CHUBB

Climate+

Evolution of The Energy Mix

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Agenda

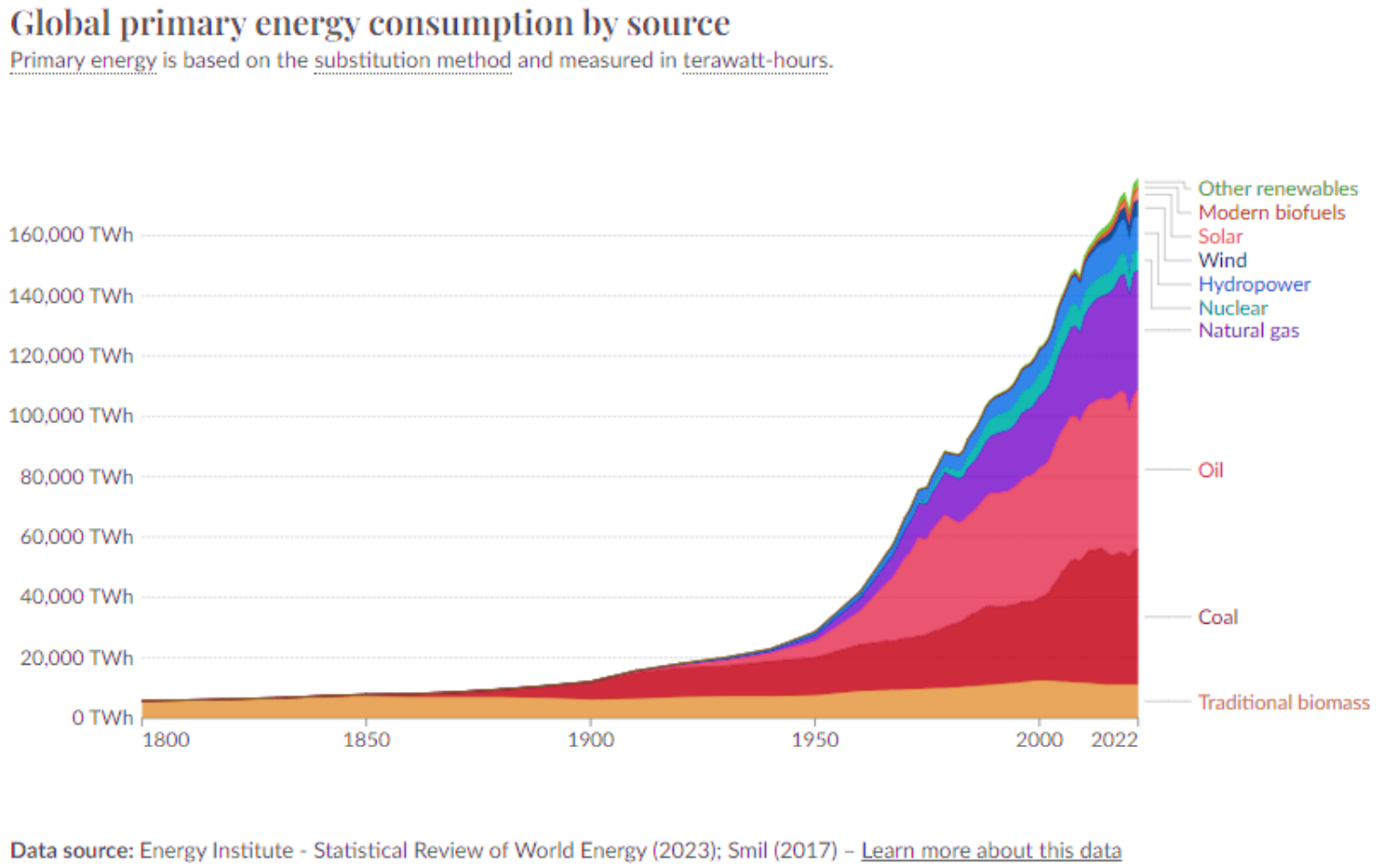
- Energy Mix: Past Present Future
- National/International Targets
- Investment in Different Technologies
- Technological Advancements
- Challenges with Renewable Power Production
- Government Support
- European Union Directives
- Conclusions

Global Energy Transition: Drivers

The **Paris Agreement** sets a **goal** to **limit the increase in global average temperature** in order to **reduce the impact of climate change**. Implicit in this goal is the need for a **transition to a low-carbon energy sector**, which accounts **for two-thirds** of **global emissions**.

