissions-in-china/#:~:text=Carbon%20dioxide%20emissions%20emissions%20in%20China%201960%2D2021&text=China%20released%2011.47%20billion%20metric,world's%20largest%20polluter%20that%20year.
http://www.sgcc.com.cn/html/sgcc_main_en/col2017112307/column_2017112307_1.shtml
https://thelawreviews.co.uk/title/the-energy-regulation-and-markets-review/china
https://www.carbonbrief.org/analysis-clean-energy-was-top-driver-of-chinas-economic-growth-in-2023/#:~:text=Our%20analysis%20shows%20that%20investment,tn%20yuan%20(%2B60%25).

CO_2 Emissions (million tons of CO_2 equivalents)



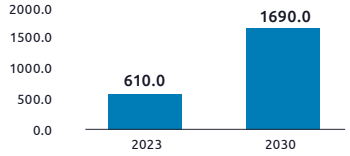
Sources: Statista, Statistical Review of World Energy 2024

2023 Electricity Mix



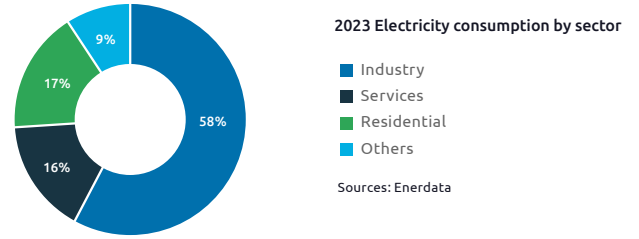
Sources: Statistical Review of World Energy 2024

New Generation Capacity - (Solar in GW)



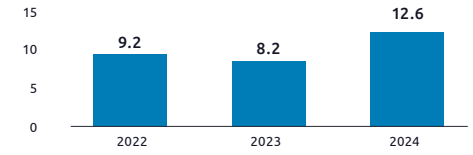
Sources: GlobalData, IRENA

2023 Electricity consumption by sector



Sources: Enerdata

CO_2 pricing (US$/tCO$_2$e)



Sources: World Bank

- State Grid Corporation of China: Supplies electricity to over 80% of China.
- **2024 Investment:** CNY 500 billion (US$70 billion) in grid network construction.
- **Plans:** Complete 6 UHV AC lines and start new UHV projects.
- China will exceed its 2030 target by 2025 with a **projected 1,720 GW** of solar and wind capacity, surpassing the 1,200 GW.

Sources: Enerdata, GlobalData

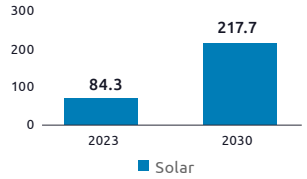
India

- **India has allocated $4.3 billion for the energy transition in the shape of increased power transmission for renewables, biogas and green fertilizer support. Further, Finance Ministry has stated that the budgeted sum would improve energy security and help achieving the target of net zero emissions by 2070.**
- **New rules under the Electricity (Amendment) Rules 2024 aim to facilitate easier grid connections for bulk consumers and energy storage systems. This is expected to enhance grid reliability and provide more affordable electricity.**

Individual State grids were interconnected to form 5 regional grids covering India. 5 power grids consist of Northern Region, Eastern Region, Western Region, North-eastern Region, and Southern Region grids.

ONGC announced a ₹2 trillion roadmap to achieve net-zero emissions by 2038, aiming to offset 9mt of CO_2., ONGC became the first fossil fuels company to outline a detailed climate plan, aligning with India's 2070 net-zero target.

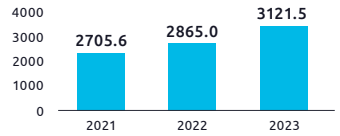
New Generation Capacity development Solar (in GW)



Sources: Invest India

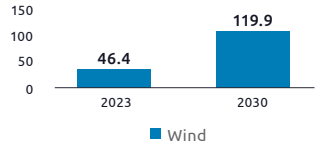
- Power distribution companies (DISCOMs) in India are being encouraged to **shift from long-term PPAs to a more dynamic power market**. This shift is necessary for integrating large volumes of renewable energy into the grid.
- The Central Electricity Regulatory Commission (CERC) is **pushing for market coupling**, a move that will likely lead to increased trading volumes in the electricity markets.
- The Ministry of Power (MoP) notified the guidelines for **tariff based competitive bidding process** for procurement of power from grid connected wind power projects on July 26, 2023.
- U.S. DOE Secretary signed a memorandum reaffirming the commitment to **purchase clean energy from Indian Tribes** to support U.S. clean energy goals

GHG Emissions (million tons of CO_2 equivalents)



Sources: Statistical Review of World Energy

New Generation Capacity Development -Wind (in GW)



Sources: Invest India

Sources:
CO_2 emissions + Electricity mix
https://www.energyinst.org/statistical-review
Electricity consumption by sector:
https://mospi.gov.in/sites/default/files/publication_reports/EnergyStatistics_India_publication_2024N.pdf
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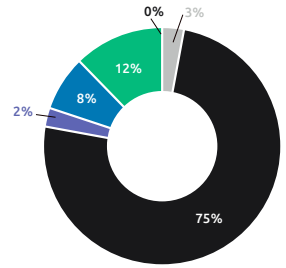
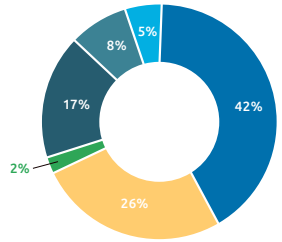
https://greentree.global/publications/state-of-carbon-emissions-and-carbon-markets-in-india-2023-24/
https://www.businesstoday.in/industry/energy/story/carbon-pricing-gaining-momentum-in-india-431712-2024-06-01
New generation capacity: Invest India
https://www.investindia.gov.in/sector/renewable-energy#:~:text=India%20aims%20for%20500%20GW,have%20been%20approved%20in%20India.
Power purchase agreements:
https://www.investopaper.com/news/nepal-india-sign-landmark-power-trade-agreement-10000-mw-electricity-export-to-india-in-10-years/
Others
https://eefa.org/resources/fixing-indias-power-market-help-add-more-renewables
https://www.energy.gov/indianenergy/articles/secretarial-memorandum-indian-energy-purchase-preference
https://www.mondaq.com/india/renewables/1394716/regulatory-updates-clean-energy-july-to-october-2023
https://www.policycircle.org/environment/ongc-clean-energy-roadmap/



2023 Electricity Mix

- Oil
- Natural Gas
- Coal
- Nuclear Energy
- Hydro
- Renewables
- Others

Sources: Statistical Review of World Energy 2024



2023 Electricity consumption by sector

- Industry
- Domestic
- Traction and Railways
- Agriculture
- Commercial
- Others

Sources: EnergyStatistics India 2024

Carbon Pricing: ETS

- As of 2024, India is preparing to launch a Carbon Market to address carbon emissions amid its economic growth.
- After adopting the legal framework for a carbon market and setting up governance structures in 2022 and 2023, India plans to implement a **Carbon Credit Trading Scheme by 2026.**

Sources: GreenTree Global Publication

Japan

Japan aims for carbon neutrality by 2050 with a 2030 milestone: 36-38% share of renewables, 20-22% nuclear power, and reducing coal to 19% and LNG to 20%. The plan includes adding 23 GW of interregional grid capacity and 777 km of new transmission lines by 2032, with significant investments in offshore wind and new transmission infrastructure.

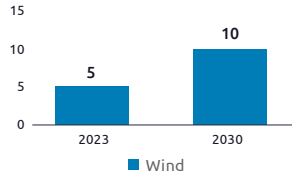
Electricity sector in Japan is governed by the Electricity Business Act (EBA).

JEPX is Japan's wholesale electricity exchange acting as an intermediary for electricity sales between producers and retailers.

Energy industry in Japan, which encompasses electric power, gas and other energy resources, is regulated by the Ministry of Economy, Trade and Industry (METI)

- **Total Electricity Capacity (estimated): 322.6 GW**
- **Electricity Consumption: 909 TWh**

Generation Capacity- Wind (In GW)

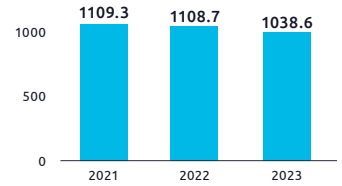


Sources: EIA

Major Players	Industry Scope	Sales - $Bn
ENEOS Holdings, Inc.	Integrated Oil/Gas	113.1
Nippon Oil Corporation	Petroleum Refining	72.6
Tokyo Electric Power Co. Holdings, Inc.	Electric Power Generation	58.7
Tepco Energy Partner Incorporated	Electric Power Generation	45.9
Jera Co. Inc.	Oil/Gas Upstream Operations	35.1
Chubu Electric Power Co., Inc.	Electric Power Distribution	30.0
Tokyo Gas Co., Ltd	Gas Utilities	24.8

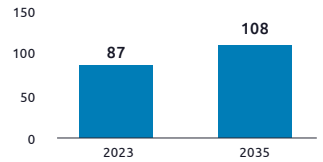
Sources:
CO_2 emissions + Electricity mix
https://www.energyinst.org/statistical-review
Energy consumption:
https://yearbook.enerdata.net/electricity/electricity-domestic-consumption-data.html

CO_2 Emissions (million tons of CO_2 equivalents)

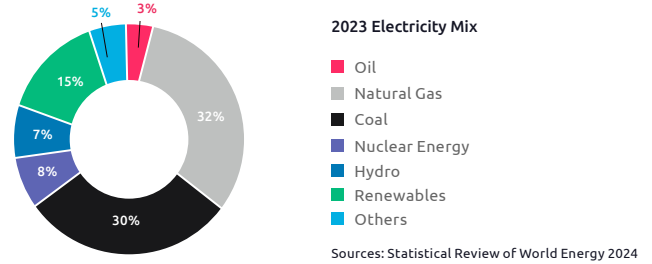


Sources: Statistical Review of World Energy 2024

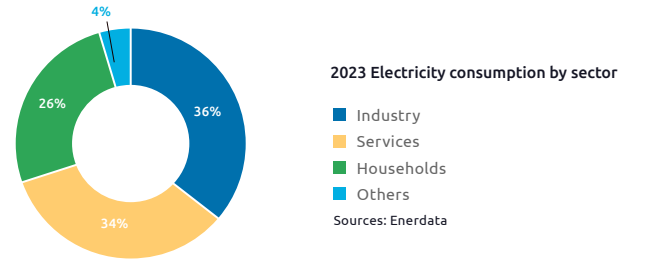
Generation Capacity - Solar (in GW)



Sources: EIA



Sources: Statistical Review of World Energy 2024

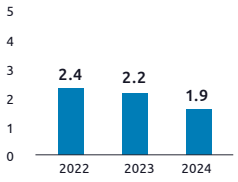


Sources: Enerdata

- Japan aims to **reduce greenhouse gas emissions by 46% by 2030** and strives for **a 50% reduction**. With a current **20 reduction achieved**, Japan is on track to meet its goal.
- Strategic Energy Plan aims for **36-38% renewable energy, 20-22% nuclear power,** and minimal thermal power by 2030,
  with coal and LNG at 19% and 20% respectively.
- Japan aims to **cut coal from 31% to 19%, petroleum from 4% to 2%, and natural gas from 34% to 20%** in electricity generation by 2030.
- Japanese government passed the **Hydrogen Society Promotion Act** on 17 May 2024, further to which the government is expected to implement two subsidy schemes commencing in the summer of 2024.

Sources:
CO_2 emissions + Electricity mix
https://www.energyinst.org/statistical-review
Electricity consumption by sector
https://www.enerdata.net/estore/energy-market/japan/#:~:text=Total%20Energy%20Consumption&text=Electricity%20consumption%20per%20capita%20was,2021%20following%20the%20Covid%20crisis.
EIA
https://www.eia.gov/todayinenergy/detail.php?id=61944#:~:text=This%20new%20policy%20calls%20for,promotion%20areas%20(4%20GW).
CO_2 pricing
https://carbonpricingdashboard.worldbank.org/compliance/price
Hydrogen society
Japan - Renewables - Japan's Hydrogen Subsidies Kicking-Off In Summer 2024 (mondaq.com)

CO_2 pricing (US$/tCO₂e)



Sources: World Bank: Carbon pricing dashboard

Sources:
Others
https://www.eia.gov/todayinenergy/detail.php?id=61945
https://powerline.net.in/2023/12/05/green-growth-goals-japans-decarbonisation-strategies/
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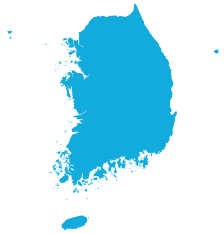
https://www.jepic.or.jp/pub/pdf/epij_Jepic2022.pdf

South Korea

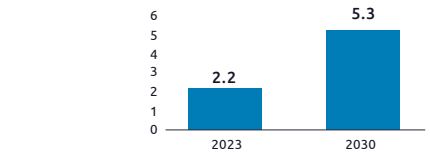


Electricity Regulatory Commission

South Korea will boost clean energy investments by 27% by 2030 for 2050 carbon neutrality. From 2021-2023, annual clean energy investment grew by 10% vs. 2016-2020. By 2025, it aims to meet the OECD average for climate development aid and focuses on nuclear exports, EVs, renewables, hydrogen, and CCUS.

The Ministry of Trade, Industry and Energy (MOTIE), is concerned with regulating some economic policy, especially about the industrial and energy sectors. MOTIE has taken on expanded roles and responsibilities, to help transform South Korea into a dynamic and economic powerhouse

While, the **Electricity Regulatory Commission (KOREC)**, a government agency functioning under the ministry, is responsible for the regulatory matters.

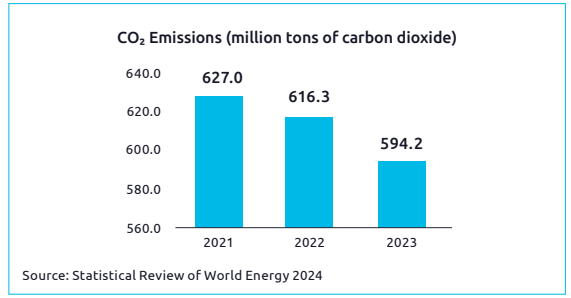


Sources: IRENA 2024, Reters

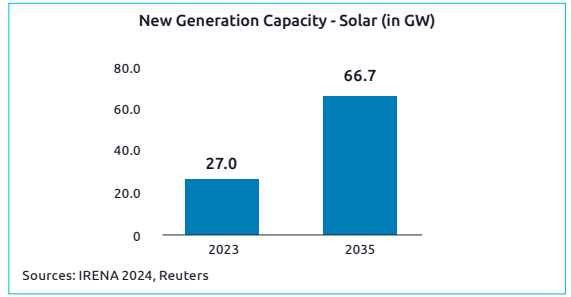
South Korea's electric grid is isolated from the neighbouring countries, and it imports most of its fuel needs.

In the domestic electric power industry, 6 power generation companies, independent power producers, and community energy systems are producing electric power, and KEPCO transports the electric power it purchased from the Korea Power Exchange through the transmission and distribution network and sells it to general customers.

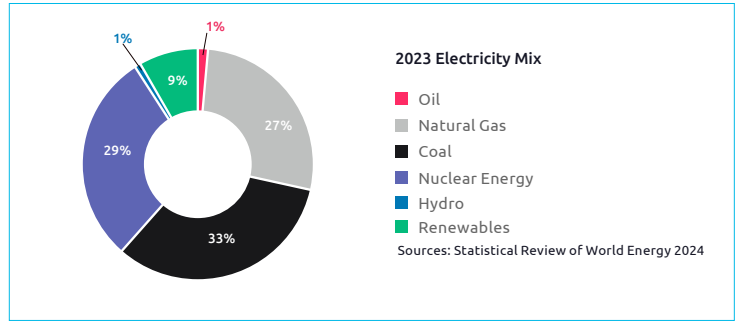
Sources:
Enerdata
https://www.enerdata.net/estore/energy-market/south-korea/
Reuters
https://www.reuters.com/sustainability/climate-energy/south-korea-plans-70-carbon-free-power-generation-by-2038-draft-shows-2024-05-31/#:~:text=The%20government%20maintained%20its%20previous,from%2023%20gigawatts%20in%202022.
Carbon pricing: other sources:
https://icapcarbonaction.com/en/news/south-korea-approves-initial-wave-near-term-ets-reforms
https://www.ieta.org/wp-content/uploads/2023/10/2023_IETA_BizBrief_SouthKorea_V2.pdf



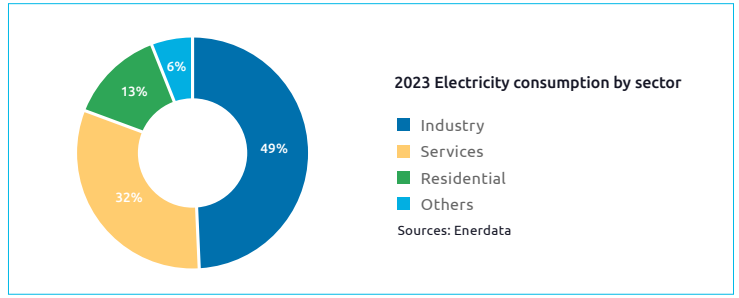
Source: Statistical Review of World Energy 2024



Sources: IRENA 2024, Reuters



Sources: Statistical Review of World Energy 2024



Sources: Enerdata

Public Utilities

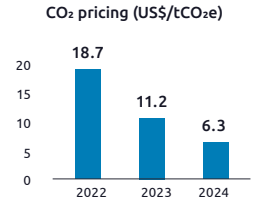
- Korea Electric Power Corporation's (KEPCO) wholly owned power generation subsidiaries, collectively referred to as the GENCOs, sustained approximately 69.5% of South Korea's electric power generation

Private Utilities

- The local Independent Power Producers (IPPs) accounted for 30.5%

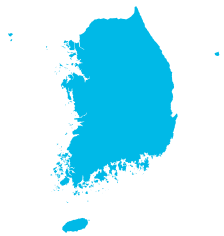
Sources: International Trade Administration

Gradual increase in **auctioning from 2024** , supply, demand, and future policy expectations affect prices, **economic downturns** reduce output, lowering prices, **faster GHG reduction** progress might decrease demand and lower prices



Sources: Worldbank, Other Sources

Indonesia



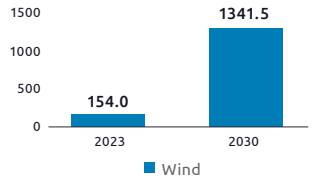
The current goal of Indonesia is between a 17% to 19 % renewable share in the energy mix by 2025, potentially rising above 30% by 2050. Latest power sector plan (RUPTL 2021–30) earmarks over 50% of new capacity for renewable energy, with 65 percent slated for development by independent power producers.

The main regulator for the energy industry in Indonesia is **MEMR (Ministry of Energy and Mineral Resources)**

PT Perusahaan Listrik Negara (Persero), an Indonesian government-owned corporation, has a monopoly on electric power distribution in Indonesia

In 2023, Indonesia had an electrical capacity of 85.1 GW with a projected capacity of 86.8 GW for 2024

New Generation Capacity- Wind (In MW)

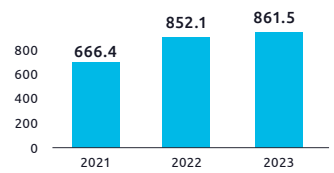


Sources: Mckinsey

- Between 2024 and 2033, Indonesia's state utility Perusahaan Listrik Negara (PLN) planned to build an **additional 31.6 GW of renewable power capacity.**
- Aimed to cut carbon emissions to **250 mmt/year by 2030** and increase **renewable energy generation to 44%.**
- The Indonesian Government implemented regulatory incentives for green growth and signed a **MoU with Singapore** for renewable electricity exports to boost the sector.

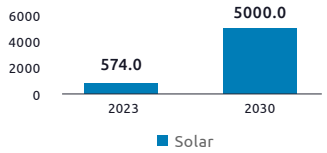
Sources:
New Generation Capacity:
https://www.mckinsey.com/id/our-insights/how-to-power-indonesias-solar-pv-growth-opportunities
Carbon pricing:
https://www.pwc.com/id/en/services/environmental-social-governance/indonesia-carbon-pricing.html
Other sources:
https://www.mordorintelligence.com/industry-reports/indonesia-power-market
https://english.kontan.co.id/news/indonesia-state-utility-plans-316-gw-renewable-power-capacity-in-2024-2033
https://www.mckinsey.com/id/our-insights/indonesias-green-powerhouse-promise-ten-big-bets-that-could-pay-off

GHG Emissions (million tons of CO_2 equivalents)



Source: Statistical Review of World Energy 2024

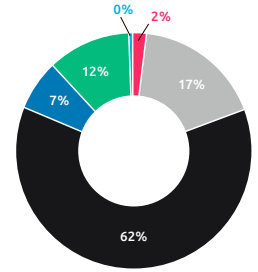
New Generation Development - Solar (in MW)



Sources: Mckinsey

- **Indonesia carbon exchange launched**: On 26 September 2023, the Indonesian Stock Exchange introduced the IDX Carbon to advance the country's goal of net zero emissions by 2060.
- **Sector-based carbon pricing mechanism**: The regulation implements a carbon pricing mechanism across various sectors (energy, waste, IPPU, agriculture, forestry) to meet Nationally Determined Contributions (NDCs) and control GHG emissions.

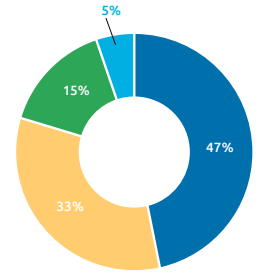
Sources: Pwc



2023 Electricity Mix

- Oil
- Natural Gas
- Coal
- Hydro
- Renewables
- Others

Sources: Statistical Review of World Energy 2024

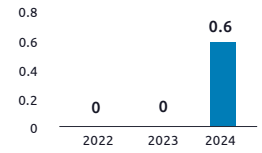


2023 Electricity consumption by sector

- Industry
- Households
- Business
- Others

Sources: Statista

CO_2 pricing (US$/tCO₂e)



Sources: Worldbank

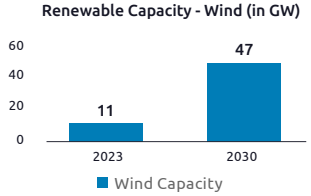
Australia

- **Australian Government in its Budget October 2024–25 has committed to unlock more than $65 billion of investment in renewable capacity through the Capacity Investment Scheme by 2030.**
- **Australia is debating a pivot; Liberal National Coalition parties are making nuclear power a central plank of their policy platform to oust the current Labor government, driven in part by their historic opposition to renewables and a poll by Essential Research in April 2024 found more than 50% of Australians were supportive of Australia developing a nuclear industry.***

AEMO manages electricity and gas systems and markets across Australia, helping to ensure Australians have access to affordable, secure and reliable energy.

ARENA is the Australian Renewable Energy Agency aims to support improvements in the competitiveness of renewable energy and enabling technologies, increase the supply of renewable energy in Australia.

Clean Energy Regulator (CER) is responsible for measuring, managing, reducing or offsetting Australia's carbon emissions.

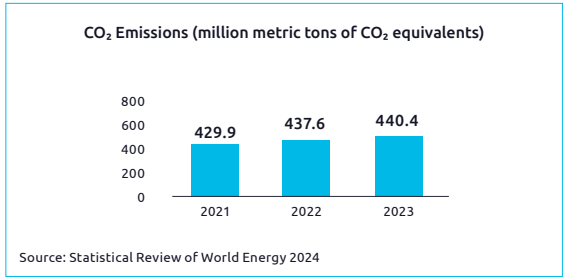


Source: IRENA and Statista

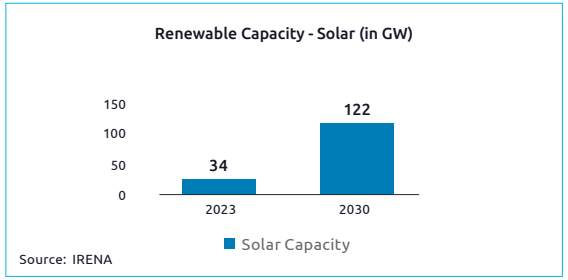
The Australian government's new energy strategy targets

- Expand renewable energy to reach 82% by 2030.
- Launch Solar Sunshot Scheme with $1B for domestic solar tech.
- Encourage investments in critical minerals and energy storage.
- Establish net zero Economy Authority for infrastructure projects.

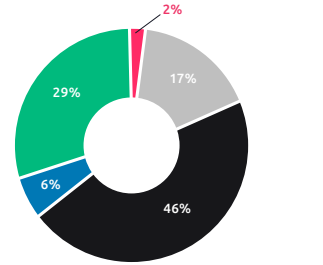
Carbon tax - Australia has implemented a $70 'shadow price' on carbon emissions in 2024



Source: Statistical Review of World Energy 2024



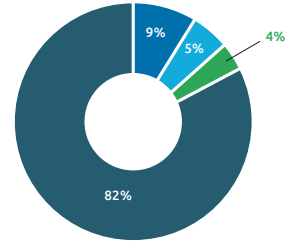
Source: IRENA



2023 Electricity Mix

- Oil
- Natural Gas
- Coal
- Hydro
- Renewables
- Others

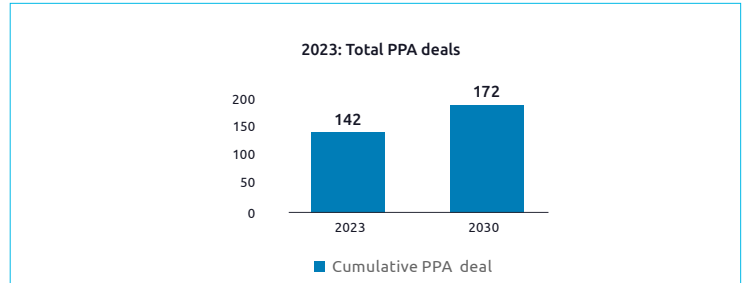
Source: Statistical Review of World Energy 2024



2023 Electricity consumption by sector

- Residential
- Commercial
- Others
- Industrial

Source: Energy.gov.au



Source: Climate-kic.org.au

*The Liberal-National coalition announced seven locations where small modular reactors (SMRs) or large-scale units could be installed, all in sites hosting coal-fired power facilities that have either closed or are scheduled to close, and each of them would have cooling water capacity and transmission infrastructure. A SMR could start generating electricity by 2035, while a larger plant could come online by 2037, according to the coalition.

Sources: https://www.japantimes.co.jp/news/2024/07/23/world/politics/nuclear-australia-climate-wars/
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COe + Electricity mix
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Consumption by Sector
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IRENA_RE_Capacity_Statistics_2024.pdf

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https://www.globalaustralia.gov.au/news-and-resources/news-items/australian-budget-commits-a25bn-clean-energy-and-renewables-projects#:~:text=Australian%20Budget%20commits%20A%2425bn%20to%20clean%20energy%20and%20renewables%20projects&text=The%20Australian%20Government%20has%20released,net%20zero%20commitment%20by%202050.y
Budget to bankroll phase two of clean energy transition – pv magazine Australia (pv-magazine-australia.com)

Saudi Arabia

The growth of renewable power in Saudi Arabia has picked up pace recently because of the country's policy to diversify its sources to ensure supply security in the long term. Due to the increasing power demand in Saudi Arabia, the country has been overutilizing its fossil fuels reserves instead of exporting them. An abundance of solar radiation and wind resources makes solar and wind power the key renewable technologies of focus.

In July 2024, PIF has announced the signing of new agreements to localize in Saudi Arabia, the manufacturing and assembly of equipment and components needed for solar and wind power. These agreements have been entered into by the Renewable Energy Localization Company (RELC), a fully owned PIF company.

RELC works toward achieving the most appropriate mix for electricity production and replacing liquid fuels currently used in electricity in Saudi Arabia, in line with Saudi efforts toward achieving Vision 2030 targets.

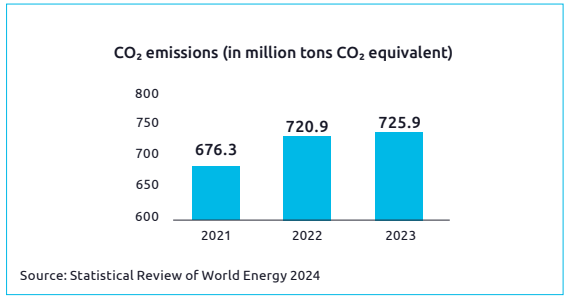
During 2015-2023, renewable power capacity in Saudi Arabia increased at a CAGR of 82.4% from 0.02GW to 3GW. In 2023, solar PV constituted 82.6% of the total renewable power capacity of the country, followed by onshore wind accounting for nearly 14.1% and solar thermal accounting for 3.1% share.

Share of renewable power capacity in Saudi Arabia's total capacity mix is estimated to reach 35.4% in 2035 from 3.2% in 2023 with an estimated share of 6.9% in 2030.

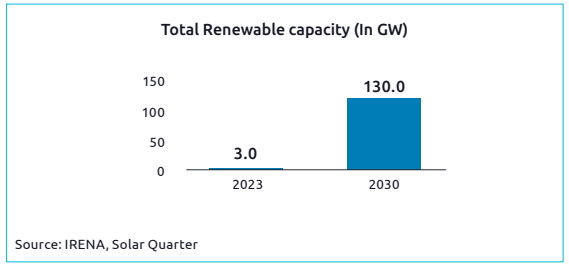
Water and Electricity Regulatory Authority (WERA) regulates the electricity and water desalination sector within the Kingdom. It also preserves these services from economic fluctuations to maintain financial growth and the prosperity of the national economy.

Saudi Electricity Regulatory Authority (SERA) is the regulatory body for the electricity sector in the Kingdom of Saudi Arabia. It aims to make the sector consumer-centric, organized, reliable, sustainable, and highly efficient.

ACWA Power is a leading developer of renewable energy projects in Saudi Arabia, with a focus on solar and wind energy. ACWA Power is working towards Saudi Arabia's renewable energy goal by contributing around 40 GW towards this target, with 24 GW of green projects already operational or in advanced stages. ACWA Power has increased its desalination capacity and aims to accelerate project timelines, ensuring that the company stays ahead of the curve. ACWA Power's efforts to expand capacity and lower costs have made Saudi solar energy among the cheapest globally. Two-fifths of ACWA Power's capacity is outside Saudi Arabia, and the company is also eyeing China for potential growth.



Source: Statistical Review of World Energy 2024



Source: IRENA, Solar Quarter

Sources:
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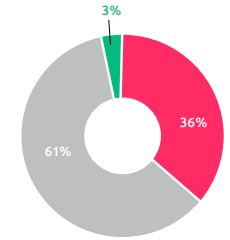
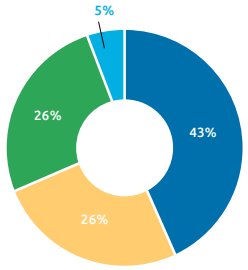


2023 Electricity mix

- Oil
- Natural Gas
- Renewables

Sources: Statistical Review of World Energy 2024



Electricity consumption by sector

- Industrial
- Residential
- Services
- Others

Sources: Enerdata, Clean Energy Wire

SPPC signs PPAs for three new solar PV projects (5.5 GW) in Saudi Arabia: The Saudi Power Procurement Company (SPPC) has signed power purchase agreements for three new solar photovoltaic projects with a combined capacity of 5.5 GW, as part of Saudi Arabia's National Renewable Energy Program. The estimated $3 Bn deals with Saudi renewable energy utility ACWA Power Company, the Water & Electricity Holding Company and Aramco Power for the following plants: 2 GW Haden, the 2 GW Al Muwayh and 1.5 GW Al Khushaybi located in the Qassim region.

Ministry of Energy announced Saudi Arabia's ambitious goal of adding 20 GW of renewable energy annually, targeting a total of 130 GW before 2030.

Sources: GreenTree Global Publication

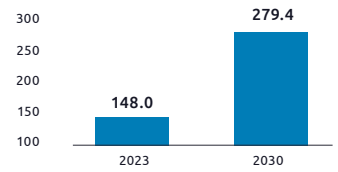
USA

- **USA expected to triple renewable energy by 2030; Investment in clean energy increases to an estimated more than $300 billion in 2024, 1.6 times the 2020 level.**
- **In October 2023, the U.S. Government announced $3.46 Bn for 58 projects to strengthen grid reliability and resilience, sparking a combined public-private investment of $8 billion, and bringing more than 35 GW of new renewable energy.**

Regulations in the USA are enforced by several federal and state government entities.

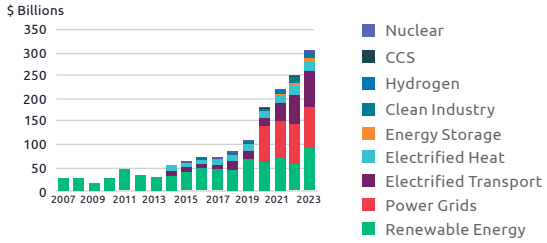
The **Federal Energy Regulatory Commission (FERC)** regulates the interstate transmission of electricity, natural gas, and oil. While several federal offices such as **U.S. Department of Energy, Environmental Protection Agency** and others oversee specific components of the oil and gas industry

New generation capacity- Wind (in GW)



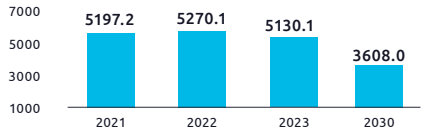
Source: IRENA, Internal Forecast

U.S. Energy transition investment, by sector



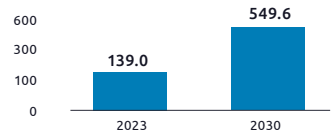
Sources: Sustainable Energy in America 2024 Factbook

CO_2 emissions (million metric tons of CO_2 equivalents)

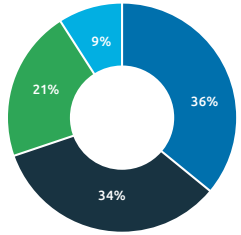


Source: Statistical Review of World Energy Data 2024 , EIA

New generation capacity- Solar (in GW)



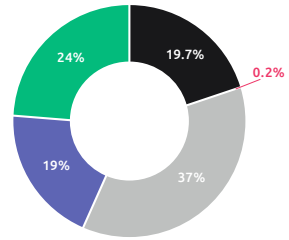
Sources: IRENA, Internal Forecast



2023 Electricity consumption by sector

- Residential
- Services
- Industry
- Others

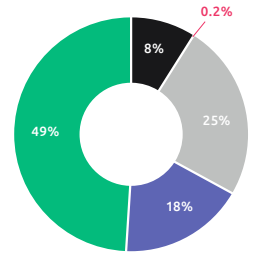
Sources: Enerdata



2023 Electricity Mix

- Coal
- Oil
- Natural Gas
- Nuclear
- Renewable Sources

Source: EIA



2030 Electricity mix

- Coal
- Oil
- Natural Gas
- Nuclear
- Renewable Sources

Source: EIA

Energy tax credits and subsidies	
Clean energy Investment Tax Credit	**30% credit** for qualifying investments in wind, solar, energy storage, and other renewable energy projects
48C Advanced Energy Project Investment Tax Credit	**additional $10 billion, a 30% credit** for facilities that manufacture clean energy technologies; facilities that reduce their emissions by at least 20%; and facilities that work in critical minerals processing, refining, and recycling
45X Advanced Manufacturing Production Tax Credit	**per-unit production incentive** for clean energy technologies that are domestically manufactured. Eligible technologies include solar, wind, battery storage components

Sources:
https://www.energyinst.org/__data/assets/pdf_file/0006/1542714/EI_Stats_Review_2024.pdf
https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf
https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf
https://www.eia.gov/environment/emissions/carbon/
https://www.eia.gov/outlooks/aeo/pdf/AEO2023_Narrative.pdf
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https://www.eesi.org/briefings/view/092823ira
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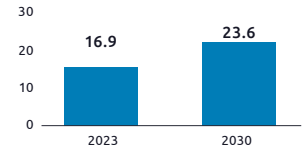
https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/30/fact-sheetbiden-harris-administration-announces-historic-investment-to-bolster-nations-electric-grid-infrastructure-cut-energy-costs-for-families-and-create-good-paying-jobs/
https://about.bnef.com/blog/1h-2024-us-clean-energy-market-outlook-moving-past-2030/

Canada

- **Solar is overtaking wind as the largest single source of new generating capacity in Canada in 2024, but new gas-fired resources, both new facilities and repowered coal plants, are expected to come into service as well**
- **Government of Canada announced plans to allow systems that utilize waste biomass to produce heat and/or electricity to claim the country's Clean Technology Investment Tax Credit and Clean Electricity Investment Tax Credit.**

The **federal government** plays a supporting role by investing in research and development and supporting the commercialization of new technologies.

The **Canada Energy Regulator** exercises federal jurisdiction over electricity exports and over international and interprovincial power lines; The **Canadian Nuclear Safety Commission** regulates the use of nuclear energy and materials to protect health, safety, security and the environment, and to implement Canada's international commitments on the peaceful use of nuclear energy.[1]



Sources: Canadian Renewable Energy Association and Statista

Canada has three power grids such as the **Western grid, the Eastern grid, and the Quebec grid.** Canada's grids are also tied into the United States' grids through 37 major transmission lines from New England to the Pacific Northwest.

The Canada Energy Regulator describes Canada's electricity grid as **"fragmented,"** with few grid connections that link different locations together. Large grid connections primarily connect provinces to the United States and electricity flows north to south.[3]

BC Hydro received a strong response to its call for new renewable power-generation projects while it continues to build out and strengthen B.C.'s electricity grid, creating jobs and supporting clean growth; Out of the proposals received, approx. 70% are wind projects, 20% are solar, and 10% include biomass and hydro.[4]

Sources:
https://www.canada.ca/en/natural-resources-canada/news/2023/09/federal-government-invests-in-12-new-wind-solar-and-smart-grid-projects-with-alberta-indigenous-and-industry-partners.html
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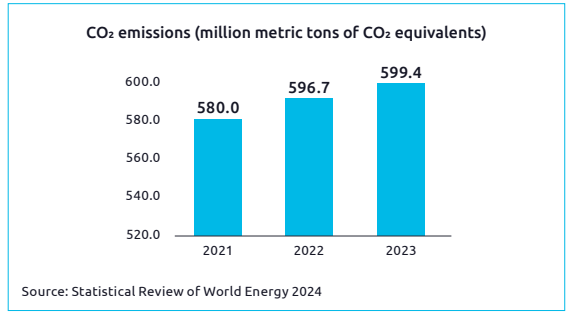
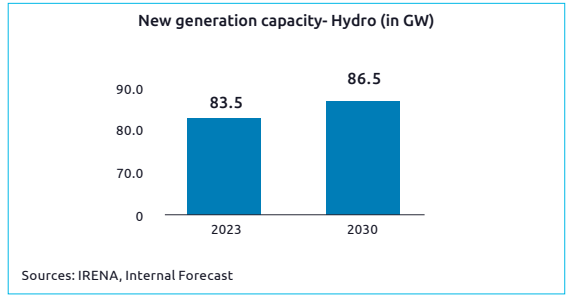
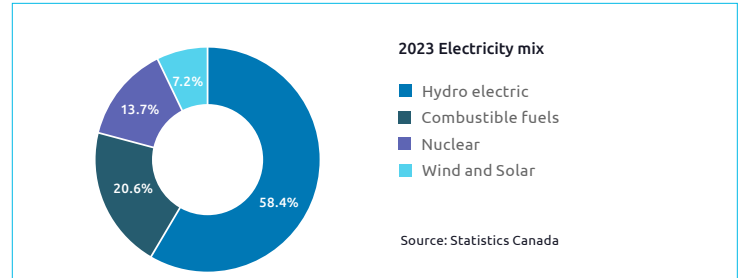
https://natural-resources.canada.ca/our-natural-resources/energy-sources-distribution/electricity-infrastructure/about-electricity/7359#structure



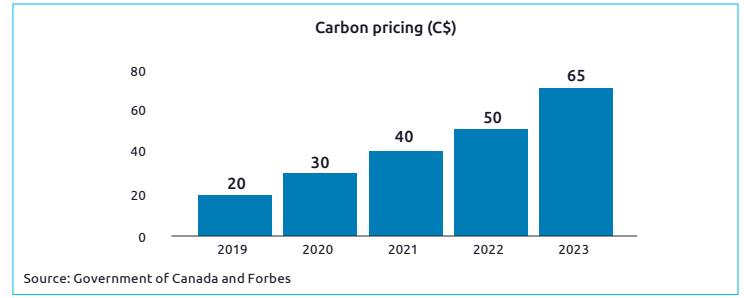
Source: Statistical Review of World Energy 2024



Sources: IRENA, Internal Forecast



Source: Statistics Canada



Source: Government of Canada and Forbes

Public (municipal, provincial): Around 60% of the utilities are municipally owned

Private (Investor-Owned)

Co-operative 20% are owned by co-operatives

Provincial governments exercise their jurisdiction through **provincial Crown utilities and regulatory agencies.** Traditionally, electricity has been provided mainly by vertically-integrated electric utilities that were often provincial Crown corporations with monopoly rights (e.g., Manitoba Hydro).

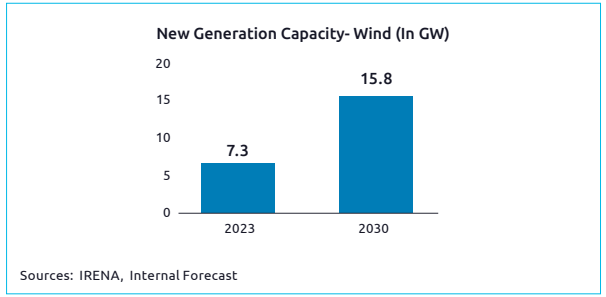
Energy tax credits and subsidies	
Refundable tax credit for clean energy investments, including solar photovoltaic, wind, storage and small modular nuclear reactors.	30% of up to CAD 6.7 billion over five years
Investment Tax Credit for Clean Electricity	15%
Investment Tax Credit for Clean Hydrogen	At least 40% the lowest carbon intensity tier that meets all eligibility requirements

Mexico

Mexico's nearshoring appeal attracted inward foreign direct investment (FDI) flows of around $36 billion in 2023, their highest level in 18 years, compared to around $14 billion in 2006

Mexico's National Electric System (Sistema Eléctrico Nacional or SEN) is comprised of 9 regions, plus a binational electricity system in Baja California. Most of the nine regions are interconnected, forming the National Interconnected System (SIN). The Baja California system operates in the Western Interconnection of the United States, overseen by the Western Electricity Coordinating Council (WECC).

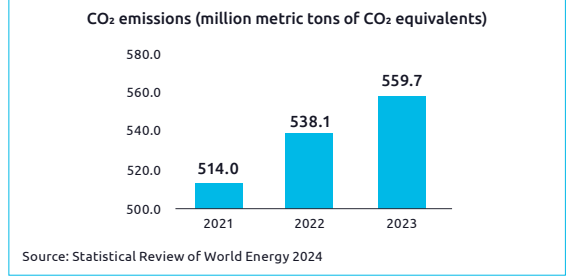
The Secretariat of Energy (SENER) is the government department in charge of production and regulation of energy in Mexico. SENER estimates there to be 64,595 MW of newly installed capacity by 2038 including PV-DG, green hydrogen, and storage systems



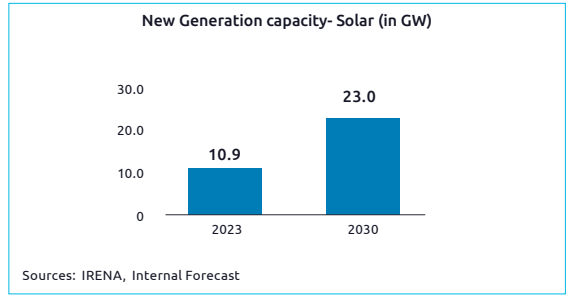
Sources: IRENA, Internal Forecast

Power Purchase Agreements (PPAs) are one of the main ways to trade energy in Mexico. Several Private energy utilities such as Iberdrola, Enel, ENGIE, and Mitsui offers attractive PPAs in Mexico for large consumers.

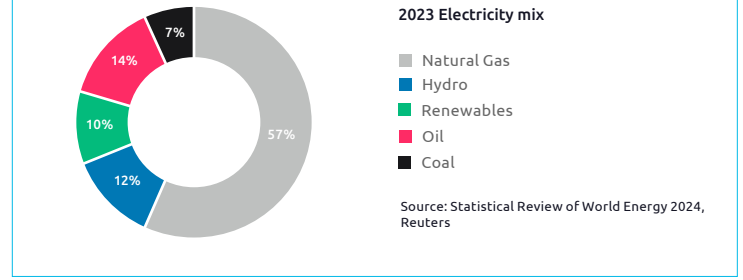
The other mechanism to trade energy is the wholesale market. The **Mexican Wholesale Electricity Market (MEM)** is a short-term market where prices are determined one day in advance or in real time. Electricity producers send bids to the National Center for Energy Control (CENACE) that indicate the amount of energy they are offering at a specific price. Currently, CFE and some private companies are participating in the markets.