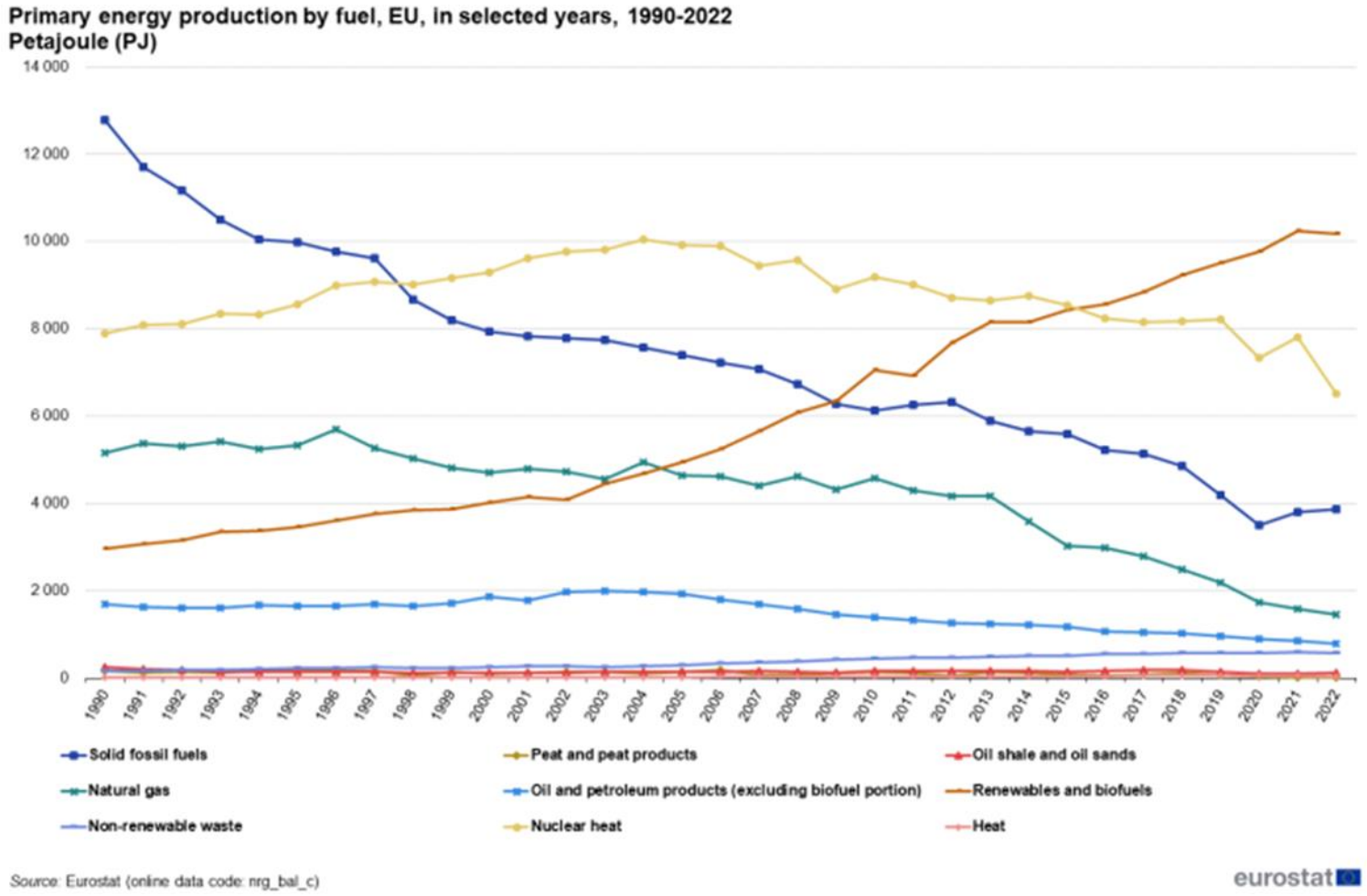
- Decarbonization
- Electrification
- Digitalization

Global Energy Mix: Past



- **Diverse energy system** is a very recent phenomenon
- Until the **mid-19th century** traditional **biomass** was the **dominant** source of energy used across the world
- By the **20th century**, around **half** the world's energy came from **coal** and **half** from **biomass**
- Throughout the **1900s**, the world adopted a broader range of sources; first **oil**, **gas** then **hydropower**
- It wasn't until the **1960s** that **nuclear** energy was added to the mix
- **Solar** and **wind** were only added much later in the **1980s**
- What stands out from this 200-year history of global energy use is that energy **transitions** have been very **slow in the past**

European Energy Mix: Present



- **Decline in Fossil Fuels**: Solid fossil fuel production has significantly decreased since 1990
- **Growth in Renewables**: There's a clear upward trend in renewables and biofuels production, especially from the early 2000s
- **Stability in Nuclear**: Nuclear heat production has been relatively stable, with no significant increases or decreases
- In 2022, **renewable energy** sources made up **41.2%** of electricity **consumption** in the EU, which is almost **4% more** than the previous year
- **Wind** and **hydro** power accounted for more **than two-thirds** of the total electricity generated from renewable sources
- **Solar** power experienced a **record growth** of **38 terawatt-hours** (TWh) compared to 2021

Targets

European Union

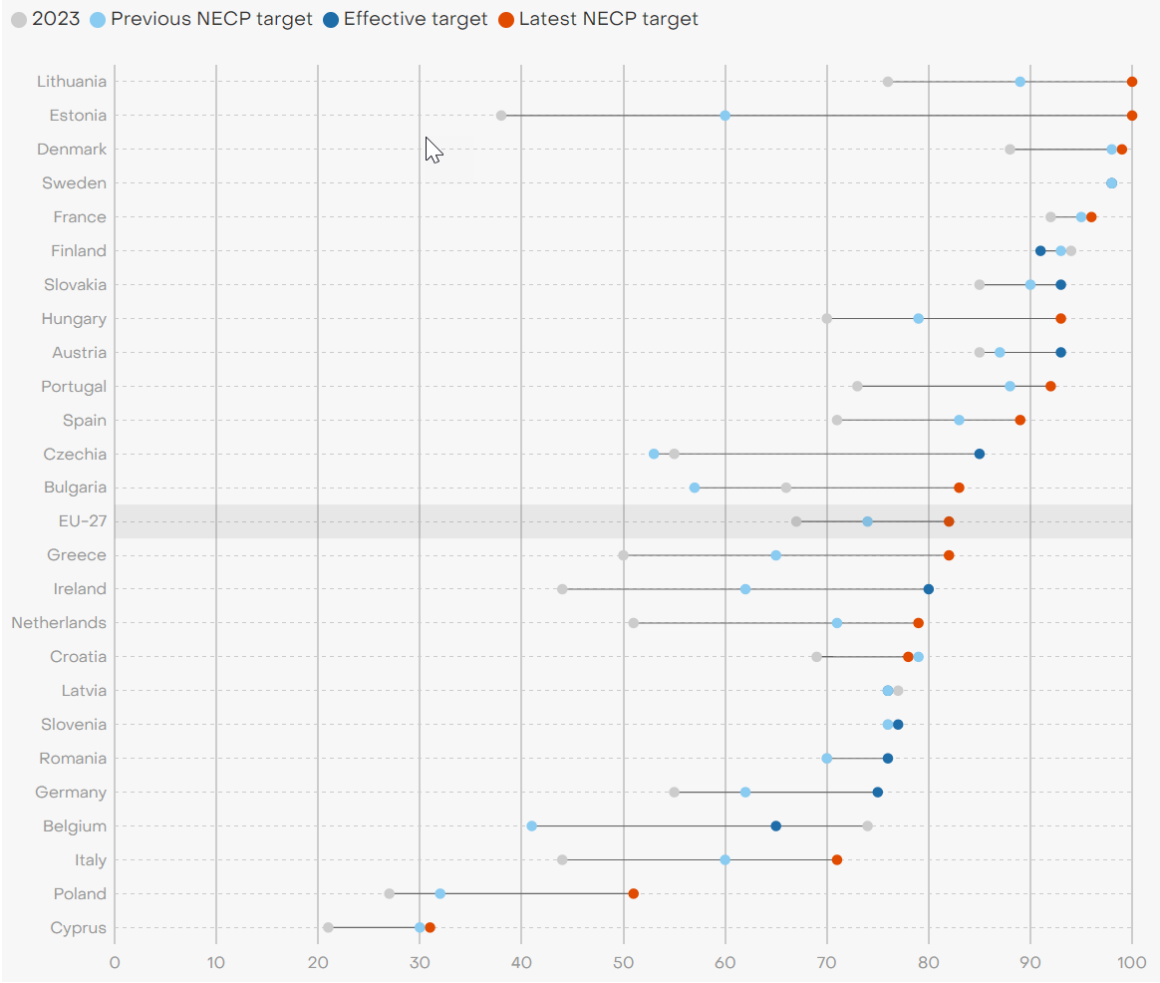
- Reduce net greenhouse gas emissions by at least 55% by 2030 (versus 1990 levels)
- Become a climate-neutral continent by 2050
- 42.5% target for renewable energy by 2030 (up from previous target of 32%); it means doubling the existing share of renewable energy in the EU