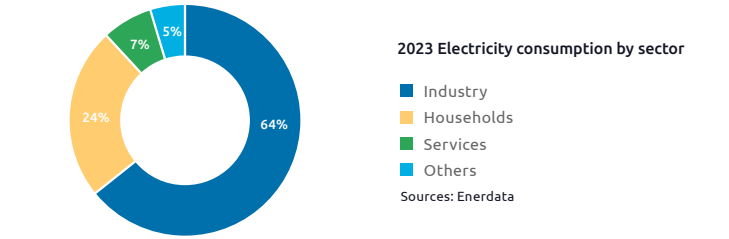
Source: Statistical Review of World Energy 2024



Sources: IRENA, Internal Forecast



Source: Statistical Review of World Energy 2024, Reuters



Sources: Enerdata

Role of government and regulators	
Energy Ministry (SENER)	Preparation, enforcement and supervision of the electricity energy policy
Energy Regulatory Commission (CRE)	Government regulator for Mexico's oil, natural gas, biofuels, and electricity sectors
CENACE (Centro Nacional de Control de Energía), a subdivision of a State-owned electric utility company, CFE (Comisión Federal de Electricidad)	Manages the wholesale electricity market and power grid. It regulates the purchase and sale market of electric energy

Public Utilities	Private Utilities
• State-owned electric utility company, **CFE (Comisión Federal de Electricidad)**, holds **54% share** of the electricity market.	• The local Independent Power Producers (IPPs) accounted for 30.5%
• In 2023, CFE produced **73%** of the electricity consumed in Mexico, covering 99.4% of the population's needs.	• Iberdrola • Naturgy • Sempra Energy • Fermaca • TC Energy

Sources: Economic Times, Mexico Business

Sources:
https://www.energyinst.org/__data/assets/pdf_file/0006/1542714/EI_Stats_Review_2024.pdf
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Figure 5: CO_2 capture capacity by Region

Figure 6: CCUS investment pipeline by type (left) and region (right) based on announced projects

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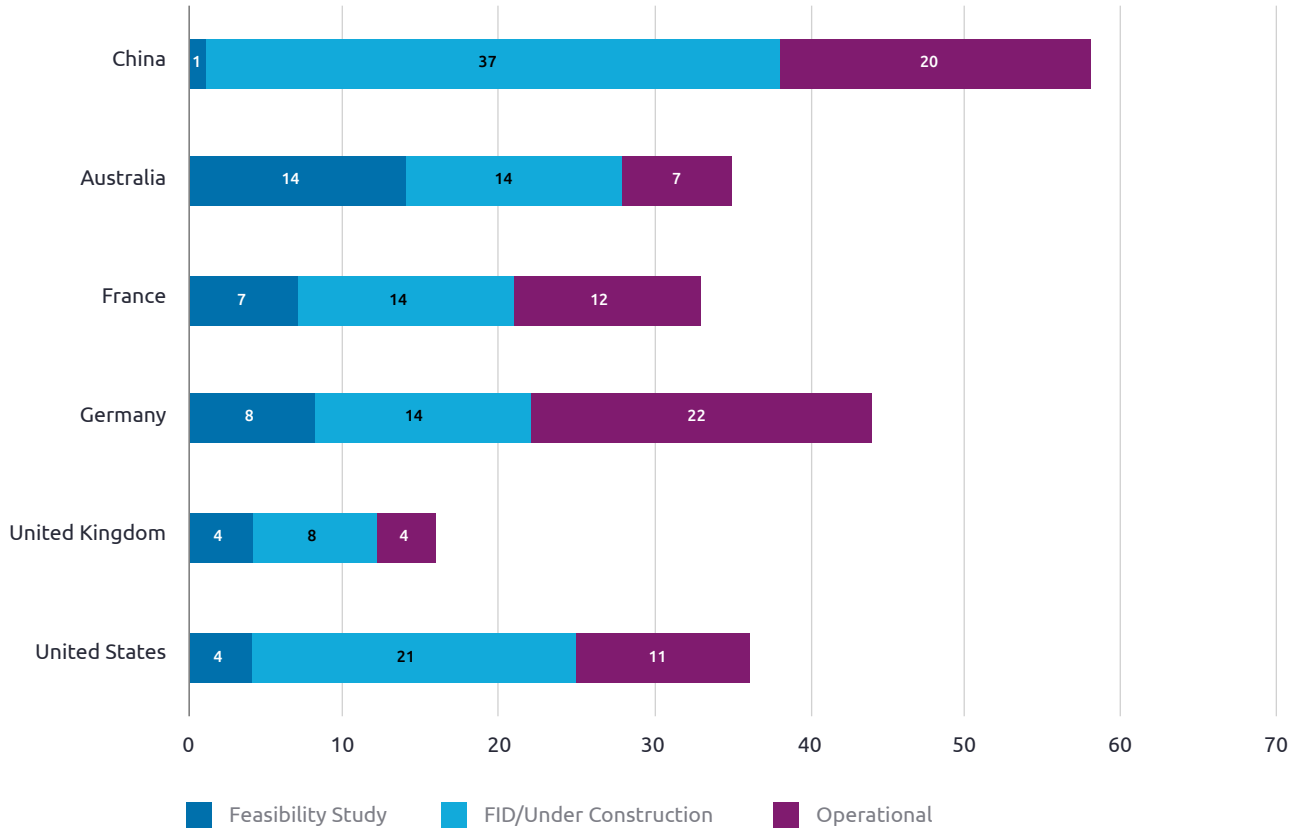
Figure 18: Deployment progress to be made by technology levers (2/2)

Hydrogen

FIGURE 1

Hydrogen production projects (2019-2024)



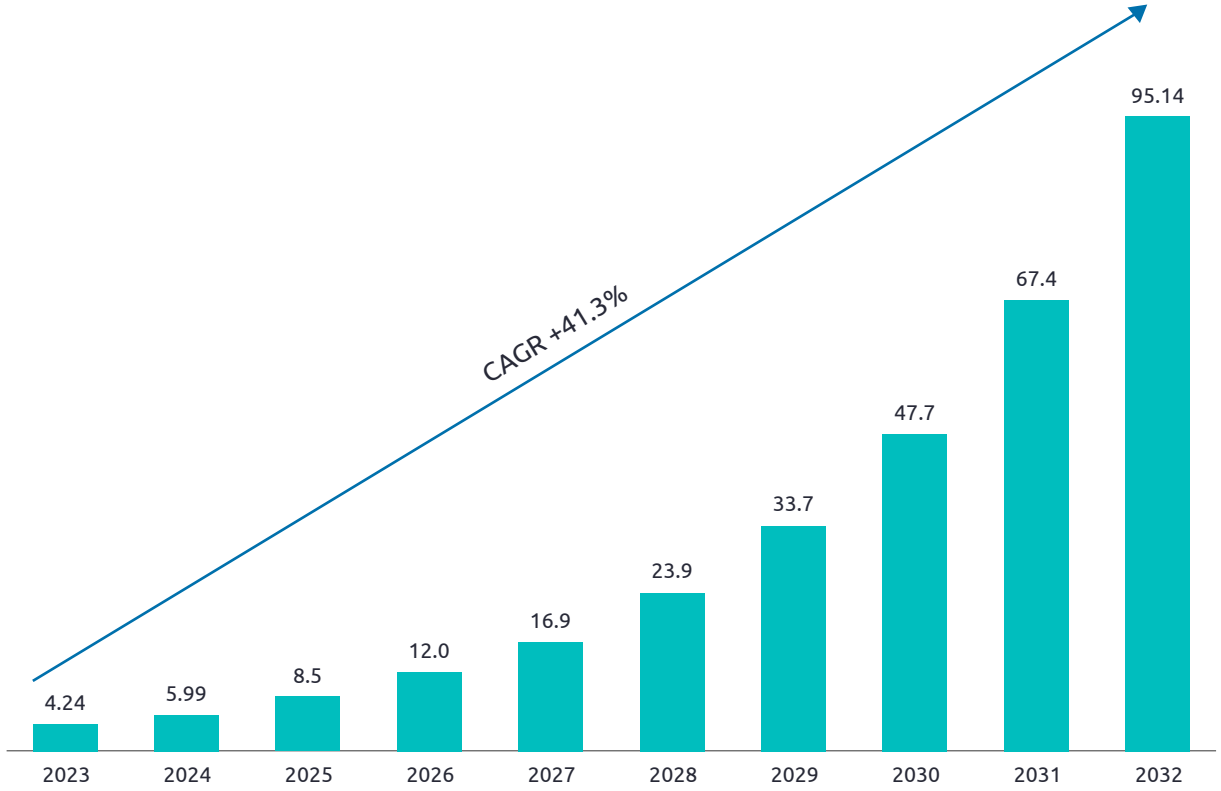
Source: IEA

Hydrogen

Green hydrogen production can grow massively by 2030 but cost challenges are hampering deployment

FIGURE 2

Green Hydrogen Market Size, 2023 - 2032 (USD bn)



Source: Polaris Market Research

- The global green hydrogen market was valued at $4.24 Bn in 2023, which is estimated to reach $95.14 Bn in 2032, growing at a CAGR of 41.3%
- More than 1,000 renewable and low-carbon hydrogen projects requiring $320Bn of investment by the end of 2030 have been announced globally, although less than 10% have reached final investment decision
- Of these projects, 112 are for gigawatt-scale production — 91 of which are green and 21 are "low-carbon", and will need about $150Bn of investment by 2030, according to the Hydrogen Insights 2023 study

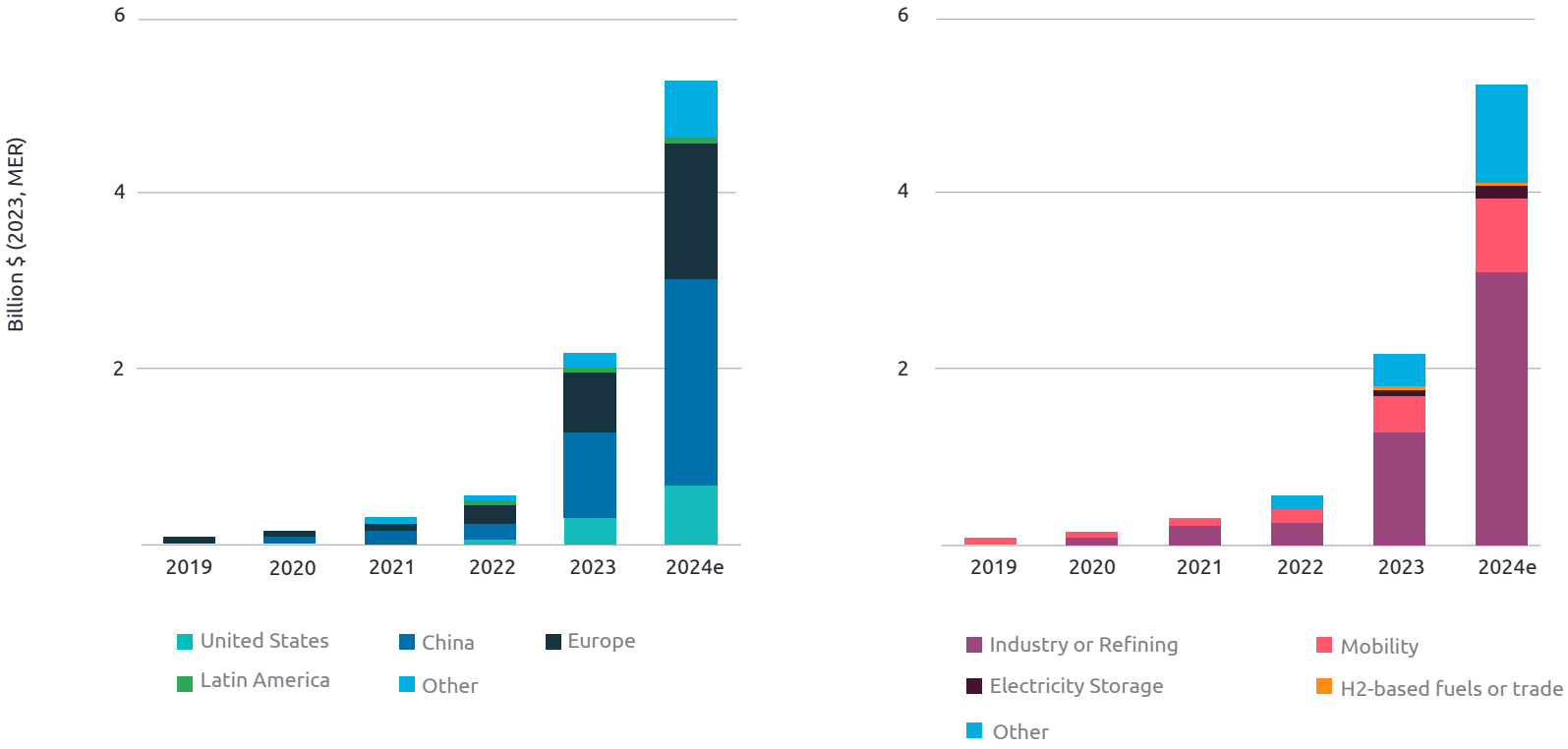
Hydrogen

Investment in hydrogen electrolysers is set to increase by 140% in 2024, reaching $5 billion due to new capacity additions and cost inflation

- China will invest $900 million in a new plant in 2024 and plans 20+ 100 MW projects by 2026
- Europe's investment will increase 120%, featuring a $270 million electrolyser in Portugal and a $7 billion steel plant in Sweden
- The USA will see a 120% rise in investment, driven by the Clean Hydrogen Production Tax Credit, with a $550 million plant in Arizona
- Saudi Arabia's $8.4 billion plant will be the world's largest, starting in 2026, and ACME Group in Oman will invest $480 million in a 2025 project

FIGURE 3

Investment in hydrogen electrolysers and other supply by region (left) and intended use (right)



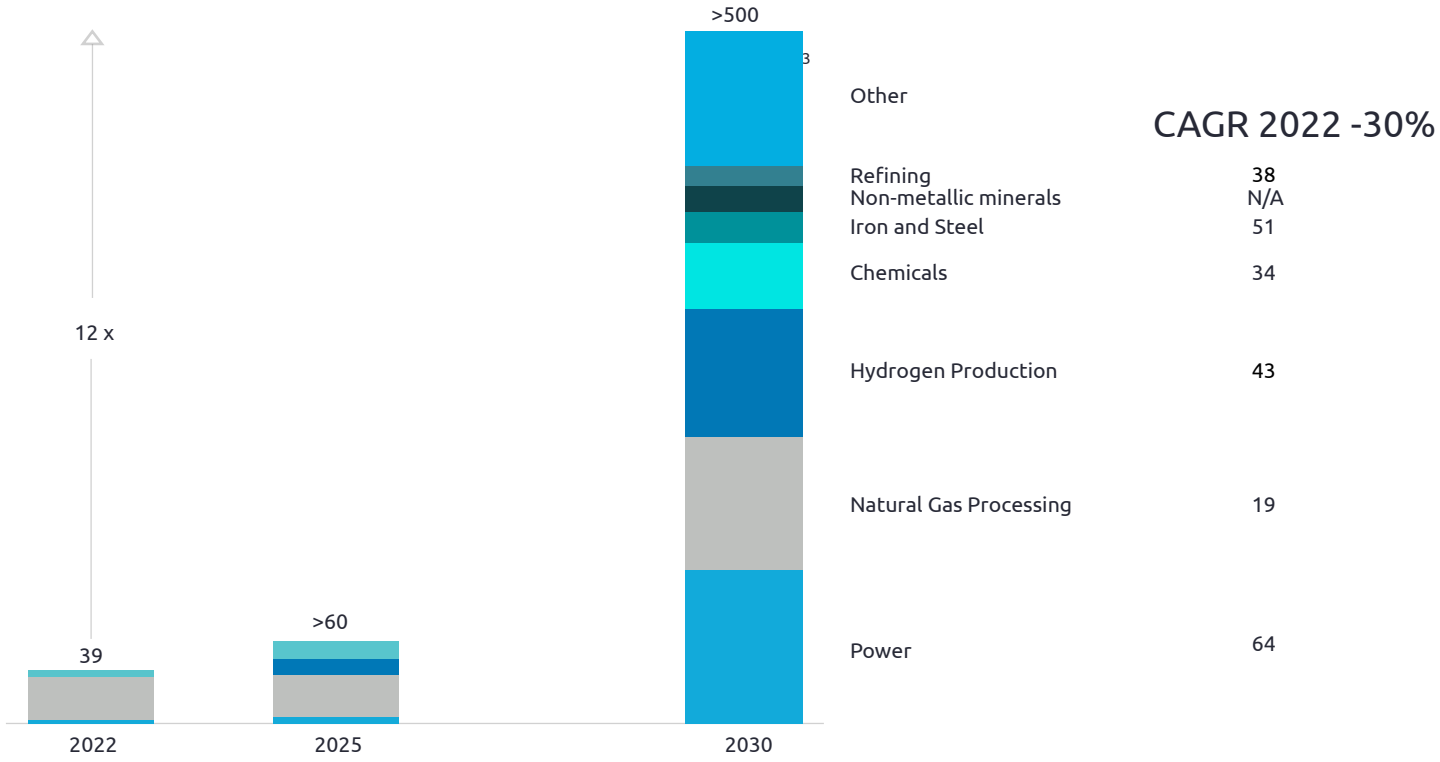
Source: World Energy Investment 2024

CCUS

CCUS: Capacity of announced CCUS PROJECTS, ($mtCO_2$ PER year)

FIGURE 4

Capacity of announced CCUS PROJECTS, ($mtCO_2$ PER year)



Source: McKinsey Energy Solutions: Global Energy Perspective 2023

- The CCUS market is rapidly expanding, with CO_2-capture capacity expected to increase at least threefold between 2020 and 2030
- In the past year, CCUS capacity under development has grown by over 40%, with more than 200 new facilities added to the pipeline, totaling 68 in operation, 39 under development, and 533 in planning
- Europe and North America together account for the largest share, <80% of announced capacity, largely driven by policy incentives

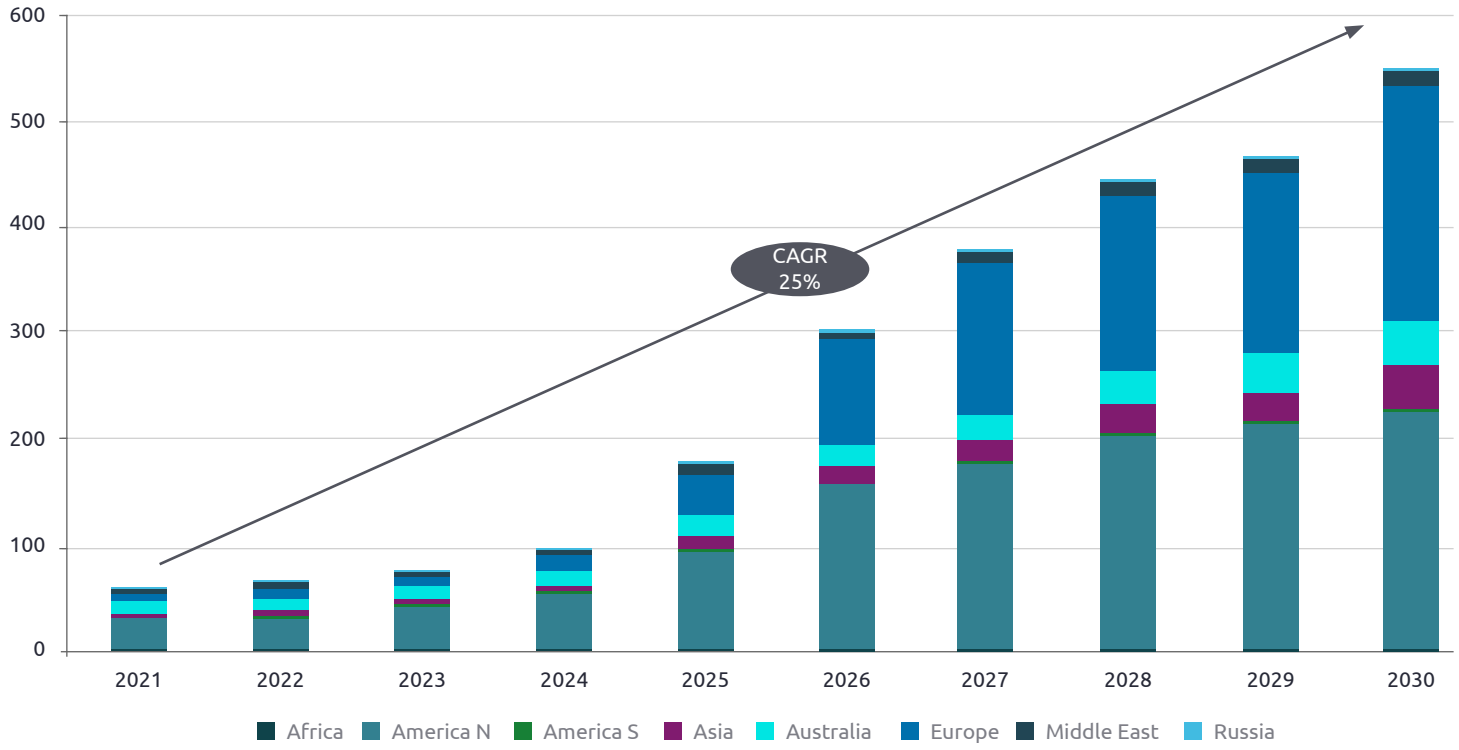
CCUS

FIGURE 5

CO_2 capture capacity by Region

Global CO_2 capture capacity by region

Million tonnes per annum



Source: Rystad

- As a result of supportive policies and incentives, Europe and North America will dominate the CCUS market by 2030, contributing 450 million tpa of capture capacity, more than 80% of the projected global total of 550 million tpa
- European capacity is projected to hit 222 million tpa by 2030

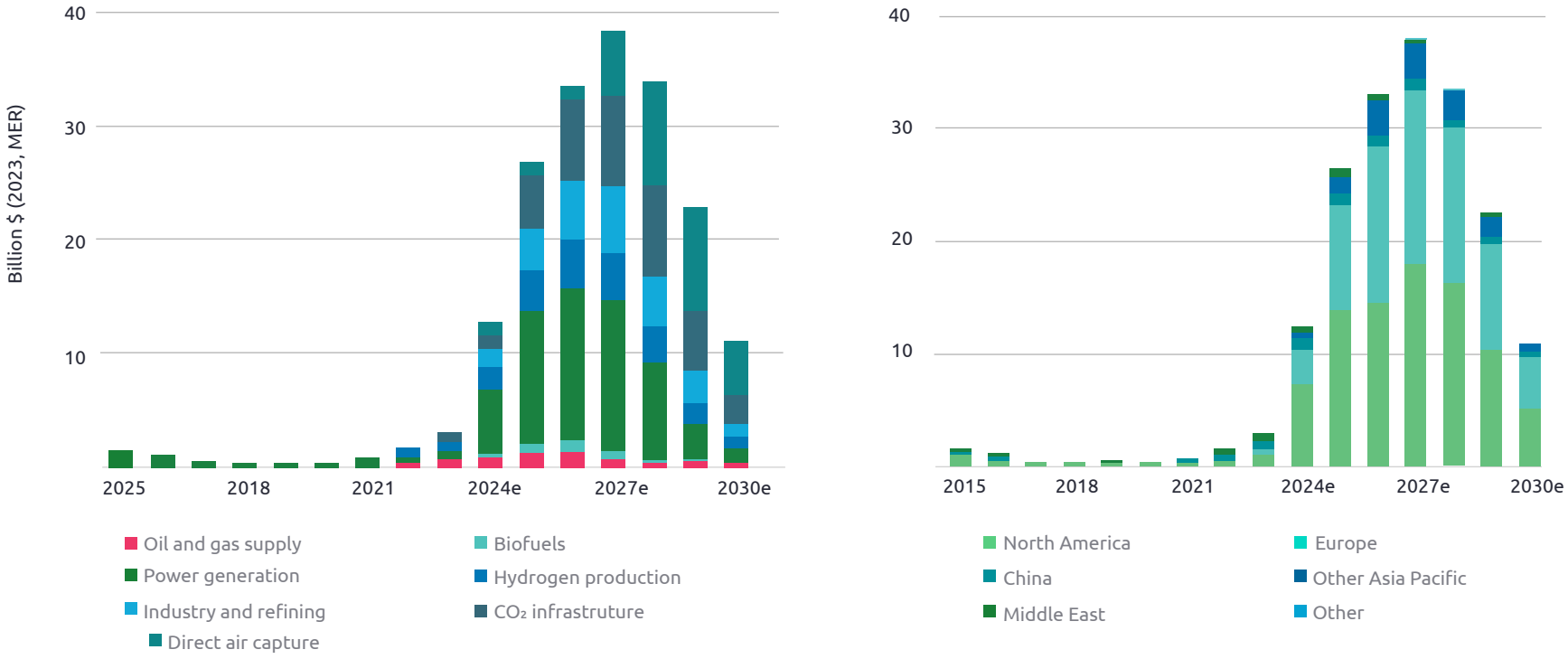
CCUS

$20bn in public funding was allocated to CCUS projects in 2023, including $1.7bn from the USA, $1.2bn from Denmark, and over $500mn from the EU

- Around 20 commercial-scale CCUS projects reached FID in 2023 across seven countries
- CCUS investment could increase nearly tenfold to $26 billion by 2025
- Global CO_2 capture capacity would increase to 430 Mt CO_2/year and storage capacity to 620 Mt CO_2/year by 2030
- Investment in DAC projects will rise to $660 million in 2024, with the Stratos project in Texas targeting a capacity of 500 kt CO_2/year by mid-2025

FIGURE 6

CCUS investment pipeline by type (left) and region (right) based on announced projects



Source: World Energy Investment 2024

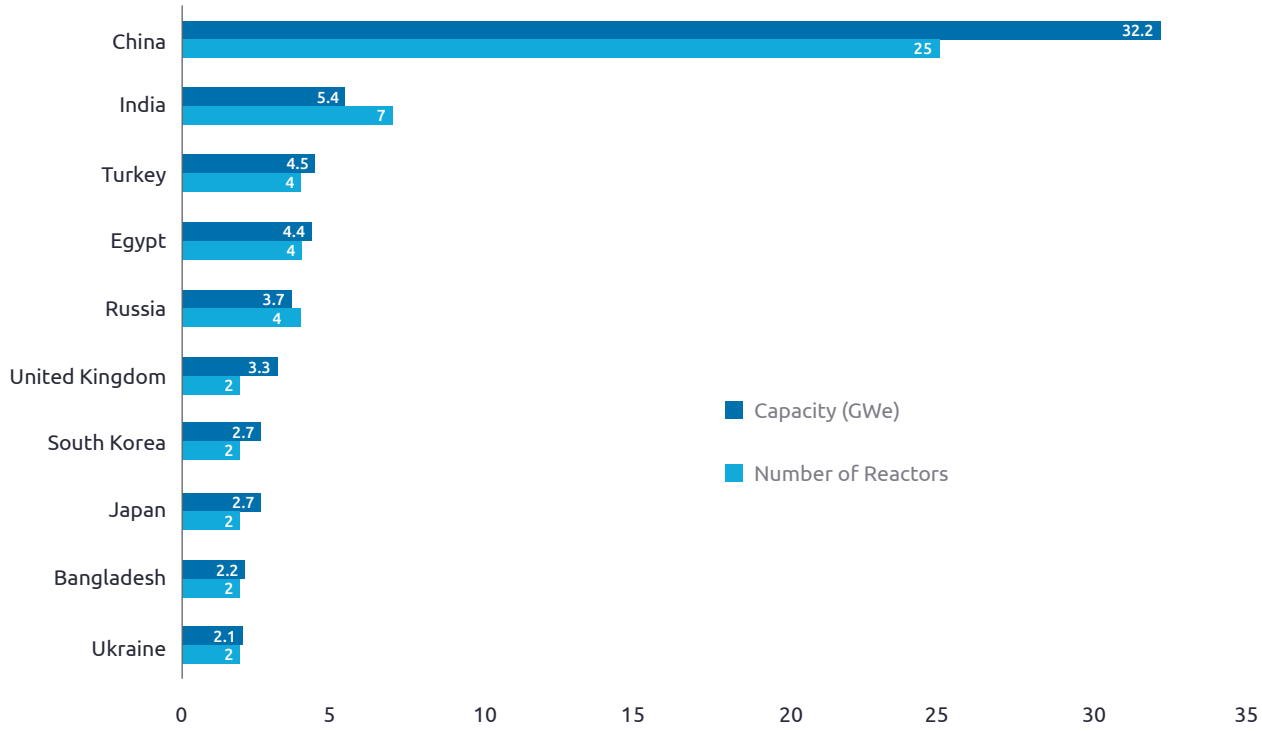
Nuclear

Nuclear renaissance triggered by climate change and sovereignty issues

FIGURE 7

Reactors under construction

Top 10 reactors under construction net capacity - 2023



Source: World Nuclear Association - Reactor Database

- In 2024, there were 64 nuclear reactors under construction worldwide with total capacity of 67.4 GWe
- China ranked first with 25 units with capacity of 32.2 GWe
- Followed by India and Turkey, with 7 and 4 reactors under construction, having capacities of 5.4 GWe and 4.5 GWe, respectively
- In 2023, 5 nuclear reactors were permanently shut down worldwide

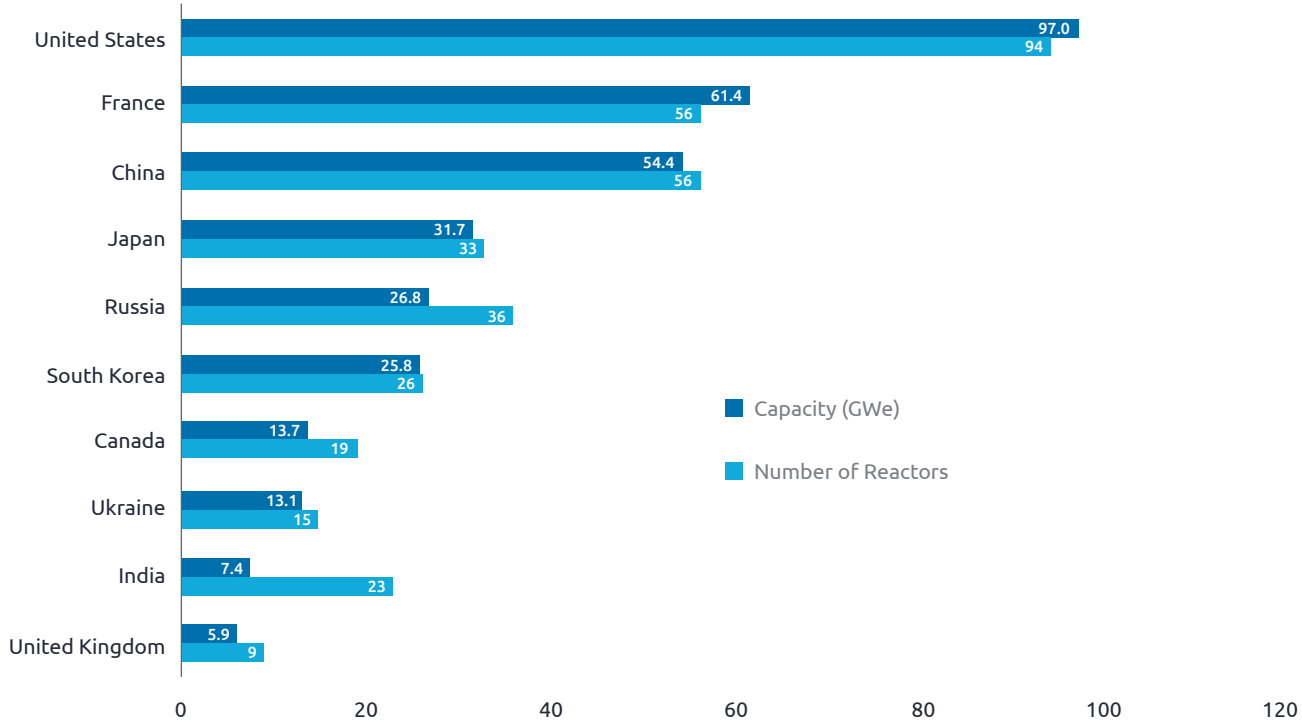
Nuclear

Nuclear renaissance triggered by climate change and sovereignty issues

FIGURE 8

Operable reactors

Top 10 operable reactors net capacity - 2023



Source: World Nuclear Association - Reactor Database

- In 2024, there were 439 nuclear reactors in operation in 32 countries around the world with total capacity of 395.4 GWe
- The United States had the largest number of nuclear power reactors in operation at the time, at 94 units with highest capacity of 97.0 GWe
- France and China had the second largest number of nuclear power reactors in operation at the time, at 56 units each with 61.4 GWe and 54.4 respectively

Nuclear

FIGURE 9

Nuclear renaissance

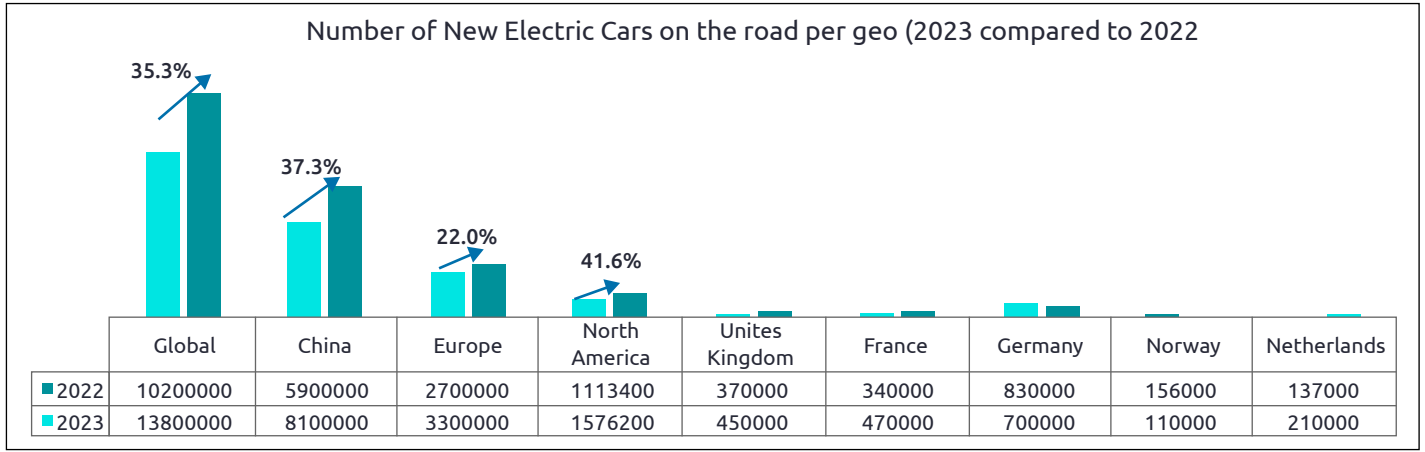
Upcoming planned reactors	**~90** planned **>300** proposed	In 2024, 88 power reactors with a total capacity of 85 GWe are planned, and 344 more are proposed with capacity of 365 GWe
Online nuclear reactors	**5**	In 2023, 5 new nuclear reactors came online (Belarus, China, Korea, Slovak Republic, and the USA)
New reactors projects	**33** completed **~60** under construction	**66GW** under construction reactors' worldwide capacity

Most reactors currently planned are in countries in Asia, characterized by fast-growing economies and rapidly-rising electricity demand

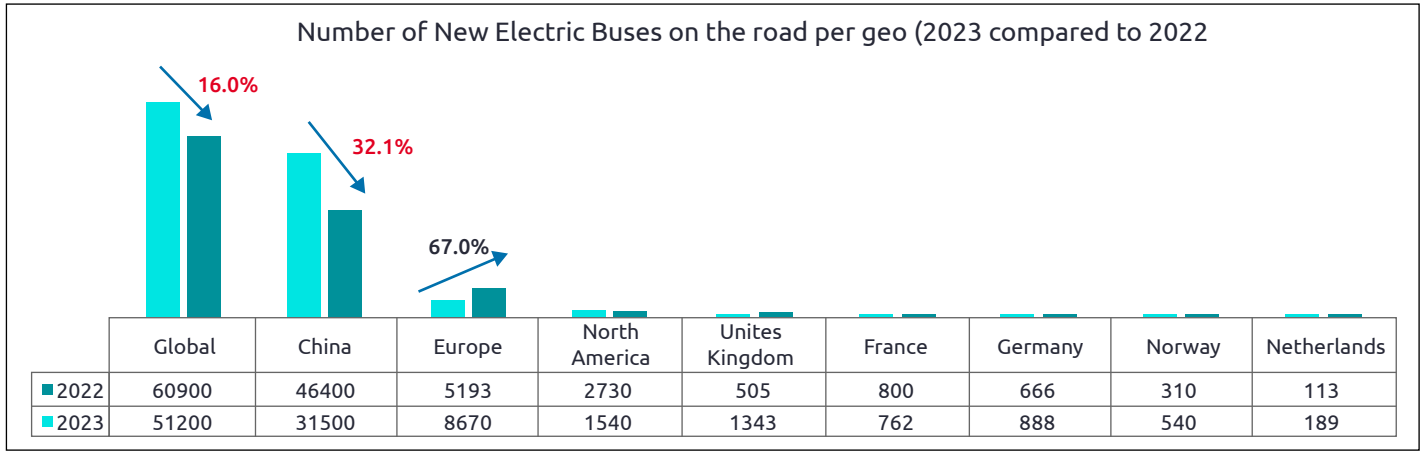
EV Transport

FIGURE 10

Number of New Electric Cars and Buses on road



	Global	China	Europe	North America	Unites Kingdom	France	Germany	Norway	Netherlands
2022	10200000	5900000	2700000	1113400	370000	340000	830000	156000	137000
2023	13800000	8100000	3300000	1576200	450000	470000	700000	110000	210000



	Global	China	Europe	North America	Unites Kingdom	France	Germany	Norway	Netherlands
2022	60900	46400	5193	2730	505	800	666	310	113
2023	51200	31500	8670	1540	1343	762	888	540	189

Source: IEA

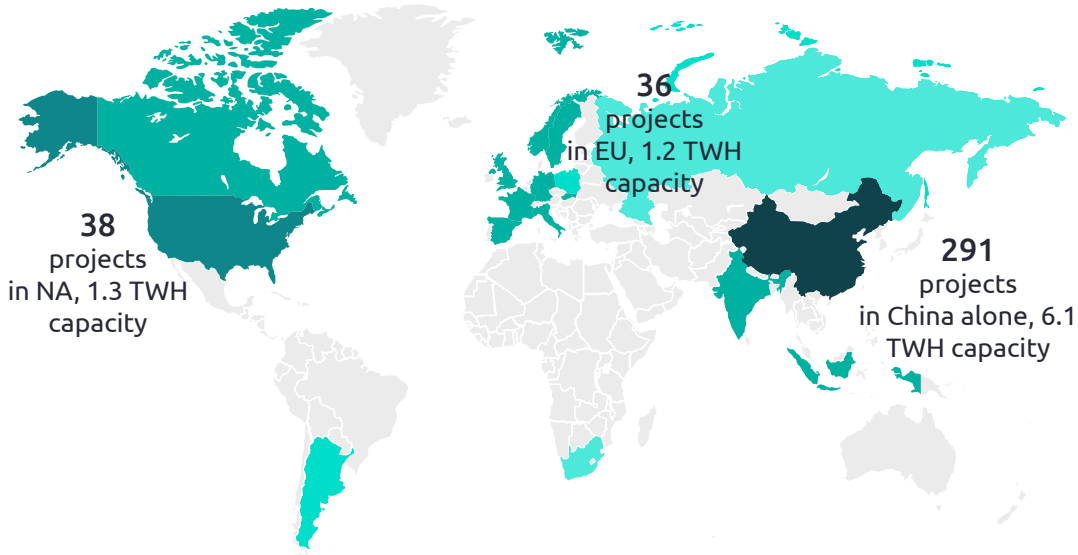
- Almost 14 million new electric cars were registered globally in 2023, 95% of which were in China, Europe and the United States
- In China, the number of new electric car registrations reached 8.1 Mn, while the new electric car registrations totalled 1.4 Mn and 3.2 Mn in the United States and Europe, respectively.
- Battery electric cars accounted for 70% of the electric car stock in 2023
- Globally, almost 50000 electric buses were sold in 2023, equating to 3% of total bus sales and bringing the global stock to approximately 635000 in total
- This relatively low share is primarily due to the limited sales shares in most emerging market and developing economies (EMDEs), as well as the low market penetration of electric buses in some larger markets such as the United States and Korea

Gigafactories

Gigafactories project update (till 2023)

FIGURE 11

Gigafactories project update

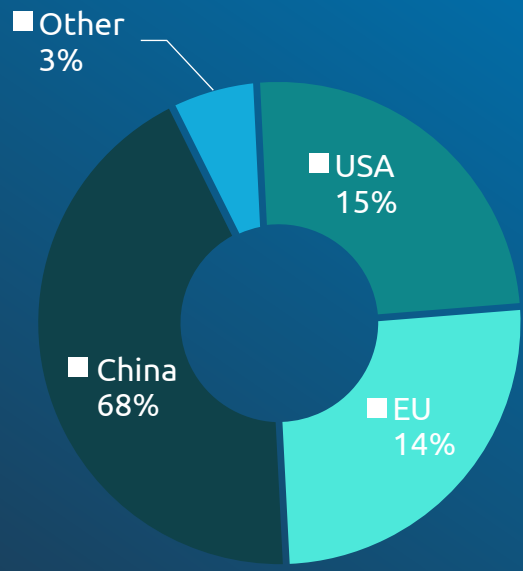


- The 2022 IRA in the USA spurred battery cell development, making the sector the 2nd largest globally outside of China by mid-2023
- Central Europe has emerged as a key gigafactory hub, with countries like Poland, Hungary, and Germany
- Chinese EV battery maker in talks to invest $1.28bn in new UK gigafactory

Electric vehicle battery recycling capacity Dec 2023, by country (in '000 metric tons)

Source: Gigafactories map, Benchmark 2023

Share of 2030 pipeline



401

Gigafactories around the world (operational – 163 and under construction – 238)

72.6%

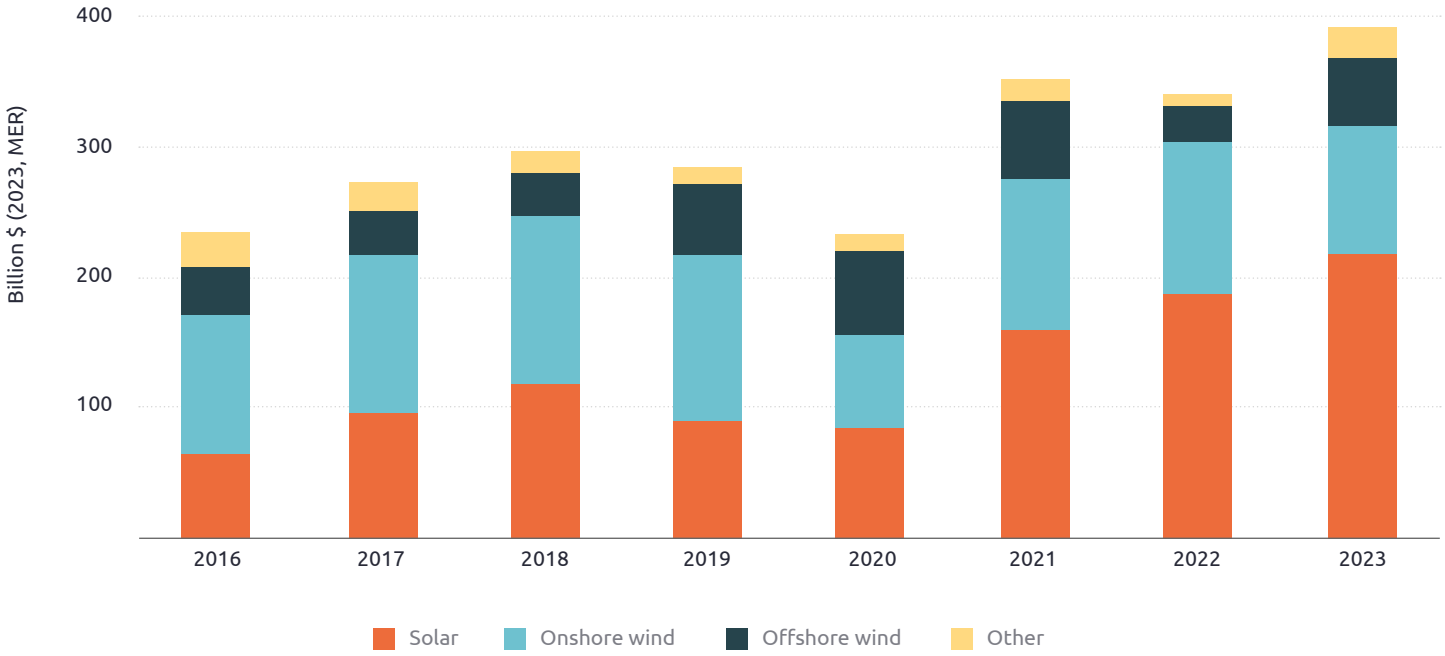
Of gigafactories are in China (291 gigafactories)

Renewables

2023: A record year for renewable capacity increase

FIGURE 12

FIDs for utility-scale renewable projects (2016-2023)



- FIDs for utility-scale renewable projects increased by 15% year-on-year to almost $400 billion in 2023, an all-time high.
- FIDs for solar plants represented more than half of the total at $220 billion – a new record and 2.5 times the amount approved in 2020.
- Wind power recovered somewhat from the previous year's drop due to a strong recovery in offshore FIDs, while fewer onshore wind projects were approved.
- The total numbers of utility-scale deals continued to increase significantly as the combined value of deals above $1 billion more than doubled.

Notes: Excludes large hydropower. "Other" includes biomass, waste-to-energy, geothermal, small hydro and marine.

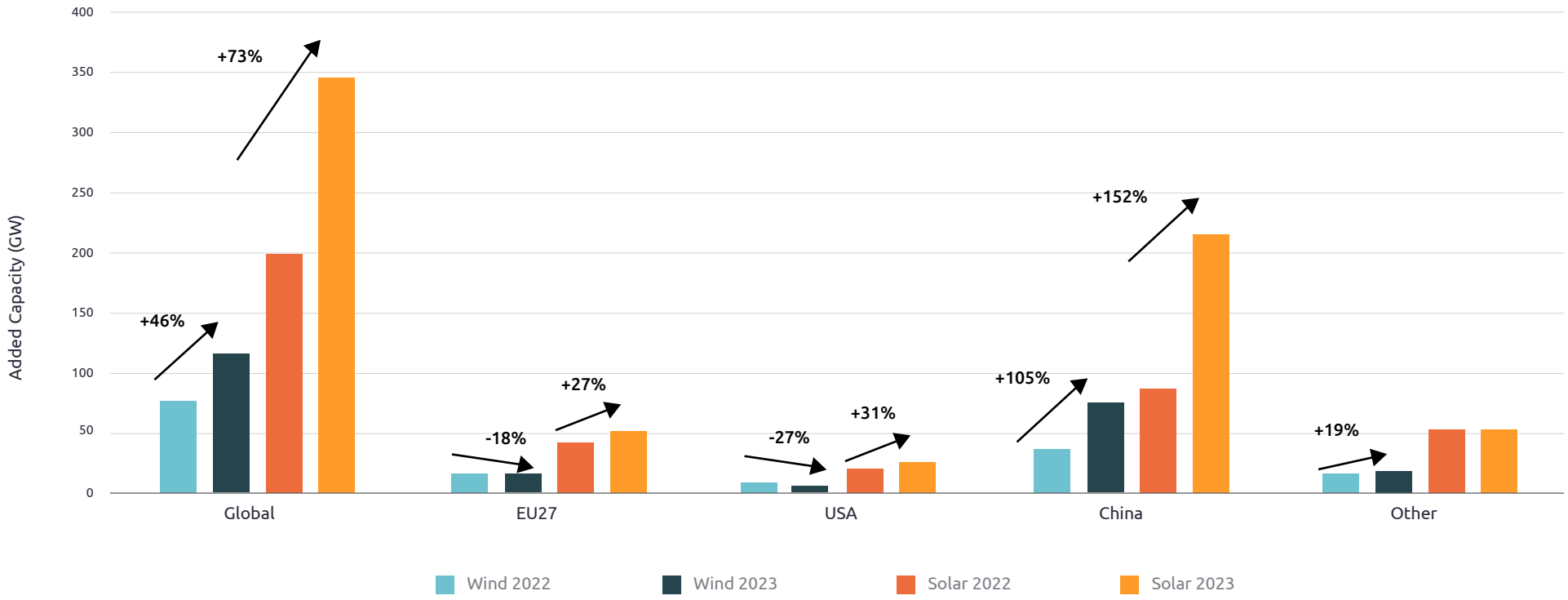
Source: Gigafactories map, Benchmark 2023

Renewables

Wind and solar capacity added (IRENA July data)

FIGURE 13

Global added wind and solar capacity in 2022 and 2023



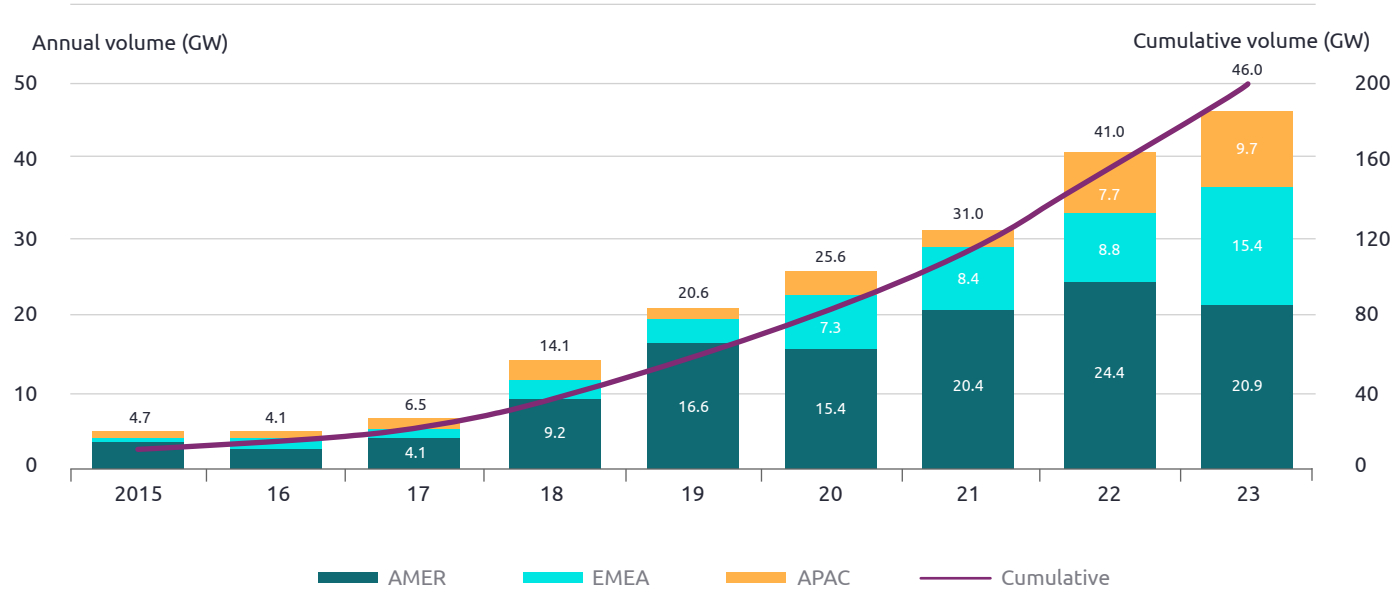
Source: Renewable Energy Capacity Statistics 2024 July (IRENA)

Renewables

Corporate ppa

FIGURE 14

Corporate PPA (in GW) from 2015 to 2023



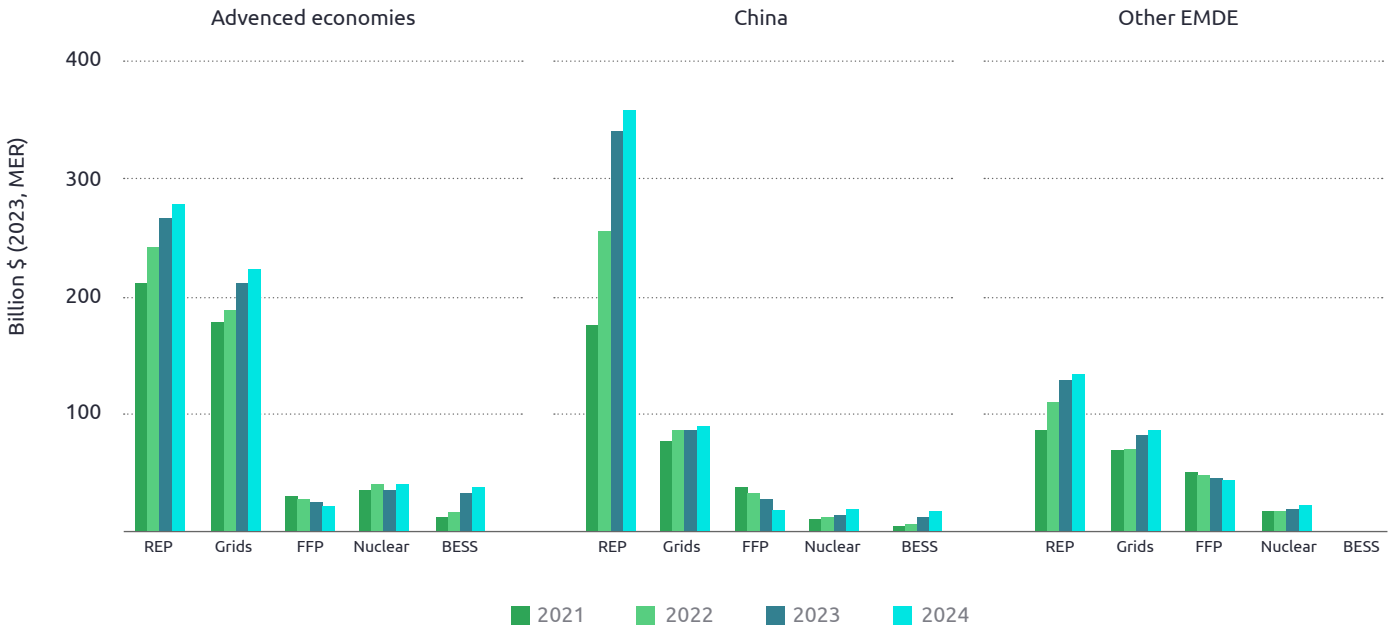
- Corporations publicly announced a record 46 gigawatts (GW) of solar and wind contracts in 2023, some 12% more than the previous record of 41GW in 2022.
- The improving economics in key regions like Europe, alongside imminent company clean energy goals, were the main drivers underpinning this growth and position the market even better for 2024.
- Some 45% (20.9GW) of corporate PPAs announced in 2023 were in the Americas region, followed by Europe at 33% (15.4GW).
- While the United States remained the largest market for PPAs, with 17.3GW of deals announced, this was down 16% from the record 20.6GW announced in 2022.