UK

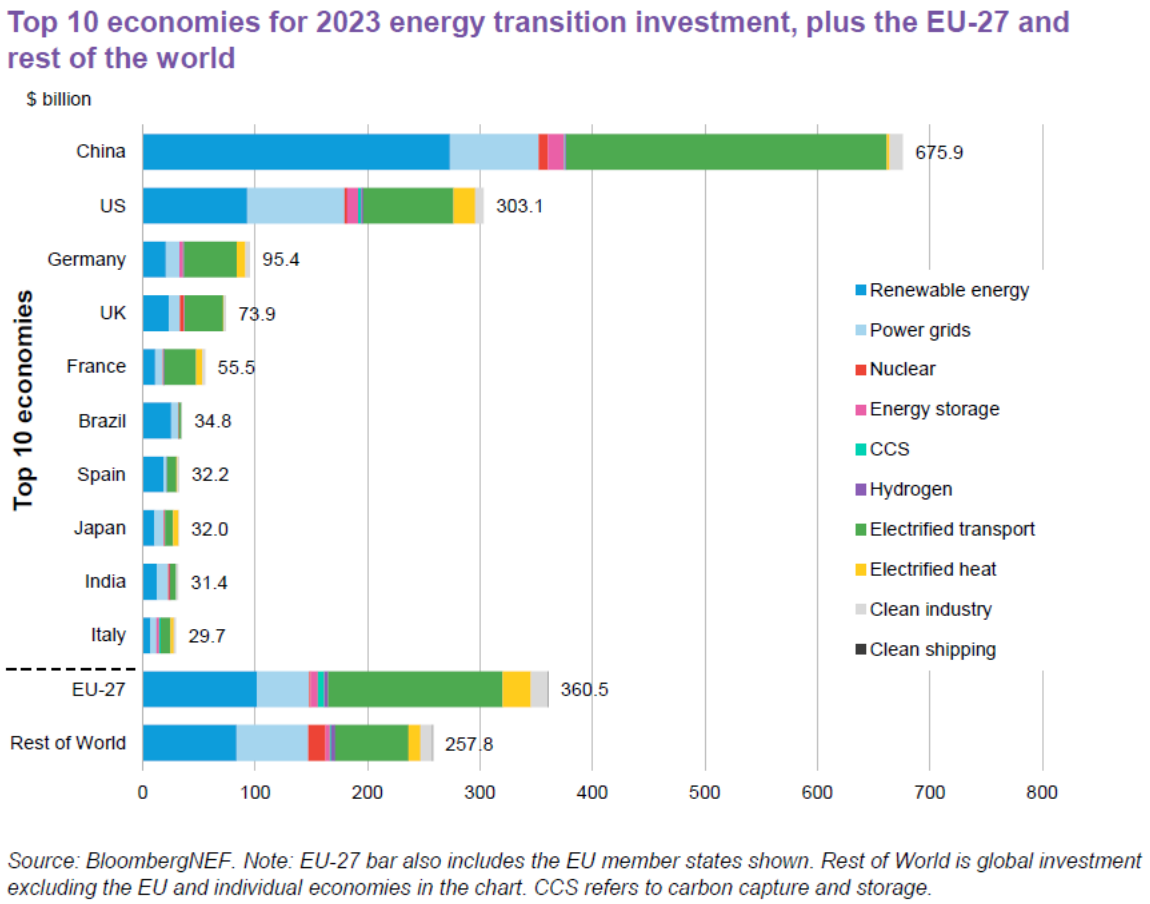
- The Climate Change Act 2008 is the basis for the UK's approach to tackling and responding to climate change
- Achieve net zero emissions by 2050
- The Climate Change (Scotland) Act 2009 commits Scotland to a "Net Zero" emissions target of 2045; this includes a 56% reduction by 2020, 75% by 2030 and 90% by 2040 against the baseline
- The Environment (Wales) Act 2016 introduces a duty on Welsh Government to develop carbon budgets for Wales, and to reduce emissions by at least 80% by 2050

European Union: Current & 2030 Forecast Share of Clean Electricity

- Shows the **progression of energy** and **climate targets** for various **European** countries
- **Effective Target**: adjustments made to the initial targets, possibly due to policy changes or progress assessments
- **Latest NECP Target**: most recent targets, which could have been influenced by new commitments or technological advancements
- **Some countries** have **increased** their **targets**, suggesting a stronger commitment to energy
- **Others** have **remained constant** or **decreased**, indicating various challenges or policy shifts



Investment: Global Energy Transition in 2023

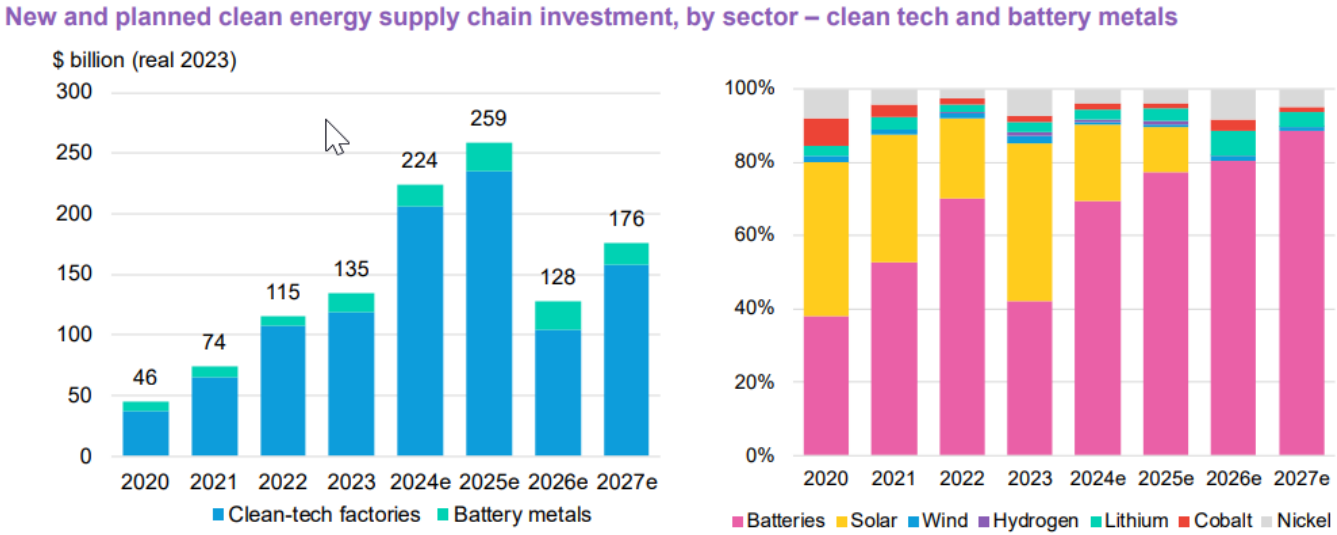


Source: BloombergNEF. Note: EU-27 bar also includes the EU member states shown. Rest of World is global investment excluding the EU and individual economies in the chart. CCS refers to carbon capture and storage.

- **Annual Global investment** of **$1.7t**
- **China Dominates**: projected investment of over **$360 bn**.
- **US Trails Behind**: investment is less than half of China's, at **$170 bn**.
- **Electrified transport**, which tracks spending on EVs and charging infrastructure, has overtaken renewable energy to become the largest sector for spending at **$634 bn** in 2023, up **36%**
- **Renewable Energy Takes Center Stage**: across most economies, it receives the highest investment.
- **Power Grids and CCS**: notable investments in power grids and carbon capture and storage (CCS) are essential for a sustainable energy transition.
- **Renewable Energy** in Europe 2023
  - Capacity 787 GW
  - Global share 20.3%
  - Change +71.2 GW
  - Growth +10.0%

Investment: Global Supply Chain Forecast

- **Investment Distribution**: close investment amount between clean-tech factories and battery metals, highlighting the balanced approach to developing both technology and raw materials
- **Energy Storage Trends:** batteries consistently dominate the investment landscape, indicating their critical role in renewable energy and electrification
- **Other sectors** (Solar, Wind, Hydrogen, Lithium, Cobalt, Nickel) also show positive growth trends
- **Future Estimates:** the upward trajectory suggests continued investment in clean energy technologies (2024 onwards are estimates)



Source: BloombergNEF. Note: Clean tech includes upstream factories for solar and batteries, electrolyzer assembly for hydrogen and nacelles for wind. Battery metals includes mines and processing facilities for battery metals. Nickel is battery-grade. Coverage applies to both charts.