Source: https://about.bnef.com/blog/corporate-clean-power-buying-grew-12-to-new-record-in-2023-according-to-bloombergnef/

Renewables

FIGURE 15

Global annual investment in the power sector by technology, 2021-2024E



Notes: REP = renewable power. FFP = fossil fuels power. BESS = Battery Energy Storage System. Investment spending on BESS in other EMDE is so small (USD 2 billion in 2024e) that it can almost not be detected on the chart. 2024e = estimated values for 2024.

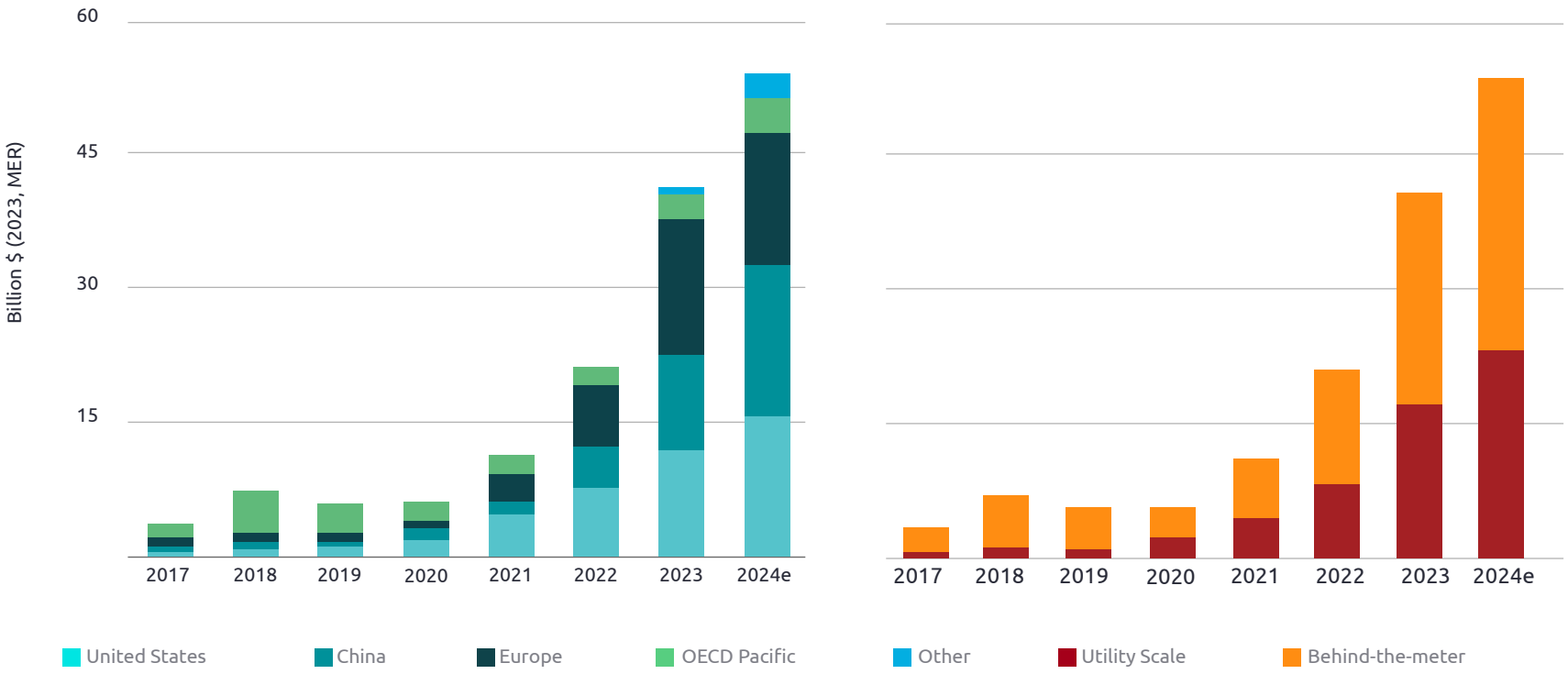
- Investment in renewable power rose rapidly across the board, with promising momentum for spending on grids, nuclear and battery storage in 2024
- Grid investment in EMDE outside China grew by an impressive 15%, reaching almost $80 billion in 2023

Renewables

Batteries storage investments are picking-up, unfortunately not enough for the moment to meet the net zero scenario requirements

FIGURE 16

Battery storage investment by geography (left) and segment (right), 2017-2024e



- Advanced economies and China led power grid investment, making up 80% of global spending, with China investment at $80 billion and the $100 billion
- Investment in advanced economies grew by 11% in 2023, with the EU spending $60 billion,
- Concessional financing and public funding accounted for 80% of grid investment in EMDE, with many regions, including Southeast Asia and Africa, facing challenges due to lack of robust regulatory frameworks and financial viability of utilities

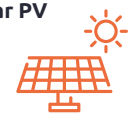
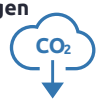
Source: World Energy Investment 2024

Transversal: Pathway to net zero

Pathway to net zero is insufficient on almost all dimensions (1/2)

FIGURE 17

Deployment progress to be made by technology – main levers (1/2)

Regions	Today (Parc / Production2023 YE)	2030 pace /objective	2050 pace / objective	Are we on track?
Wind 	**2023 total capacity: 1,021 GW** (Fleet) **2023 added: 115.0 GW**	**~150** GW / y	**500** GW / y	
Solar PV 	**2023 total capacity: 1,418 GW** (Fleet) **2023 added capacity: 345 GW**	**550** GW / y	**615** GW / y	
Nuclear 	**2023 total capacity: 396 GW (440 units)** (Fleet) **2023 added capacity: 33.0 GW**	**541** GW (Fleet)	**1,160 GW** (Fleet)	
Low-carbon Hydrogen 	**2023 total capacity: 1** Mt / y **2023 added capacity: 0.3** Mt / y	**125** Mt / y	**523** Mt / y	
Storage 	**96 GWh** stationary **8,500 GWh** pumped	**6.000 GWh**	**6,000 GWh** **10,000 GWh**	

Transversal: Pathway to net zero

Pathway to net zero is insufficient on almost all dimensions (2/2

FIGURE 18

Deployment progress to be made by technology – main levers (2/2)

Regions	Today (Parc / Production2023 YE)	2030 pace / objective	2050 pace / objective	Are we on track?
Electric transportation	**40 M** (Fleet) **14 M** (2023 sales +35% YoY)	**360 M** (Fleet)	**2180 M** ((Fleet)	
Heat pumps	**200 M** units (Fleet) **+ 18 M pa / +11% YoY** (Growth)	**450 M** (Fleet)	**800 M** (Fleet)	
Carbon Capture and Storage	**0,4 GT** capture / y (production)	**1.7 GT** / y	**3.3 GT** / y	
Energy Intensity improvement	**1.3% / y** (growth)	**3.3%** / y	**2.8%** / y	

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Figure 36: Share of taxes and levies paid by non-household consumers for electricity, H2-2023 (%)

Figure 37: Development of natural gas prices for household consumers, 2008-2023 (€ per kWh)

Figure 38: Natural gas prices for household consumers, second half 2023

Figure 39: Share of taxes and levies paid by household consumers for natural gas, 2nd half 2023 (%)

Figure 40: Development of natural gas prices for non-household consumers, 2008-2023 (€ per kWh)

Figure 41: Natural gas prices for non-household consumers, second half 2023

Figure 42: Share of taxes and levies paid by non-household consumers for natural gas, H2-2023 (%)

Figure 43: Evolving AI Rules & Regulations – EU

Figure 44: Evolving AI Rules & Regulations – USA

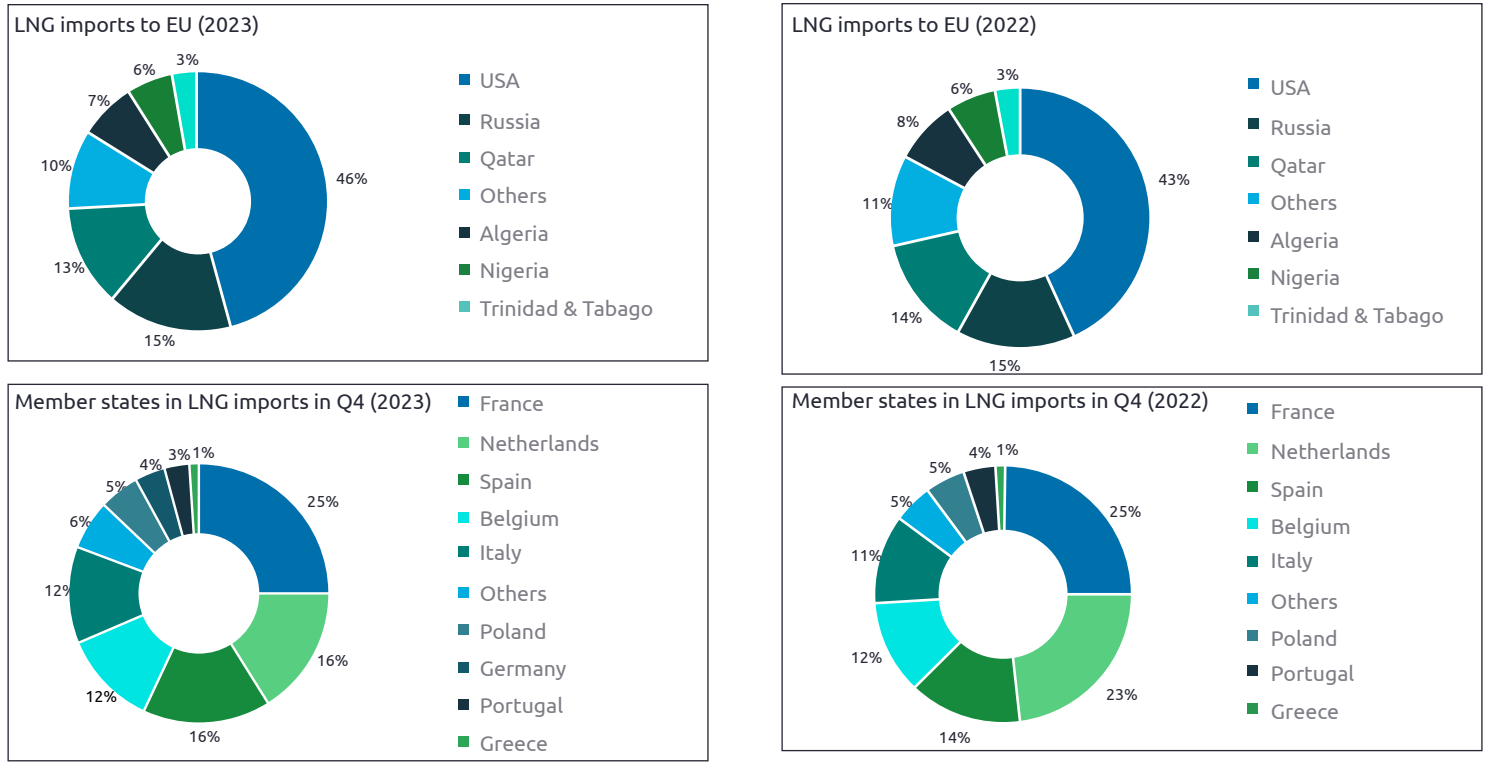
Figure 45: Evolving AI Rules & Regulations – Other Nations

Figure 46: AI Legal and Regulatory Landscape, China

Energy sovereignty

FIGURE 1

Major LNG gas imports in EU



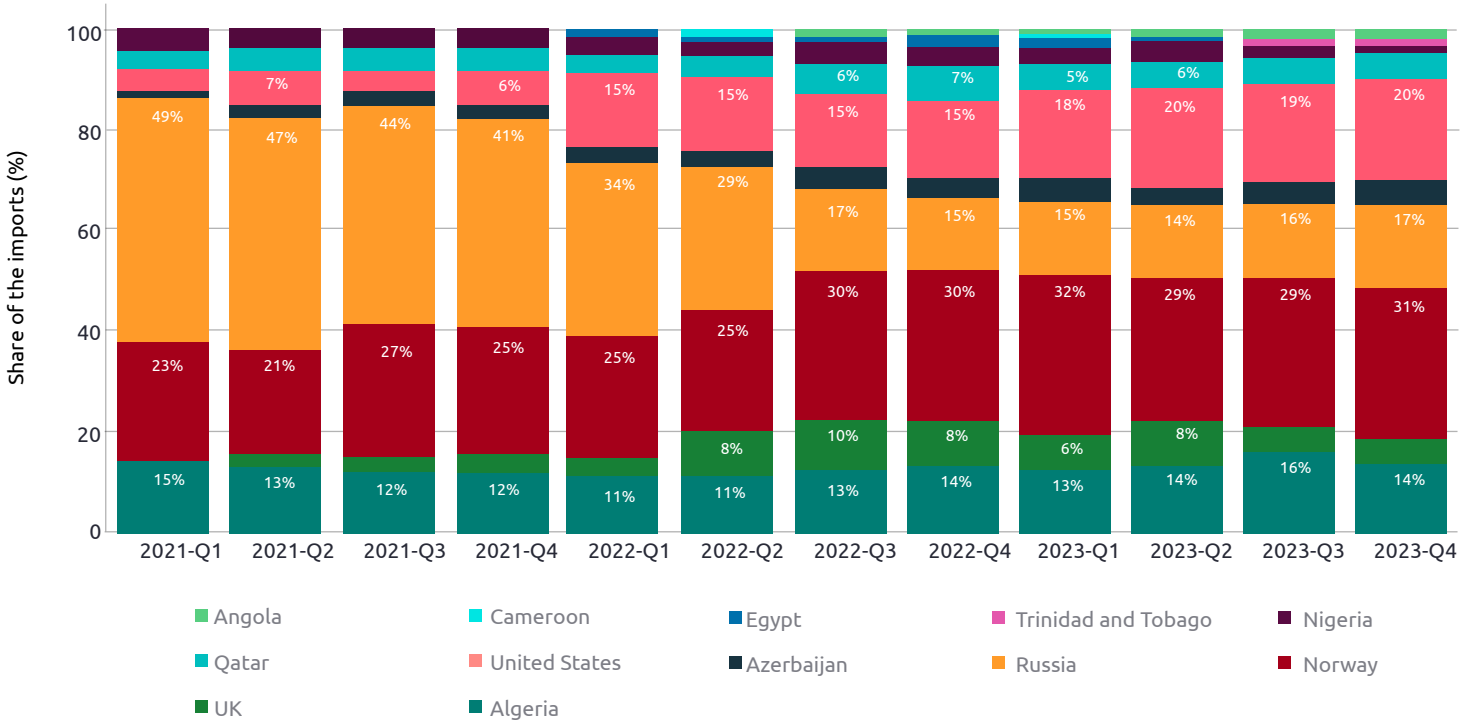
Source: European Commission 2023

- In 2023, The largest LNG exporter to the EU was the USA with a 46% (56.3 bcm) share, followed by Russia (15%, 17.8 bcm) and Qatar (13%, 15.5 bcm) on the 2nd and 3rd place, respectively
- Algeria (7%, 8.5 bcm), Nigeria (6%, 7.6 bcm) and Norway (4%, 4.6 bcm) were also significant LNG exporters to the EU occupying the 4th, 5th and 6th market shares, respectively
- The largest LNG importer was France (22%, 26.7 bcm) in 2023. Spain (18%, 22.8 bcm) and the Netherlands (17%, 20,7 bcm) occupied the 2nd and 3rd position
- They were followed by Italy (11%, 14 bcm) and Belgium (10%, 12.8 bcm) on the 4th and 5th largest LNG importer position

Energy sovereignty

FIGURE 2

Russian gas exports in EU



- A 19% increase of Russian gas exports (pipeline+LNG) imports, the 4th quarter of 2023, compared to the previous and 16% increase y-o-y
- Compared to the 4th quarter of 2021, total Russian gas exports were down by 64% (-22.5 bcm)
- Despite fluctuations, the importance of LNG in overall Russian exports has increased compared to the historic Russian gas export structure to the EU
- The EU was the largest buyer, purchasing 49% of Russia's LNG exports
- As of 11 April 2024, the European Parliament has passed a law allowing Member States to ban Russian LNG imports by preventing Russian firms from booking gas infrastructure capacity. However, no major importer has indicated they will exercise this option

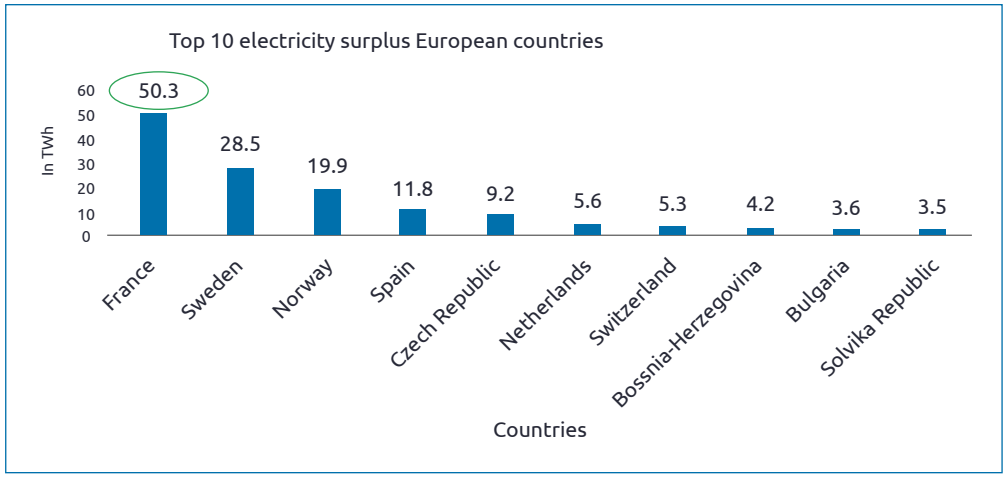
Note: Quarterly share of gas imports within the total, combining both pipeline and LNG imports

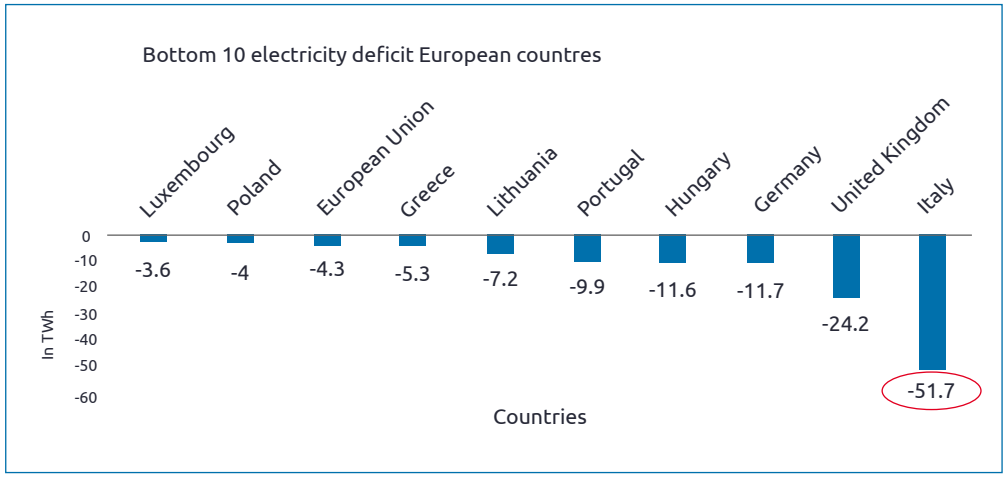
Source: European Commission 2023, CREA

Energy sovereignty

FIGURE 3

Electricity import/export in Europe in 2023

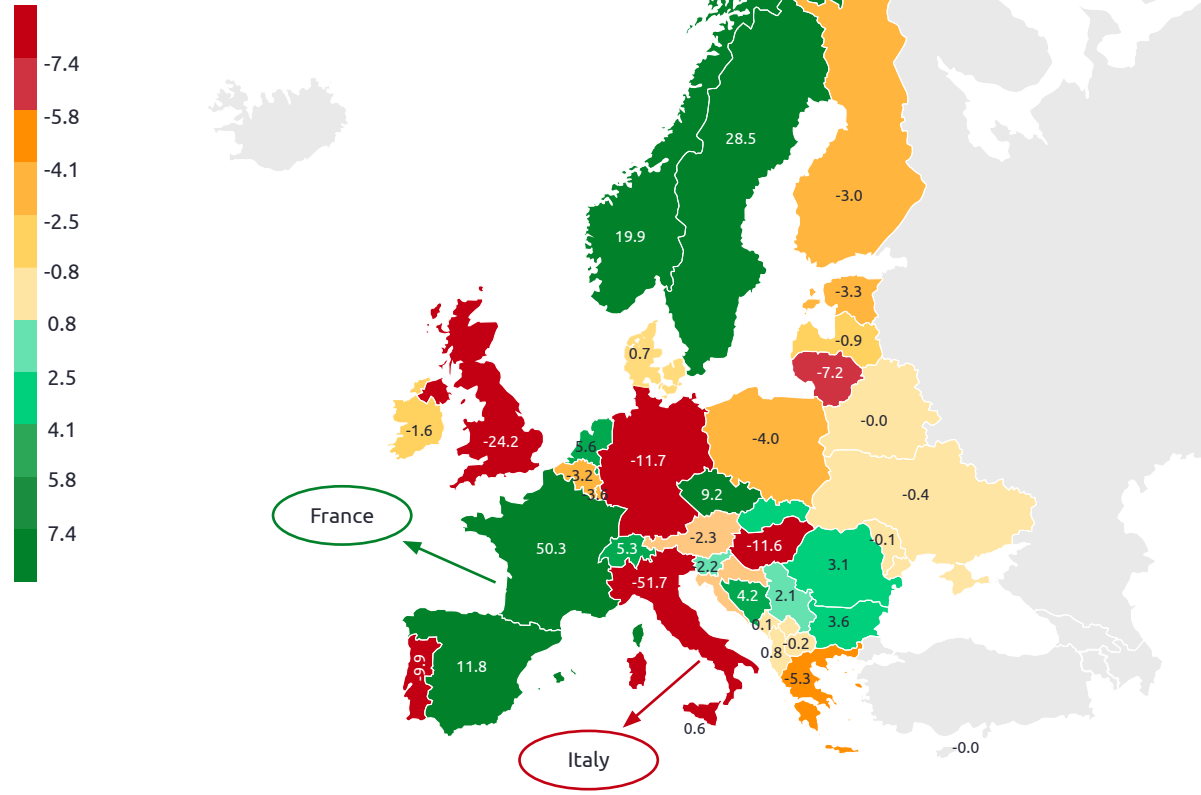




Source: Energy-Charts

Cross border electricity trading in 2023

In TWh, positive values (green) mean exports, negative values (red) mean imports

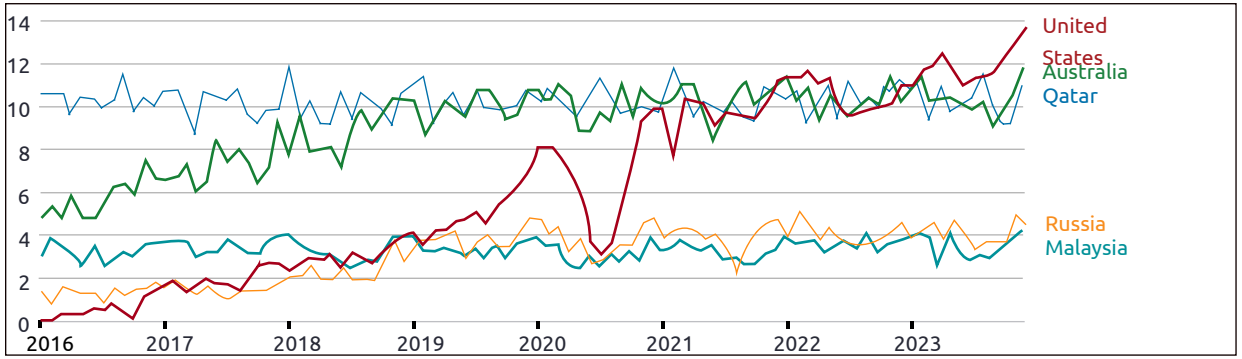


Energy sovereignty

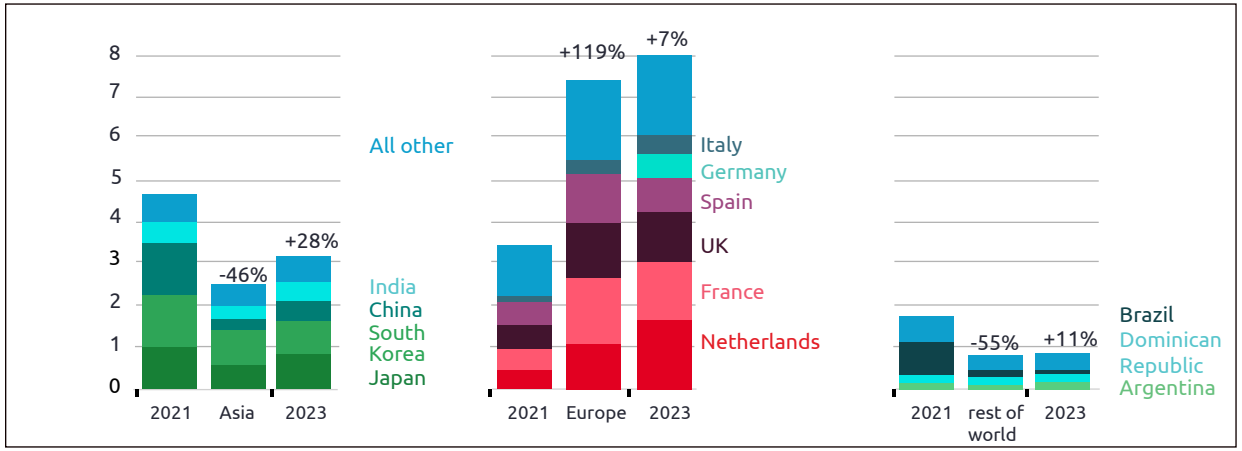
FIGURE 4

Development of major gas exports - USA

Monthly liquefied natural gas exports from select countries (Jan 2016 - Dec 2023) billion cubic feet per day



Annual USA liquefied natural gas exports



Source: EIA

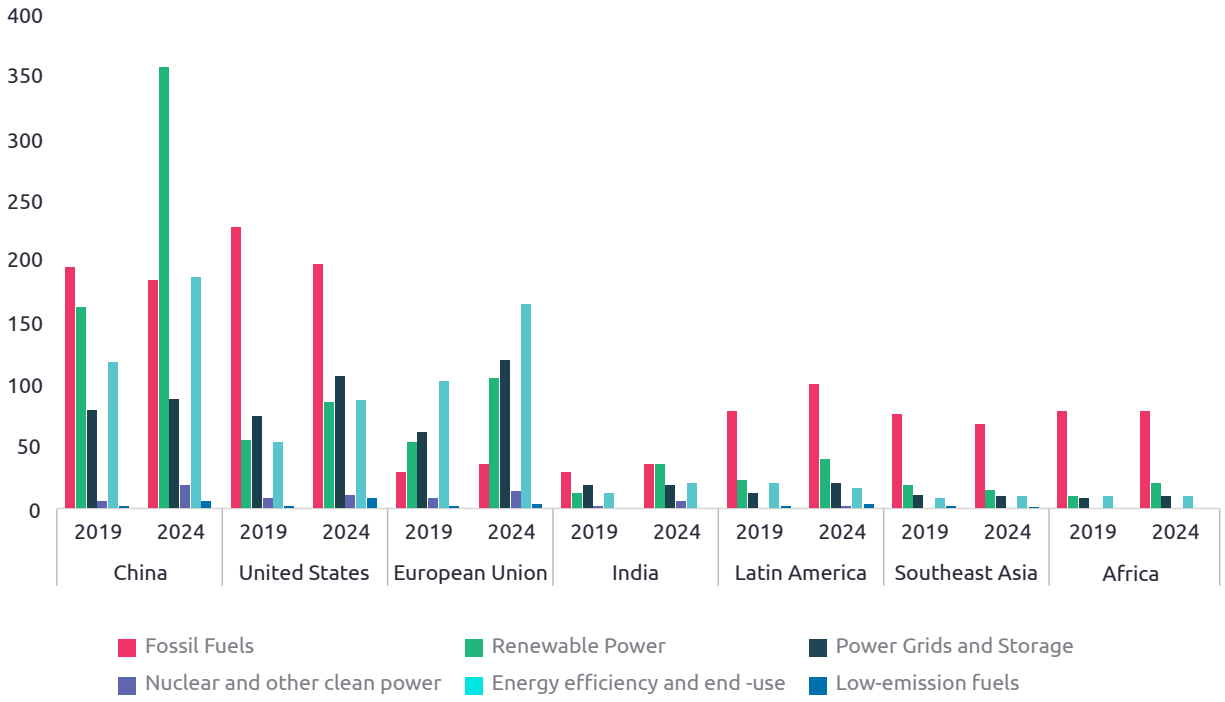
- In 2023, the USA led global LNG exports 11.9 bn cf/d, a 12% increase from 2022, primarily driven by strong European demand and record exports in November and December
- Europe, including Türkiye, was the main destination for USA LNG, accounting for 66% of exports, with the Netherlands, France, and the UK being the largest importers
- Asia received 26% of USA LNG exports, Japan and South Korea were the top Asian importers, while new import activities began in the Philippines and Vietnam in 2023
- LNG import capacity in Europe continued to grow, with significant expansions in the Netherlands and new facilities in Germany

Note: The United States was the world's largest liquefied natural gas exporter in 2023

Changing commitments and focus

FIGURE 5

Annual Investment In Clean Energy By Selected Country And Region, 2019 And 2024, In $ Bn



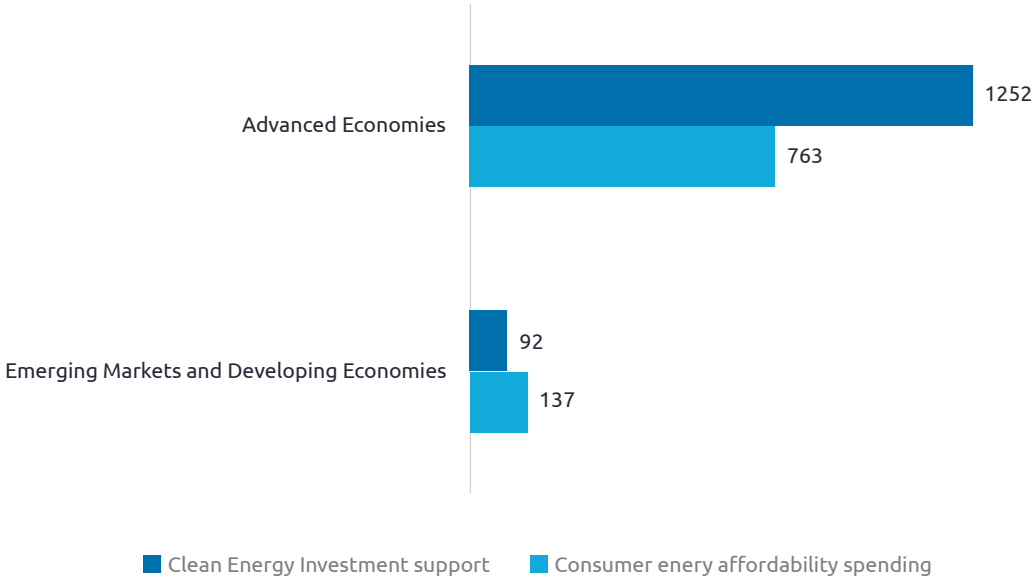
Source: IEA

- Global energy investment is set to exceed $3 tn for the first time in 2024, with $2 tn going to clean energy technologies and infrastructure.
- Investment in clean energy has accelerated since 2020, and spending on renewable power, grids and storage is now higher than total spending on oil, gas, and coal.
- In 2024, the share of global clean energy investment in Emerging Market and Developing Economies (EMDE) outside China is expected to remain around 15% of the total

Changing commitments and focus

FIGURE 6

Government Clean Energy Investment Support And Consumer Energy Affordability Spending Earmarked By Region, Q2 2023, In $ Bn



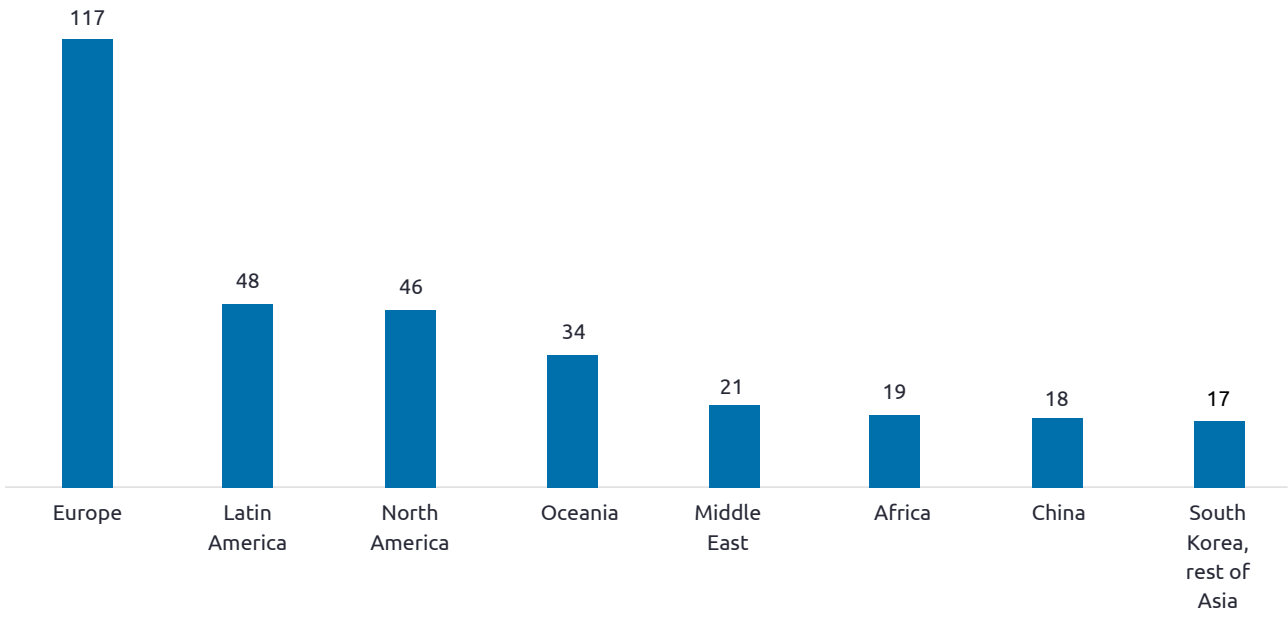
Source: IEA

- As of Q2 2023, the vast majority of spending on both affordability and clean energy remains concentrated in advanced economies, which now account for 93% of total government clean energy investment support and 85% of consumer affordability support tracked to date
- As of Q2 2023, spending by EMDEs on affordability measures increased compared to the past six months by additional $23 Bn
- These measures were largely in the form of direct transfers to energy companies for keeping prices at affordable levels through the early part of the energy crisis, as was the case in Indonesia, Mexico, Nigeria, and Malaysia

Changing commitments and focus

FIGURE 7

Direct Investments Into Hydrogen Projects Announced Through 2030, As Of 31st January 2023, In $Bn, By Region



Source: Hydrogen Council

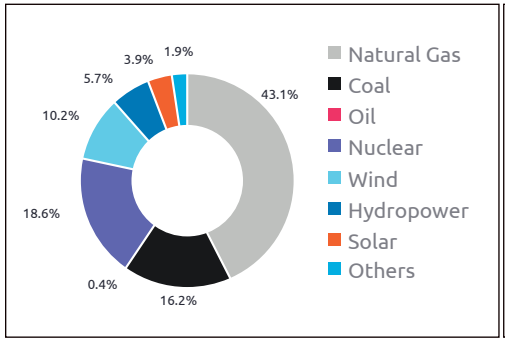
- Globally, the industry has announced more than 1,000 large-scale project proposals as of the end of January 2023
- Since May 2022, more than 350 new proposals have been announced. Of the total, 795 aim to be fully or partially commissioned through 2030 and represent total investments of $320 Bn of direct investments into hydrogen value chains through 2030 (up from $240 Bn)
- Europe remains the global leader in hydrogen project proposals, with the highest total investments ($117 Bn, 35% of global investments)
- Latin America and North America follow Europe, each representing about 15% of announced investments

Changing commitments and focus

FIGURE 8

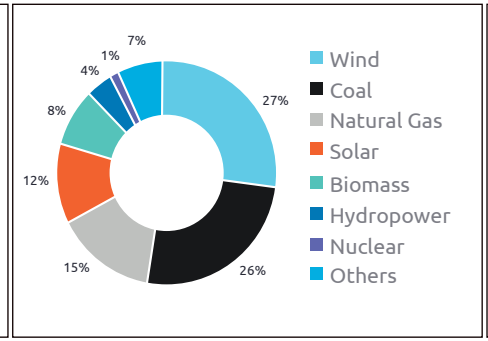
Electricity Mix across the world, 2023

USA Electricity Mix, 2023



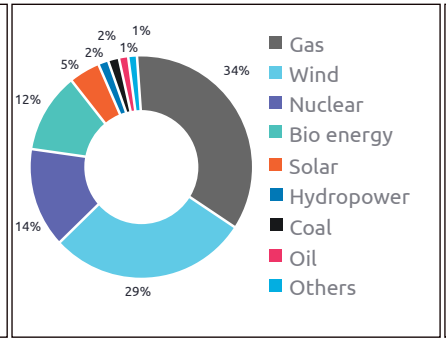
Source: Statistical Review of World Energy 2024

Germany Electricity Mix, 2023



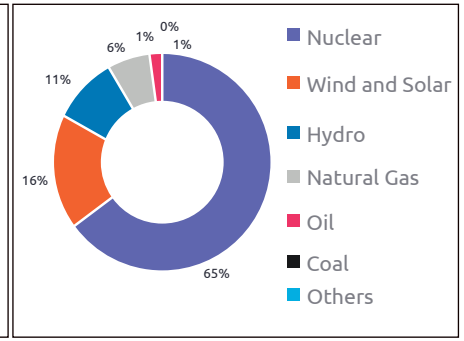
Source: Statista

UK Electricity Mix, 2023



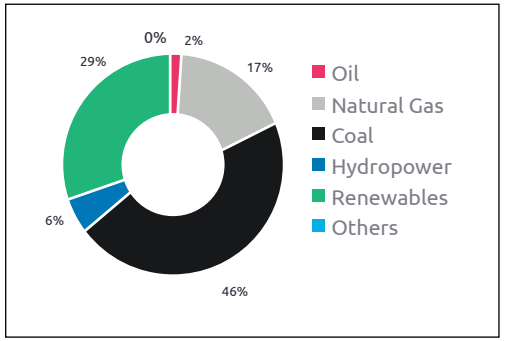
Source: Gov.UK - Energy Trends June 2024

France Electricity Mix, 2023



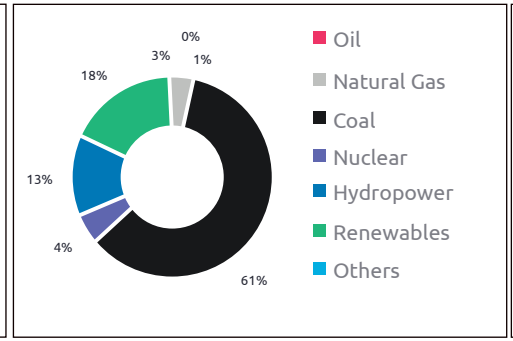
Source: Statistical Review of World Energy Data 2024

Australia Electricity Mix, 2023



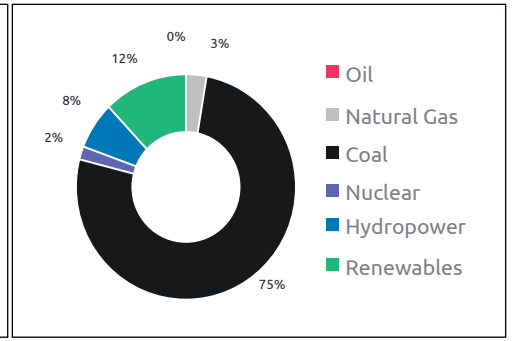
Source: Statistical Review of World Energy 2024

China Electricity Mix, 2023



Source: Statistical Review of World Energy 2024

India Electricity Mix, 2023



Source: Statistical Review of World Energy 2024

Market reform

FIGURE 9

Existing market designs across the world (1/4)

Key Existing Energy Market Design In the USA			
Market Design	**Operators**	**Key Insights**	**Country/Region**
Energy-Only	**The Electric Reliability Council of Texas (ERCOT)**	• **ERCOT manages** the **Texas Interconnection**, the electric grid in most of Texas • It operates an **energy-only market** where **generators** are **paid** only when they **provide power** to the **grid** on a day-to-day basis	USA
Hybrid (Energy, Capacity and Ancillary Model)	**Pennsylvania New Jersey Maryland Interconnection (PJM)**	• **PJM operates** the **Reliability Pricing Model (RPM)**, a **forward capacity market** into which capacity resources participate by selling their available capacity to help PJM meet its forecasted load needed to ensure reliability in each delivery year • It coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia	USA
Hybrid (Energy, Capacity and Ancillary Model)	**Midcontinent Independent Operator (MISO)**	• **MISO** is a not-for-profit quasi-governmental organization that **ensures** the **reliable**, **least-cost delivery of electricity** across all or parts of 15 USA states (Arkansas, Illinois, Indiana, Iowa, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Montana, North Dakota, South Dakota, Texas, and Wisconsin) and one Canadian province (Manitoba). It is geographically the largest ISO in the USA	USA
Hybrid (Energy, Capacity and Ancillary Model)	**ISO New England (ISO-NE)**	• ISO-NE **ensures** the day-to-day **reliable operation** of New England's **bulk power generation** and **transmission system**, oversees and ensures the fair administration of the region's wholesale electricity markets, and manages comprehensive, regional planning processes • SO-NE's existing **forward capacity market** was originally designed in line with the average three-year development timeline for new gas power plants. But the grid operator now expects nearly all new capacity resources in the New England region to be offshore wind, solar and battery storage by 2029.	USA
Hybrid (Energy, Capacity and Ancillary Model)	**New York ISO (NYISO)**	• **NYISO operates** New York State's **high voltage transmission network, administers** and **monitors** the **wholesale electricity markets** in the state, and plans for the state's energy future. While NYISO operates only NY's grid, it is subject to FERC's regulatory authority because the grid is interconnected with other grids in the region	USA

Source: Thomson Reuters, SP Global

Market reform

FIGURE 10

Existing market designs across the world (2/4)

Key Existing Energy Market Design In Europe (1/2)			
Market Design	**Operators**	**Key Insights**	**Country/Region**
Energy-Only	*Note: It is a Mechanism*	• **The Capacity Market (CM)** was introduced by the UK Government to manage security of electricity supply and safeguard against the possibility of future blackouts • There are two annual capacity auctions: ✓ **T-4 Auction:** The main auction held four years in advance, securing most of the needed capacity and allowing new generators to obtain 15-year agreements. ✓ **T-1 Auction:** Top-up auctions just before each delivery year, used for sites not ready for the T-4 auction. Most businesses aim to participate in T-4 for better prices	UK
Energy-Only	**Operador del Mercado Ibérico de Energía (OMIE)**	• **OMIE** is the nominated electricity market operator (NEMO) for **managing** the **Iberian Peninsula's day-ahead and intraday electricity markets** • It actively participates in connecting wholesale electricity markets in the EU, along with all of the NEMOs nominated in each member state	Spain
Energy-Only	**Nord Pool**	• The day-ahead market at Nord Pool is an auction-based exchange for electricity to be delivered physically • Nord Pool publishes a price for each hour of the coming day in order to help balance supply and demand	Nordics & Baltics
Energy-Only	**Gestore dei Mercati Energetici SpA (GME)**	• **Gestore dei Mercati Energetici SpA (GME)** is responsible for the **organization and economic management of the electricity market**, according to criteria of neutrality, transparency, objectivity and competition between producers and which also ensures the economic management of adequate availability of the power reserve • GME operates Italian power, gas and environmental markets and it has been nominated **Nominated Electricity Market Operator (NEMO)** for the **day ahead** and **intraday markets** in Italy following the approval of the EU Regulation 1222/2015 (CACM)	Italy
Capacity Market	*Note: It is a Mechanism*	• Poland has introduced market wide and technologically neutral capacity market based on capacity auctions. **Mechanism** has been **approved** in the **EC decision "State aid No. SA.46100 (2017/N) – Poland – Planned Polish capacity mechanism"** • The Polish capacity market is open for all electricity generation technologies including DSR and energy storage. Energy storage is treated as a generating unit, so it can participate in the capacity market as a physical generating unit or a part of DSR unit (part of an end user's installation).	Poland

Source: Nord Pool, OMIE

Market reform

FIGURE 11

Existing market designs across the world (3/4)

Key Existing Energy Market Design In Europe (2/2)			
Market Design	**Operators**	**Key Insights**	**Country/Region**
Energy-Only and Capacity Model	***Bundesnetzagentur*** *Note: It is a Regulatory Body Operating In Germany*	• The **Bundesnetzagentur** (Federal Network Agency) in Germany oversees both **energy-only and capacity-based aspects** of the electricity market. It ensures **efficient** and **reliable operation** of the **energy market**, facilitates the integration of renewable energy sources, and regulates market activities to maintain stability and security of supply	Germany
Capacity Model	**RTE (Réseau de Transport d'Électricité)**	• RTE plays a role in the implementation and management of capacity mechanisms, which are designed to ensure there is enough generation capacity to meet peak demand and maintain grid reliability. While RTE itself does not operate power plants, it coordinates with generators and other market participants to secure and manage capacity • RTE **charges balance responsible** entities for the **costs** of **balancing offers** due to **negative imbalances** and **compensates** them for **positive imbalances**	France

Source: Bundesnetzagentur, RTE

Market reform

FIGURE 12

Existing market designs across the world (4/4)

Key Existing Energy Market Design In APAC			
Market Design	**Operators**	**Key Insights**	**Country/Region**
Energy-Only	**Australian Energy Market Operator (AEMO)** - National Electricity Market (NEM)	• **Electricity generated** in eastern and southern Australia is **traded** through the **National Electricity Market (NEM)**. Generators make offers to sell electricity into the market and the **Australian Energy Market Operator (AEMO) schedules** the **lowest priced generation available** to meet demand • **NEM** facilitates the exchange of electricity between generators and retailers • It **interconnects** the **six eastern** and **southern states** and territories and **delivers** around **80%** of all **electricity consumption** in Australia	Australia
Bilateral Contract Model	*Note: It is a Mechanism*	• Currently, 90% of the electricity traded is through **long-term power purchase agreements (PPAs)**. However, the two-part tariff structure of thermal power PPAs has locked electricity distribution companies (DISCOMs) into long-term capacity payments. Combining this with self-scheduling of power dispatch at a regional-level results in a sub-optimal outcome for the DISCOMs	India
Hybrid Model	*Note: It is a Mechanism*	China's **Electricity Market Design** combines elements of both energy-only and capacity-based markets, with a growing emphasis on clean energy • **Energy Only Aspect:** ✓**Spot Market**: China has a spot market for real-time electricity trading ✓**Medium-to-Long-Term (MLT)** Contracts: Almost all (97%) of interprovincial power trade in China takes the form of MLT ✓contracts ✓**Provincial-Level Trading**: Electricity is primarily traded within provinces • **Capacity-Based Aspects:** ✓**Power Capacity Market**: Ensures sufficient capacity for reliability. ✓**Inter-Provincial Trading**: Efforts to enhance flexible, inter-provincial allocation of electricity	China

Source: IEEFA, Australia Government, IEA

Market reform

FIGURE 13

Changing energy market design Overview (1/2)

Region / Country	Design Changes	Key Insights	Year
EU	• To reform the **EU's Electricity Market Design (EMD**	• The **reform aims** to make **electricity prices less dependent** on **volatile fossil fuels prices, shield consumers** from **price spikes,** accelerate the **deployment** of **renewable energies** and improve **consumer protection**	**2024 (Ongoing)**
EU	• To revise **Regulation On Wholesale Energy Market Integrity And Transparency (REMIT)**	• The proposal for an amending Regulation to **improve** the Union's protection **against market manipulation** in the **wholesale energy market**, which revises the **Regulation On Wholesale Energy Market Integrity And Transparency (REMIT)** and the **ACER Regulation**	**2023 (Ongoing)**
EU	• **Green Deal Industrial Plan**	• **To boost renewables, better protect consumers and enhance industrial competitiveness**, the Commission proposed a reform of the current electricity market rules in March 2023, **as part of the Green Deal Industrial Plan** • **The new electricity market design rules** consist of the amending **Directive EU/2024/1711** and the amending **Regulation EU/2024/1747**. They were adopted on 21 May 2024 and entered into force on 16 July 2024	**2023 (Ongoing)**
UK	• In 2022, the then Department for Business, Energy & Industrial Strategy launched its **Review of Electricity Market Arrangements (REMA) consultation**	• REMA aims to create a market that supports rapid decarbonisation while protecting security of supply • The **second stage of consultation focus** on four key **challenges:** ✓ REMA proposes **retaining marginal pricing** in the **wholesale power market**, while **developing** the existing **Contracts for-Difference (CfD)** scheme to decouple gas and power prices ✓ **Future-proofing** the **CfD scheme** to support renewable investment by moving away from output-based payments, adjusting reference prices, and allowing CfDs for partial project capacity ✓ **Optimize** the **Capacity Market to support** emerging **low-carbon technologies** like CCUS-equipped thermal generation, hydrogen-fired generation, and long-duration energy storage (LDES) ✓ **Exploring** whether a **single national price** or **locational pricing** is **better** for a decarbonised power market, excluding nodal pricing due to its potential negative impact on investor confidence	**2022 (Ongoing)**
USA	• **USAID Strengthening Utilities and Promoting Energy Reform (SUPER)**	• The Strengthening Utilities and Promoting Energy Reform (SUPER) program is focused on addressing key energy sector challenges in USAID's partner countries related to utility performance, under-investment, legal and regulatory frameworks, sector reforms and cross-cutting interventions	**2020 (Ongoing)**

Source: USAID, UK Parliament, European Council

Market reform

FIGURE 14

Changing energy market design Overview (2/2)

Region / Country	Design Changes	Key Insights	Year
Australia	• To modernise **National Electricity Market (NEM)**	• The NEM needs modernization to adapt to changes in electricity generation, emerging technologies like solar batteries, and shifting consumer preferences • In 2018, the **Australian Government** and **state/territory governments tasked** the Energy Security Board with advising on a **long-term market framework** for **reliability** from 2025. **The Post-2025 Market Design project** was established to **ensure** the **NEM meets future electricity needs** with **diverse generation sources, demand response, storage,** and **distributed energy participation**	**2018 (Ongoing)**
China	• **China** aims to build a **Unified National Power Market** by **2030**	• The expansion of renewable energy in China has been driven by the government's 2020 pledge to reach peak carbon dioxide emissions by 2030 and become carbon neutral by 2060 • Under a **2022 guideline** on establishing a **unified national power market issued by** the **National Development and Reform Commission**, the country's top planner, **China aims to build** the **unified electricity market system** by **2030**, by which time **renewable energy will fully participate** in market trading	**2022 (Ongoing)**

Source: Australia Government, IEA

LCOE

USA and European LCOE 2023

Despite high end LCOE declines for selected renewable energy technologies, the low ends of U.S. LCOE have increased for the first time ever, driven by the persistence of certain cost pressures (e.g., high interest rates, etc.). These two phenomena result in tighter LCOE ranges (offsetting the significant range expansion observed last year) and relatively stable LCOE averages year-over-year. Solar and wind power remain the cheapest sources for new electricity generation, with utility-scale solar and onshore wind leading the way.

The levelised cost of electricity (LCOE) for green technologies in Europe is set to drop up to 10-15% in 2024. In 2023, the average European LCOE for offshore wind was last seen around €100/MWh, according to Irex. For onshore wind, LCOE should remain stable or fall up to 5% this year. For solar energy, Irex expected panel costs to fall by 10-15%, leading to a drop in LCOE of just under 10% for large photovoltaic systems and agrivoltaics plants comprising solar panels on farmland. The drop in LCOE for rooftop or floating PV is not expected to be more than 5%.

FIGURE 15

U.S. LCOE - Unsubsidized Analysis ($/MWh)

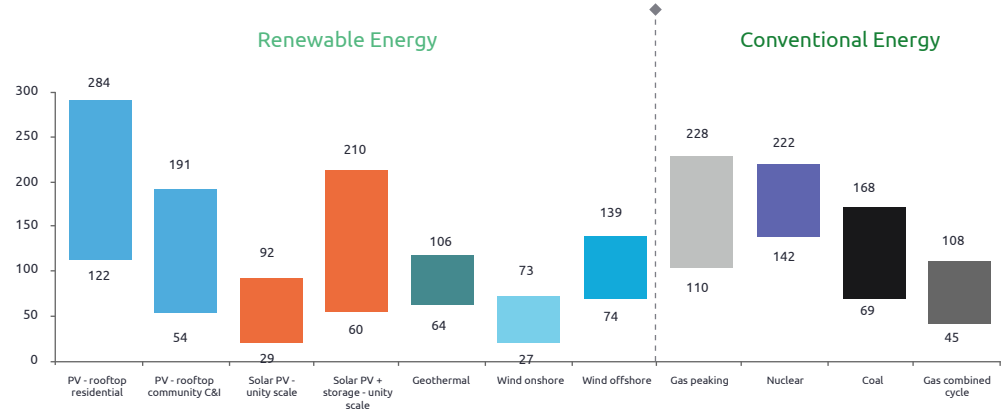
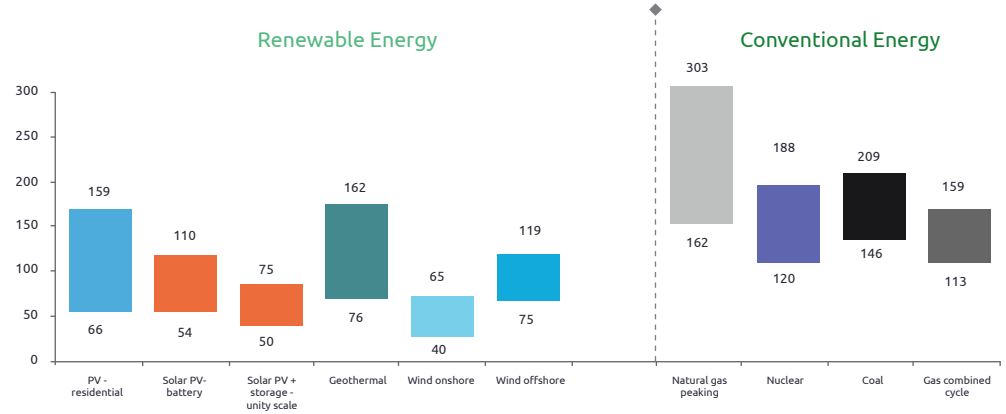


FIGURE 16

Average European LCOE ($/MWh)

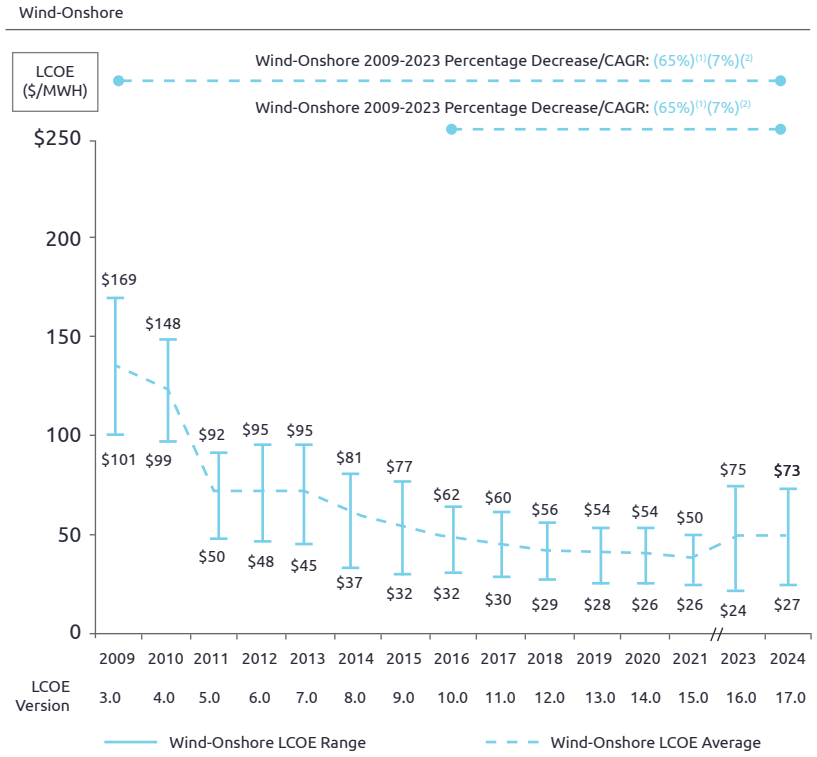


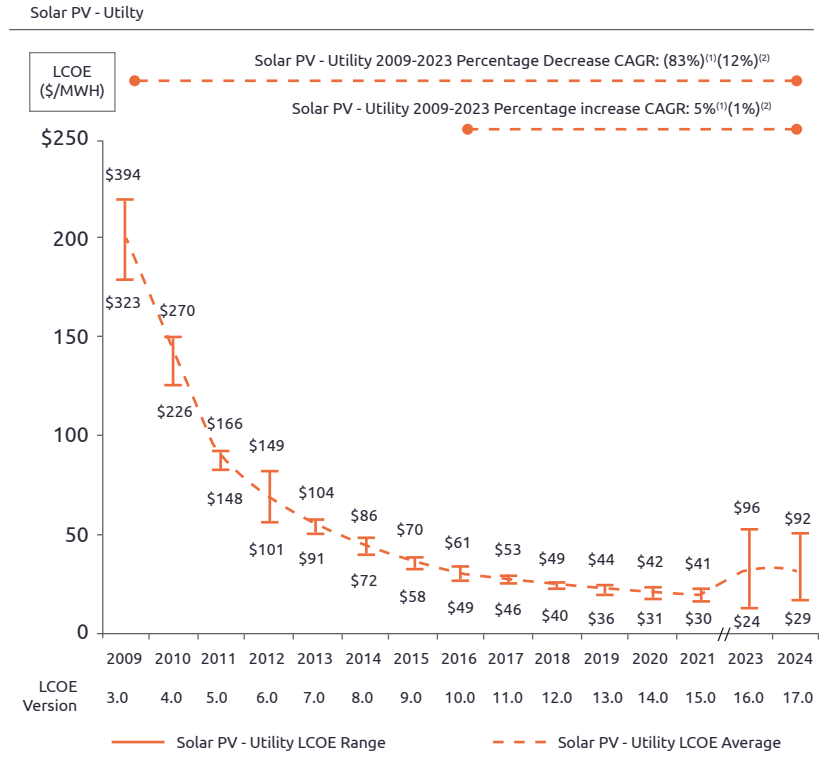
Source: 2024 Lazard's Levelized Cost of Energy Analysis, Wood Mackenzie, Montel, Nuveen, BNEF

LCOE

FIGURE 17

Levelized Cost of Energy Comparison - Historical Renewable Energy LCOE





Note: (1) Reflects the average percentage increase (decrease) of the high end and low end of the LCOE range.
(2) Reflects the average compounded annual rate of decline of the high end and low end of the LCOE range.

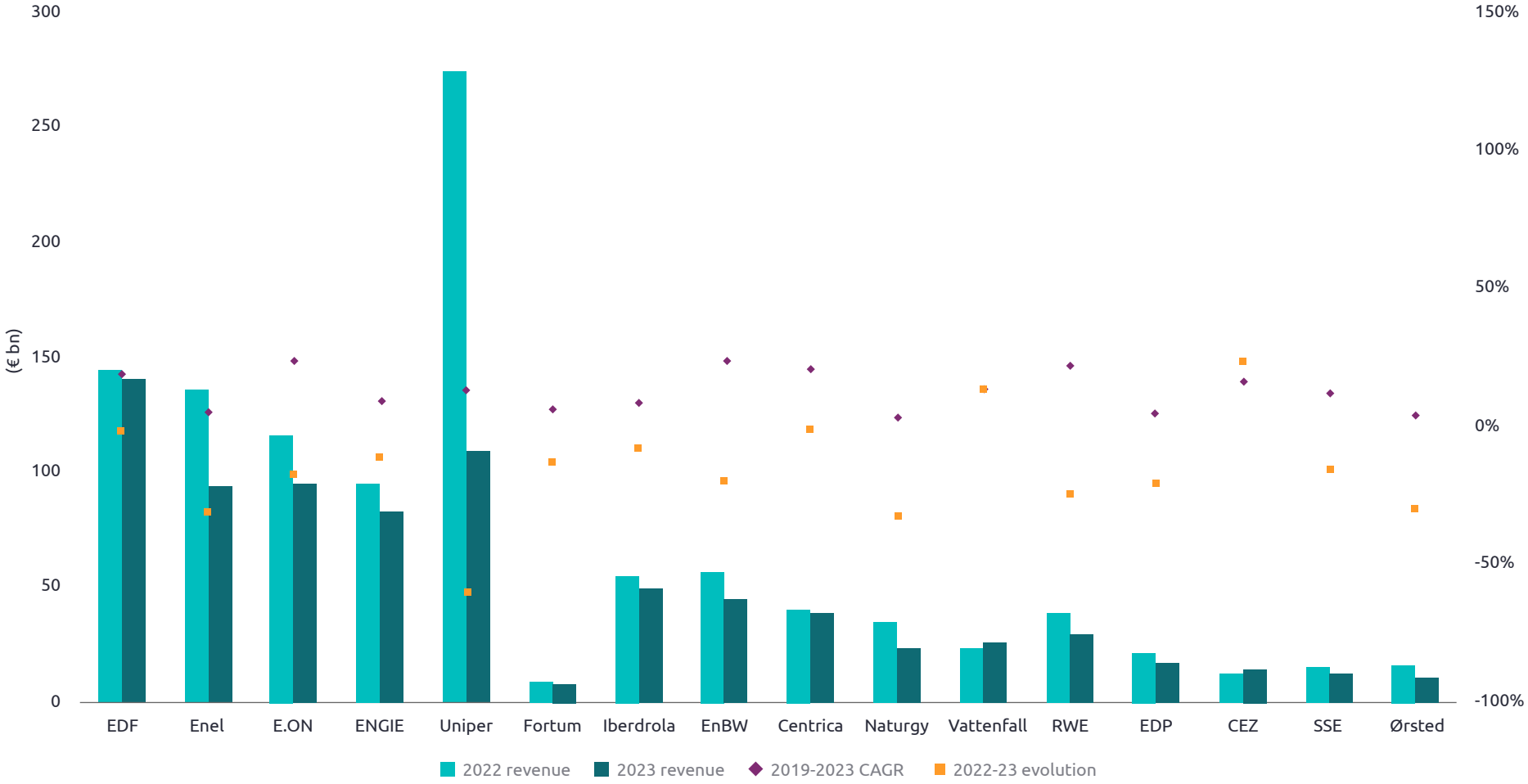
Source: 2024 Lazard's Levelized Cost of Energy Analysis

While the low end of the LCOE for both wind and solar has increased slightly, reflecting current market conditions, the average has remained nearly flat and the overall range has narrowed, reflecting, among other things, reconciliation of the supply chain challenges that were notable last year

Performance of key players: Europe

FIGURE 18

Europe - 2022 and 2023 revenues and CAGR 2019-2023

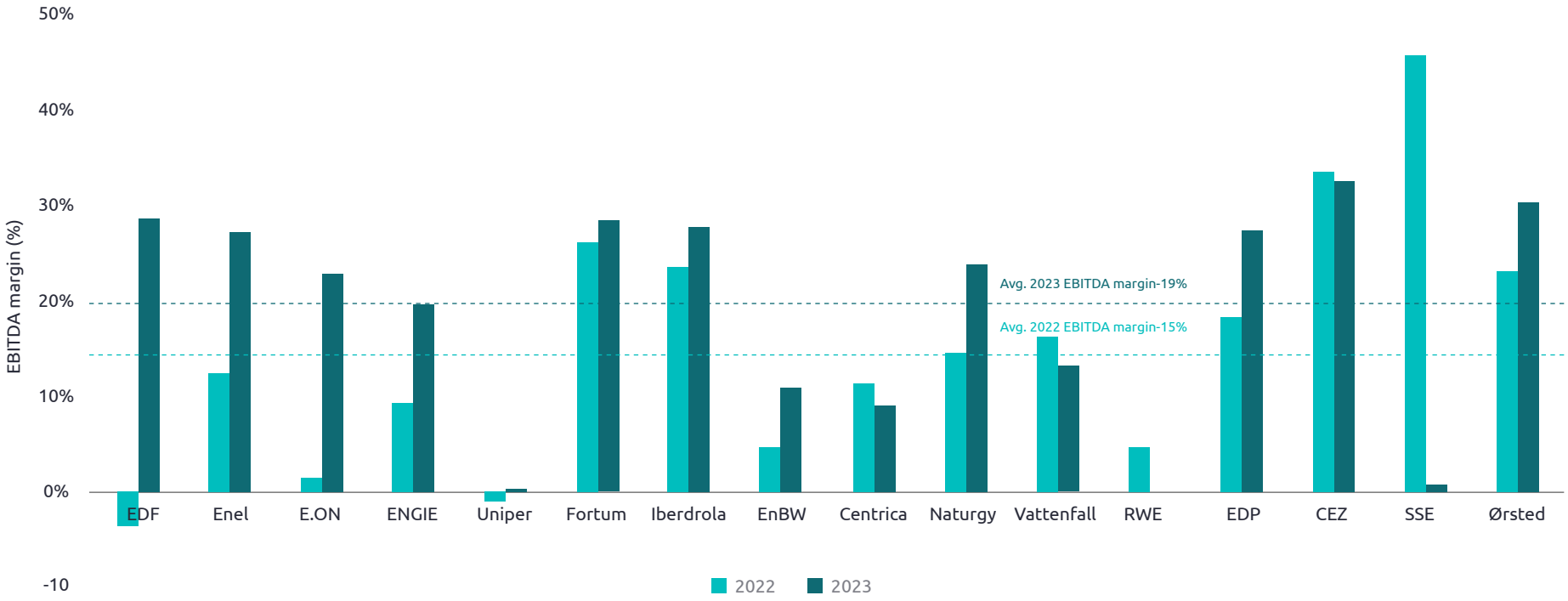


Source: Refinitiv

Performance of key players: Europe

FIGURE 19

Europe - 2022 and 2023 EBIDTA margins



Source: Refinitiv

Performance of key players: Europe

FIGURE 20

Europe - Leverage Ratios 2022 & 2023

	Leverage ratio 2022	Leverage ratio 2023	Evolutions
Centrica	-	-	
CEZ	1.41x	1.40x	↓
E.ON	-	1.25x	
EDF	2.50x	1.36x	↓
EDP	4.19x	3.98x	↓
EnBW	2.48x	1.66x	↓
ENEL	3.47x	2.50x	↓
ENGIE	2.87x	1.66x	↓
Fortum	3.66x	1.60x	↓
Iberdrola	3.16x	3.21x	↑
Naturgy	2.42x	2.20x	↓
Ørsted	1.46x	1.71x	↑
RWE	-	-	
SSE	2.01x	2.27x	↑
Vattenfall	-	0.94x	
Average	**2.69x**	**1.98x**	↓

Note: Leverage ratio = Net debt/EBITDA

Source: Refinitiv

Performance of key players: Europe

FIGURE 21

Europe - 2023 Standard & Poor (S&P) credit ratings

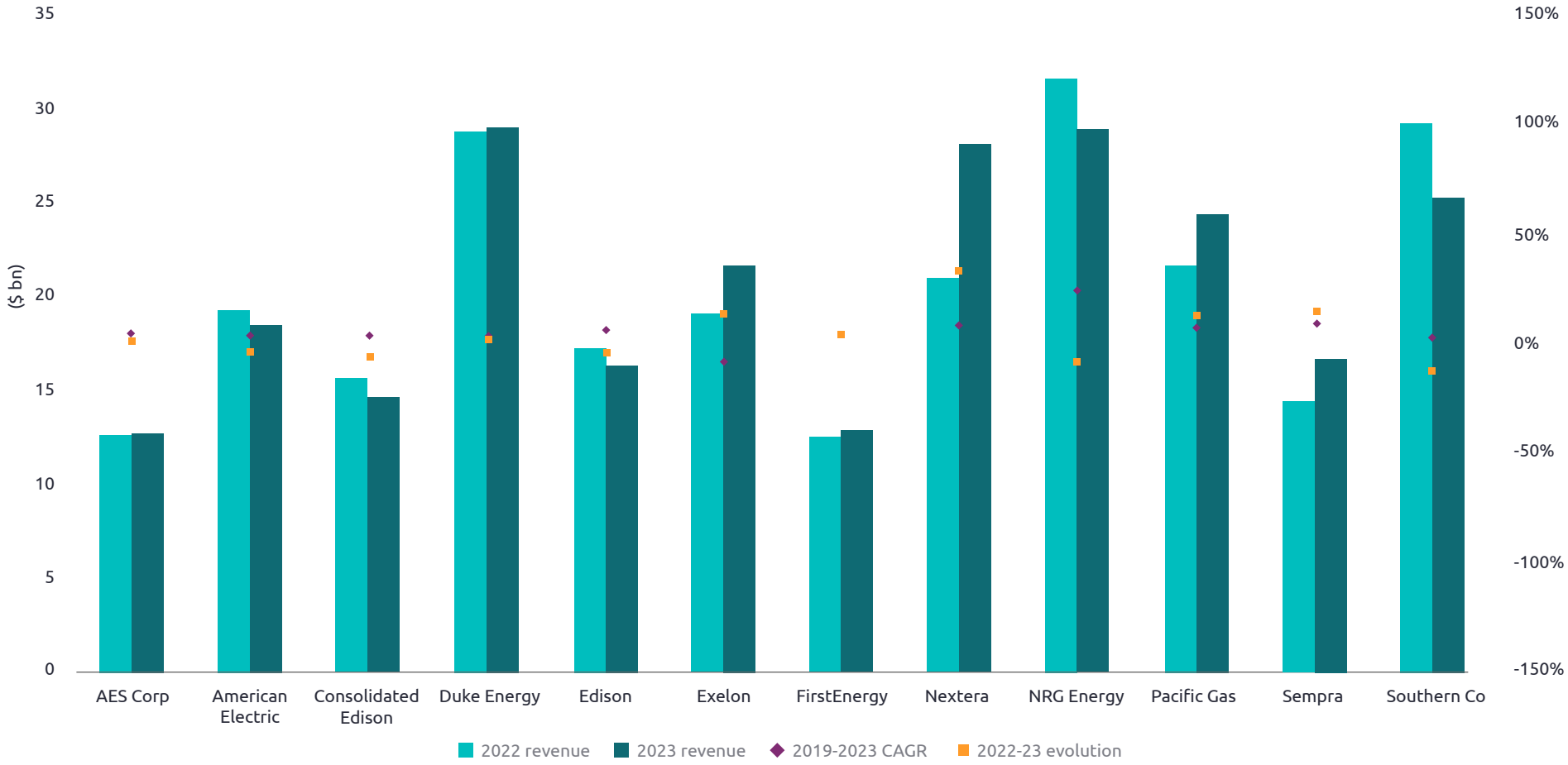
Company	2019	2020	2021	2022	2023
Centrica	BBB	BBB	BBB+	BBB	BBB
CEZ	A-	A-	A-	A-	A-
E.ON	BBB	BBB	BBB	BBB	BBB+
EDF	A-	BBB+	BBB	BBB	BBB
EDP	BBB-	BBB-	BBB	BBB	BBB
EnBW	A-	A-	A-	A-	A-
Enel	BBB+	BBB+	BBB+	BBB+	BBB
ENGIE	A-	BBB+	BBB+	BBB+	BBB+
Fortum	BBB	BBB	BBB	BBB	BBB+
Iberdrola	BBB+	BBB+	BBB+	BBB+	BBB+
Naturgy	BBB	BBB	BBB	BBB	BBB
Ørsted	BBB+	BBB+	BBB+	BBB+	BBB
SSE	BBB+	BBB+	BBB+	BBB+	BBB+
Uniper	BBB	BBB	BBB	BBB-	BBB-
Vattenfall	BBB+	BBB+	BBB	BBB+	BBB+

Source: Refinitiv

Performance of key players: North America

FIGURE 22

North America - 2022 and 2023 revenues and CAGR 2019-2023

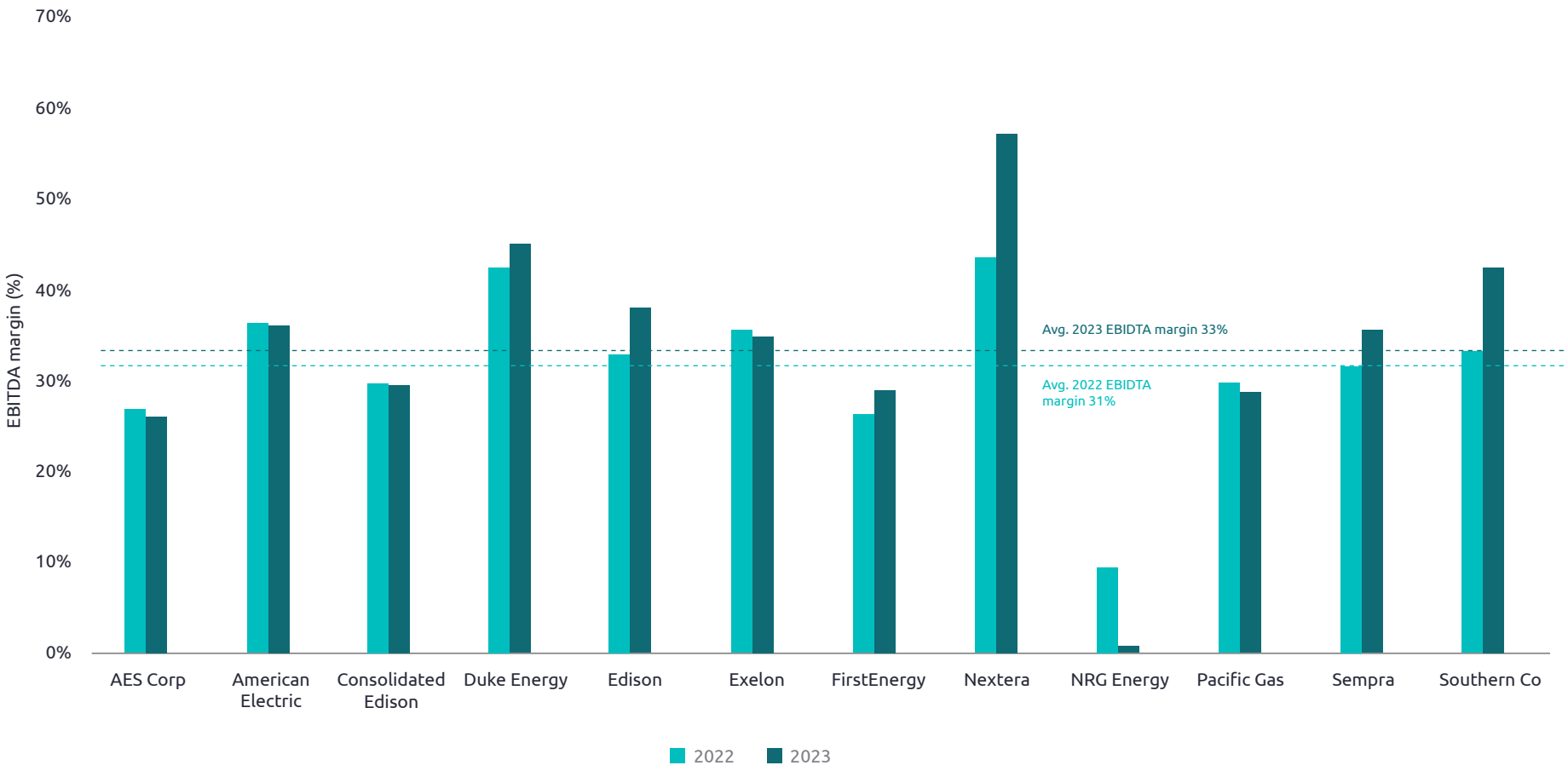


Source: Refinitiv

Performance of key players: North America

FIGURE 23

North America - 2022 and 2023 EBIDTA margins



Source: Refinitiv

Performance of key players: North America

FIGURE 24

North America - Leverage Ratios 2022 & 2023

	Leverage ratio 2022	Leverage ratio 2023	Evolutions
AES Corp	5.70X	6.97X	↑
American Electric	5.34X	6.05X	↑
Consolidated Edison	4.93X	5.25X	↑
Duke Energy	5.71X	5.78X	↑
Edison International	5.09X	5.17X	↑
Exelon	5.97X	5.52X	↓
FirstEnergy	6.68X	6.21X	↓
Nextera	6.44X	4.15X	↓
NRG Energy	2.50X	-	
Pacific Gas	6.70X	7.02X	↑
Sempra	5.75X	5.00X	↓
Southern Co.	5.48X	5.44X	↓
Average	**5.52x**	**5.69X**	↓

Note: Leverage ratio = Net debt/EBITDA

Source: Refinitiv

Performance of key players: North America

FIGURE 25

North America - 2023 Standard & Poor (S&P) credit ratings

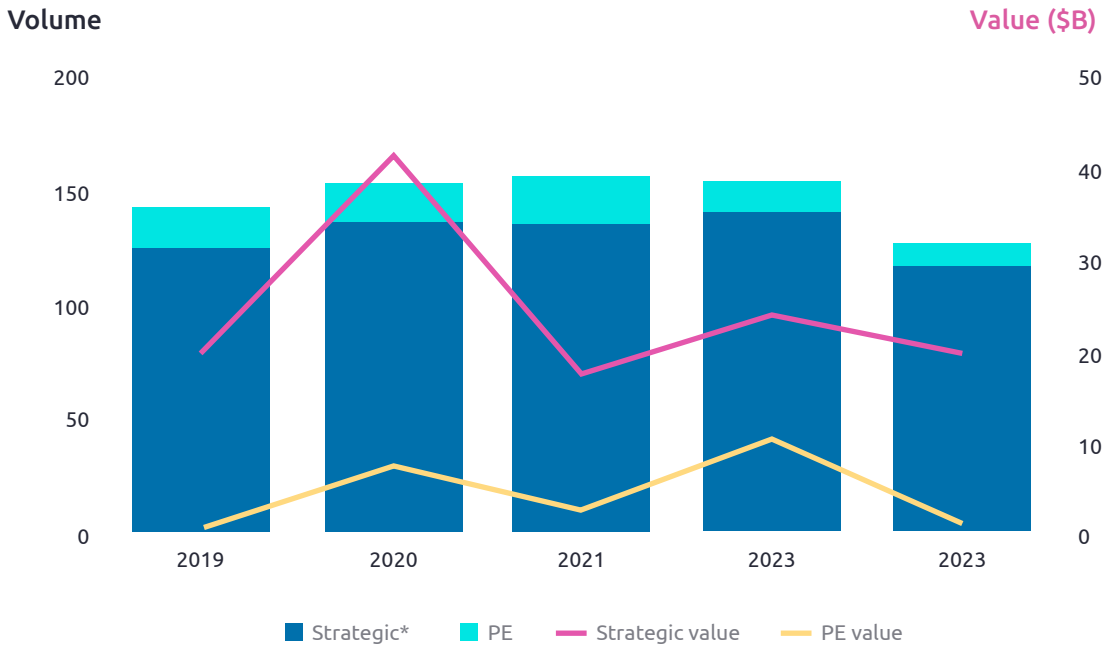
Company	2019	2020	2021	2022	2023
AES Corp	BB+	BBB-	BBB-	BBB-	BBB-
American Electric	BBB+	BBB+	BBB+	BBB+	BBB+
Consolidated Edison	A-	A-	A-	A-	A-
Duke Energy	A-	A	BBB+	BBB+	BBB+
Edison	BBB	BBB	BBB	BBB	BBB
Exelon	BBB+	BBB+	BBB+	BBB+	BBB+
FirstEnergy	BBB	BB	BBB-	BBB	BBB
Nextera	A-	A-	A-	A-	A-
NRG Energy	BB	BB+	BB+	BB+	BB
Pacific Gas	D	BB-	BBB-	BB-	BB-
Sempra	BBB+	BBB+	BBB+	BBB+	BBB+
Southern Co.	BBB	BBB	BBB	BBB	BBB

Source: Refinitiv

M&A trends in energy utilities

FIGURE 26

Top Power and Utilities Deal Activity by Type



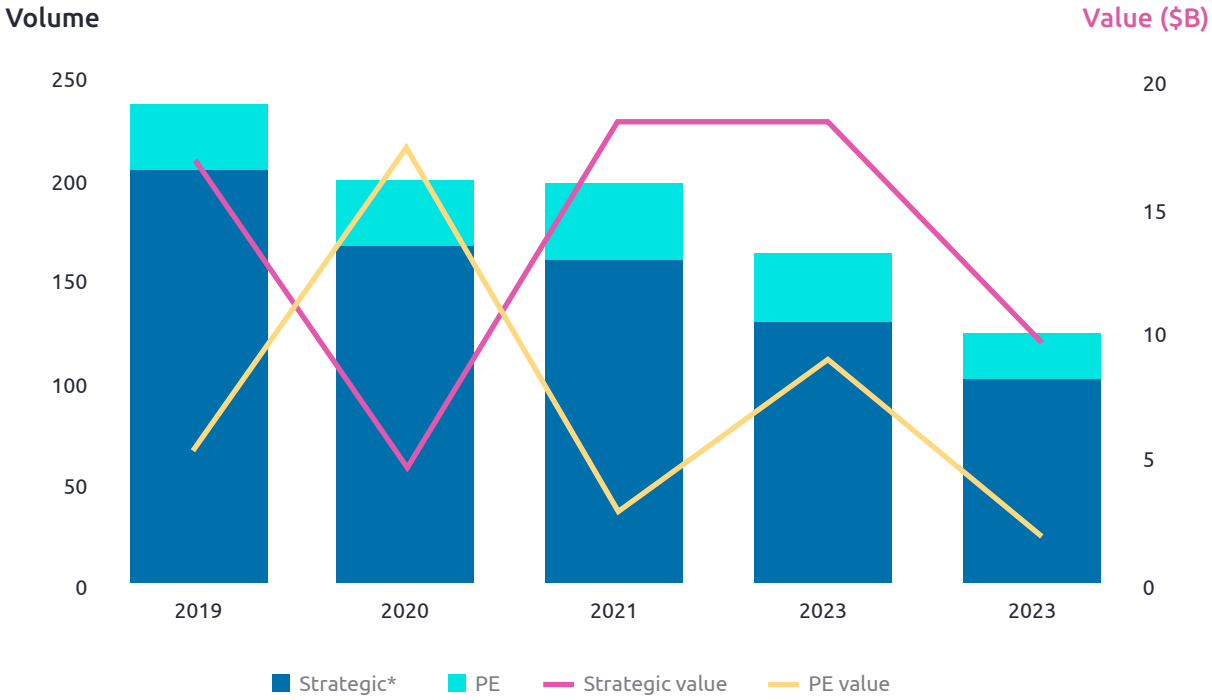
Source: KPMG

- Power and utility companies are divesting non-regulated and non-core assets, and selling shares to reduce business risk, improve balance sheets, and avoid additional debt issuance or equity issues.
- These divestments are helping them to gear up for substantial investments in energy infrastructure.
- Moreover, significant growth in the volume of new renewable assets has spurred M&A activity in the power and utilities sector.

M&A trends in energy utilities

FIGURE 27

Top Renewable Energy Deal Activity by Type



Source: KPMG

- Renewable energy M&A deals faced significant headwinds, including economic uncertainty, geopolitical tensions, high interest rates, inflationary pressures, supply chain constraints.
- Voluntary carbon reduction plans and the IRA continue to drive significant investments in renewables and related green sectors, with substantial amounts of private capital flowing into the renewables industry.
- M&A activity in Asia has been driven by large renewable platforms trading at significant premiums.
- Acquisitions involving partnerships with international firms seeking to leverage Chinese technology and gain market access are taking place, alongside investment in the development of clean technologies.

M&A trends in energy utilities

FIGURE 28

Transacted Capacity by Technology, in GW, 2022 - 2023

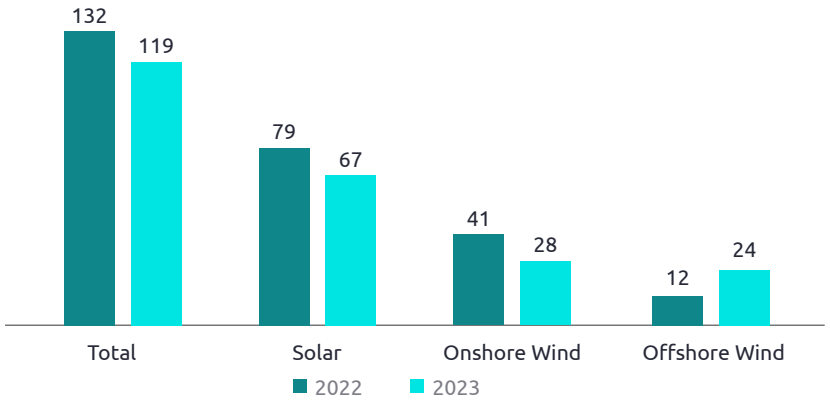
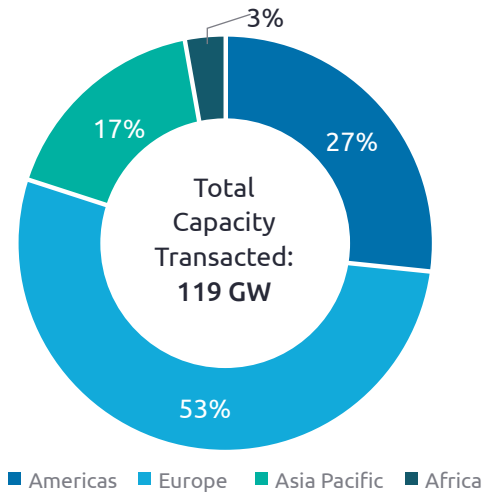


FIGURE 29

Deals by Geography - 2023



Source: Peak Wind

- In both 2022 and 2023, solar assets dominated the deal activity, accounting for nearly 60% of the deal capacity in 2023.
- Over the same period, the transacted solar capacity decreased by 15% from ~78.7 GW in 2022 to ~67.3 GW in 2023. This decrease indicates an overall reduction in the average transaction size from 347 MW to 302 MW.
- In 2023, Europe maintained its dominant position in global renewable energy transactions, accounting for 53% of the transacted capacity, reaffirming the continent's strong position in the industry.

M&A trends in energy utilities

FIGURE 30

Major power, utilities, and renewable energy deals in 2023

Acquirer	Target	Rationale	Value (in $ Bn)
Brookfield Infrastructure Corp.	Triton International Limited	• Owner of renewable energy projects expanding its logistics business	**13.3**
Enbridge Inc.	Dominion Energy Questar Corporation	• Establish the largest natural gas utility platform in North America	**4.3**
Enbridge Inc.	Public Service Company of North Carolina, Inc.	• Add gas utility operations in North Carolina	**3.1**
Brookfiled Renewable Partners L.P. Brookfield Renewable Corporation	Duke Energy Renewables	• Acquisition of scale renewable platform for cash flows and development	**2.8**
IRG Acquisition Holdings LLC	American Electric Power Co. Inc.	• Expand presence in the USA electrification and renewable energy sector	**1.5**

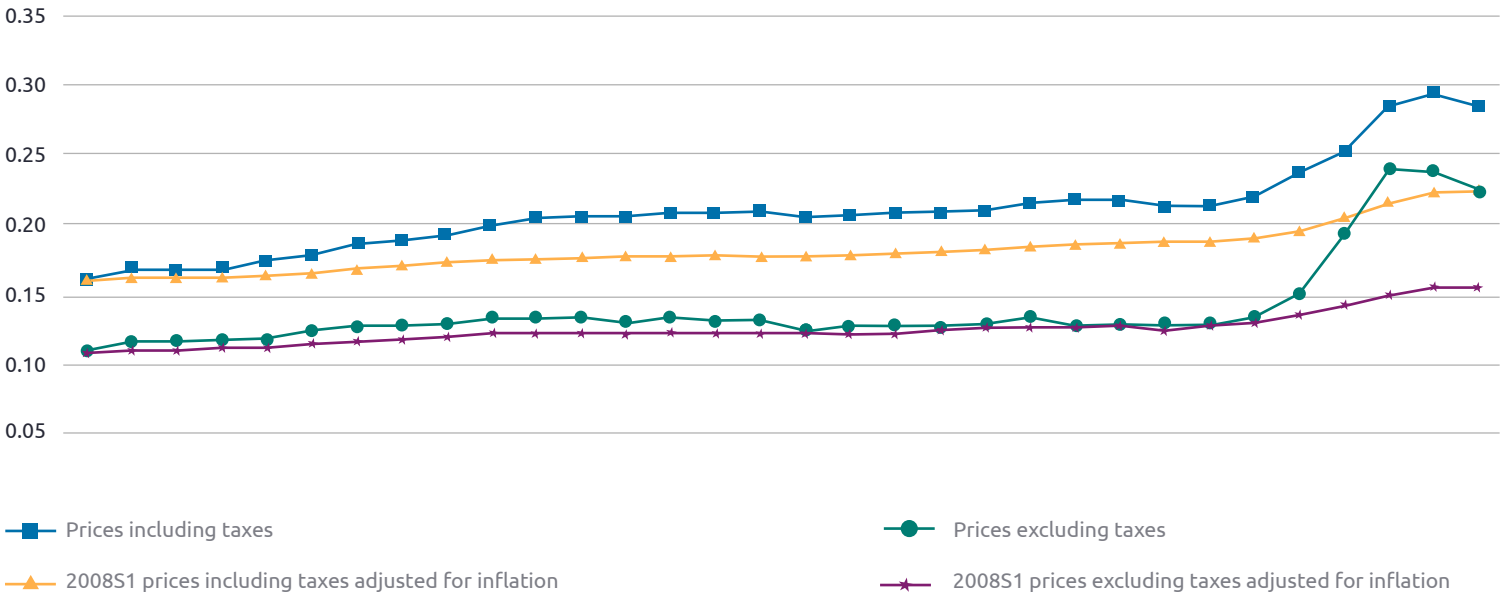
*Note: Deal data has been sourced from Capital IQ, Pitchbook, and KPMG analysis and majorly excludes asset purchases/minority purchases

Source: KPMG

Government market interventions

FIGURE 31

Development of electricity prices for household consumers, 2008-2023 (€ per kWh)



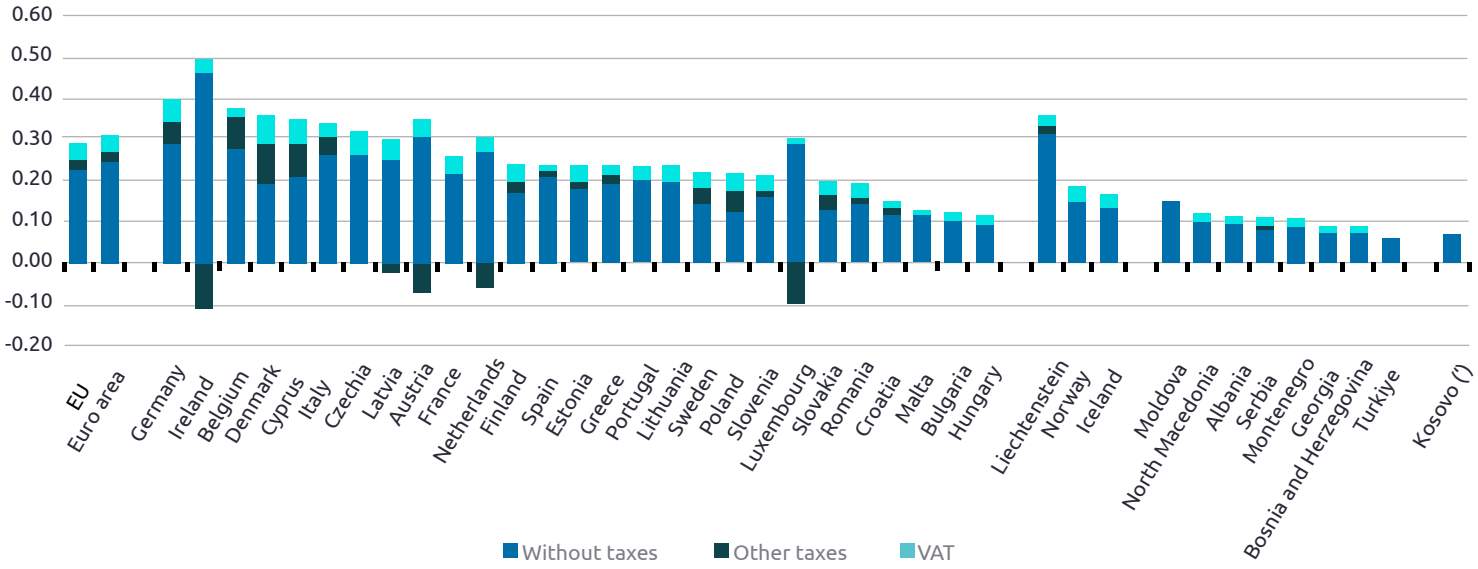
- In the H2-2023, compared with the second half of 2022, household electricity prices in the EU showed the sharpest increase in the Netherlands (86%). The largest decrease was observed in Denmark (-39%).
- In the H2-2023, Ireland and Luxembourg gave the biggest allowances to household consumers.
- For household consumers in the EU (for medium-sized consumers with an annual consumption between 2 500 Kilowatt hours (kWh) and 5 000 kWh), electricity prices in the second half of 2023 were highest in Germany (€0.4020 per kWh), Ireland (€0.3794 per kWh), Belgium (€0.3778 per kWh) and Denmark (€0.3554 per kWh).

Source: Eurostat

Government market interventions

FIGURE 32

Electricity prices for household consumers, second half 2023 (€ per kWh)



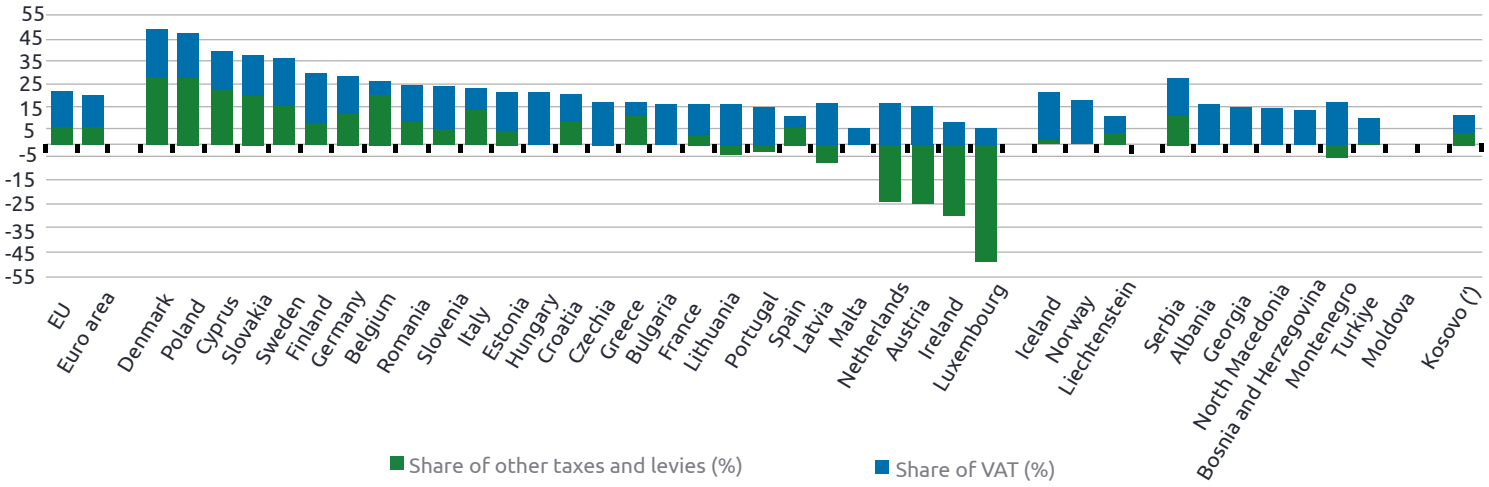
- For German household consumers, the per kWh cost was 41 % above the EU average price, whereas households in Hungary, Bulgaria and Malta paid less than half the price than the EU average.
- The EU average price in the second half of 2023 — a weighted average using the most recent (2022) consumption data for electricity by household consumers — was €0.2847 per kWh.