Investment: Announced Projects by Technology Europe

Technology	Project Value	Number of Projects
Wind Energy	450,885	540
Solar PV	91,763	626
Nuclear	71,518	14
Hydrogen Production Plants	67,174	136
Underwater	36,110	12
Transformer Stations & Substations	22,305	13
Hydroelectric	21,083	44
Energy Storage	8,485	50
Underground	7,272	11
Solar PV; Wind Energy	5,848	6
Biofuel Plants/Bio-Refinery	4,200	11
Biomass	2,576	9
Geothermal	2,505	11
Transmission Cables	1,971	2
Solar Energy	1,733	8
Concentrated Solar Power (CSP)	424	1
Switching Stations & Substations	320	2
Desalination Plants	115	1
Grand Total	796,998	1,500

$000s
Q3 2024 – Q4 2025 Announced Projects >$30m
Source: GlobalData

- Wind and Solar energy dominate
- Hydrogen attracting significant investment; will these projects come to fruition?
- 50 Battery Energy Storage Systems (BESS) projects announced

Investment: Announced Projects by Technology UK&I

Technology	Project Value	Number of Projects
Wind Energy	140,201	156
Nuclear	110,309	5
Hydrogen Production Plants	49,971	41
Solar PV	25,157	305
Energy Storage	20,891	129
Underwater	12,952	5
Switching Stations & Substations	12,760	1
Hydroelectric	6,066	12
Biomass	4,458	22
Ocean	3,736	10
Transmission Cables	1,911	1
Biofuel Plants/Bio-Refinery	1,227	2
Solar Energy	575	7
Transformer Stations & Substations	255	4
Underground	250	2
Solar PV; Wind Energy	195	1
Biofuels	184	1
Geothermal	113	1
Desalination Plants	61	1
Grand Total	403,746	721

$000s
Q3 2024 – Q4 2025 Announced Projects >$30m
Source: GlobalData

- Wind and Solar energy dominate
- Hydrogen attracting significant investment; will these projects come to fruition?
- 50 Battery Energy Storage Systems (BESS) projects announced

Investment: Announced Projects by European Country Europe

- Spain, France, Finland, Germany and Italy have the most projects announced
- Poland ahead in $ value of projects announced
- Chubb can work with you to build multi-line solutions around this project pipeline

Country	Project Value	Number of Projects
Poland	106,346	76
Spain	81,258	202
Germany	73,762	105
Finland	72,161	159
Norway	66,769	20
Denmark	61,991	32
Sweden	48,068	78
Italy	44,735	109
Romania	31,918	74
Iceland	29,657	6
Bulgaria	27,404	29
Netherlands	26,816	42
Portugal	25,668	35
Estonia	24,712	17
France	23,306	111
Greece	14,246	58
Hungary	13,945	5
Serbia	13,490	49
Croatia	7,261	35