Source: Eurostat

Government market interventions

FIGURE 33

Share of taxes and levies paid by household consumers for electricity, 2nd half 2023 (%)



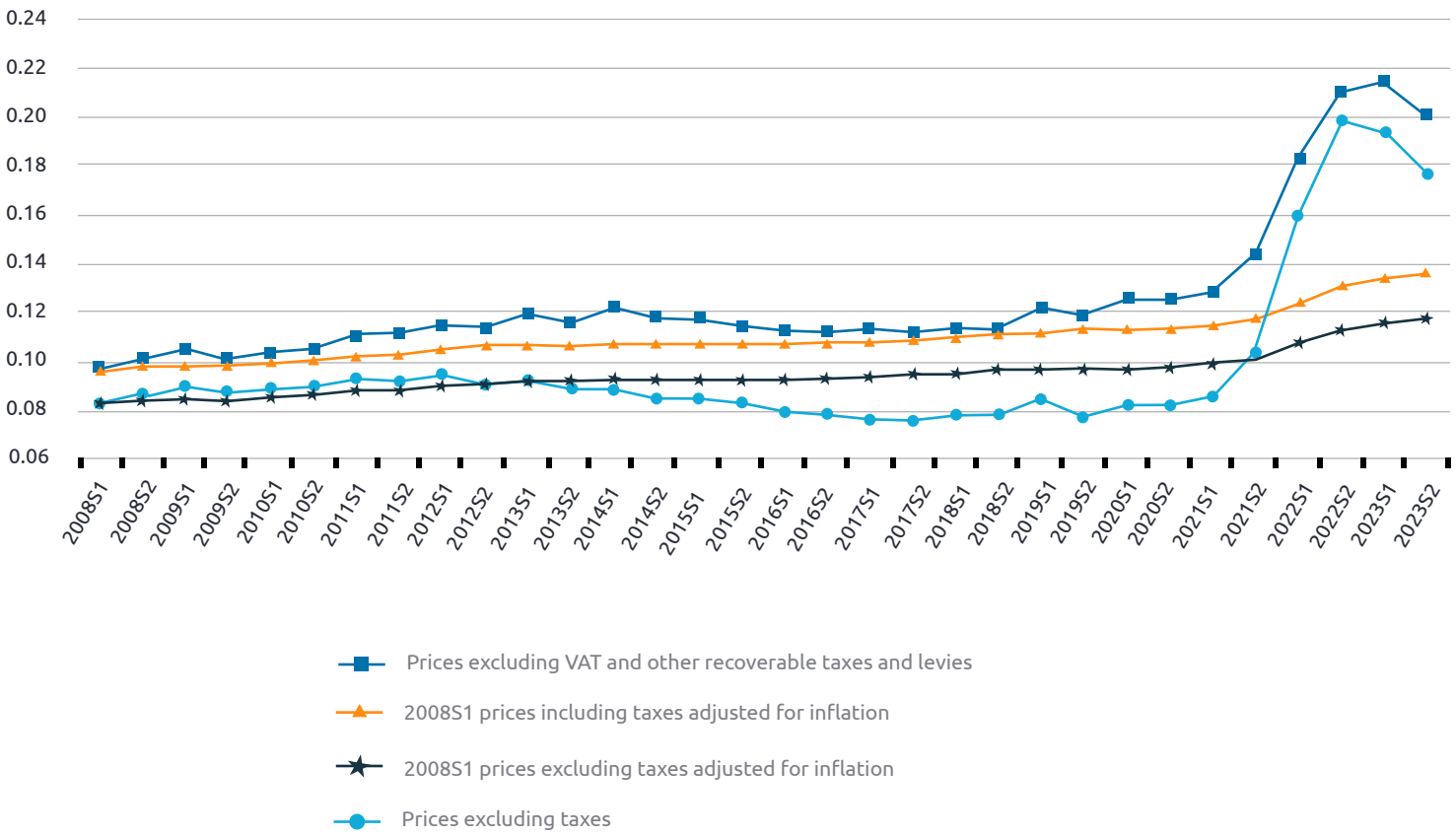
- In the EU, the share of taxes in the second half of 2023 was the least in Luxembourg, where the values were in fact negative (-49.2%). Negative taxes, reflecting the subsidies and allowances, were also observed in Ireland, Austria, the Netherlands, Latvia, Portugal and Lithuania
- The relative share of taxes was highest in Denmark, making up 48.1% of the total price. The average share of total taxes and levies at EU level in the second half of 2023 was 21.8 %, an increase of 6.3 percentage points (pp) when compared with the second half of 2022, and an increase of 2.6 percentage points (pp) when compared with the first half 2023, mostly driven by reduction of subsidies and allowances.
- The VAT in the EU represented 13.7 % of the total price. It ranged from 4.8 % in Malta to 21.3 % in Hungary.

Source: Eurostat

Government market interventions

FIGURE 34

Development of electricity prices for non-household consumers, 2008-2023 (€ per kWh)



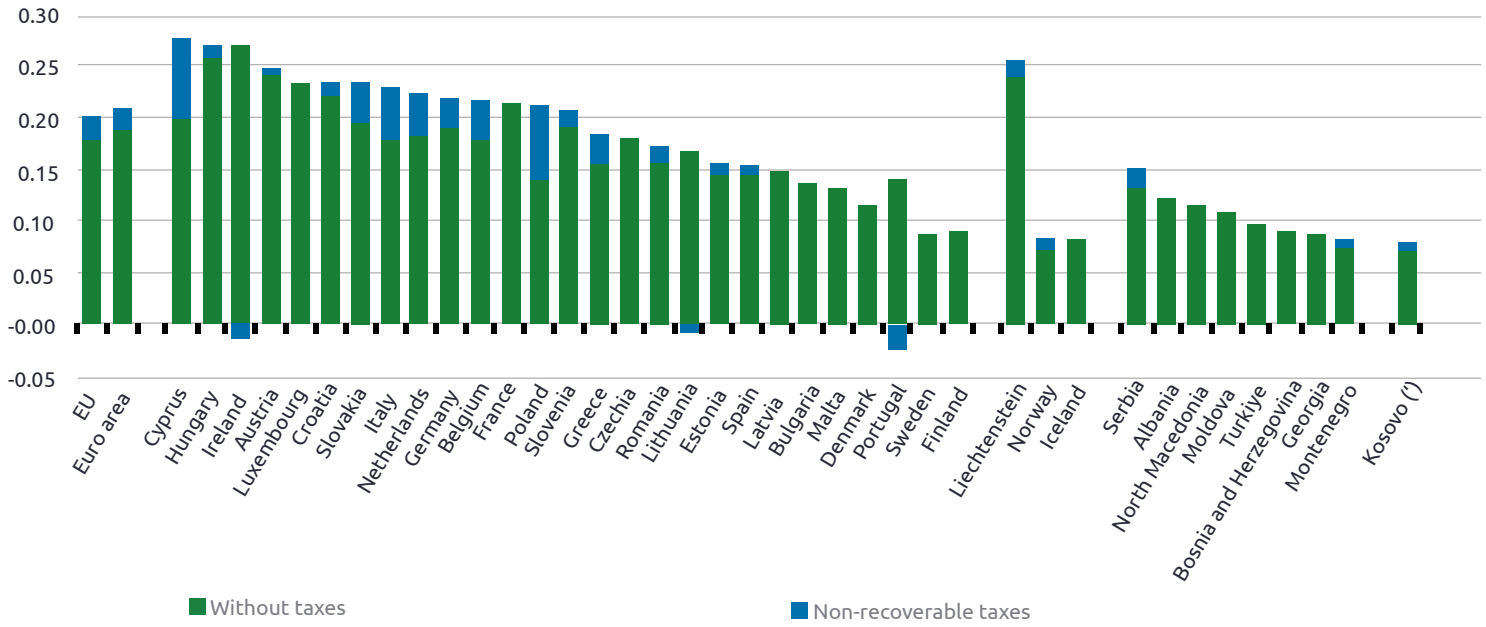
- Looking at the non-household total price, i.e., including the non-recoverable taxes, for the second half of 2023, it more than doubled (107.4%) compared with the 2008 first half year price, from €0.0968 per kWh to €0.2008 per kWh.
- For the prices adjusted for inflation, the total price for non-household consumers, i.e. including taxes, was €0.1367 per kWh in the second half of 2023 compared with €0.0968 per kWh in the first half of 2008. The total price for non-household consumers, without taxes, was €0.1771 per kWh in the second half of 2023 compared with €0.0834 per kWh in the first half of 2008.

Source: Eurostat

Government market interventions

FIGURE 35

Electricity prices for non-household consumers, second half 2023, (€ per kWh)



(') This designation is without prejudice to position on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo Declaration of Independence

Source: Eurostat (online data codes: nrg_pc_205)

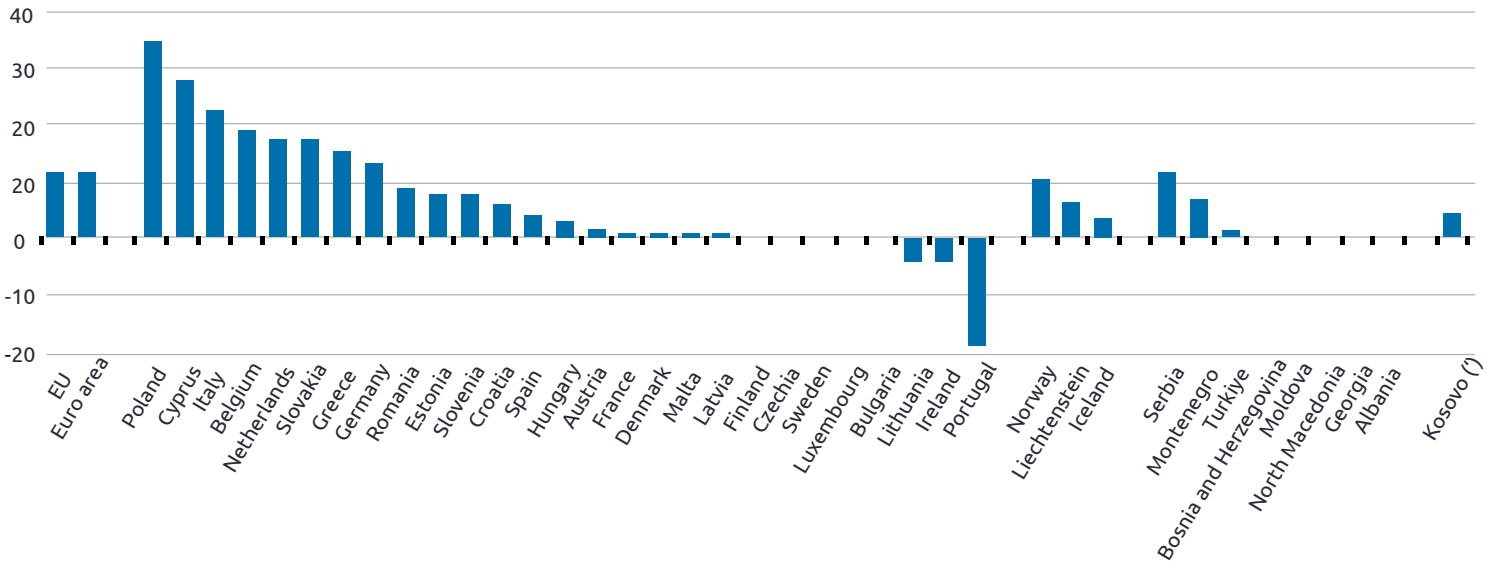
- Non-household consumers are medium-sized consumers with an annual consumption between 500 MWh (Mega Watt hours) and 2000 MWh.
- Electricity prices in the second half of 2023 were highest in Cyprus (€0.2759 per kWh) and Hungary (€0.2695 per kWh). The lowest prices were observed in Finland (€0.0885 per kWh) and Sweden (€0.0901 per kWh).
- The EU average price in the second half of 2023 was €0.2008 per kWh. The aggregates are weighted averages taking into consideration the average consumption in each band.

Source: Eurostat

Government market interventions

FIGURE 36

Share of taxes and levies paid by non-household consumers for electricity, H2-2023 (%)



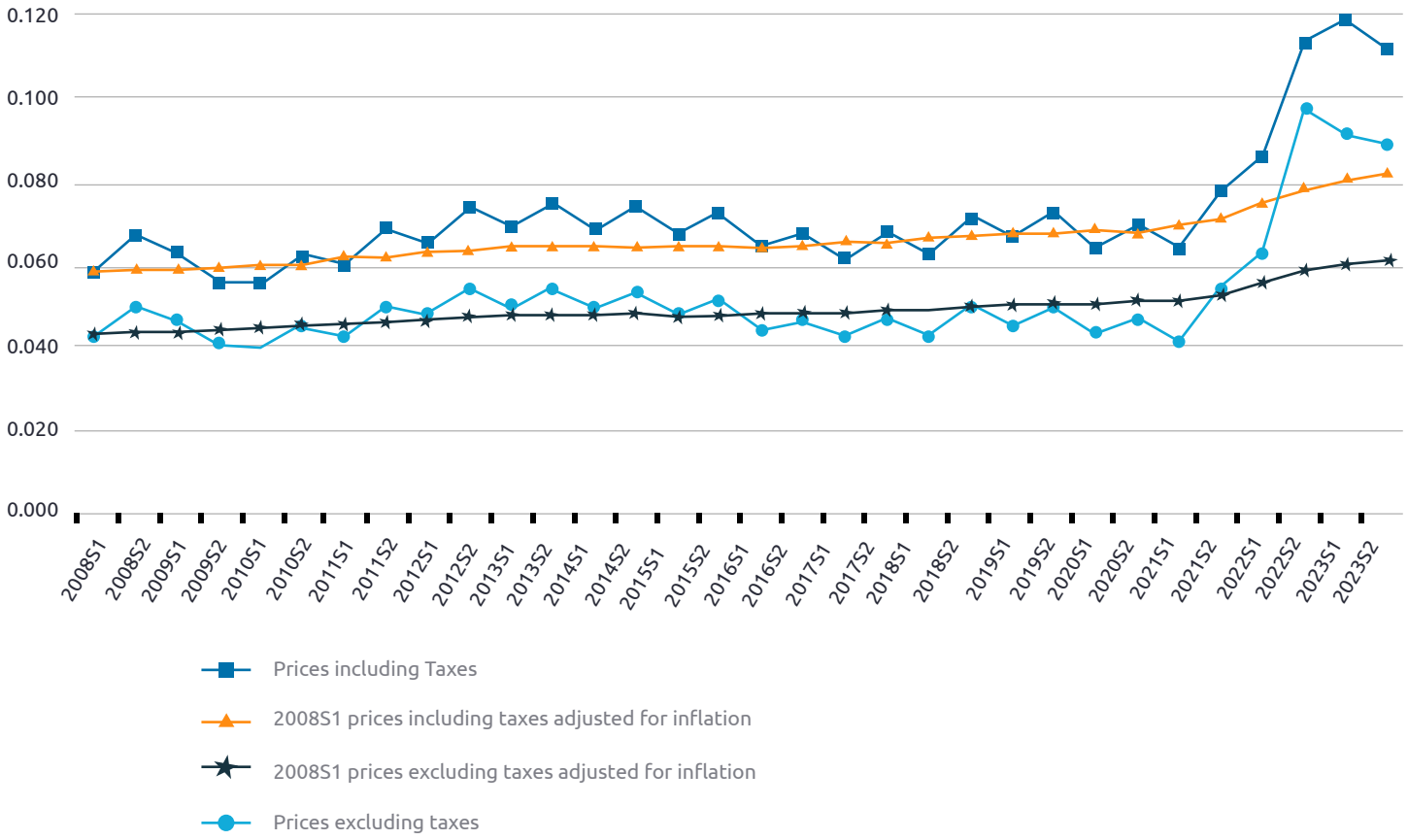
- In the second half of 2023, the share of taxes was highest in Poland and Cyprus, where non-recoverable taxes and levies made up 34.9 % and 28.0 % of the total price respectively.
- The share of taxes for the EU in the second half of 2013 stood at 11.8 %, showing an increase when compared with the second half 2022 (5.6 %), being also in a higher level, compared with the first half of 2023 (10.0 %).

Source: Eurostat

Government market interventions

FIGURE 37

Development of natural gas prices for household consumers, 2008-2023 (€ per kWh)



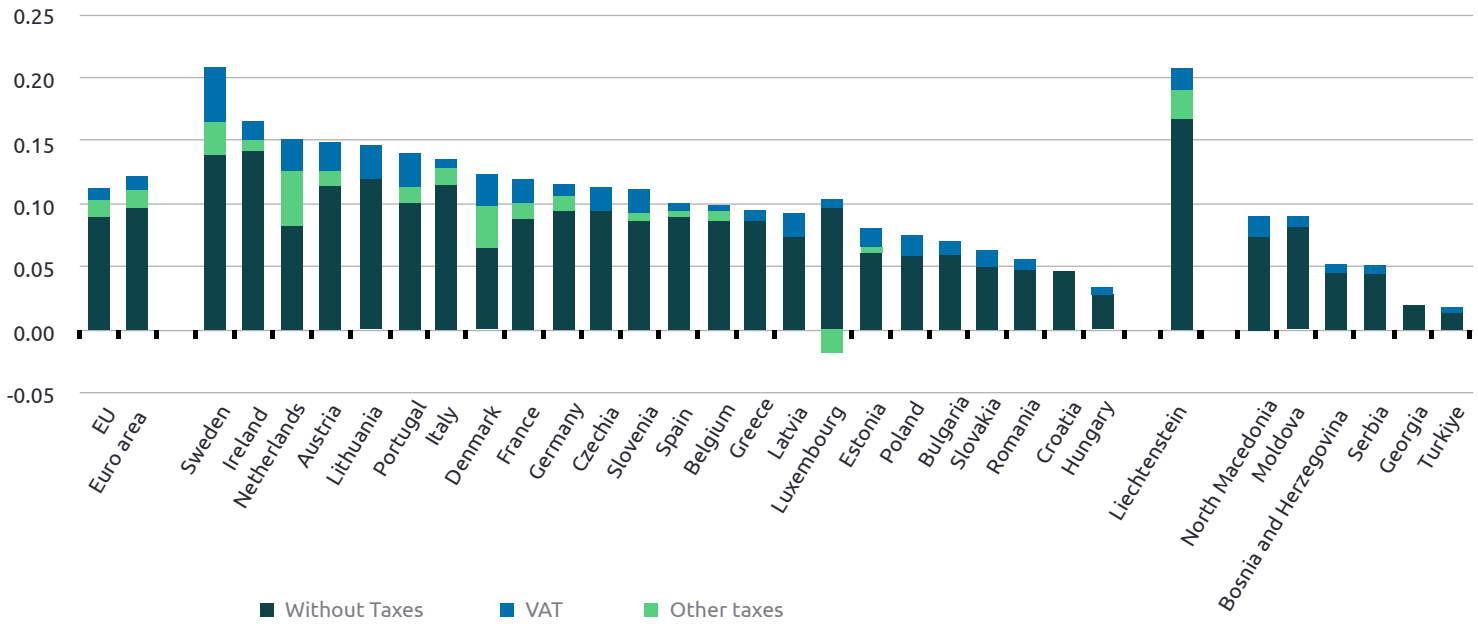
Source: Eurostat

- In the H2-2023, the price of natural gas for household consumers decreased to €0.1125 per kWh, from €0.1137 per kWh the year before, after an all-time high in the first half of 2023. The proportion of the taxes increased from 25 % in the first half of 2008 to 36 % in the first half of 2021 and then decreased to 20.8 % in the second half of 2023, reflecting the subsidies and allowances measures taken from the countries to alleviate the burden of high energy prices.
- Prices excluding taxes in the second half of 2023 (€0.0891 per kWh) were lower than the respective prices of the first half of 2023 (-2.7 %) and also lower than the second half of 2022 (-9.1 %).

Government market interventions

FIGURE 38

Natural gas prices for household consumers, second half 2023 (€ per kWh)



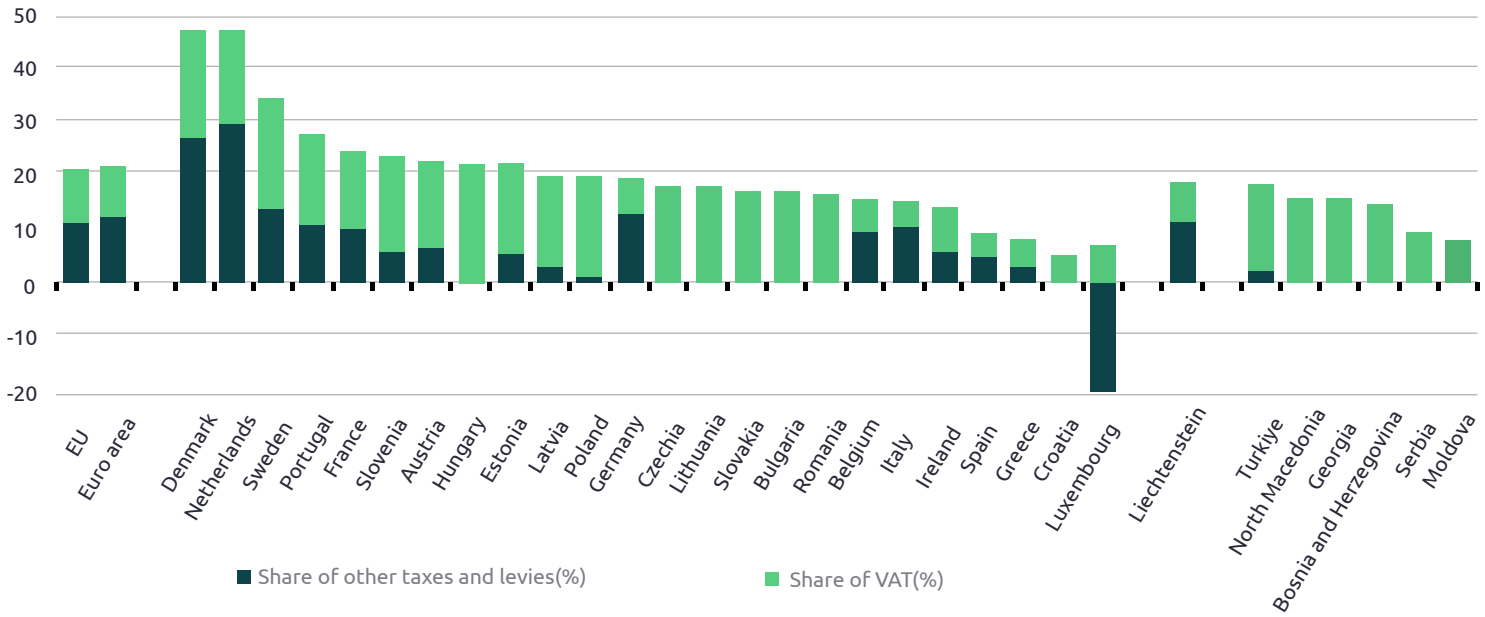
- For household consumers in the EU (medium-sized consumers with an annual consumption between 20 Gigajoules (GJ) and 200 GJ), natural gas prices in the second half of 2023 were highest in Sweden, Ireland and the Netherlands and lowest in Hungary, Croatia and Romania
- The price of natural gas for households in Sweden (€0.2070 per kWh) was more than six times the price charged in Hungary (€0.0335 per kWh) and 84 % higher than the EU average price (€0.1125 per kWh).

Source: Eurostat

Government market interventions

FIGURE 39

Share of taxes and levies paid by household consumers for natural gas, 2nd half 2023 (%)



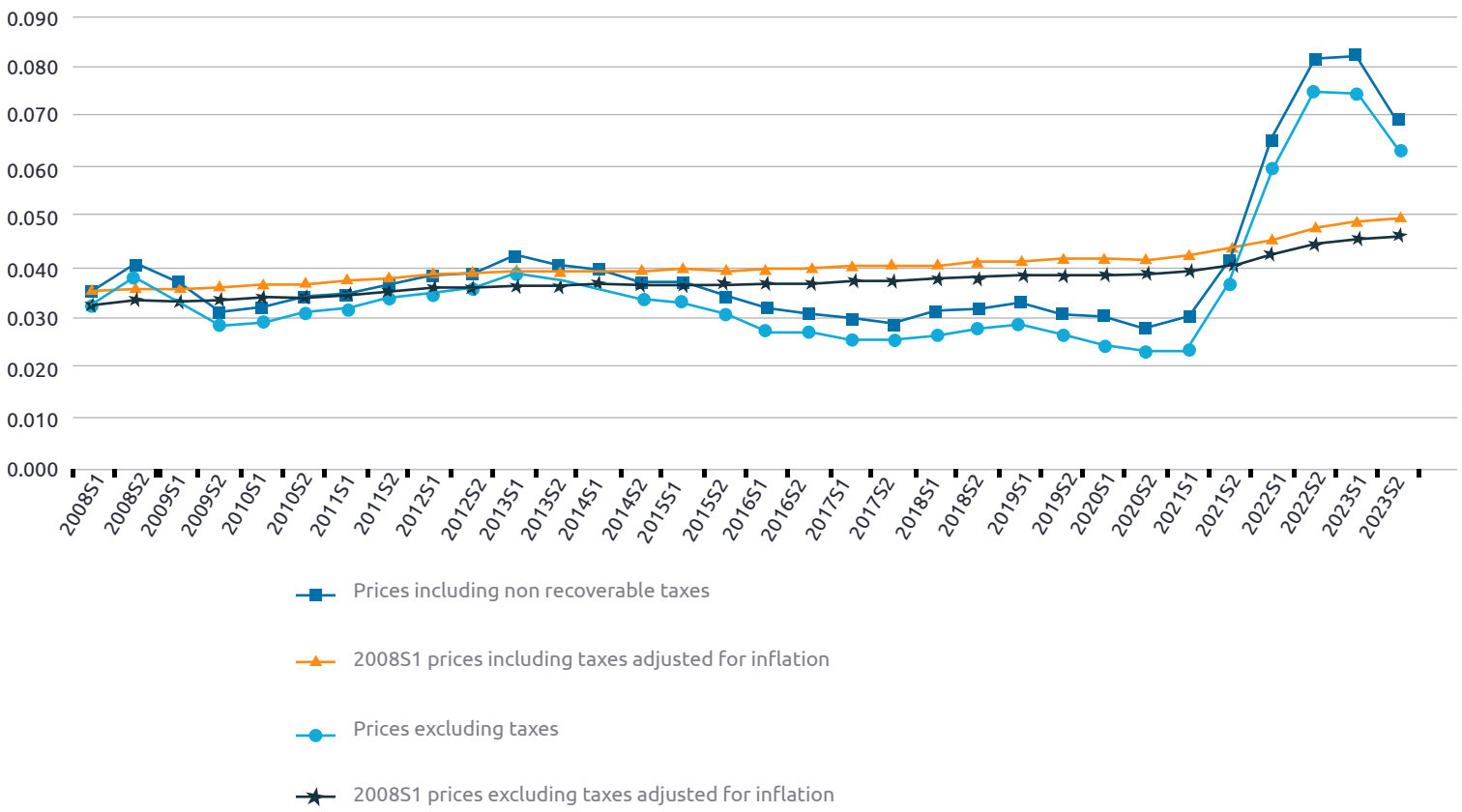
Source: Eurostat

- The relative tax contribution in the second half of 2023 was the least in Luxembourg, where subsidies and allowances led to negative figures (-13.88 %). The highest taxes were observed in Denmark, where total taxes and levies corresponded to 46.64 % of the final price. In the Netherlands, this percentage was 46.53 %. The VAT in the EU represented 9.69 % of the total price.
- These changes relate to the governmental allowances and subsidies to mitigate high-energy costs in the second half of 2022, reduced in the first half of 2023, and further reduced in the second half of 2023, but is also a consequence of the overall changes in the price of the energy and supply component.

Government market interventions

FIGURE 40

Development of natural gas prices for non-household consumers, 2008-2023 (€ per kWh)



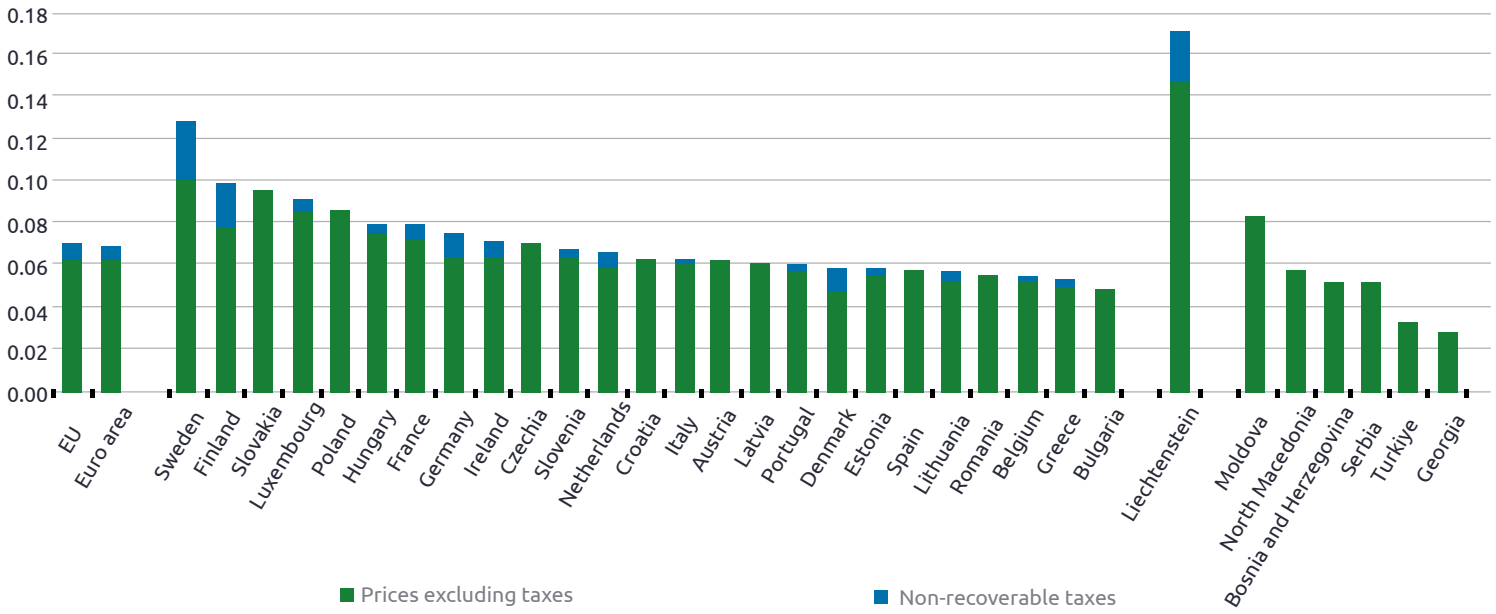
- From the second half of 2021 the price recorded increases which reached €0.082 per KWh in the first half of 2023.
- In the second half of 2023 a decrease is observed for the price including non-recoverable taxes, which dropped to €0.0689 per KWh. Excluding taxes, in the second half of 2023, the price was €0.0682 per KWh, showing a decrease, compared with the previous semester (-15.1 %) and the same semester of the previous year (-16.0 %).

Source: Eurostat

Government market interventions

FIGURE 41

Natural gas prices for non-household consumers, second half 2023 (€ per kWh)



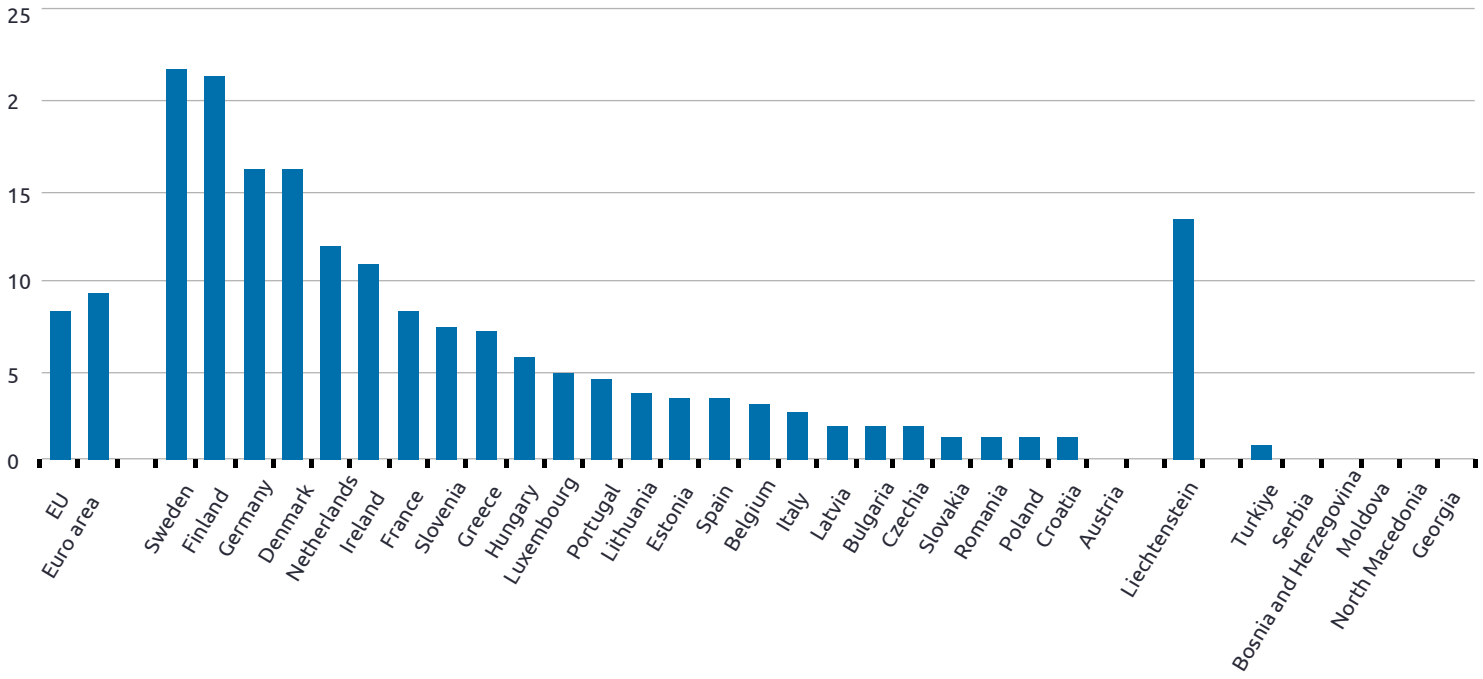
- For non-household consumers in the EU (medium-sized consumers with an annual consumption between 10 000 GJ and 100 000 GJ), natural gas prices in the second half of 2023 were highest in Sweden (€0.1276 per kWh) 85 % above the EU average, followed by Finland (€0.0985 per kWh) and Slovakia (€0.0961 per kWh).
- Sweden and Finland have very little natural gas consumption. The lowest prices were recorded in Bulgaria (€0.0460 per kWh)

Source: Eurostat

Government market interventions

FIGURE 42

Share of taxes and levies paid by non-household consumers for natural gas, H2-2023 (%)



Source: Eurostat

- The weight of all the taxes increased from around 7.6 % in 2008 to around 21 % in the first half of 2021 and then dropped to 7.5 % in the second half of 2022 with subsequent increase to 8.4 % in the second half of 2023.
- For non-household consumers, the share of these non-recoverable taxes in the second half of 2023 was 21.8 % in Sweden, 21.4 % in Finland and 16.2 % in Germany. Austria had zero percentage and together with Croatia (1.1 %) and Poland (1.3 %) found themselves at the other end of the spectrum, registering the lowest shares of taxes.

AI regulations in energy and utility

FIGURE 43

Governments are proposing AI regulations for the energy and utility sectors, though comprehensive regulations are still lacking (1/3)

Evolving Rules & Regulations	What Does It Address?
EU AI Act	• The European Union's long-awaited and much-debated **AI Act,** which was formally adopted by the European Parliament on **13 March 2024,** addresses the rapid advancement and integration of artificial intelligence technologies across sectors, including the **entire energy value chain,** as organizations work to **develop responsible AI solutions** • **EU AI Act is a law that will govern the development and/or use of artificial intelligence (AI) in the European Union (EU). The act takes a risk-based approach to regulation, applying different rules to AI according to the risk they pose.** The EU AI Act applies to multiple operators in the AI value chain, such as providers, deployers, importers, distributors, product manufacturers and authorized representatives). • The Commission is asked to request European standardization organizations to produce a standardization deliverable on reporting and documentation processes to improve AI systems' resource performance, **such as reduction of energy and other resources consumption** of the high-risk AI system during its lifecycle, and on energy efficient development of general-purpose AI models. • The EU AI Act regulates AI systems based on risk level. Risk here refers to the likelihood and severity of the potential harm. Some of the most important provisions include: • a prohibition on certain AI practices that are deemed to pose unacceptable risk, • standards for developing and deploying certain high-risk AI systems, • rules for general-purpose AI (GPAI) models. • AI systems that do not fall within one of the risk categories in the EU AI Act are not subject to requirements under the act (these are often dubbed the 'minimal risk' category), although some may need to meet transparency obligations and they must comply with other existing laws. • The act also lists specific uses that are generally considered high-risk, including AI systems used: • in employment contexts, such as those used to recruit candidates, evaluate applicants, and make promotion decisions • in certain medical devices • in certain education and vocational training contexts • in the judicial and democratic process such as systems that are intended to influence the outcome of elections • to determine access to essential private or public services, including systems that assess eligibility for public benefits and evaluate credit scores. • in critical infrastructure management (e.g. water, gas and electricity supplies etc.) • in any biometric identification system which are not prohibited, except for systems that whose sole purpose is to verify a person's identity (for example, using a fingerprint scanner to grant someone access to a banking app).

Source: 2024 Lazard's Levelized cost of Energy Analysi

AI regulations in energy and utility

FIGURE 44

Governments are proposing AI regulations for the energy and utility sectors, though comprehensive regulations are still lacking (2/3)

Country/Region	Evolving Rules & Regulations	What Does It Address?
USA	• **Federal Energy Regulatory Commission (FERC)**	• The **incorporation of AI** into the regulatory frameworks established by FERC 2023 aligns impeccably with the directive's aspirations, propelling the energy sector toward a future where efficiency, resilience, and sustainability are paramount • FERC 2023 emerges as a visionary regulatory framework designed to refine the interconnection process, bolster efficiency, and fortify the resilience of the energy grid
USA	• **The California Privacy Protection Agency**	• **The California Privacy Protection Agency** board in March 2024 voted 3-2 **to advance** rules about **how businesses use artificial intelligence** and **collect** the **personal information** of consumers, workers, and students • The proposed rules seek to create **guidelines** for the many areas in which **AI** and **personal data** can influence the lives of **Californians**
USA	• **U.S. Department of Energy (DOE)** **Note:** This is not a regulatory body	• DOE **outlines multiple efforts** to accelerate the **responsible deployment of AI technologies** to promote innovation, strengthen America's Energy and National Security, and help **tackle the climate crisis** • In April 2024, as part of President Biden's Investing in America agenda, the U.S. Department of Energy (DOE) announced a series of actions delivering on key elements of the Executive Order on the Safe, Secure, and Trustworthy Development and **Use of Artificial Intelligence**

Source: Morgan Lewis, DOE

AI regulations in energy and utility

FIGURE 45

Governments are proposing AI regulations for the energy and utility sectors, though comprehensive regulations are still lacking (3/3)

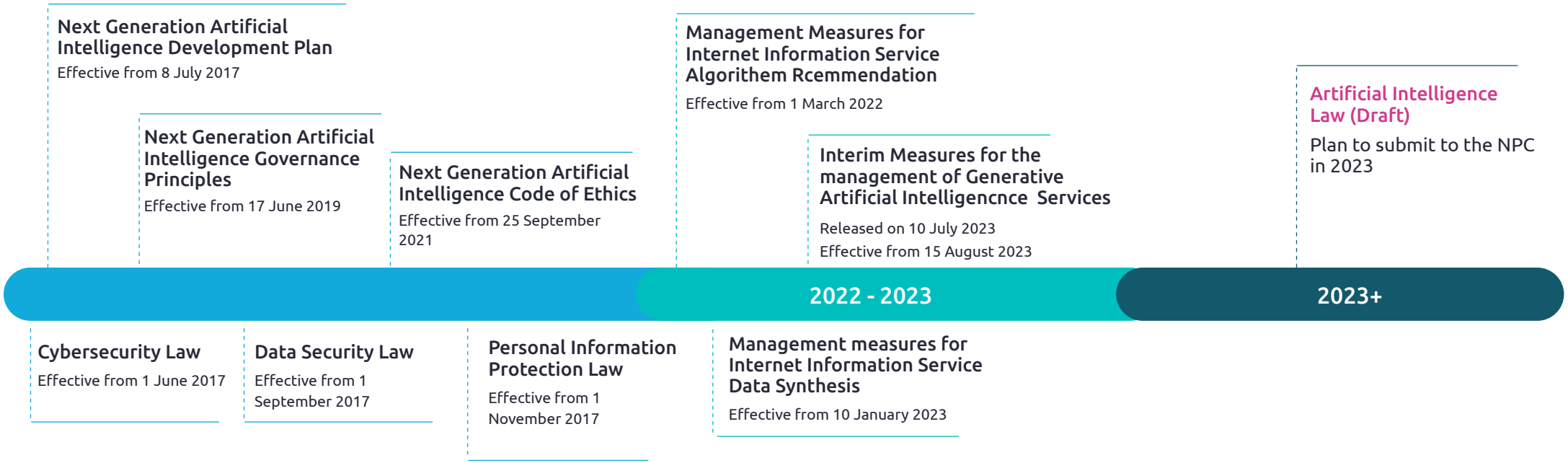
Country/Region	Evolving Rules & Regulations	What Does It Address?
UK	• The UK's framework for AI regulation (Proposed) **Note:** This is not a regulatory body	• The **UK Government** is working on a **framework** to **make sure** that when **AI is used energy consumers benefit** from it and are **protected** • The **Department for Science, Innovation and Technology (DSIT)** has **set** out **what regulators should do** to **make sure** that the sectors they **regulate follow the UK's AI regulatory principles** • AI policy will be based on the principles set out in the white paper. They are: • Safety, Security And Robustness • Transparency And Explainability • Fairness • Accountability And Governance • Contestability And Redress
Note: • **Italy:** Currently, there are no specific laws, statutory rules, or regulations in Italy that directly regulate AI, and Italy is not expected to enact its own general, far-reaching AI regulation. As for all EU Member States, the EU AI Act will be Italy's central general and cross-sectoral AI legislation • **Germany:** Aside from minor references in German labor law regarding works councils, Germany does not have specific AI regulations. The EU AI Act is expected to serve as the comprehensive AI legislation for Germany and other EU Member States • **France:** France does not have specific AI regulations and is not expected to create its own comprehensive AI laws, as the EU AI Act will cover this. However, France may regulate AI on a sector-specific basis		
Australia	• Eight AI Ethics Principles • AI Assurance Framework **Note:** This is not a regulatory body	• As at April 2024, there is currently no generally applicable law regulating the use of artificial intelligence (AI) in Australia. However, a voluntary framework consisting of **Eight AI Ethics Principles** has existed at a federal level since 2019 • In addition, the New South Wales state government has issued a range of AI-related guidance, including an **AI Assurance Framework** for NSW government agencies seeking to design, build and use AI-enabled products and solutions • In January 2024, the **Australian government** published an interim response relating to its **safe and responsible AI consultation.** Broadly speaking, the government **indicated** that it would **use a risk-based framework** to **support** the **safe use of AI and to prevent harm occurring from the use of AI**

Source: Morgan Lewis, Ofgem, The UK Government, White & Case

AI regulations in energy and utility

FIGURE 46

AI Legal and Regulatory Landscape, China



- In July 2023, the Cyberspace Administration of China, along with six other PRC authorities, jointly issued the highly anticipated Interim Measures for the management of generative artificial intelligence services. These Measures came into effect on August 15, 2023

Source: Linklaters

Data and Digital

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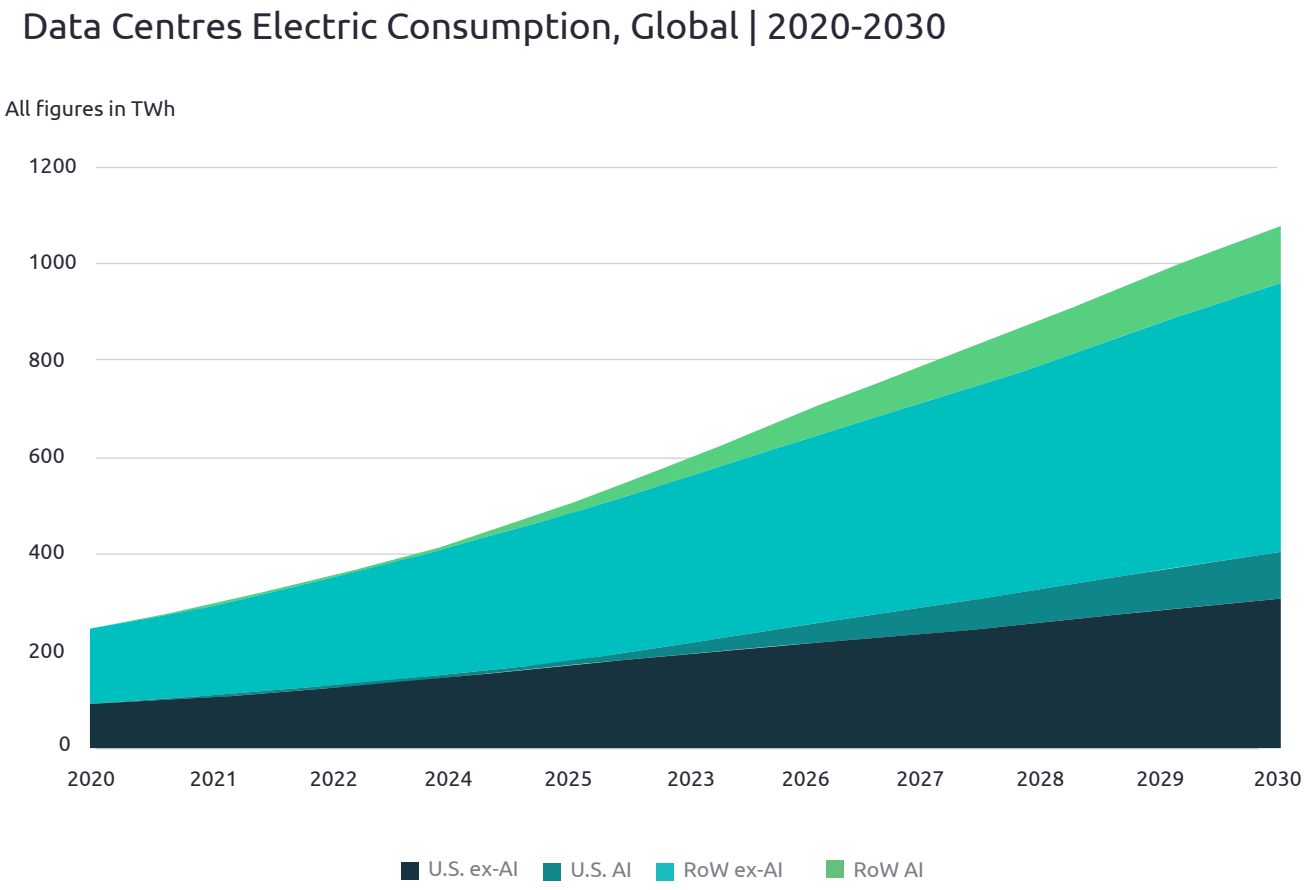
Figure 16: Control Room of the Future Capabilities

Gen AI

FIGURE 1

Data centres are significant drivers of growth in electricity demand in many regions