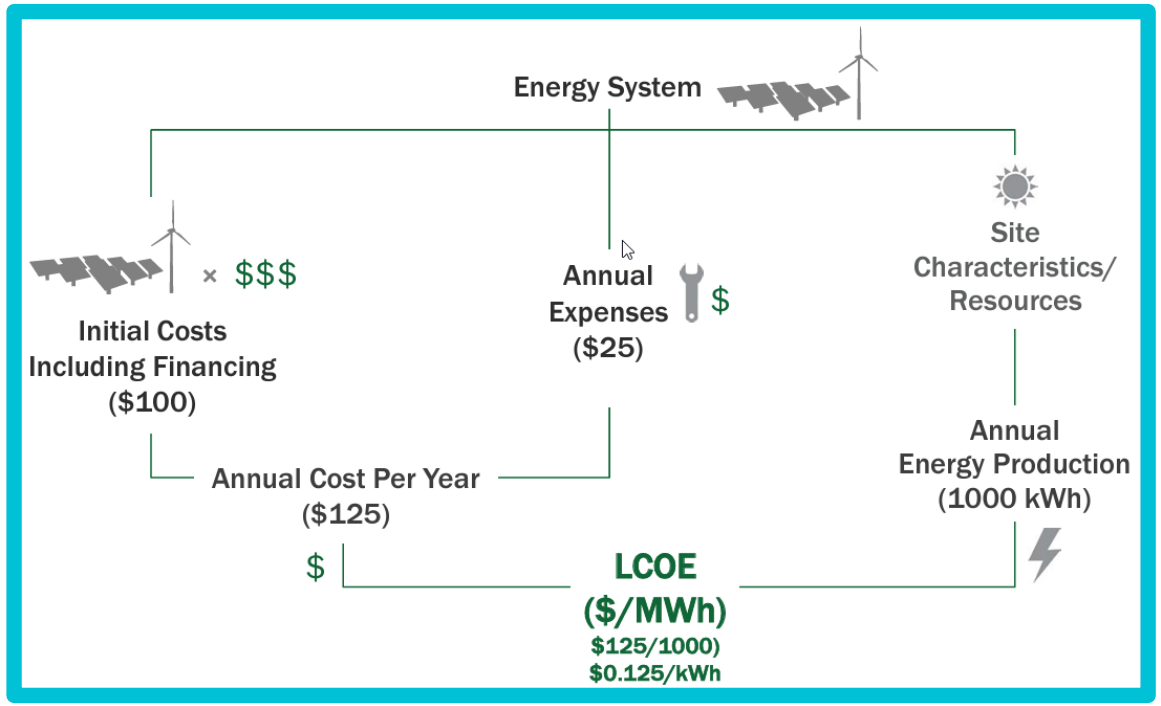
Country	Project Value	Number of Projects
Lithuania	5,164	20
Bosnia and Herzegovina	4,679	47
Montenegro	3,917	23
Belgium	3,864	61
Albania	3,122	17
Turkey	2,547	15
Macedonia	2,245	14
Austria	2,159	8
Switzerland	2,018	28
Latvia	1,383	13
Kosovo	1,031	10
Slovenia	703	6
Malta	700	1
Slovakia	363	5
Czechia	185	2
Cyprus	125	2
Moldova	106	2
Luxembourg	56	1
Grand Total	**849,290**	**1,533**

$000s
Q3 2024 – Q4 2025 Announced Projects >$30m
Source: GlobalData

Technology: Drivers of Development

OEMs compete among themselves and design features that

- Reduce the Levelized Cost of Energy (LCOE) of their commercial offerings
  - Reducing manufacturing cost
  - Improving performance
- Fulfil the public policies and regulatory requirements



Technology: Solar Photovoltaic

The most affordable source of Energy
88% decrease in Levelized Cost of Energy (LCOE) from 2010 to 2021

93% decrease in PV modules price from 2010 to 2021
- Losses during the cutting of cell wafers using diamond wire sawing techniques have fallen 58% compared to 2010
- Wafer thickness has also fallen
- Use of Ag (Silver) declined by 66% since 2010

82% decrease in total installed costs from 2010 to 2021
- Declining project costs directly related to surface area, such as racking and mounting, cabling and installation

23% increase in PV modules efficiency from 2010 to 2021
- From 14% when Al-BSF multi crystalline cell modules dominated, to around 20% in 2020, when mono-PERC cell architectures are used

55% increase in module power (watts) from 2010 to 2021
- Less surface required for the same area

24% increase in Capacity factor

Technology: Onshore Wind

The second most affordable source of Energy
67% decrease in LCOE from 2010 to 2021

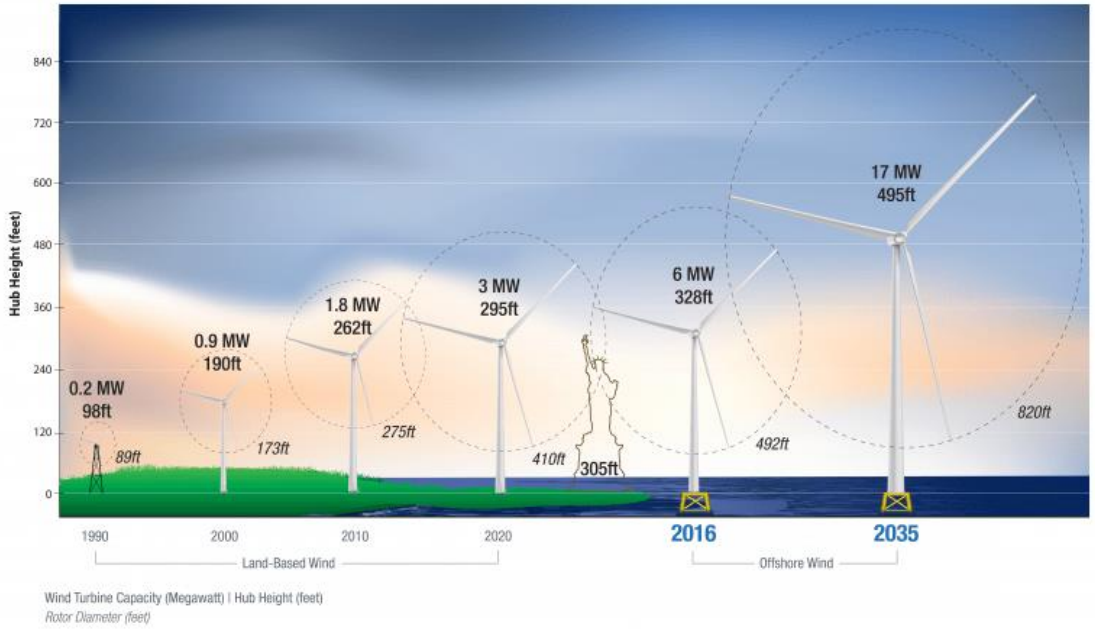
49% decrease in Wind Turbine Generators (WTG) weighted price