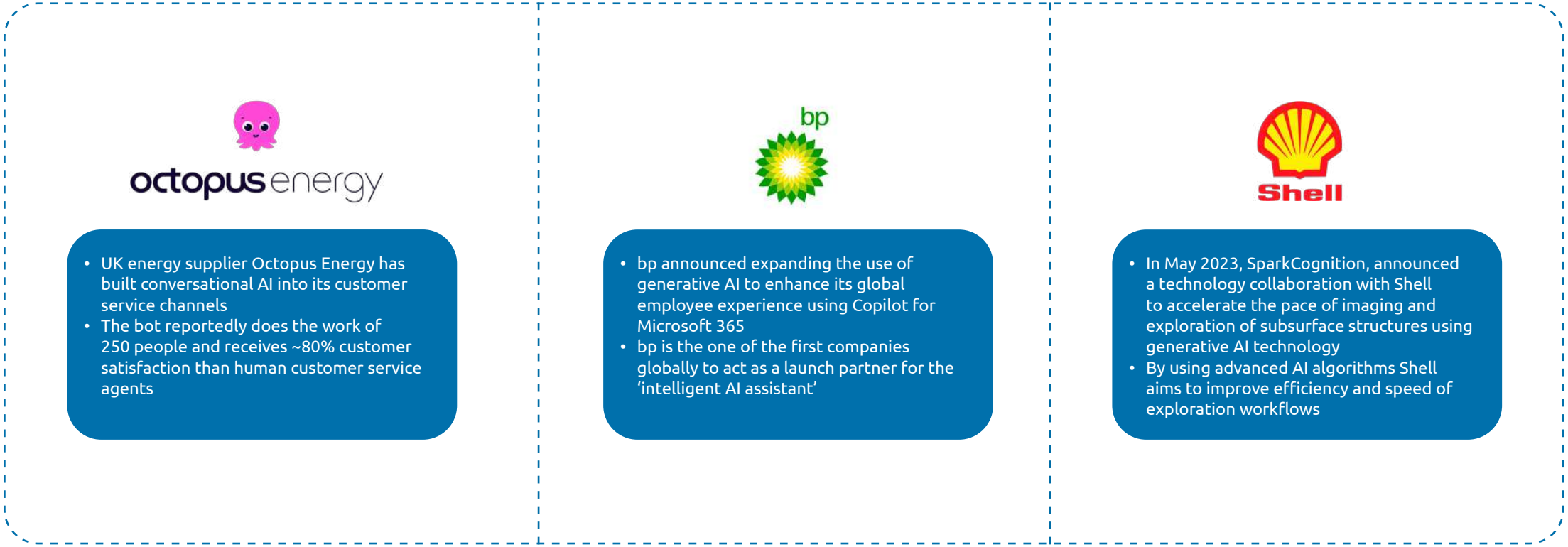
Source: Goldman Sachs

- Since 2020, the efficiency gains appear to have dwindled, and the power consumed by data centers has risen
- Some AI innovations will boost computing speed faster than they ramp up their electricity use, but the widening use of AI will still imply an increase in the technology's consumption of power. For instance, a single ChatGPT query requires 2.9 watt-hours of electricity, compared with 0.3 watt-hours for a Google search, according to the International Energy Agency
- Updated regulations and technological improvements, including on efficiency, will be crucial to moderate the surge in energy consumption from data centres

Gen AI

FIGURE 2

Gen AI scope / functional coverage (1/3)

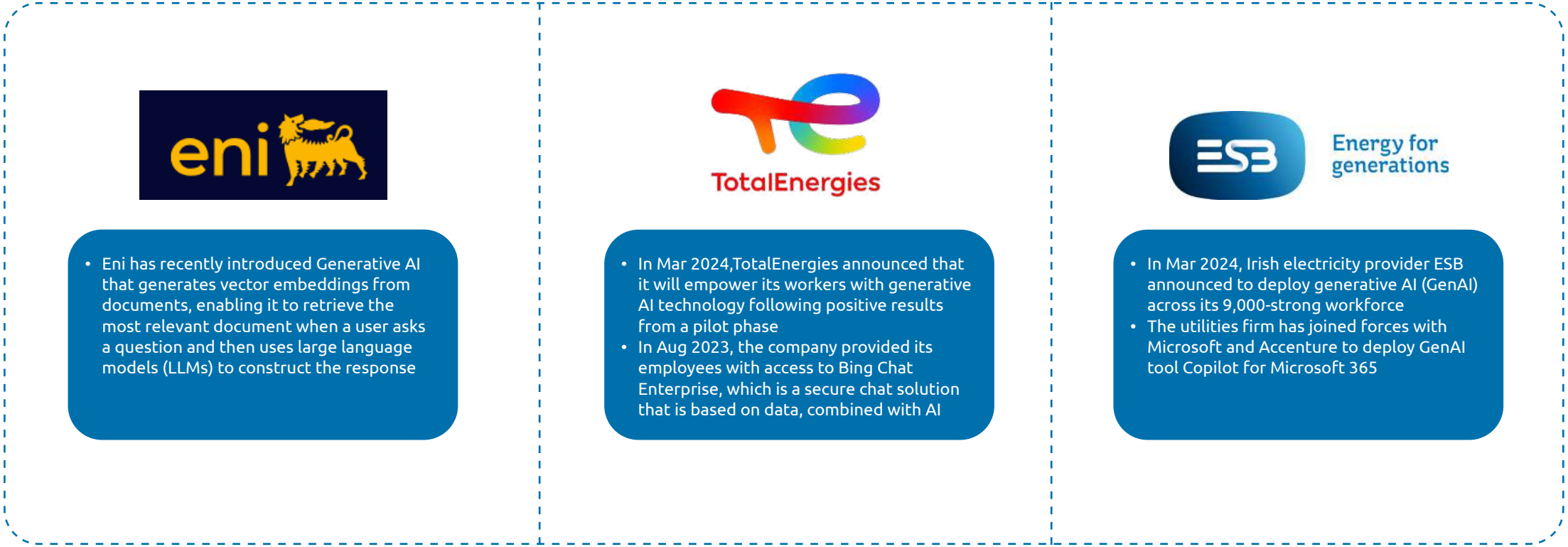


Source: Company Websites and Press Releases

Gen AI

FIGURE 3

Gen AI scope / functional coverage (2/3)

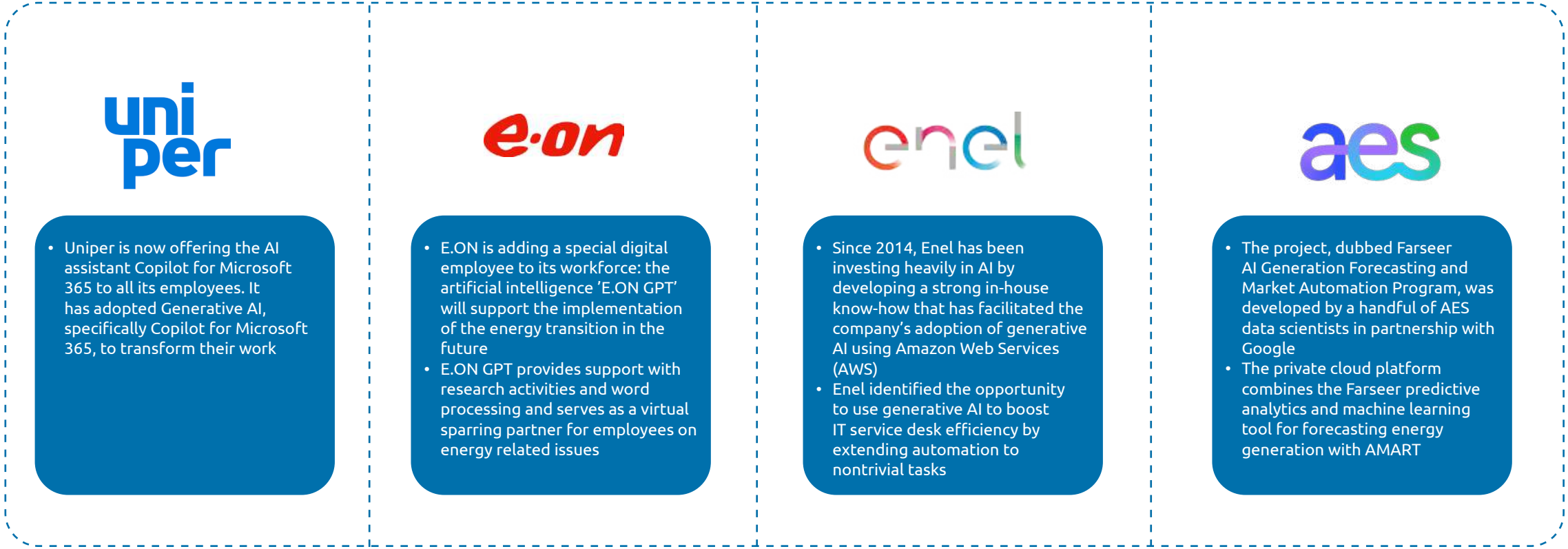


Source: Company Websites and Press Releases

Gen AI

FIGURE 4

Gen AI scope / functional coverage (3/3)



Source: Company Websites and Press Releases

Gen AI

FIGURE 5

Capgemini Gen AI use-cases with major energy & utilities (1/2)

Challenges
- Difficulty in highlighting the opportunity to improve sales' conversion with tailored offers
- Struggling to identify new sales opportunities to improve operational efficiency and personalization strategies

Capgemini Approach & Solutions
- With the help of Capgemini, client was able to achieve the exhaustive mapping of all the possible Gen AI use cases.
- Analysis of value, transposability & feasibility of Gen AI resulting in a top 10 list of the most relevant use cases for the customers.
- Zoom on the top 10 use cases, with emphasis on description, objectives, results observed in the market and an example of a demonstrator

Outcome
- 10 Valuable cases across Customer Service, Sales, E-Commerce and Marketing
- Enhanced Productivity and Employee Experience
- Improved Sales and Operations

Challenges
- To help organizations address challenges related to implementing new technologies by providing training, support, and resources to employees, managing resistance, and aligning technology initiatives with business objectives

Capgemini Approach & Solutions
- Ready to Deploy Experimentation Pack Strategy for Governance and Use Case Collection Approach
- Evaluation Dossier that includes Qualitative & Quantitative Business Benefits & Effort to Deploy
- Copilot Libraries for the list Of Use Cases Per Population and Copilot pilot users Animation for the Community Management Design & Animation

Outcome
- +90% Training Satisfaction
- +20pt NPS increase in 1 month
- 30+ Value Cases collected in 2 weeks

Source: Company Websites and Press Releases

Gen AI

FIGURE 6

Capgemini Gen AI use-cases with major energy & utilities (2/2)

Challenges
- Client found it difficult to process a high volume of technical documents
- Too much time spent to search and combine information from multiple data sources manually

Capgemini Approach & Solutions
- Capgemini engineering supplied a solution using machine learning and NLP strategies to extract, process and score the suggestion to provide to the assistant
- This solution divided into three conceptually independent parts:
  - ✓ Layout Analysis – Recognition and extraction of PDF elements
  - ✓ Text Processing & Extraction – Processing of extracted textual content, recognition of BOs, splitting the text into individual elements together with metadata assigned to them
  - ✓ Scoring – Scoring of elements for suggestions, thus providing a ranking order for suggestions

Outcome
- Full digitalization of documents with transformation into a quarriable system
- Promote standardization of documents editing
- Promote validation of shared information
- Simplify the access and usage of a vast amount of technical knowledge

Challenges
- Eneco eMobililty was facing increasing pressure on customer service and was looking for a solution that could help serve its customers better, faster, and cheaper

Capgemini Approach & Solutions
- The team worked with Capgemini to implement Microsoft Dynamics 365 Contact Center to improve customer satisfaction and employee productivity and experiences

Outcome
- Increased customer and employee satisfaction; Improved agent productivity, reducing the average wrap-up time by 50%; Higher case throughput; Reduced training time from four to just one hour to master the copilot-assisted functionality; Lower licensing costs by a factor of two

Source: Company Websites and Press Releases

Data for vulnerable customers

FIGURE 7

The government offers various programs to aid vulnerable customers in improving their energy efficiency

Government Initiatives for Vulnerable Customers		
Region	**Initiative**	**What's In It?**
Europe	The Energy Poverty Advisory Hub (EPAH)	• The **Energy Poverty Advisory Hub (EPAH)** is the leading EU initiative aiming to **eradicate energy poverty** and accelerate the just **energy transition of European local governments** • EPAH's mission is to be the **central platform** of **energy poverty expertise** in Europe for local authorities and all stakeholders interested in taking action to **combat energy poverty** in Europe by **providing** direct **support**, online **trainings,** and research **results** and by building a **collaborative network** of stakeholders interested in taking action to combat energy poverty in Europe
Europe	The Social Climate Fund	• The **Social Climate Fund**, **established** in May **2023** by Regulation EU/2023/955, **aims** to **provide funding** to EU countries to **support vulnerable households**, including those affected by energy poverty, and vulnerable micro-enterprises by supporting investments for increased energy efficiency
Europe	The Commission Energy Poverty And Vulnerable Consumers Coordination Group	• In April 2022, the **Commission Energy Poverty and Vulnerable Consumers Coordination Group** was established (Decision EU/2022/589). It **aims** to **provide** EU countries with a **space** to **exchange best practices** and **increase coordination** of **policy measures** to **support vulnerable** and **energy-poor households**
Europe	The Gas Directive 2009/73/EC and Gas Regulation (EC) No 715/2009	• In December 2021, the **European Commission** launched the review and revision of the **Gas Directive 2009/73/EC and Gas Regulation (EC) No 715/2009,** referred to as the hydrogen and gas markets decarbonisation package • To support sustainable energy choices and **ensure inclusivity in the energy transition**, the Commission proposed extending consumer rights and protections from the Electricity Directive to gas legislation. This includes price regulation, **support** for **vulnerable customers**, and simplifying the process for comparing and switching energy providers

- In May 2023, **U.S. Government announced** new **initiatives** and **investments** to **reduce energy costs** and **enhance** the energy **efficiency** and climate resilience of affordable homes for **hard-working families**
- **Canada government** is **yet to act** and fund clean, efficient energy solutions for Canada's most **vulnerable populations**

Source: European Commission, The White House, The Pointer

Data for vulnerable customers

FIGURE 8

Energy and utility companies are leveraging data to help vulnerable customers in energy savings

UK Energy Company (Name Undisclosed): Case Study

Client	Vendor	Challenges	Solution	Impact
A major independent **UK energy company** (Name Undisclosed)	**BJSS**	• A leading **independent UK energy company**, providing gas and electricity services to both residential and commercial customers, sought to **leverage data to more effectively identify, understand, and support its most vulnerable customers** • In light of recent developments in the energy industry, the company aimed to identify customers experiencing financial difficulties, health issues, or other challenges that might impact their interaction with energy services	• **BJSS** provided **Data Science capability** to create a **unified view** of the **vulnerable customer base** by integrating multiple internal data sources through a scalable and well-documented data pipeline built in **Google Cloud Platform DataForm.** This included data such as: ✓ Customer demographics to understand segments and geographical elements ✓ Payment history to understand financial vulnerability ✓ **Energy usage to understand potential rationing** ✓ Contacts and complaints to understand pain points customers had ✓ Priority Service Register (PSR) information to understand customer medical vulnerability	• The customer view developed by BJSS enabled the company to analyse its customer data more efficiently and effectively, allowing for the swift identification and understanding of vulnerable customers

Initiative for Vulnerable Customers By Energy/Utility Companies

Energy/Utility Company	HQ	Initiative
EDF Energy	**UK**	• In 2022, the Debt team in Customer Operations and the Data Science Team at EDF strived to uphold the principle of innovation by **developing** a **data-driven tool** to **detect signs** of **financial vulnerability** among their smart pay-as-you-go **customers**
Cadent	**UK**	• Cadent funds, resources, and trains community centres to enhance their services and **provide** trusted **advice** on **energy efficiency, gas safety, and the Priority Services Register** to **vulnerable households** • It also **aims** to **enhance** the use of **data and analytics** to better **understand vulnerability**
NGED Home	**UK**	• Company's **Power Up programme** helps them to identify, contact and support vulnerable customers • It uses **data** to **identify** at-risk **customers** who may be **vulnerable** during a power cut and **offer** them the chance to **sign-up** for one of our **Power Up projects** to **support** them to **save money** and keep warm

Source: BJSS, EDF Energy, Cadent

Data for vulnerable customers

FIGURE 9

European energy and utility companies are leveraging data to help vulnerable customers in energy savings

Initiative for Vulnerable Customers By Energy/Utility Companies		
Energy/Utility Company	**HQ**	**Initiative**
EDF	**France**	• **EDF is identifying financially vulnerable customers using smart-meter data**. Its agile product team is composed mainly of data scientists working with a product lead to research the problem, explore the available data, and create a proof of concept (POC) product
EDF	**France**	• In Nov 2023, EDF **rolled back standing charges** to pre-energy crisis levels for its most **vulnerable customers** this winter as part of a **£40 Mn (€46 Mn)** winter support package
E.ON	**Germany**	• Company's efforts and initiatives include: ✓ **The E.ON Next Energy Fund**, which helps eligible customers who are struggling to pay their bills with direct financial support, replacement of inefficient or broken appliances, and debt write-off ✓ **The Warm Home Discount Scheme**, which offered struggling customers £150 credit on their energy bills to help them through the cold winter months ✓ **The E.ON Next Priority Register**, which helps vulnerable customers with services such as prioritised support in the case of a supply interruption, the option to nominate a family member or carer to look after an energy account, and other measures to provide vulnerable customers with peace of mind ✓ **Wellbeing Checks**, which have helped us provide tailored support to more than 75,000 customers • **Half-hourly smart meter readings** ensure more accurate billing, preventing unnecessary debt, while **providing data** to quickly **support vulnerable customers** and offer targeted energy efficiency measures to keep bills low
Iberdrola	**Spain**	• The company collaborate with public administrations, different institutions and NGO to facilitate access to energy for economically disadvantaged people • It has implemented a **procedure to protect customers in a situation of vulnerability** with the aim of ensuring energy supply for economically disadvantaged citizens. This includes energy supply under the **social bonus** for pensioners or for families in which all members of the family unit are unemployed. **In 2022, more than 1.6 million customers in Spain are covered by the electric social bonus**

Source: EDF, E.ON, Iberdrola

Trust and security

FIGURE 10

Major cyber protection Initiatives around the world (1/3)

Region	Implemented / Funded by	Initative	What's In It?	Region
2024	**Government**	**EU Is Tightening Cybersecurity For Energy Providers**	• On March 11th, 2024, the European Commission adopted new cybersecurity rules—**the EU network code on cybersecurity for the electricity sector (C/2024/1383)**—to "establish a recurrent process of **cybersecurity risk assessments** in the **electricity sector**"	**Europe**
2024	**Government**	**G7 To Develop Cybersecurity Framework For Energy Sector**	• The G7 nations will **develop** a collective **cybersecurity framework** for operational technologies in energy systems, aimed at both manufacturers and operators • The framework **aims** to **strengthen** the **cybersecurity** of the global **supply chain** of key technologies used to **manage** and **operate electricity**, **oil and natural gas systems** across the world	**G7**
2024	**Government**	**DOE Invests $45 Million To Fortify USA Energy Sector To Enhance Cybersecurity, Protect From Cyber Threats**	• The U.S. **Department of Energy (DOE)** announced a funding of **$45 Mn** to **protect** the nation from **cyber threats** and improve cybersecurity in its **energy sector** • The agency announced 16 research, development, and demonstration (RD&D) projects selected by the Office of Cybersecurity, Energy Security, and Emergency Response (CESER) across six states to develop new tools and technologies to **prevent cyber attacks and reduce energy disruptions** from cyber incidents	**USA**
2024	**Government**	**U.S. Department Of Energy Releases Cybersecurity Baselines For Utilities And DERS**	• The DOE announced its support for the release of **cybersecurity baselines** for **electric distribution systems** and distributed energy resources ("DERs") • The initiative was funded by the DOE's Office of Cybersecurity, Energy Security, and Emergency Response ("CESER") in partnership with the National Association of Regulatory Utility Commissioners ("NARUC")	**USA**

Source: Tripwire, Infosecurity Magazine, Industrial Cyber, Foley Hoag

Trust and security

FIGURE 11

Major cyber protection Initiatives around the world (2/3)

Region	Implemented / Funded by	Initative	What's In It?	Region
2024	**Government**	**ERIA Partners With Nomura Research Institute Singapore And The Cyber Civilization Research Center To Enhance Cyber Security In ASEAN Smart Grids**	• **ERIA** announced a research collaboration with **Nomura Research Institute (NRI) Singapore** and the Cyber Civilization Research Center (CCRC) at Keio University to conduct a study on **promoting cybersecurity** for Distributed Energy Systems (DES) and smart grids in ASEAN • The objectives of the study include **developing guidelines** on the **cybersecurity** of DERs in ASEAN and Japan by forming a study group	**ASEAN**
2024	**Aramco**	**Oil Giant Aramco Drills Down On Saudi ICS Security**	• **Aramco,** the national oil company of Saudi Arabia, says that it's exploring ways of **strengthening cyber protections** for Aramco's industrial assets and infrastructure, as well as those critical to Saudi Arabia more broadly • Specifically, Aramco is looking to boost security for operational technology (OT) environments, and will be working with **Dragos**, a cybersecurity firm, to open a Saudi Arabia-based academy to **provide training** for that area	**Saudi Arabia**
2024	**Dragos**	**Dragos Launches Community Defense Program To Help Secure Industrial Infrastructure For Small Utilities**	• **Dragos** Inc., the global leader in cybersecurity for operational technology (OT) environments, announced the Dragos **Community Defense Program** to provide free OT **cybersecurity software for small water, electric, and natural gas providers** • Initially available in the United States, offerings include the Dragos Platform and Neighborhood Keeper	**USA**

Source: ERIA, Darkreading, Dragos

Trust and security

FIGURE 12

Major cyber protection Initiatives around the world (3/3)

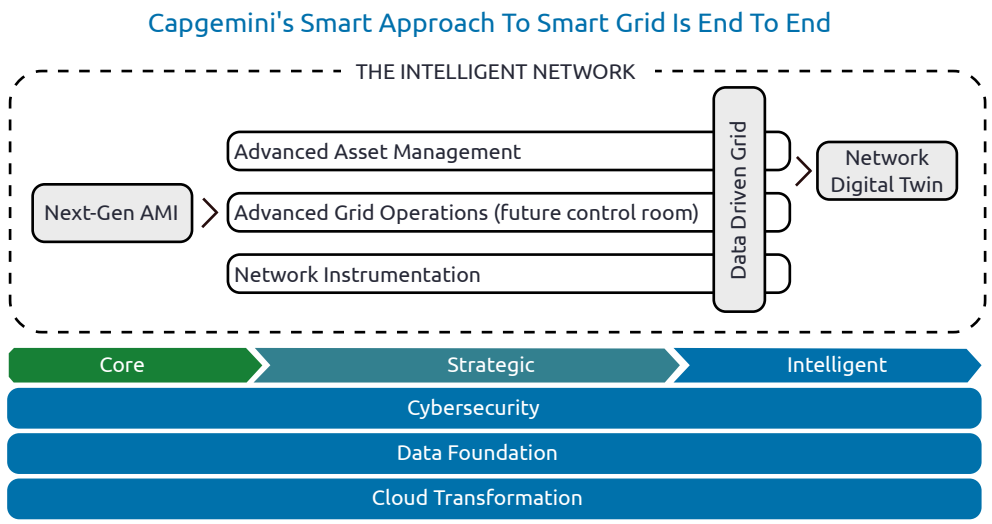
Region	Implemented / Funded by	Initative	What's In It?	Region
2023	**Government**	**TSA Directives Enhance Oil And Gas Pipeline Cybersecurity, As Focus Shifts To Evaluation Of Implemented Measures**	• Following the release of the **U.S. TSA** (Transportation Security Administration) oil and gas pipeline **cybersecurity directives**, asset owners and operators need to focus on adopting a **performance-based approach** to **enhancing security**, allowing operators to leverage new technologies and be adaptive to changing environments	**USA**
2023	**Government**	**EU Adopts "World First" Cybersecurity Legislation For Manufacturers, Including Oil, Gas Industry**	• The European Commission welcomed the political agreement reached between the European Parliament and the Council on the Cyber Resilience Act, proposed by the Commission in September 2022 • The **Cyber Resilience Act** is the **first legislation of its kind** in the world. It will **improve** the level of **cybersecurity** of digital products to the benefit of consumers and businesses across the EU, as it introduces proportionate mandatory cybersecurity requirements for all hardware and software	**Europe**
2023	**Government**	**Project Aims To Ensure Offshore Renewable Innovations Remain Cyber Secure**	• **Researchers from the University of Plymouth**, in **partnership** with the **Offshore Renewable Energy** (ORE) Catapult and supported by Expleo Engineering UK Limited, have secured a grant to develop a state-of-the-art facility focused on **enhancing the cyber-resilience of offshore wind networks** • The Cyber-Resilience of Offshore Wind Networks (CROWN) project aims to create a specialized lab that mimics the software and hardware found in wind turbine arrays and their integration with the power grid. This simulation will be instrumental in identifying vulnerabilities and devising robust security measures to ensure uninterrupted energy flow from wind farms	**UK**

Source: World Oil, Industrial Cyber, Seanews

Control room of the future/ Smart grid

FIGURE 13

Capgemini is driving Smart Grid innovation worldwide with its expertise in energy, engineering, cloud, and data management



- Capgemini's support has transformed leading power grid companies through a strategic, end-to-end approach, guiding them through every stage of their transformation
- Capgemini serves 75 smart energy clients globally. In advanced metering infrastructure, it handles seven of the world's ten largest implementations, manages 170 million smart meters across projects, and operates 1.5 million smart meters daily

- **Capgemini uses digital technologies and data management to help grid companies achieve three key business objectives:**

✓ Integrate intermittent renewable distributed energy sources, such as solar and wind
✓ Improve grid reliability, security and affordability
✓ Implement demand response management and energy storage optimization

- Grid companies partnering with Capgemini benefit from:

✓ **Advanced Asset Lifecycle Management:** Leveraging data analytics, IoT, and AI to optimize asset lifecycles, improving reliability and reducing maintenance costs
✓ **Advanced Dynamic Grid Operations:** Leveraging real-time data, predictive analytics, and automation for efficient electricity flow management. This includes an integrated control center that combines IT, OT, automation, and analytics with diverse data sources, including live weather forecasts

- **Key enablers include:**

✓ Next-Generation AMI: Integrates advanced smart meters, communications, and data management to enhance utility performance, resilience, and cost efficiency while enabling innovative services
✓ Network Instrumentation: Smart substations manage supply and demand across the grid, handling diverse generation sources and variable loads
✓ Data-Driven Grids: IoT data optimizes investments and modernization, while AI reduces OPEX and drives new business models. Data sharing enhances collaboration and ensures regulatory compliance

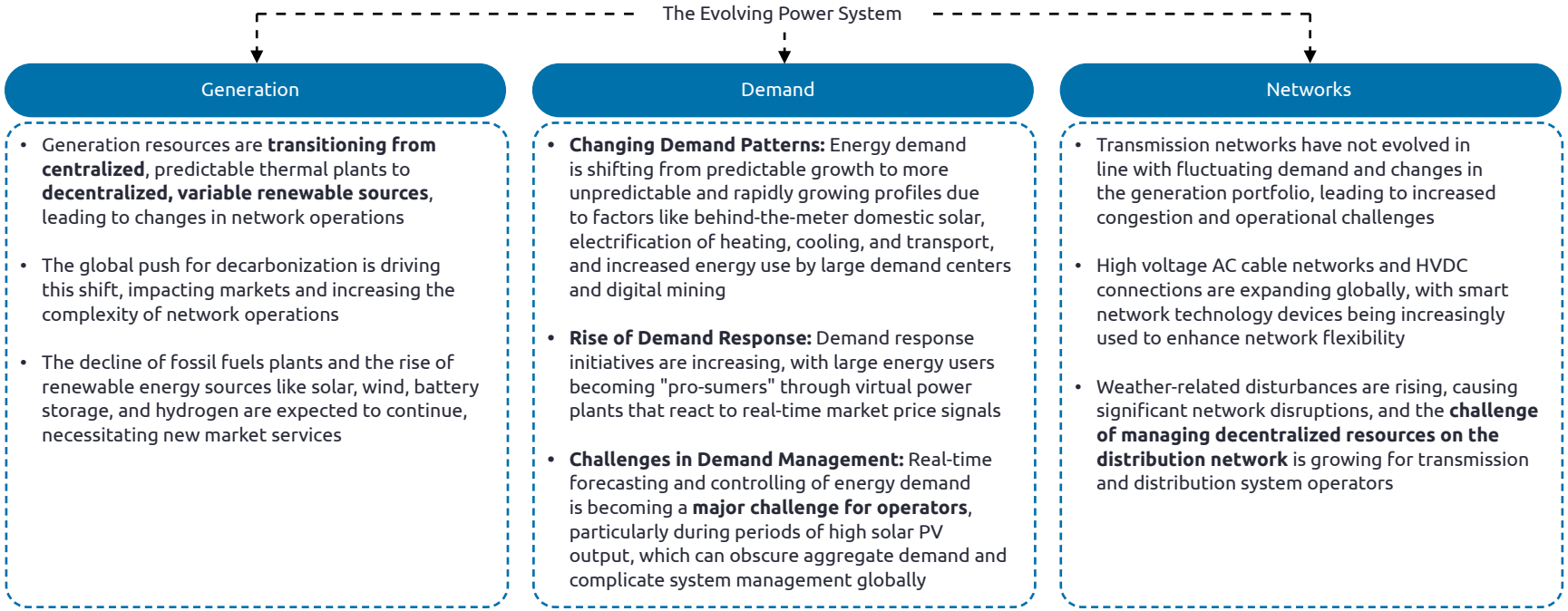
Source: Capgemini

Control room of the future/ Smart grid

FIGURE 14

The Evolving Power System – Generation transition, demand changes and operational challenges

- The primary function of real-time operations in electricity networks has always been to ensure a reliable power supply and resilience to disturbances, a core responsibility that remains unchanged
- Control rooms have consistently played a crucial role in network operations, evolving in technology to manage the increasing complexity of power systems
- As transmission operators face significant changes, such as new operational modes and resource adequacy challenges, they are enhancing their control rooms and operational capabilities. Adapting processes and advancing analytical capabilities will be essential to maintaining reliability and security during the transition to clean energy



Source: G-PST Consortium

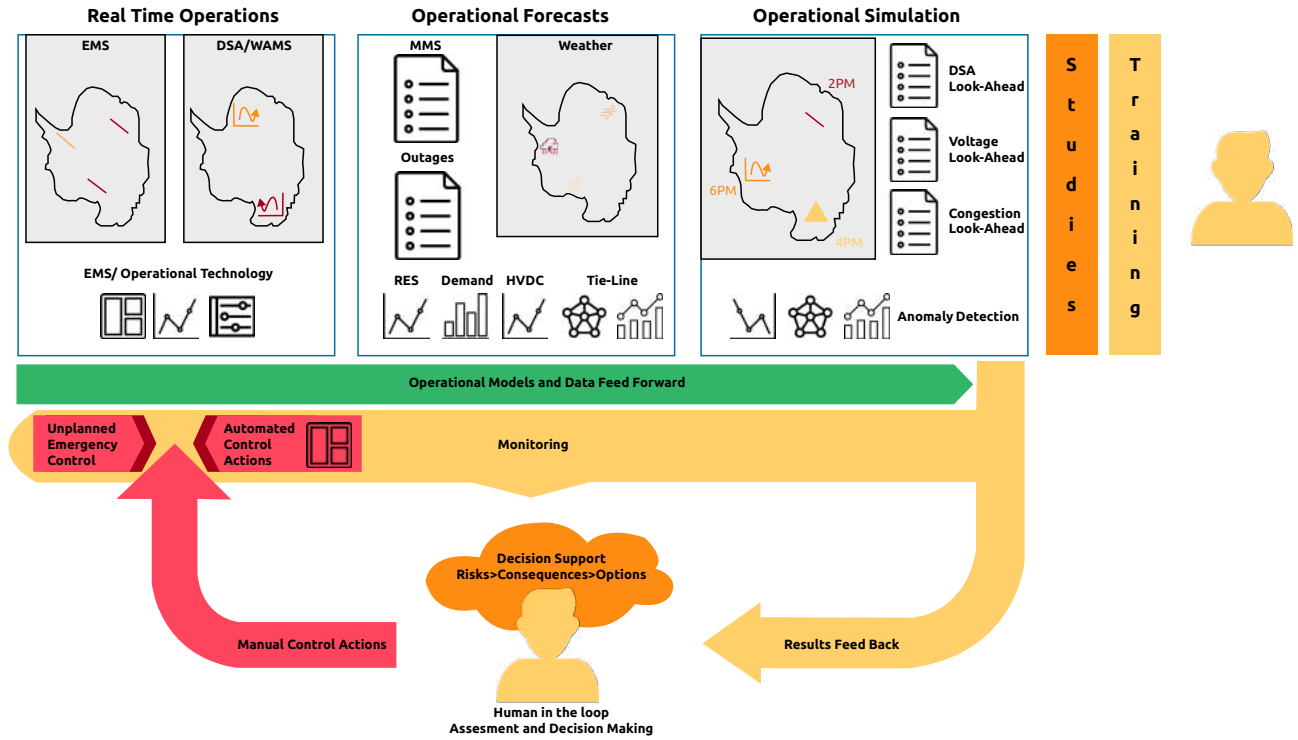
Control room of the future/ Smart grid

FIGURE 15

The Control Room of the Future Vision Statement outlines a vision for advanced, automated, and secure control rooms

The Control Room of the Future Vision Statement

- **Operational Technology (OT) Toolkit:** A modular, service-oriented architecture that provides secure automated control actions and decision support for operators
- **Real-Time and Forecasted Assessments:** Parallel processes for real-time reliability and security assessments, as well as future state forecasts, allowing operators to adjust the system proactively
- **Automation and Training:** Manual processes are automated, with clear links between operational and training simulators. Operators are trained to supervise automated systems and intervene when necessary
- **Advanced Operator Roles:** Operators focus on knowledge-based processes, monitoring system risks, and managing forecasted risks with advanced engineering know-how



Source: G-PST Consortium

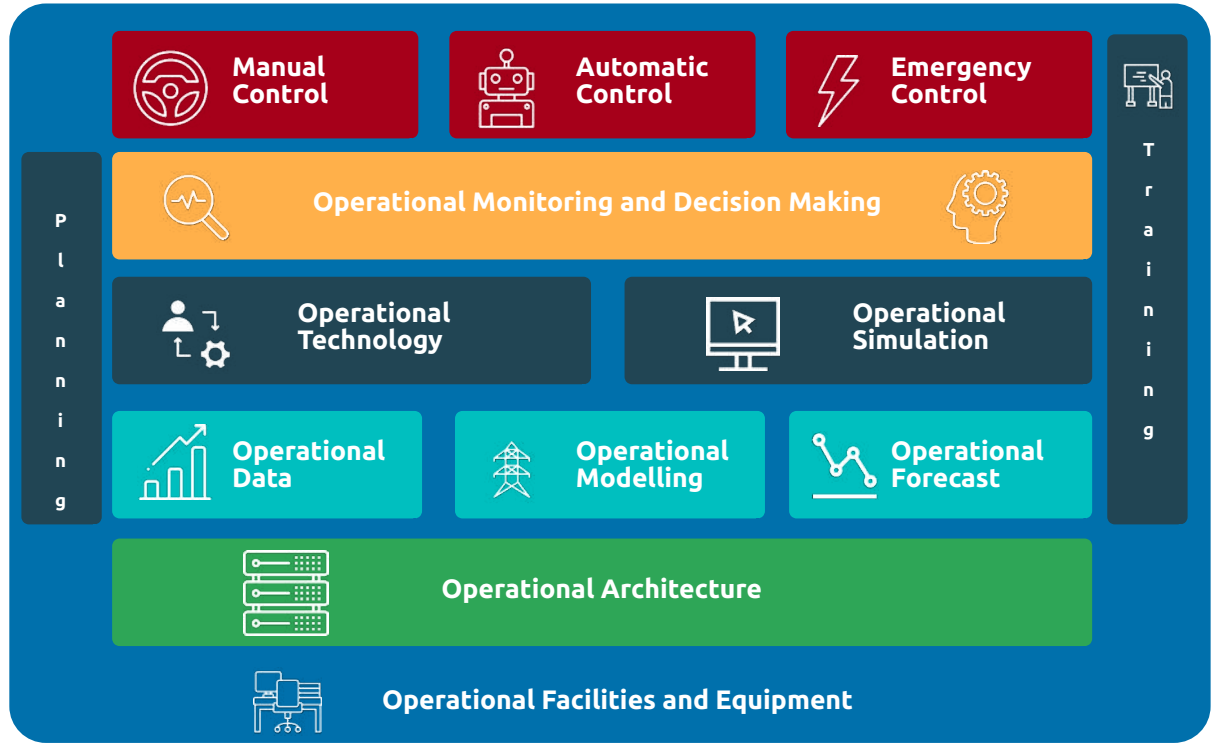
Control room of the future/ Smart grid

FIGURE 16

Control room of the future capapbilities

Control Room of the Future Capabilities

- **Operational Capabilities:** Each block in the framework represents an operational capability essential for future system operations
- **Interconnected Architecture:** Capabilities are linked through a complex architecture and data flows, highlighting their interdependence
- **Focus Areas:** Control room operators will concentrate on monitoring, decision-making, operational processes, and control (manual, automatic, and emergency)
- **Development Goals:** These capabilities need to be developed over the coming years to ensure reliable and secure system operations



Source: G-PST Consortium

Customers

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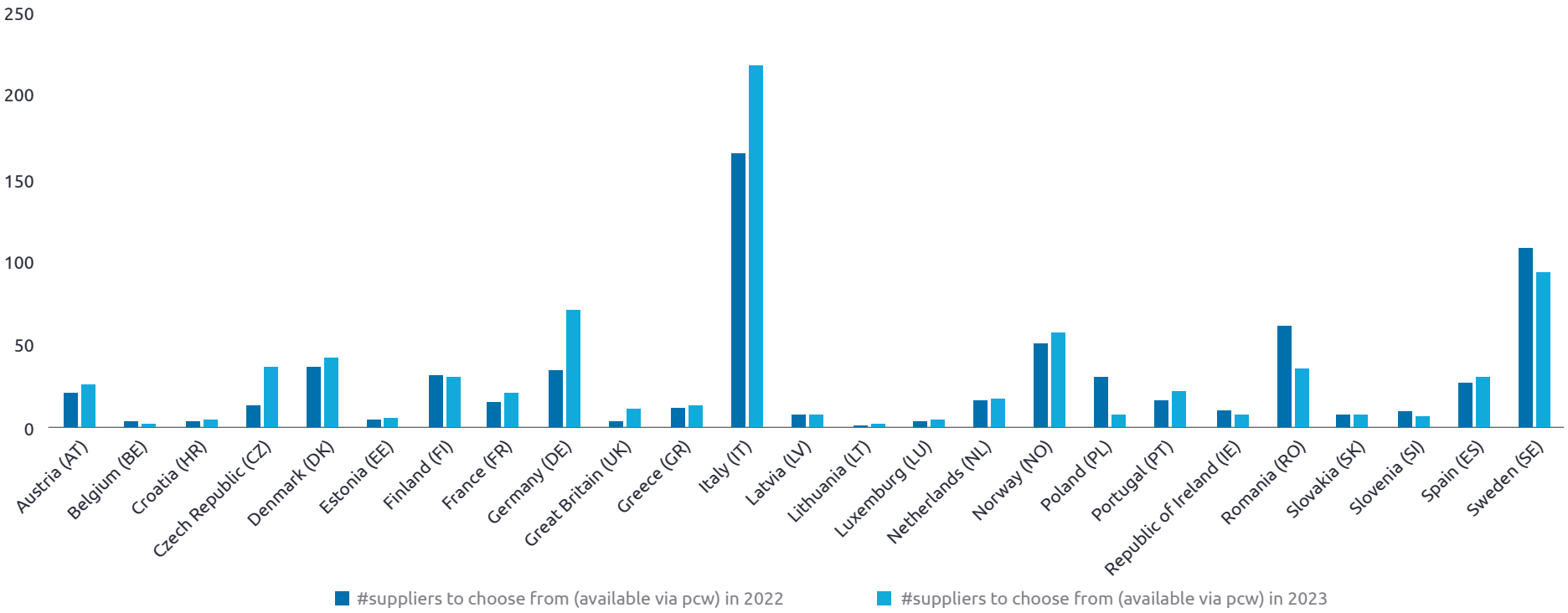
Number of suppliers for residential and SME customers

Comprehensive landscape of electricity suppliers across markets, tailored for residential customers' selection

FIGURE 1

Electricity: Number Of Suppliers across EU markets | Residential Customers | 2022 & 2023



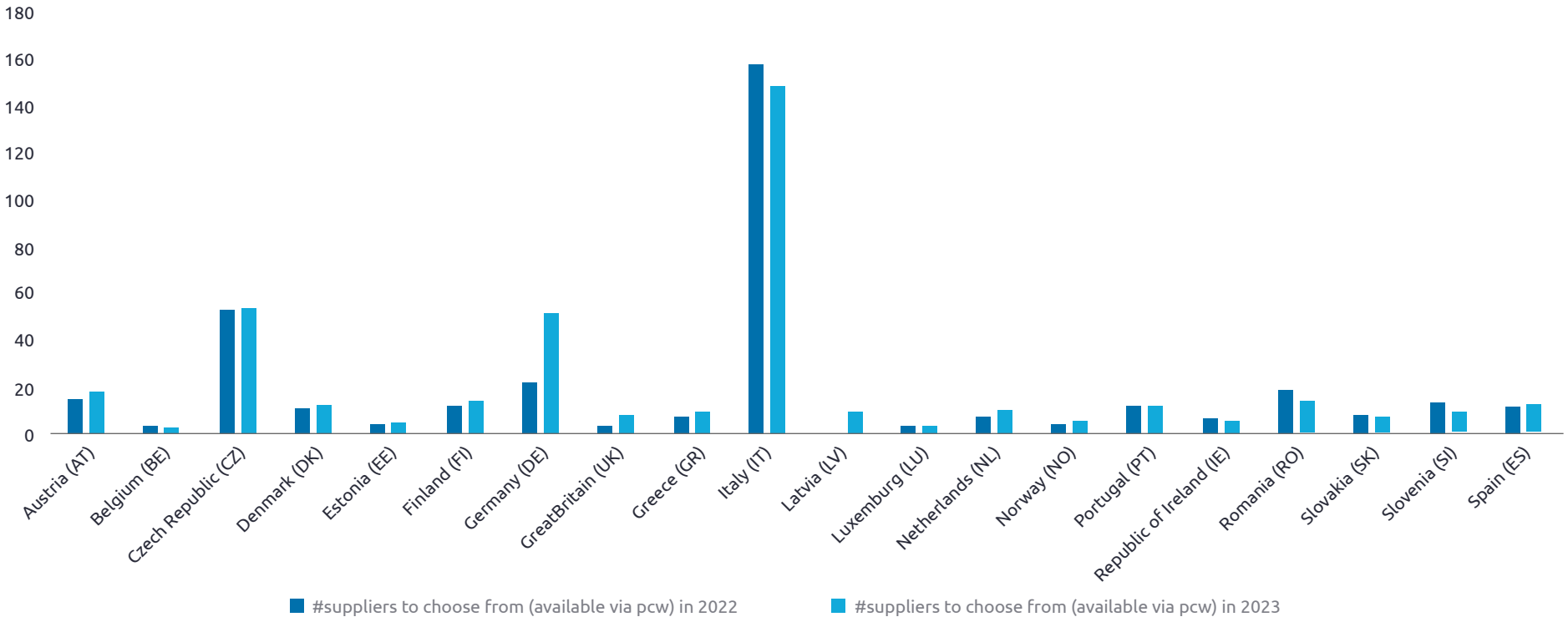
Source: VaasaETT

Number of suppliers for residential and SME customers

Comprehensive landscape of gas suppliers across markets, tailored for residential customers' selection

FIGURE 2

Gas: Number Of Suppliers across EU markets | Residential Customers | 2022 & 2023



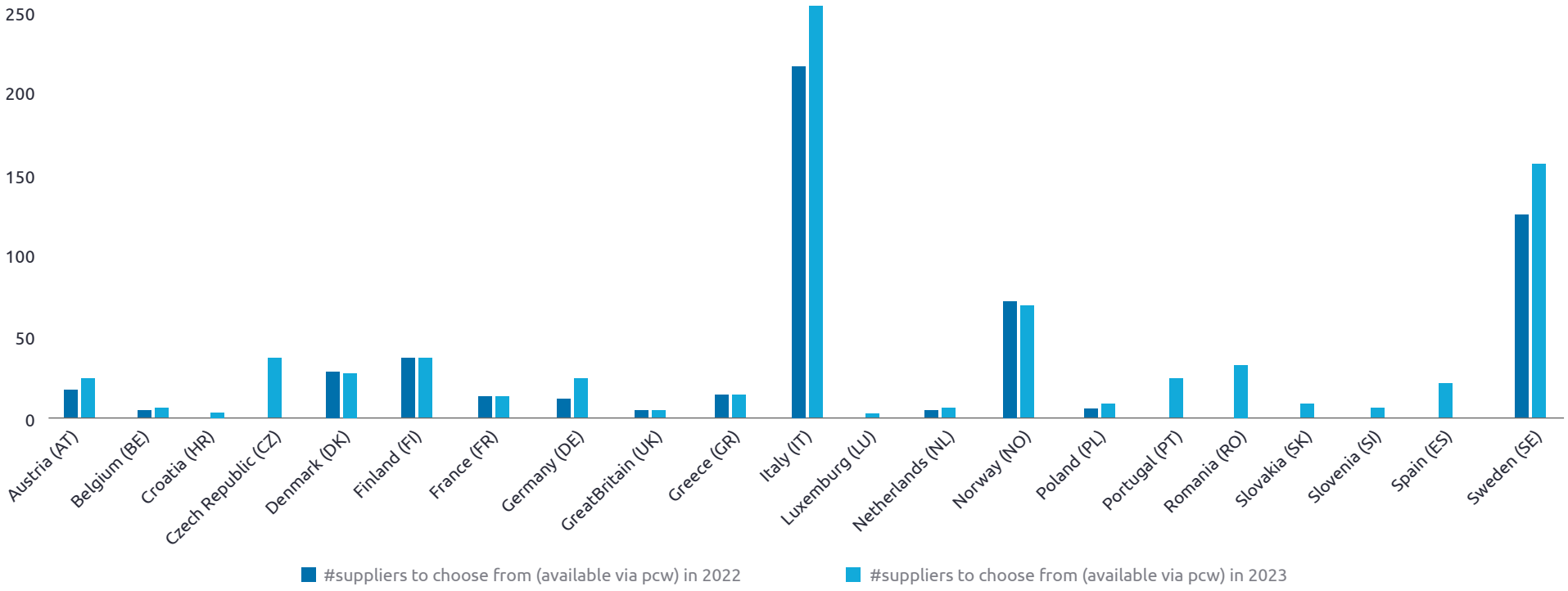
Source: VaasaETT

Number of suppliers for residential and SME customers

Comprehensive landscape of electricity suppliers across markets, tailored for SME customers' selection

FIGURE 3

Electricity: Number Of Suppliers across EU markets | SME Customers | 2022 & 2023



Source: VaasaETT

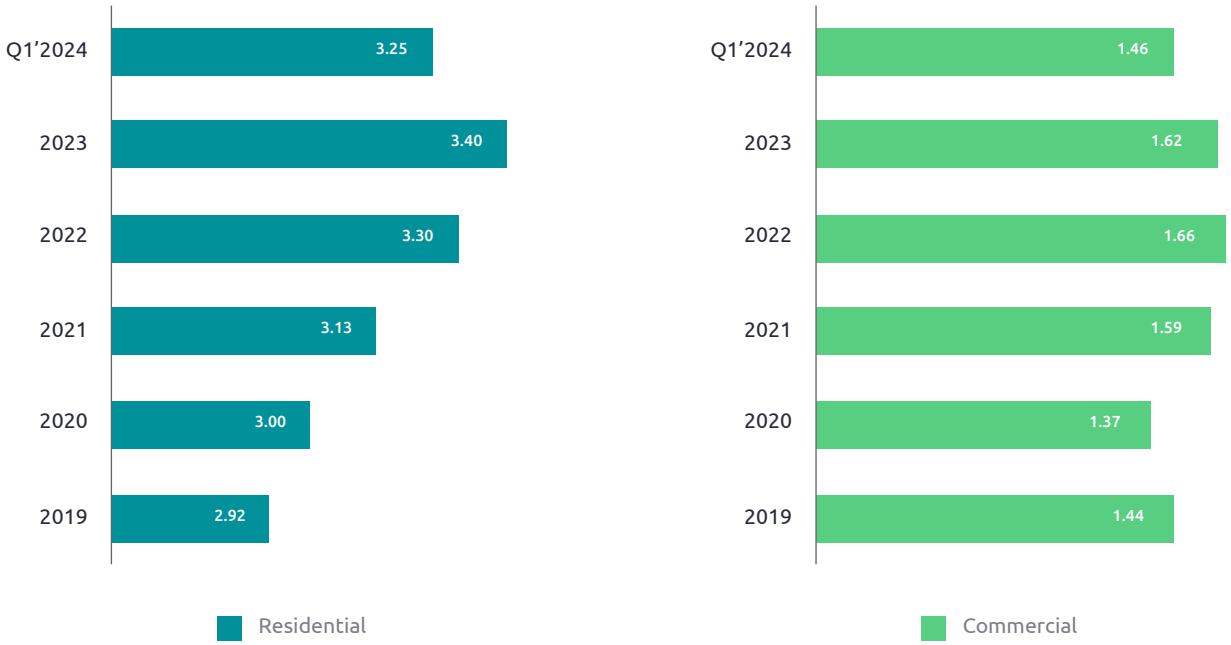
Solar panel cost, average EV cost, average cost of electricity

The marginal increase in residential solar prices from 2020 to 2023 is mostly due to pandemic-related supply chain disruptions and interest rates increase

FIGURE 4

Average PV System Price, USA | 2019-Q1'2024

All Figures in $/Watt



Source: Solar Energy Industries Association (SEIA)

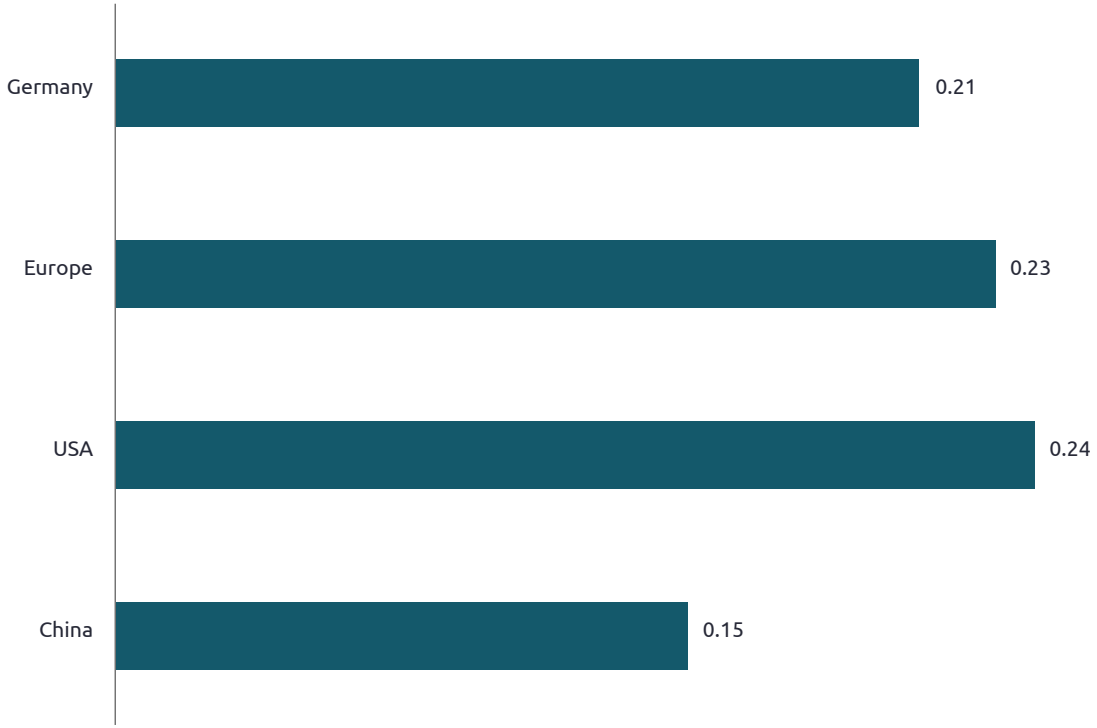
- The price of solar panels has significantly decreased over the past decade as the industry has matured and achieved large-scale global production
- The slight increase in residential solar pricing from 2020 to 2023 is primarily due to supply chain disruptions caused by the pandemic, as well as the interest rates
- USA solar prices are anticipated to keep declining in the coming years as new local manufacturing facilities become operational
- Globally prices to continue declining, with the China manufacturing overcapacity

Solar panel cost, average EV cost, average cost of electricity

Panel production costs in Europe stood significantly higher than that in China

FIGURE 5

Solar Panel Production Costs In Different Regions, in $/Watt, In 2023



Source: Asiafinancial, Thecooldown, Bruegel

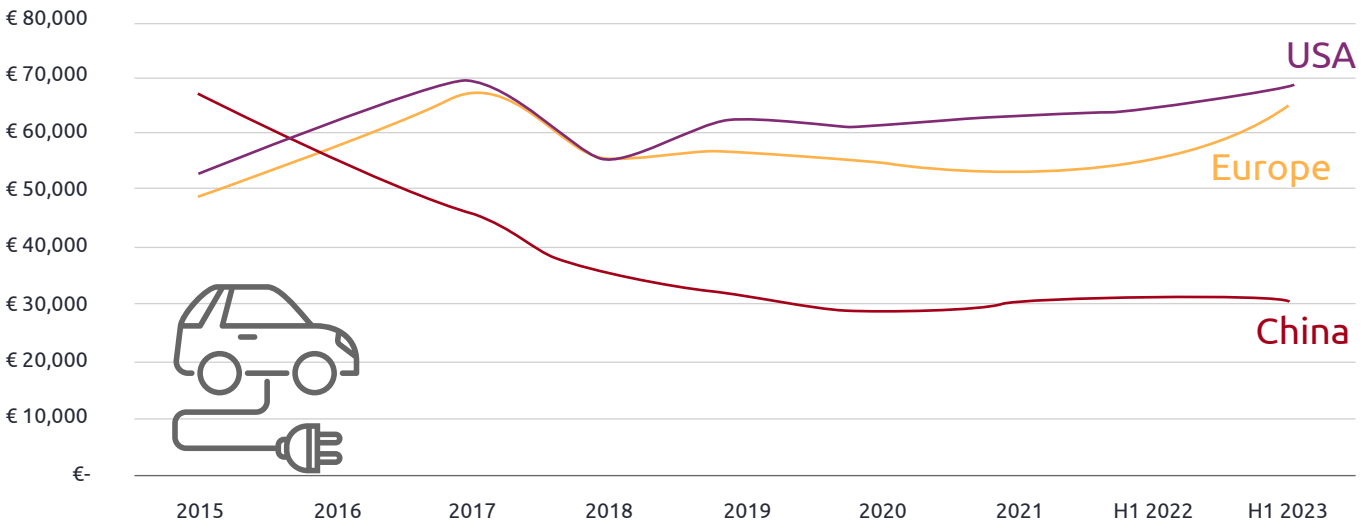
- Panel Production costs in Europe stood at around 0.23 $/Watt in 2023, significantly higher than that in China.
- The European Union plans a major increase in solar PV capacity from 263 GW (as of 2023) to almost 600 GW by 2030.
- If nothing changes, this expansion will be based almost exclusively on solar panels imported from China, which supplies over 95 percent of solar panels used in the EU. This dependence has raised concerns about EU economic security and geopolitical vulnerabilities, especially in light of recent global disruption.

Solar panel cost, average EV cost, average cost of electricity

The average retail price of an electric car available in China is considerably lower than that in the USA or Europe

FIGURE 6

Average Retail Price Of The Electric Cars Available, In €, 2015 - H1 2023



- In the first half of 2022, the average retail price of a BEV was €31,829 in China, €55,821 in Europe (+75% vs China), and €63,864 (+101% vs China) in the USA.
- A year later, the average retail price of an electric car available in China is now less than half the price seen in both Europe and the USA.
- In H1 2023, an electric car cost €31,165 in China, €66,864 in Europe (+115% vs China) in Europe, and €68,023 (+118% vs China) in the USA.

Source: JATO Dynamics

Solar panel cost, average EV cost, average cost of electricity

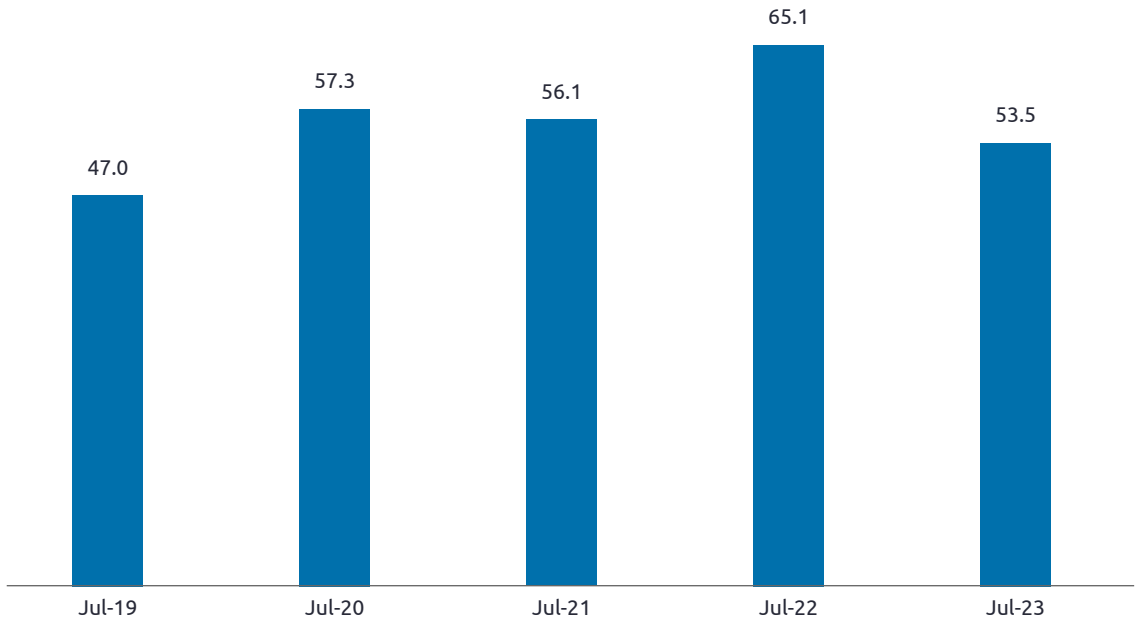
In Jul 2023, the price of EV dropped by 18% primarily due to the steadily improved inventory

- In Jul 2023, The price of EV dropped by 18% primarily due to the steadily improving inventory
- With increased inventories and higher incentives driving prices down, there are compelling reasons for shoppers to consider returning to the market
- The average price paid for a new electric vehicle (EV) dropped in Jul 2023 by 2.3% compared to Jun 2022 ($68,206). The price increased by 16% versus Jul 2021

FIGURE 7

Average EV Transaction Price, USA | Jul 2019-Jul 2023

All Figures in Thousands $



Source: Kelley Blue Book

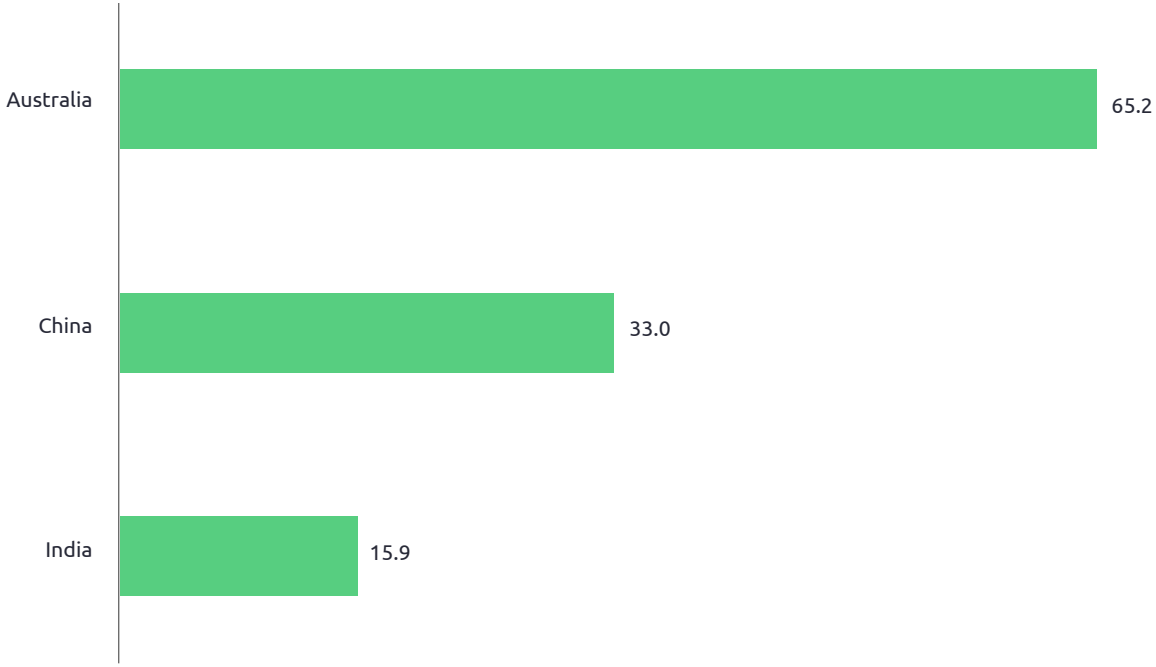
Solar panel cost, average EV cost, average cost of electricity

Average price of EV in APAC is between $16-65 Thousands in 2023

FIGURE 8

Average Price of EV in APAC, 2023

All Figures in Thousands $



Source: Synergy.net, Forbes, and Motoroctane

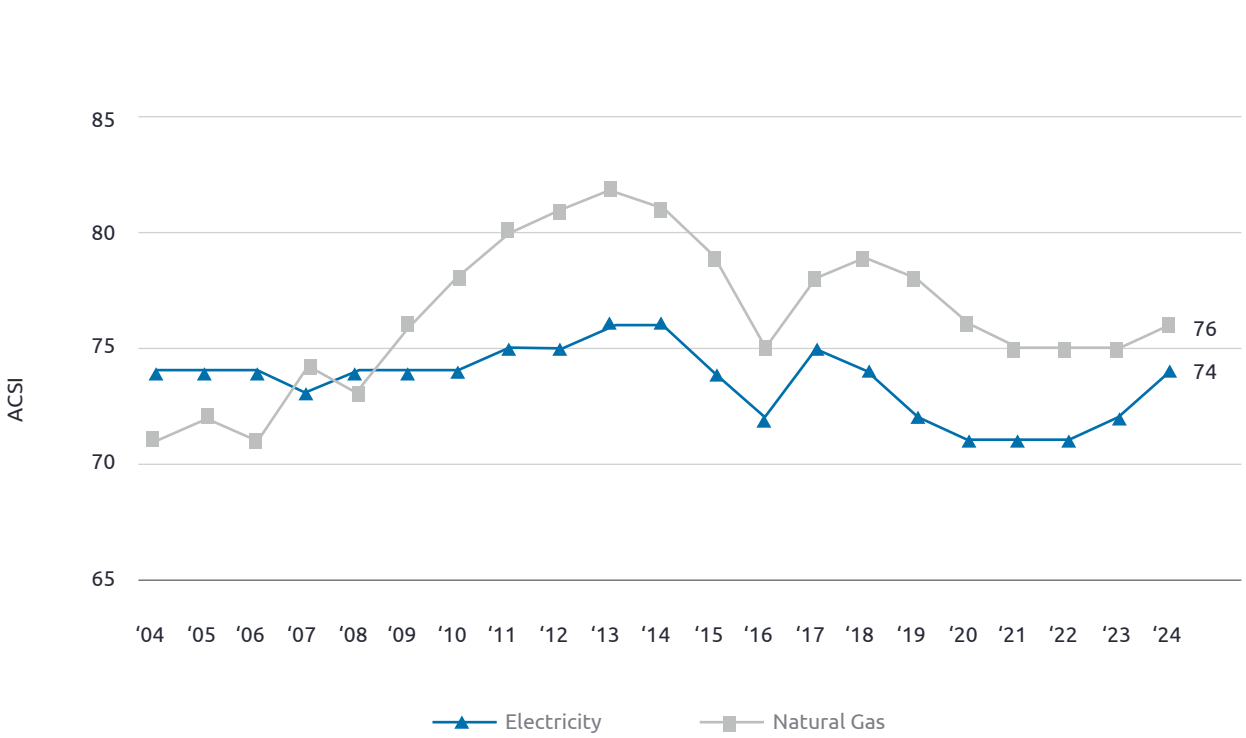
- Cheap Chinese EVs starting at $40,000 have lowered the average price, though most range from $60,000 to $90,000
- In China, automakers have made rapid progress, offering affordable electric vehicles at scale. The price gap has widened, with the average retail price of an electric car available in China now less than half the price seen in both Europe and the USA
- India aims for 30% electric vehicles (EVs) by 2030 to cut its carbon footprint and reduce oil imports. To support this goal, the government has introduced incentives such as GST reductions on EVs, income tax exemptions on EV loans, and the establishment of charging infrastructure nationwide

Customer satisfaction indicators

Effective complaint handling boosts satisfaction; successful utilities gain, others fall behind

FIGURE 9

American Customer Satisfaction Index, 2023-2024



Source: American Customer Satisfaction Index (ACSI®)

- Following four years of stagnant performance, residential customer satisfaction has increased by 4%, reaching an ACSI score of 75. This improvement is driven by gains across the customer experience, which have outweighed concerns about rising utility rates
- As energy utilities continue to grapple with external challenges such as inflation, extreme weather, and increased demand, maintaining strong customer relationships will be crucial. Building trust and fostering patience through effective problem resolution and complaint handling will become even more important

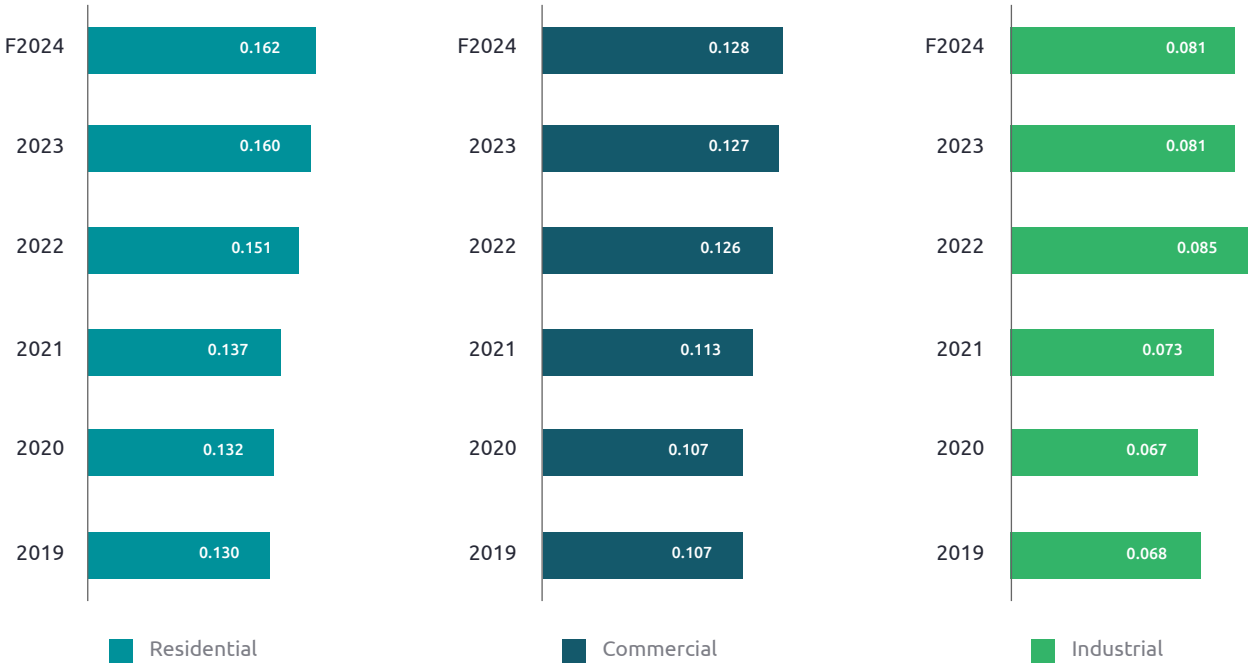
Electricity and gas prices

The average USA residential electricity price rose 5.7%, from $0.151/kWh in 2022 to $0.160/kWh in 2023

FIGURE 10

Average Electricity Price, USA | 2019-2023

All Figures in $/kWh



Source: U.S. Energy Information Administration (EIA)

F: Forecast

- The average USA residential electricity price rose 5.7%, from $0.151/kWh in 2022 to $0.160/kWh in 2023
- USA average retail price of Electricity in the Commercial Sector is at a current level of $0.127/kWh, up from 0.126 one year ago. This is a change of 1.51% from an year ago
- Industrial consumers of electricity in the USA paid an average of $0.081/kWh in 2023. This figure marked a decrease compared to the previous year, when prices peaked at $0.085/kWh
- Note: The average electricity prices is for New England, Middle Atlantic, E. N. Central, W. N. Central, S. Atlantic, E. S. Central, W. S. Central , Mountain and Pacific regions

Note: The average electricity prices is for New England, Middle Atlantic, E. N. Central, W. N. Central, S. Atlantic, E. S. Central, W. S. Central , Mountain and Pacific regions

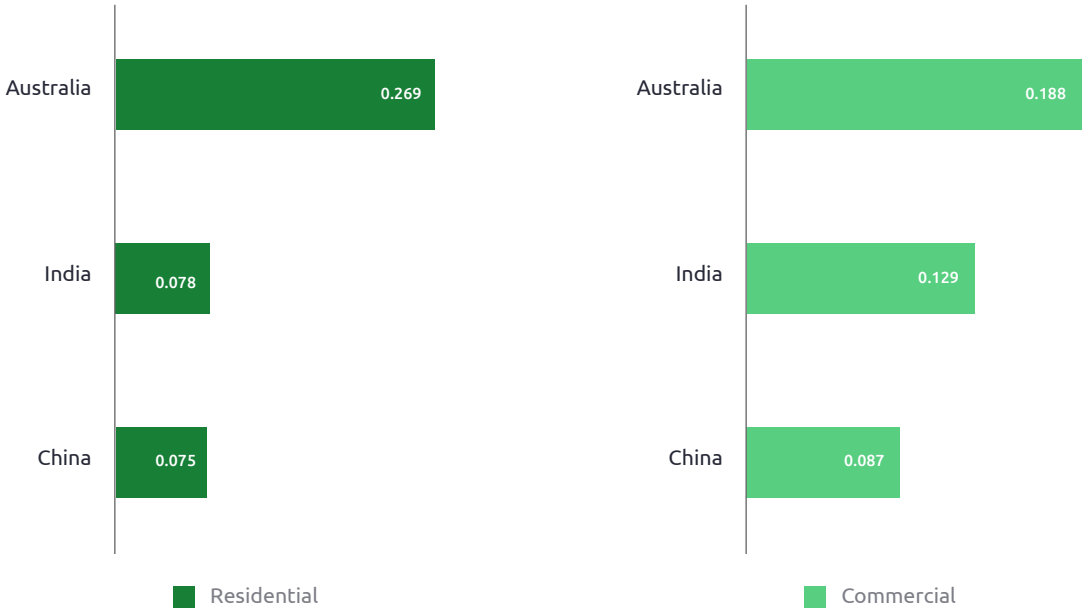
Electricity and gas prices

Average price of electricity in China is lower than in India and Australia

FIGURE 11

Average Electricity Price, APAC | Dec 2023

All Figures in $/kWh



Source: GlobalPetrolPrices

- In China, the price of electricity for households is $0.075/kWh. The electricity price for businesses is $0.087/kWh
- In India, the price of electricity for households is $0.078/kWh. The electricity price for businesses is $0.129/kWh
- In Australia, the price of electricity for households is $0.269/kWh. The electricity price for businesses is $ 0.188/kWh

Note: Prices includes all components of the electricity bill such as the cost of power, distribution and taxes

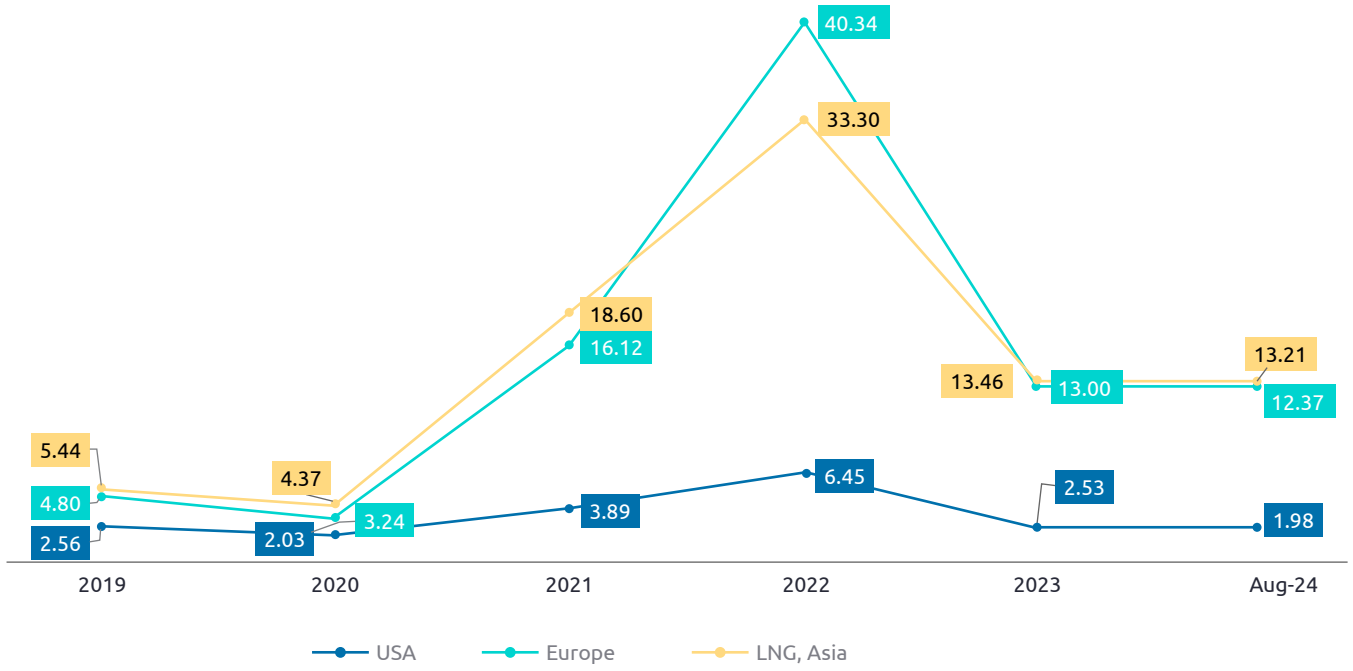
Electricity and gas prices

Average natural gas spot price in the USA fell by 61% in 2023

FIGURE 12

Natural Gas Spot Prices, World | 2019-Aug 2024

All Figures in $/MMBtu (Average Spot Price)



Source: World Bank, U.S. Energy Information Administration (EIA) and FRED Economic Data

- Following the all-time highs reached in 2022, natural gas prices moderated significantly across all key markets in 2023. The steep demand declines recorded in Europe and mature Asian markets provided downward pressure on gas prices
- In Europe, average prices declined by almost 70 per cent compared with 2022 to an average of $13 /MMBtu in 2023. The steep demand reductions, together with lower gas storage injection needs and healthy LNG inflows, softened natural gas prices despite the continued decline in Russian piped gas deliveries to the European Union

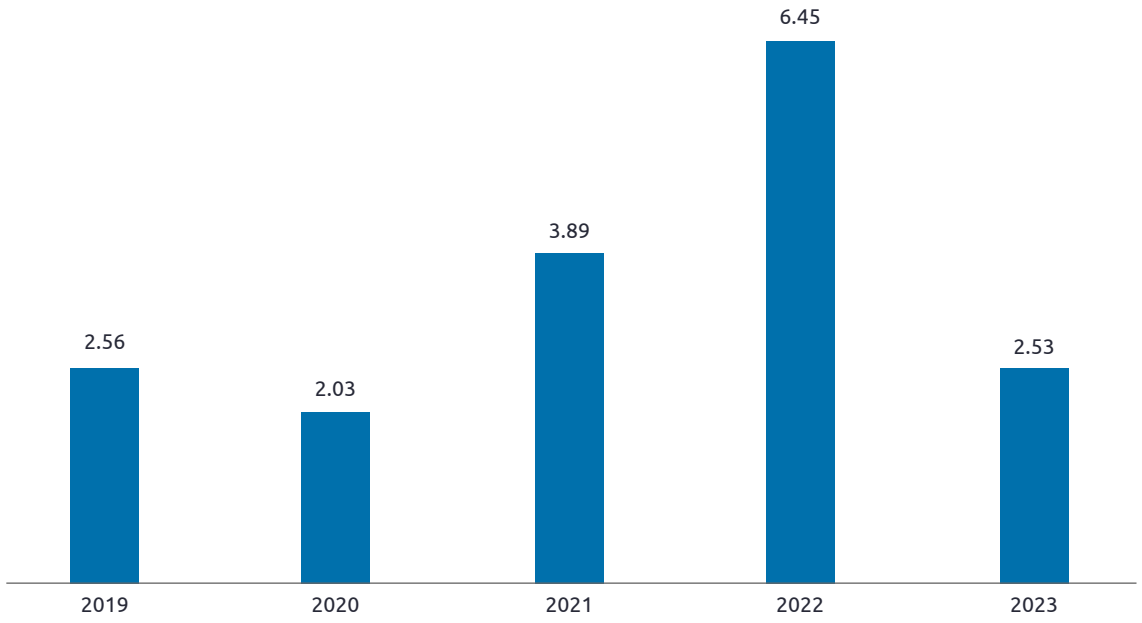
Electricity and gas prices

Increased natural gas production, surpassing growth in consumption, was the key factor driving lower prices in 2023

FIGURE 13

Natural Gas Spot Prices, USA | 2019-2023

All Figures in $/MMBtu (Average Henry Hub Spot Price)



Source: U.S. Energy Information Administration (EIA)

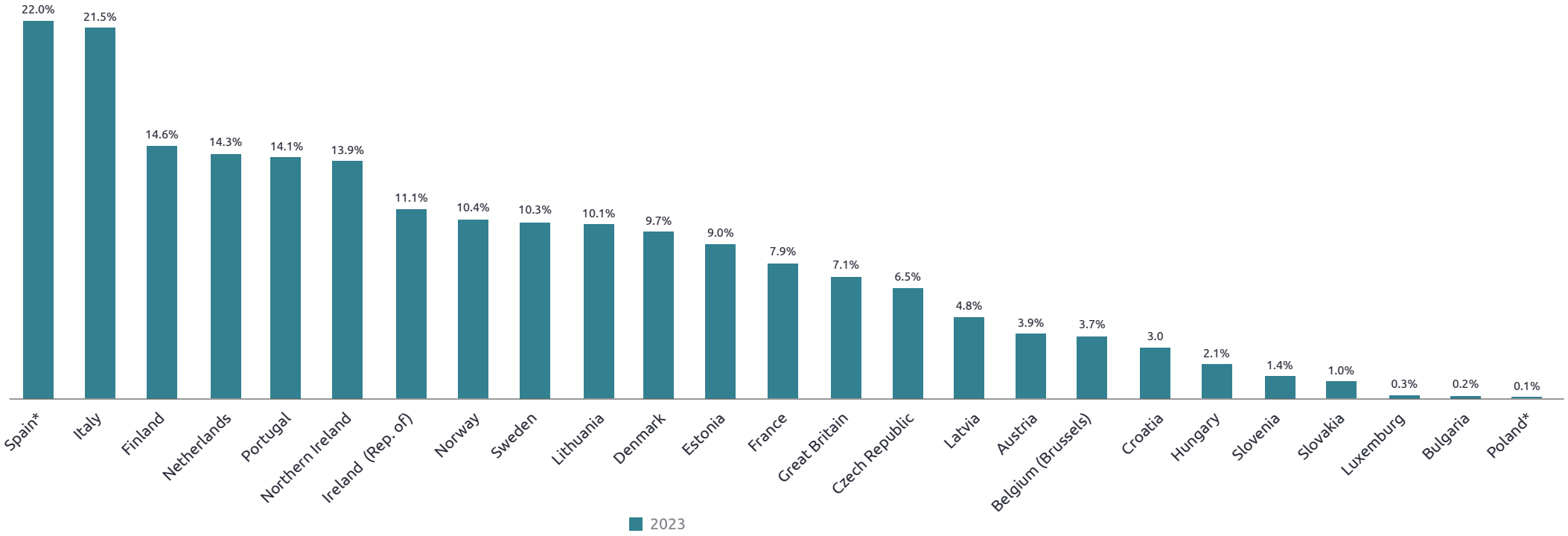
- Right after the Russia – Ukraine war and Russian gas ban, record-high natural gas production, LNG availability, stable consumption, and increasing natural gas inventories all played roles in driving prices lower in 2023 compared to 2022
- The average Henry Hub natural gas price was $6.45/MMBtu in 2022, 66% higher than in 2021
- Declining natural gas production due to production freeze-offs and high net withdrawals of natural gas from storage were the reasons behind the high price of gas in 2022

Energy intensity progress, churn rates

Aggregated European electricity switching rates 2023 (%)

FIGURE 14

Aggregated European Electricity Switching Rates 2023 (%)



Notes: *Estimation based on Q1 - Q3 of 2023

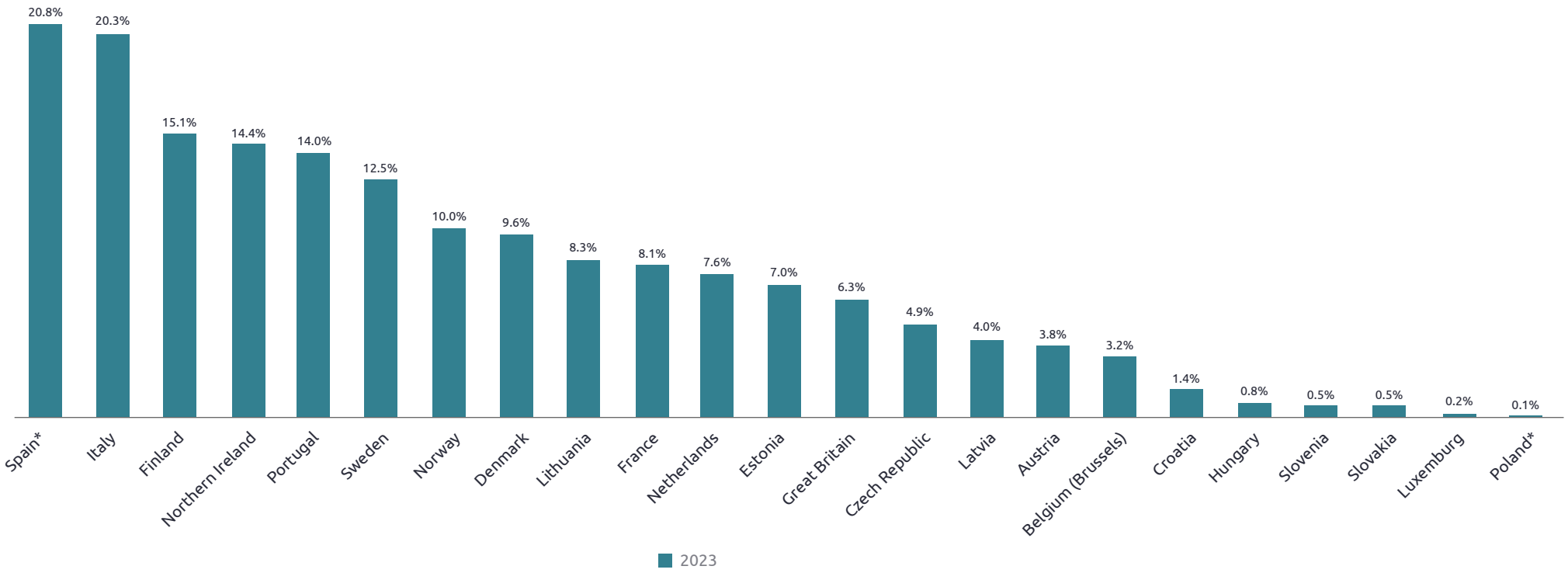
Source: VaasaETT

Energy intensity progress, churn rates

Residential European electricity switching rates 2023 (%)

FIGURE 15

Residential European Electricity Switching Rates 2023 (%)



Notes: *Estimation based on Q1 - Q3 of 2023

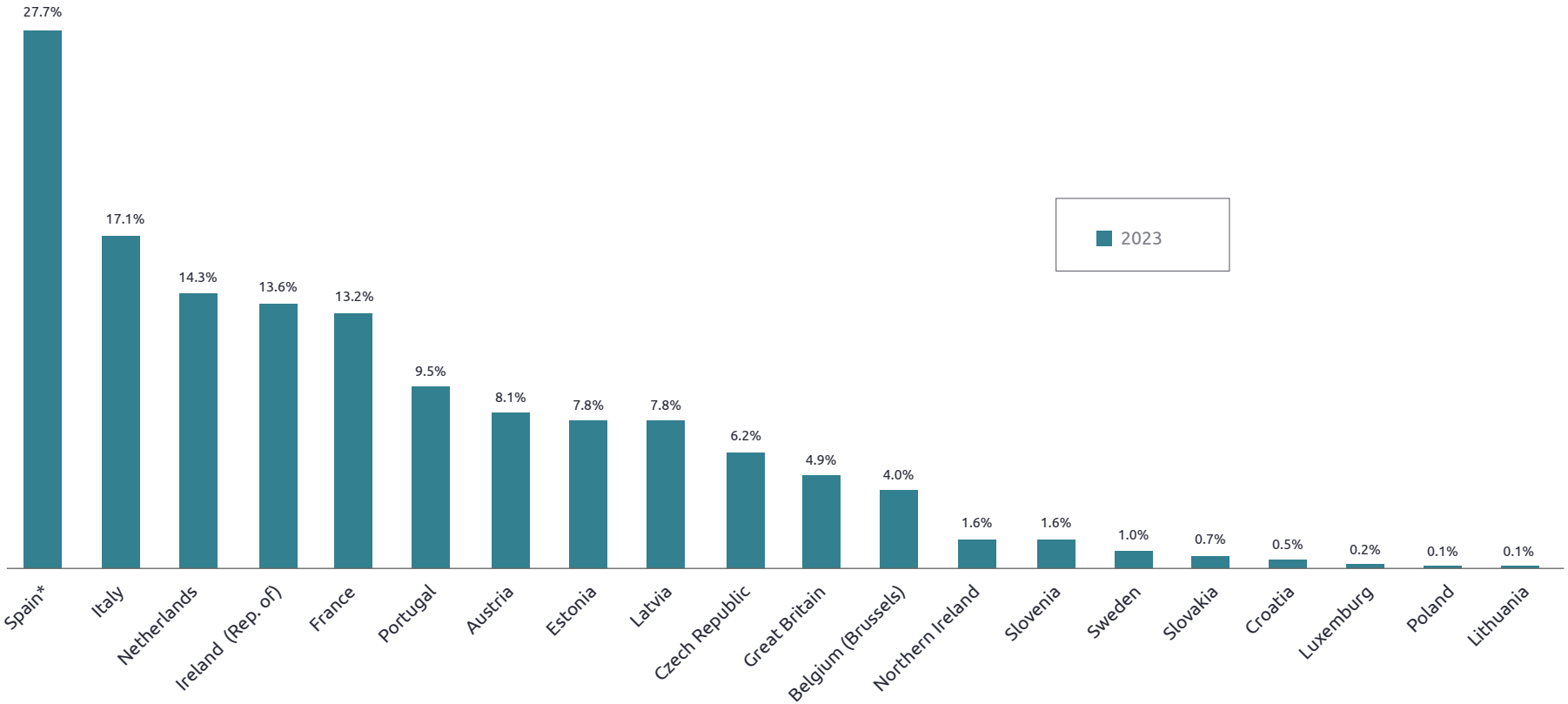
Source: VaasaETT

Energy intensity progress, churn rates

Aggregated European gas switching rates 2023 (%)

FIGURE 16

Aggregated European Gas Switching Rates 2023 (%)



Notes: *Estimation based on Q1 - Q3 of 2023

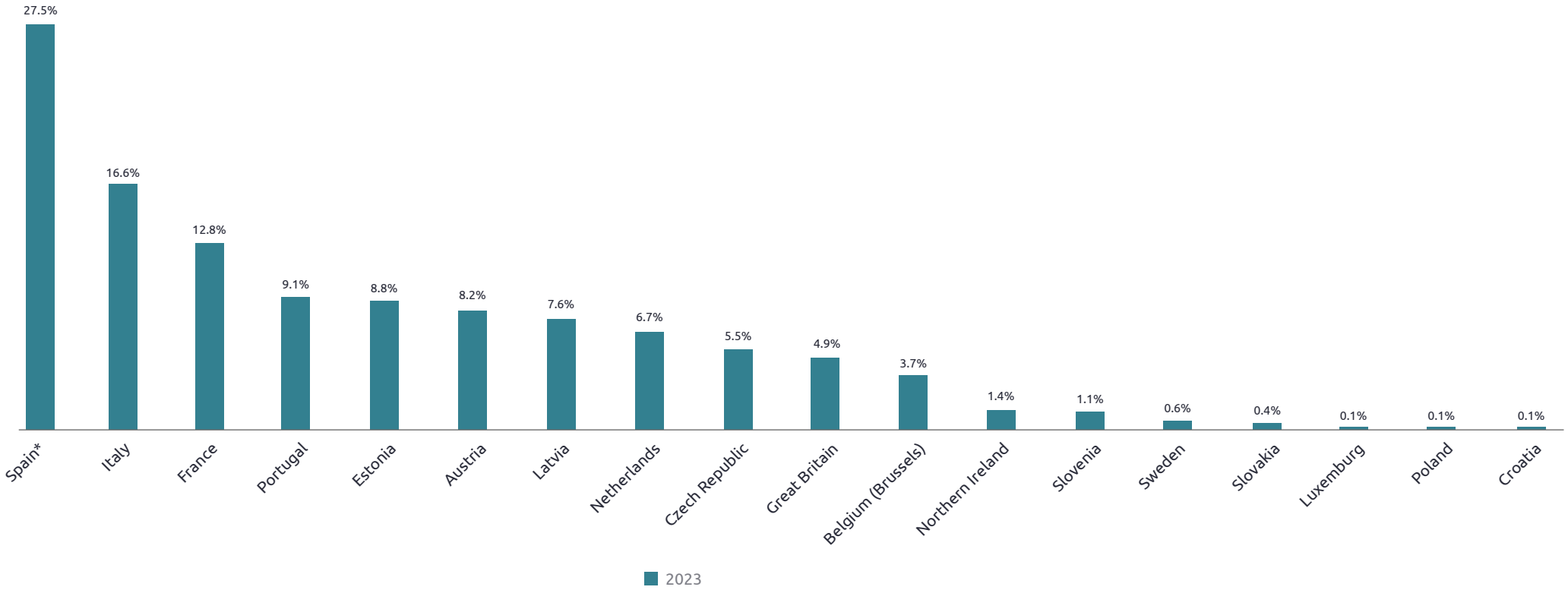
Source: VaasaETT

Energy intensity progress, churn rates

Residential European gas switching rates 2023 (%)

FIGURE 17

Residential European Gas Switching Rates 2023 (%)



Notes: *Estimation based on Q1 - Q3 of 2023

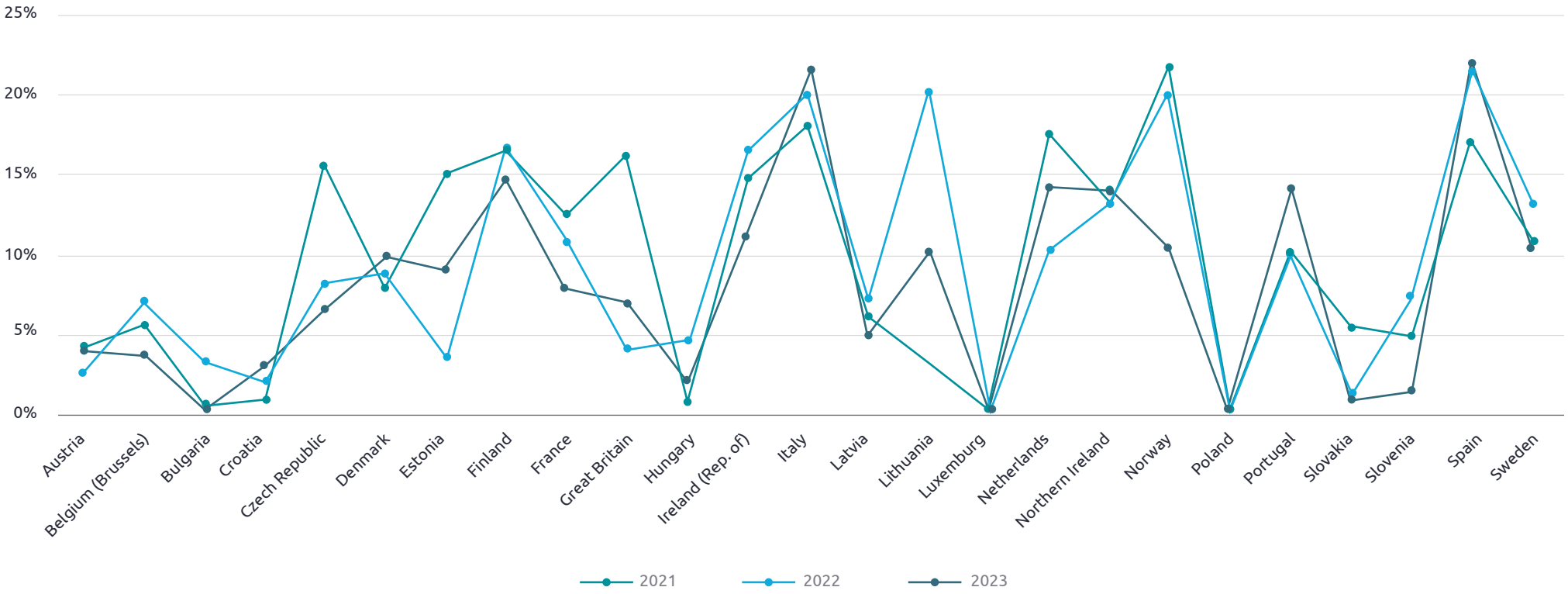
Source: VaasaETT

Energy intensity progress, churn rates

Aggregated electricity churn rate, Europe

FIGURE 18

Aggregated Electricity Churn Rate, Europe | 2021-2023



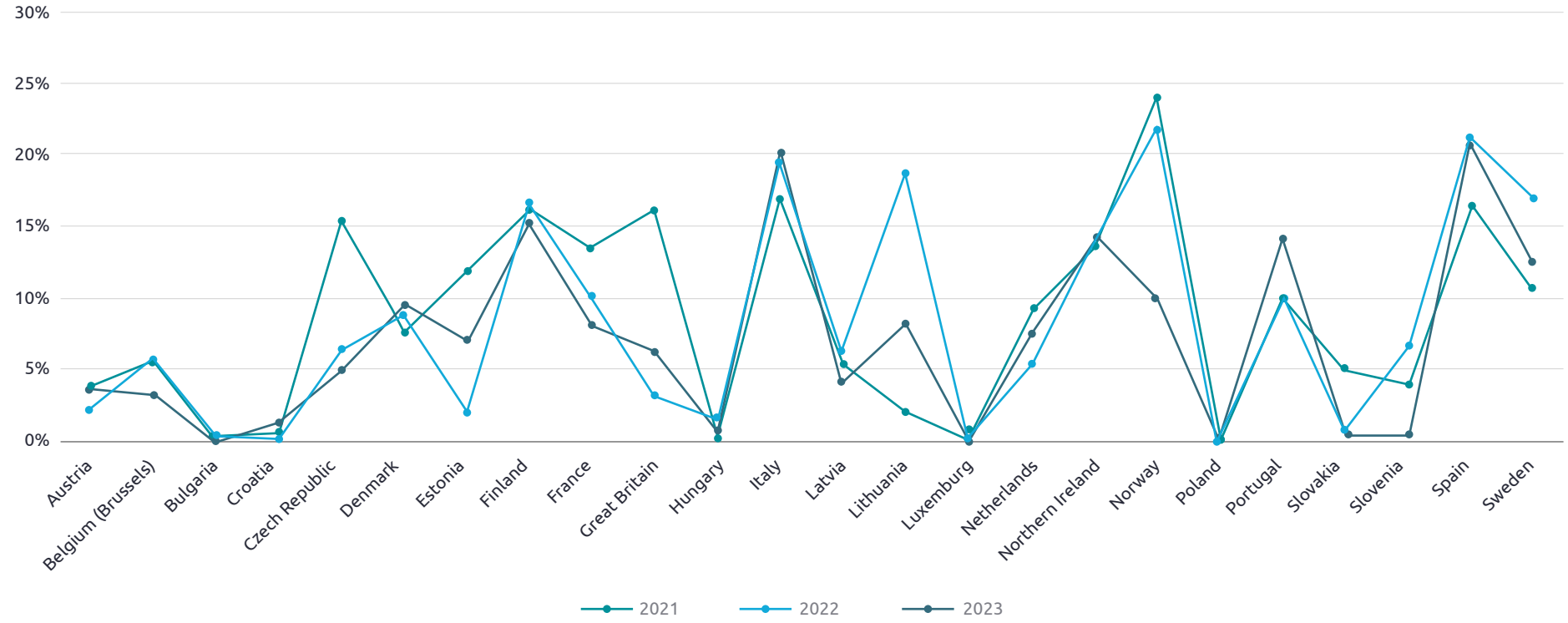
Source: VaasaETT

Energy intensity progress, churn rates

Residential electricity churn rate, Europe

FIGURE 19

Residential Electricity Churn Rate, Europe | 2021-2023



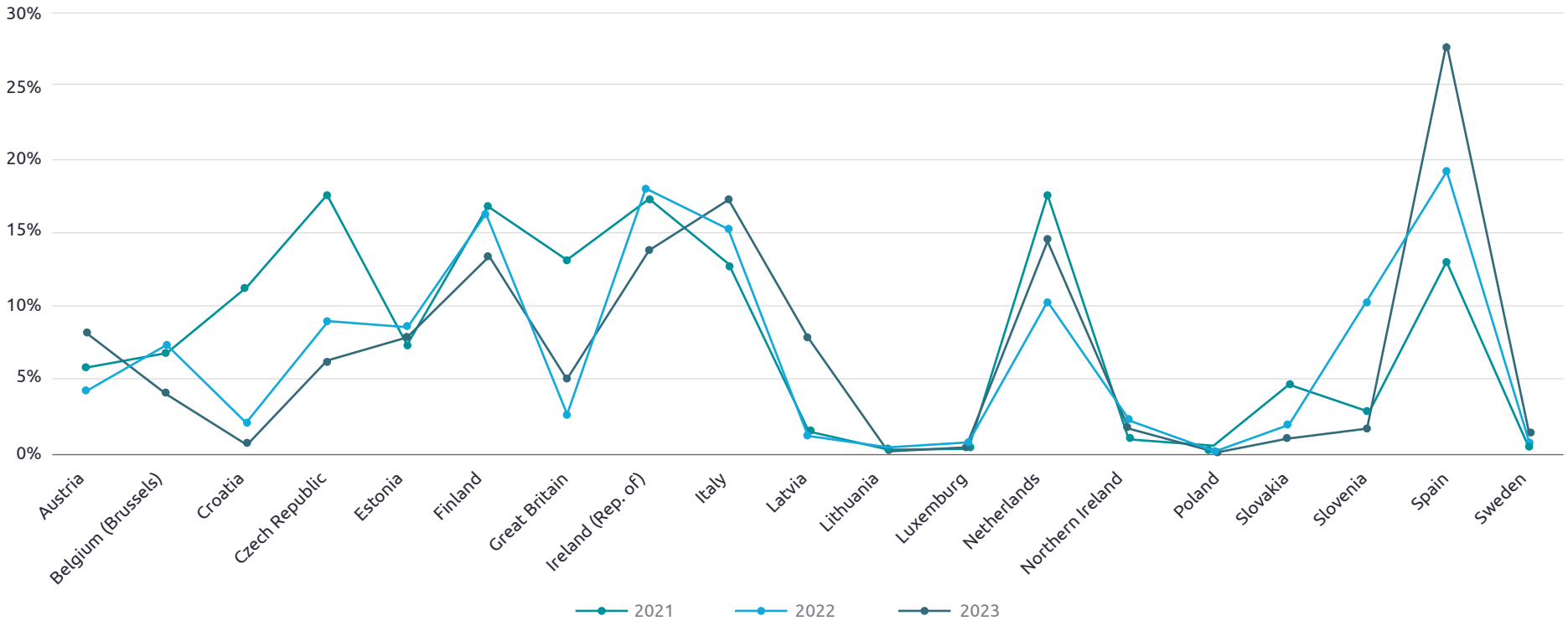
Source: VaasaETT

Energy intensity progress, churn rates

Aggregated gas churn rate, Europe

FIGURE 20

Aggregated Gas Churn Rate, Europe | 2021-2023



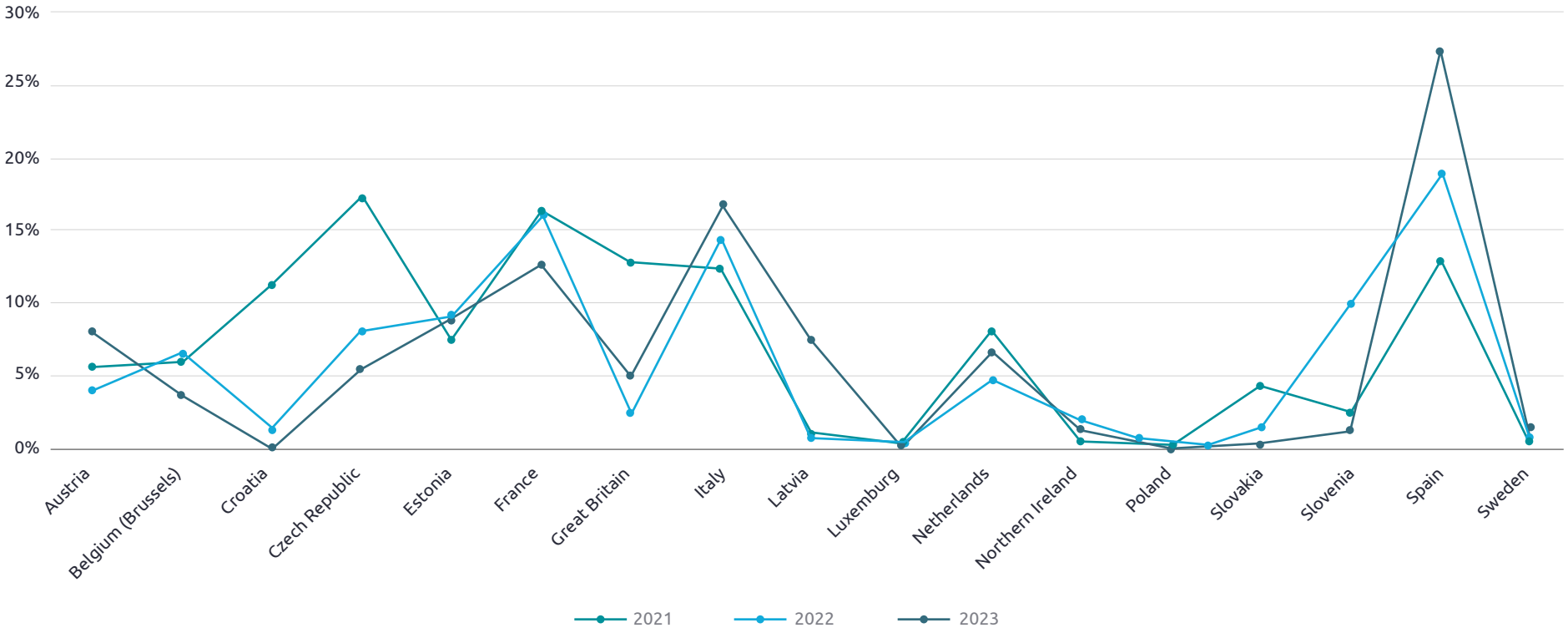
Source: VaasaETT

Energy intensity progress, churn rates

Residential gas churn rate, Europe

FIGURE 21

Residential Gas Churn Rate, Europe | 2021-2023



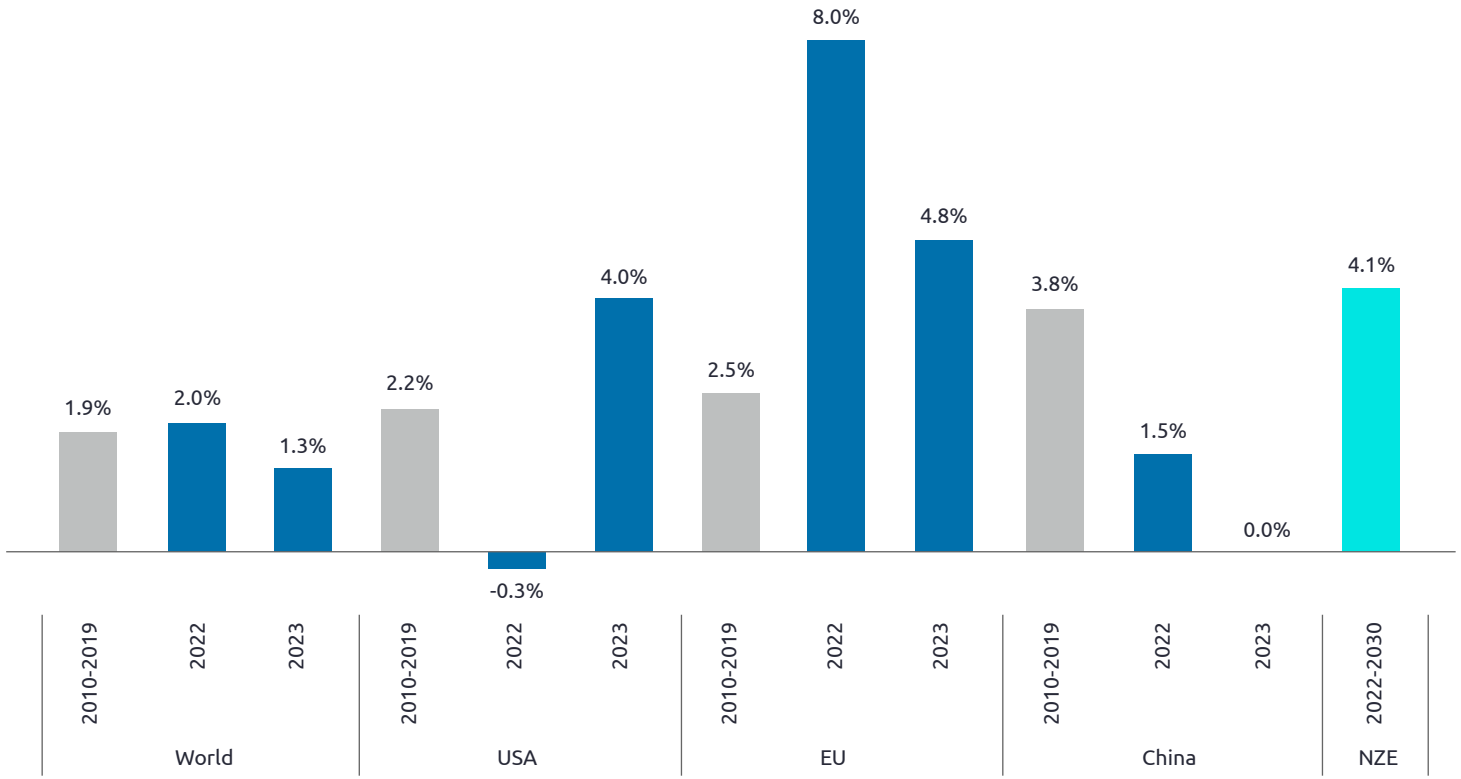
Source: VaasaETT

Energy intensity progress, churn rates

Energy efficiency progress combined with high prices and consumption reduction trigger energy intensity drop in europe

FIGURE 22

Annual Primary Energy Intensity Improvement, 2010-2023 And In The Net Zero Scenario, 2022-2023



Source: International Energy Agency (IEA)

- The impact of the energy crisis was most immediate and severe in Europe. Driving prices up and making a consumption collapse effect. In the European Union, energy intensity progress reached nearly 8% in 2022, followed by 5% in 2023. This was due to ongoing pressure to conserve energy during the crisis and the initial effects of incentives from REPowerEU starting to take hold
- The USA achieved a 4% improvement in energy intensity in 2023, driven by high energy prices and a milder climate, as the record heat affecting other regions largely missed the country
- China's weaker energy intensity progress significantly affected the global rating. After pandemic restrictions ended, China's economic growth rebounded to 5% in 2023 from 3% in 2022

Government incentives & support schemes

FIGURE 23

USA and Canada Government provides incentives/policies that promotes clean energy

Regions	Countries	Key Government Incentives/ Policies	Key Insights
Americas	USA	**Residential Clean Energy Tax Credit: 25D**	• Rooftop solar is covered under the 25D tax credit and provides households an **uncapped 30% tax credit** • Those who upgrade their electrical panels in conjunction with rooftop solar are also eligible for a 30% uncapped tax credit
		Energy Efficient Home Improvement: 25C	• The Inflation Reduction Act significantly expands and extends the 25C tax credit, now known as the Energy Efficient Home Improvement Credit • Previously, this tax credit was limited to 10% of your project costs but is now increased to up to **30% and available on an annual basis**
		Federal Tax Credit	• The federal government offers as high as a **30% tax credit** for homeowners who install a home energy storage system starting from the **beginning** of **2023** to the **beginning** of **2035**
		Self-Generation Incentive Program (California)	• Any residential customer of Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company (SoCalGas), or San Diego Gas & Electric (SDG&E) is eligible for a General Market SGIP **rebate** of **approximately $250/kWh,** which means the **rebate covers** approximately 25% of the cost of an **average energy storage system**
	Canada	**The Canada Greener Homes Grant**	• **The Canada Greener Homes Loan** offers **interest-free loans** of **up to $40,000** to help Canadians make their **homes** more **energy efficient** and comfortable

Source: FranklinWH, Government of Canada

Government incentives & support schemes

FIGURE 24

Germany and France Governments provide tax incentives/credit for energy efficient building renovations

Regions	Countries	Key Government Incentives/ Policies	Key Insights
Europe	Germany	**Tax deductions for building renovation**	• Germany provides homeowners with tax incentives for energy efficient renovations, allowing them to deduct **20% of the costs** for renovations of up to **€40,000 from their taxes.** • Insulation measures, new windows and exterior doors, the replacement or optimisation of old heating and ventilation systems and the installation of digital energy management systems are eligible for support.
		Zero VAT rate for solar modules and installation	• The German government has introduced **a new zero VAT rate** for the supply and installation of solar modules. The tax relief was implemented on January 1, 2023 for single-family residential and commercial photovoltaic (PV) and battery systems up to 30 kWp.
		Feed-in tariff (FIT) scheme	• Households in Germany that produce renewable energy at home can sell any excess to the national grid. The feed-in tariff (FIT) scheme pays renewable energy producers a set rate per kilowatt-hour for electricity they feed into the grid. • The feed-in tariff for photovoltaic systems in 2024: For systems with an output of up to 10 kWp, the initial compensation rates in **January 2024 are 8.1 cents per kWh** for partial feed-in and **12.9 cents per kWh** for full feed-in.
		SolarPlus subsidy program	• With the SolarPlus subsidy program, the Berlin Senate is promoting the expansion of electricity generation with photovoltaic systems in a targeted manner. SolarPlus is aimed at private individuals and companies that want to use photovoltaic systems and electricity storage solutions. • The funding program already offers support in the preparation stage: The costs for feasibility studies, expert opinions and concepts are covered by **up to 65%.**
	France	**The Energy Transition Tax Credit (CITE)**	• The energy transition tax credit in France (CITE) is providing an **income tax credit** for expenditures related to certain building renovation work to improve the energy efficiency of private dwellings or the modernization of heating installations.

Source: IEA, Solarstone, EUKI

Government incentives & support schemes

FIGURE 25

In the UK, the Government offers grants to homeowners for energy efficiency upgrades of buildings

Regions	Countries	Key Government Incentives/ Policies	Key Insights
Europe	Spain	**Spain's 2022–2025 State Housing Plan**	• This program deals with funding measures to reduce energy demand in homes and buildings, in terms of both heating and cooling, reducing the consumption of non-renewable primary energy and replacing exterior elements (thermal insulation, changing windows). • Grants will cover **40% of procedure costs,** with a limit of **€3,000 per home.** An essential requirement for this is that the home in question must be a primary and permanent residence.
		PREE 5000	• This subsidy is aimed at small towns with a population no greater than 5,000 inhabitants. It includes changing a building's thermal enclosure, replacing fossil-based heating systems for renewable energy sources and improving lighting efficiency. Changes to thermal enclosures are subsidized for the amount of 50%–40%, while changes to heating systems receive **40%–30%** and lighting improvements get **20%**.
	Italy	**Superbonus 110%**	• Until 2023, this relief allowed property owners to benefit from a significant tax credit **up to 110%,** encouraging energy improvement interventions and seismic risk reduction. However, from 2024, the Superbonus rate is **reduced to 70%,** reserved exclusively for condominiums. This represents a significant change from the dual version of 110% and 90% currently in place.
	United Kingdom	**Home Energy Grant**	• HUG is a government initiative that'll deliver up to **£700 Mn in funding** between 2023 and 2025. It is a local authority funding program designed to provide energy efficiency upgrades, such as new windows and loft installation, and also low-carbon heating, such as solar panels and heat pumps, to households in England.
		Home Energy Scotland Grant	• Homeowners in Scotland can apply for the Home Energy Scotland grant and could **get up to £15,000.** They could get: up to £7,500 for energy efficiency improvements; up to £7,500 for clean heating systems.
		Social Housing Decarbonisation Fund	• In 2019, the UK government committed to the Social Housing Decarbonisation Fund (SHDF). They proposed making **£3.8 Bn available over a 10-year period,** aiming to help decarbonise a significant amount of social housing stock held within the UK. The fund is there to be used to improve measures such as ground source heat pumps, which will, in turn, help tackle fuel poverty.
		Smart Export Guarantee (SEG)	• The SEG offers **export tariffs** for a variety of small-scale low-carbon energy generating technologies, as a means to encourage UK homeowners to pursue renewable energy. Under the SEG, energy companies will offer tariffs for the renewable energy exported to the National Grid.

Source: Repsol Foundation, E.ON, mygov.scot

Government incentives & support schemes

FIGURE 26

Australian government is likely to deliver the upgrades to public and community social houses with the policies

Regions	Countries	Key Government Incentives/ Policies	Key Insights
APAC	Australia	**ACT Home Energy Support: Public Housing Program**	• The Australian **Government is investing $7.2 Mn** to provide **energy efficiency upgrades** to over **5,000 homes** in the **Australian Capital Territory** • This investment adds to the **ACT Government's $28 Mn** for the ACT Home Energy Support: Public Housing Program. This brings the total program funding to **$35.2 Mn**
		Homes Tasmania Energy Efficiency	• The **Australian Government** is investing **$8.3 Mn** to provide **energy efficiency upgrades** to **1,600 social houses in Tasmania** • This investment matches the Tasmanian Government's funding for the Homes Tasmania Energy Efficiency program. This brings the total program funding to **$16.6 Mn**
		NSW energy performance upgrades	• The **Australian Government** is **investing $87.5 Mn** to provide energy performance upgrades to over **24,000** homes in **New South Wales** • This investment matches the NSW Government funding. This brings the total program to $175 Mn
		Victorian Energy Efficiency in Social Housing Program	• The Australian Government is investing **$46 Mn** to electrify and modernise around **5,000 social houses in Victoria** • This investment matches the Victorian Government's funding to expand the Victorian Energy Efficiency in Social Housing Program. This brings the total expanded program to $96 Mn
	India	**PM Surya Ghar: Muft Bijli Yojana' (Free Electricity Scheme)**	• Aimed at benefiting about **one crore (10 Mn) households.** Under the scheme, households who install rooftop solar are set to get **300 units of electricity free every month**
		Pradhan Mantri Ujjwala Yojana (PMUY)	• Introduced in 2016 to provide clean cooking fuel to women in rural areas • The scheme provides **free LPG connections** to eligible households and has already benefitted over **8 crore (80 Mn) households**
		• **Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME)** • **Atal Jyoti Yojana**	• Promotes the adoption of electric and hybrid vehicles and solar-powered lighting to rural areas, a move which reduces emission footprint

Source: Australian Government - Department of Climate Change, Energy, the Environment and Water, Government of India – Ministry of Petroleum & Natural Gas

Climate Data

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Global and regional emissions, performance

FIGURE 1

Global performance – GDP, Energy and Emissions

	2022	2023	2024 est.
			Forecasts
GDP evolution	+3.5%	+3.2%	+3.2%
Primary Energy Consumption	+1.8%	+2.1%	Not available forecast
CO_2 emissions	+1.3%	+2.1%	Not available forecast
Energy Intensity	+2.0%	+1.3%	Not available forecast

Source: IMF,, Energy institutre,

Global and regional emissions, performance

FIGURE 2

North America performance – GDP, Energy and Emissions

	2022	2023	2024 est.
			Forecasts
GDP evolution	+2.3%	+2.5%	+2.6%
Primary Energy Consumption	+2.3%	-1.0%	Not available forecast
CO_2 emissions	+1.8%	-1.9%	Not available forecast
Energy Intensity (USA)	-0.3%	+0.4%	Not available forecast

Source: IMF,, Energy institutre,

Global and regional emissions, performance

FIGURE 3

Europe performance – GDP, Energy and Emissions

	2022	2023	2024 est.
			Forecasts
GDP evolution	+2.5%	+1.0%	+1.4%
Primary Energy Consumption	-4.1%	-2.2%	Not available forecast
CO_2 emissions	-2.5%	-5.3%	Not available forecast
Energy Intensity	+8.0%	+4.8%	Not available forecast

Source: IMF,, Energy institutre,

Global and regional emissions, performance

FIGURE 4

APAC performance – GDP, Energy and Emissions

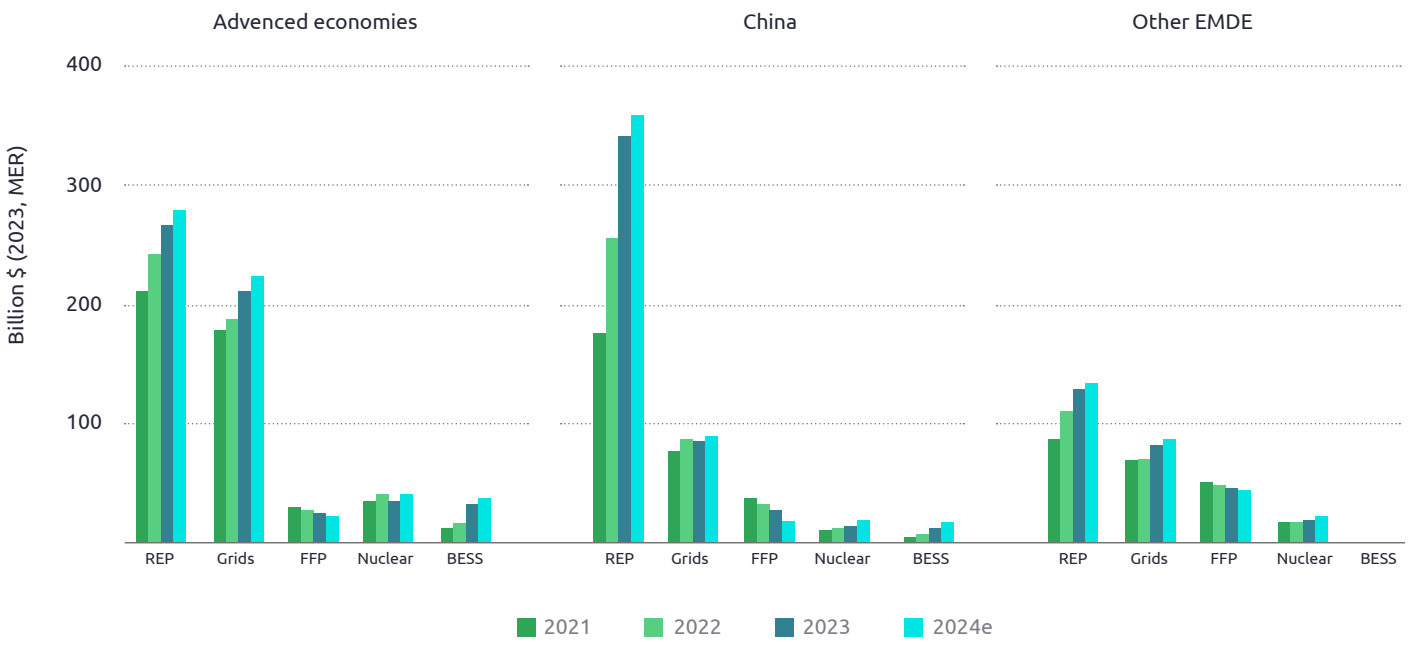
	2022	2023	2024 est.
			Forecasts
GDP evolution	+4.0%	+4.8%	+4.4%
Primary Energy Consumption	+2.4%	+4.6%	Not available forecast
CO_2 emissions	+0.4%	+4.9%	Not available forecast
Energy Intensity (China)	+1.5%	+0.0	Not available forecast

Source: IMF,, Energy institutre,

Investments

FIGURE 5

Annual investment in the power sector by geography and category, 2021-2024



- Investment in renewable power rose rapidly across the board, with promising momentum for spending on grids, nuclear and battery storage in 2024
- Global investment in the power sector grew by 15% in 2023, reaching a record $1.3 trillion
- Global spending on renewables also hit a new record of $735 billion, driven by solar PV and wind

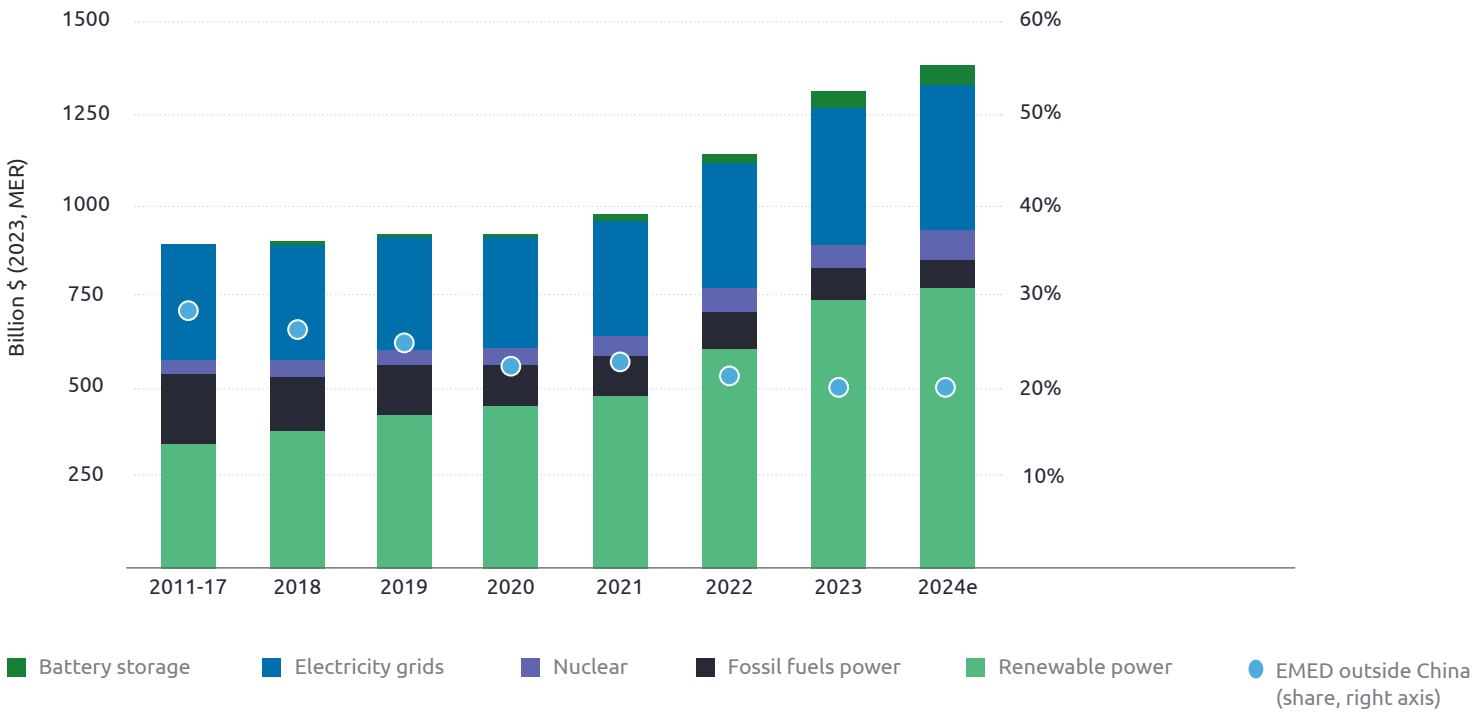
Notes: REP = renewable power. FFP + fossil fuels power. BESS = Battery Energy Storage System. Investment spending on BESS in other EMED is so small (USD 2 billion in 2024e) that it can almost not be detected on teh charts. 2024e = estimated values for 2024.

Source: IEA

Investments

FIGURE 6

Global annual investment in the power sector by category, 2011-2024



- Investment in solar PV now surpasses all other generation technologies combined
- China alone saw solar PV spending jump to $220 billion – almost half of global solar investment for the year

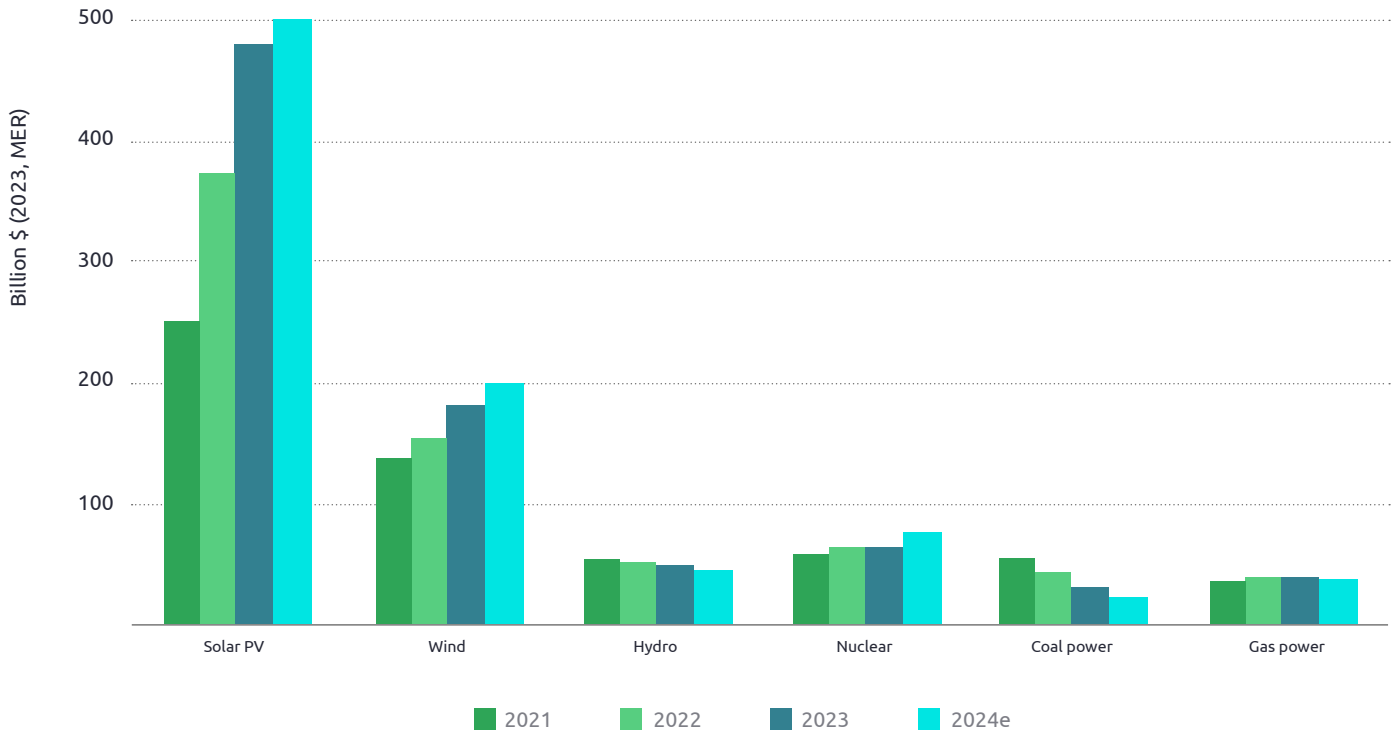
Notes: Investment throughout is measured as ongoing capital spending on new and existing power capacity. All numbers throughout are power includes unabated and abated power. EMED = emerging market and developing economics. 2024e = estimated values for 2024.

Source: IEA

Investments

FIGURE 7

Global annual investment in power generation by selected technologies, 2021-2024



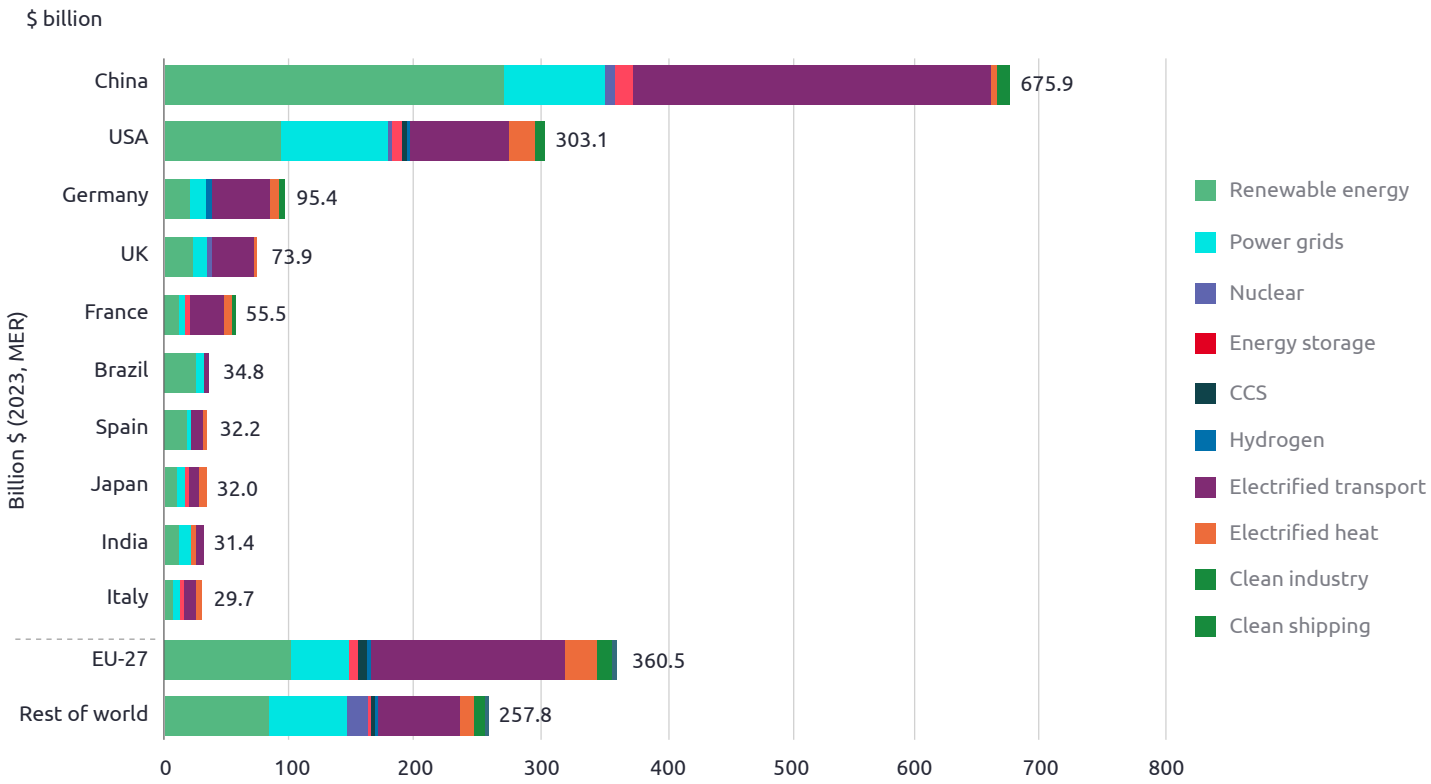
Source: IEA

- Global spending on renewables also hit a new record of $735 billion, driven by solar PV and wind
- Solar PV attracted a record $480 billion in spending in 2023 – more than all other generation technologies combined – while investment in coal power has fallen by 40% since 2021
- While investment in nuclear power remained largely unchanged in 2023, expected growth of around 20% in 2024 promises renewed momentum.

Investments

FIGURE 8

Top 10 economies for 2023 Energy Transition Investment



- The largest country for investment by far was China, with $676 billion invested in 2023 – equivalent to 38% of the global total. Although China remains dominant, its lead has been reduced
- Taken together, the European Union, USA and UK outpaced China with $737 billion of investment – a feat they hadn't managed to achieve in 2022. Investment in the USA jumped 22% year-on-year, to $303 billion, as the effects of the Inflation Reduction Act started to be felt

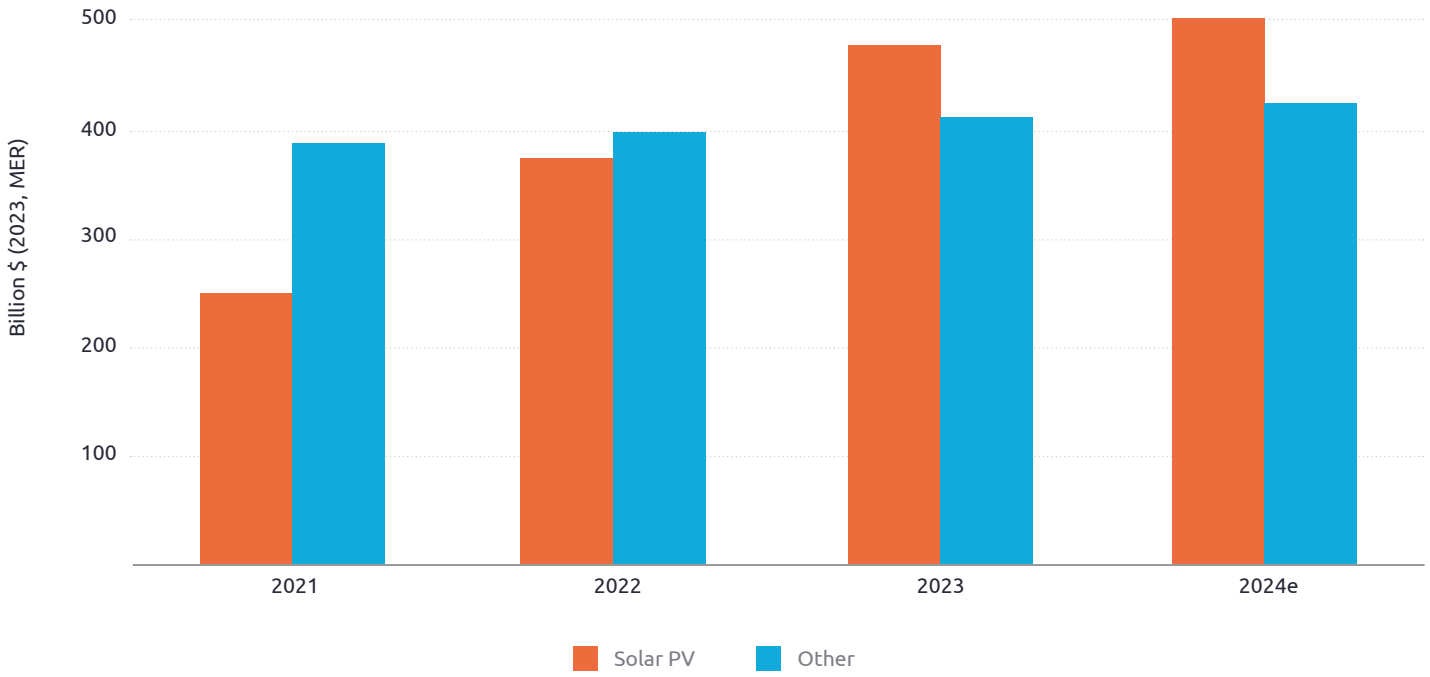
Notes: EU-27 bar also includes the EU member state shown. Rest of world is global investment excluding the EU and individual economies in the chart. CCS refers to carbon capture and storage.

Source: BNEF

Investments

FIGURE 9

Global annual investment in solar PV and other generation technologies, 2021-2024



- Investment in solar PV now surpasses all other generation technologies combined
- China alone saw solar PV spending jump to $220 billion – almost half of global solar investment for the year

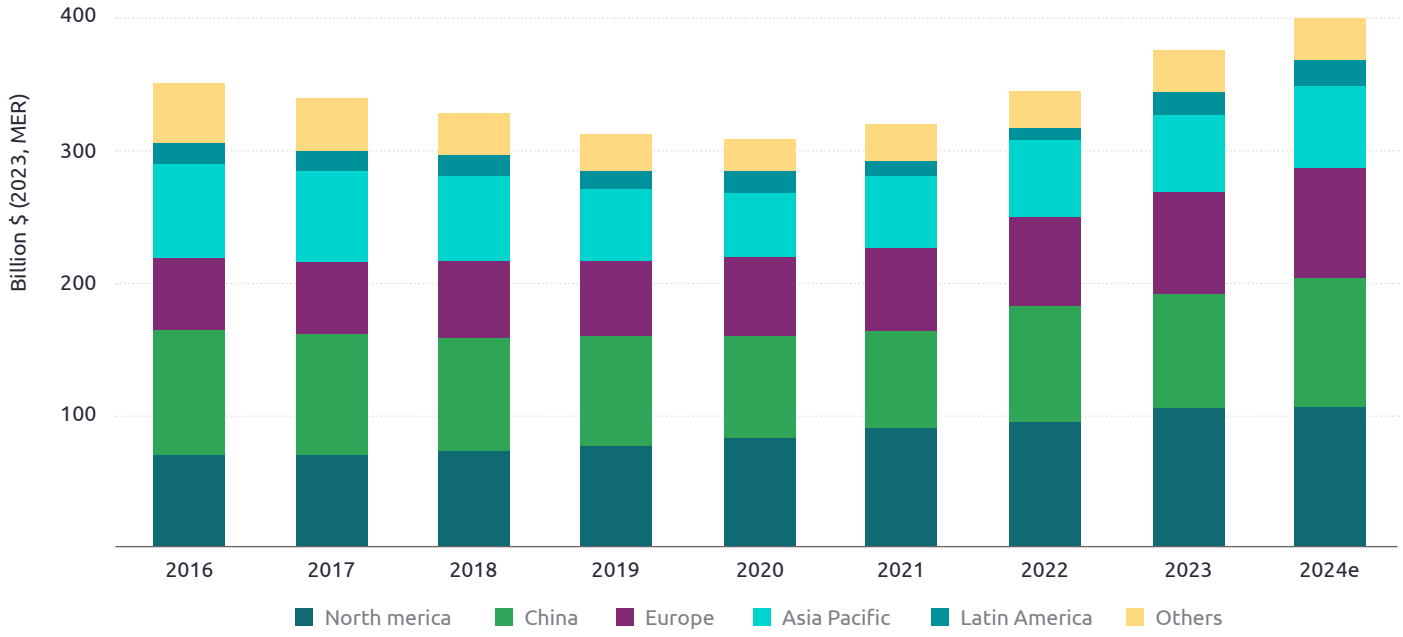
Notes: 2024e = estimated values for 2024. Other = electricity generation from all other technologies including coal, oil, natural gas, wind, hydro and nuclear.

Source: IEA

Investments

FIGURE 10

Investment in power grid infrastructure by geography, 2016-2024



Source: IEA

- Grid investment is starting to pick up and is expected to reach $400 billion in 2024, with Europe, the United Sates, China and parts of Latin America leading the way
- Advanced economies and China continue to lead investment in power grids, accounting for about 80% of global spending. China held its level of investment at $80 billion, with the government-owned State Grid Corporation maintaining its appetite for new grids and networks
- Investment in advanced economies grew at a rate of 11% in 2023, led by the United States, which spent $100 billion – mostly on enhancing grid reliability and upgrading old infrastructure
- Spending in the European Union rose strongly, reaching $60 billion, bolstered by the European Commission's Grid Action Plan which targets more than $600 billion in spending on grids in the next six years

Investments

FIGURE 11

Clean Energy investments in Oil & Gas Industry

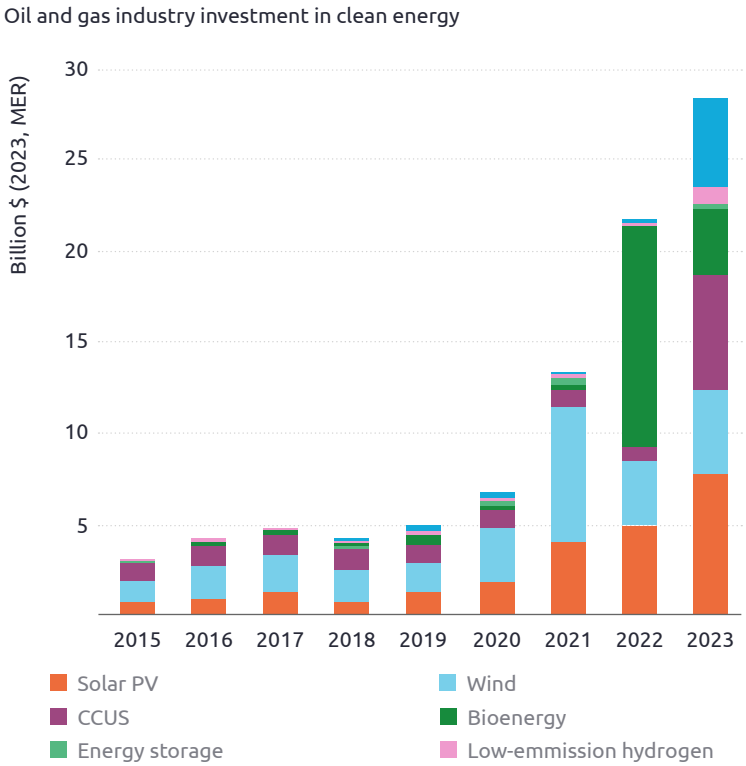
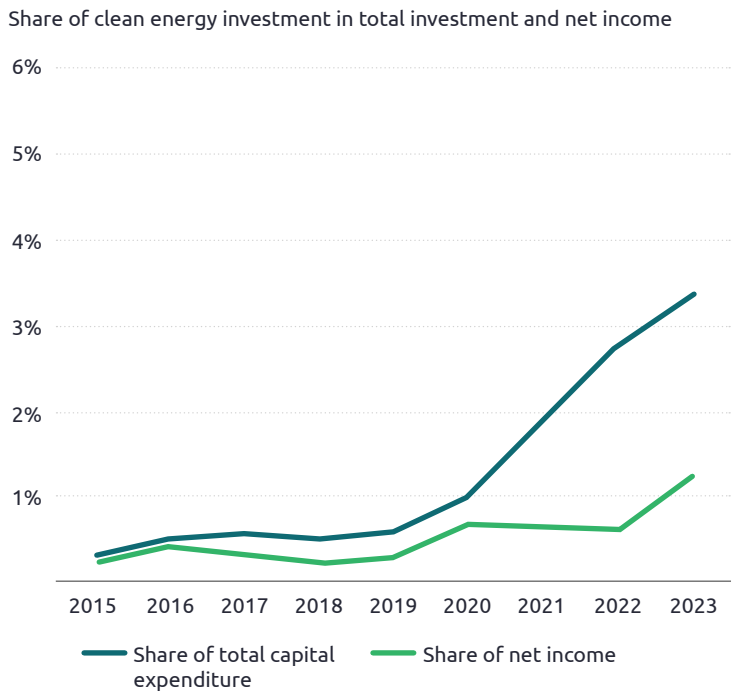


FIGURE 12

Share of clean Energy investment in total investment & net income in Oil and Gas Industry



- Clean energy investment by oil and gas companies grew to $28 billion in 2023 which is less than 4% of overall capital spending and less than 1% of net income
- 2023 oil and gas companies' investment into clean energy is a 30% increase from 2022 levels. This was well below the 65% jump seen from 2021 to 2022, reflecting in part the inflationary environment and supply chain issues for some renewable projects in the wake of the energy crisis, as well as some recalibration of company strategies.

Source: IEA

Investments

FIGURE 13

Clean Energy investmentS in Oil & Gas Industry

Major Oil and Gas Players	Clean Energy Investments- per year ($Bn)
Total Energies	5.8
Shell	4.2
Exxon	3.4
Equinor	2.6
Chevron	2
BP	1.5
Eni	1.5
Galp	0.75

FIGURE 14

Clean Energy investments Per Year by Energy & Utility Players

Major Energy & Utilities	Clean Energy Investments- per year ($Bn)
Engie	6
Iberdrola	5.6
Enel	4.3
EDF	3
Uniper	1.1
Centrica	1
E. ON	0.5

Notes: Average is calculated related to investment per year calculation for any player providing investment figures for more than 1 year; Latest Investment figures are considered from 2023/2024

Source: Secondary research

Stakeholder pressures

FIGURE 15

Energy transition 2023 new public authorities' interventions, reinforcing climate change action plans (extract).

U.S.

U.S. DOE finalizing Energy Efficiency Standards for Commercial Unitary Air Conditioners and Heat Pumps, Circulator Pumps, Dishwashers, and Miscellaneous Refrigeration Appliances-Delivering Savings to Consumers as Directed by Congress and with Strong Industry and Stakeholder Support

Growing stakeholder expectations for climate action is a key trend shaping the energy landscape in 2023. It is a major concern for organizations and as a result, they will ramp up their sustainability efforts. Science-based targets will become the bare minimum and investments in renewable energy solutions will continue to rise

EU

Revised Renewable Energy Directive (RED III): The European Union has updated its Renewable Energy Directive to increase the binding target for renewable energy to 45% by 2030. This revision aims to accelerate the adoption of renewable energy sources across member states

EU

Carbon Border Adjustment Mechanism (CBAM): The EU has implemented the CBAM to prevent carbon leakage and ensure that imported goods are subject to the same carbon costs as products produced within the EU. This regulation aims to level the playing field and encourage global emission reductions. Hydrogen is a critical component in the CBAM, which aims to prevent carbon leakage by ensuring that imported goods are subject to the same carbon costs as those produced within the EU

EU

In 2023, the EU adopted a unified batteries regulation introducing sustainability, recycling, and safety requirements applicable to design, production, and waste management of batteries produced or sold in the EU.

UK

Energy Act 2023 received Royal Assent and became law in what is described as “the biggest piece of energy legislation in the UK’s history.” Exactly a month later, the UK Department for Business and Trade published on November 26, 2023, a UK battery strategy setting out the UK government’s vision for the country to achieve a globally competitive battery supply chain that supports economic prosperity and the net zero transition, following a call for evidence launched in August 2023.

Source: Secondary research

Market Data

01. Physical Energy Flows

02. Money, Markets and Regulation

03. Data and Digital

04. Customers

05. Climate

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Energy in the Regions and Countries

Europe card

North America card

Middle East card

Africa card

South East Asia card

Germany

UK

France

Italy

Netherlands

Switzerland

Poland

Turkey

Spain

Sweden

Belgium

Norway

China

India

Japan

South Korea

Indonesia

Australia

Saudi Arabia

USA

Canada

Mexico

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