35% decrease in total installed costs
- Wide variation depending on the region
- Size of the project

32% increase in WTGs capacity

43% increase in Rotor Diameter

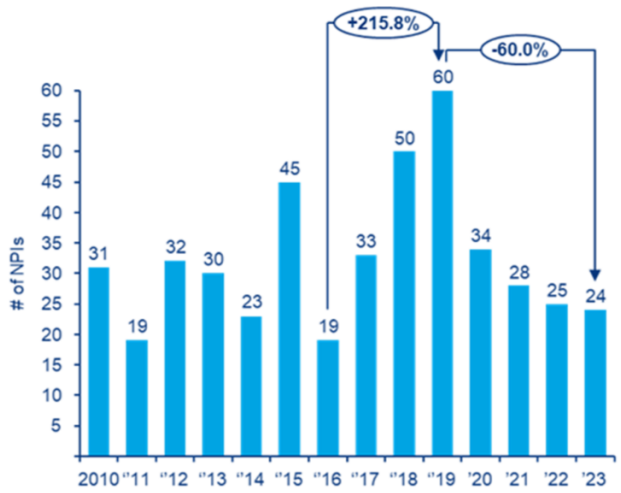
31% increase in Capacity Factor

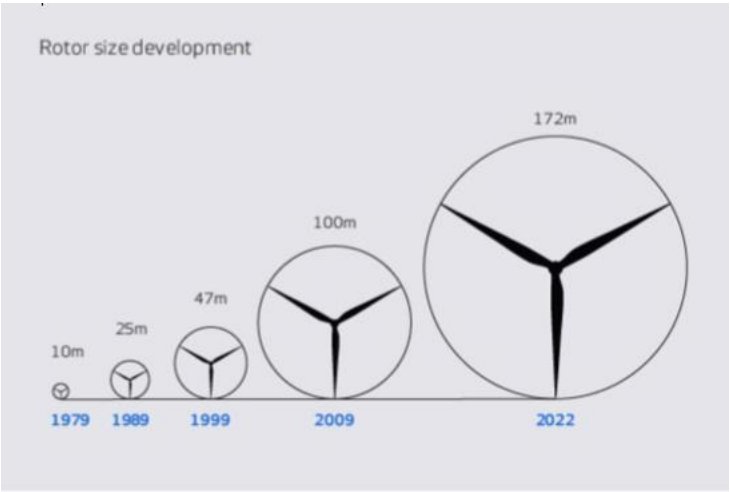


Innovation: Onshore Wind

- **Frantic** innovation up to 2019 with **large R&D costs** and new **factories** and manufacturing **equipment**
- The emphasis on **rotor extension** versus MW uprate to increase performance at low-wind sites
- **Logistics** and **transportation** issues have become the primary **limitation** preventing turbine **technology scale-up**

OEMs and suppliers of components are under huge **pressure to innovate**, **invest** wisely in R&D and **reduce the time to market** for next-generation technologies





Technology: Battery Energy Storage Systems (BESS)

Price arbitrage is the main driver of the growth of these systems

98% decrease in Li-ion price 1991-2018
Thermal stability

239% increase in Cell Energy Density 1991-2018, from 213 watt hours/litre of volume (Wh/L) to 721 Wh/L.

- **Energy density** is the key parameter. It allows to store the same energy using less materials
- Cylindrical cells tend to show the higher energy density and specific energy
- Reducing Co content in the Cathode

Independent data for specific technical performance characteristics is hard to obtain.

Technology: Hydrogen Electrolysers

Being an energy carrier and storage medium is the main driver of the growth of these systems.

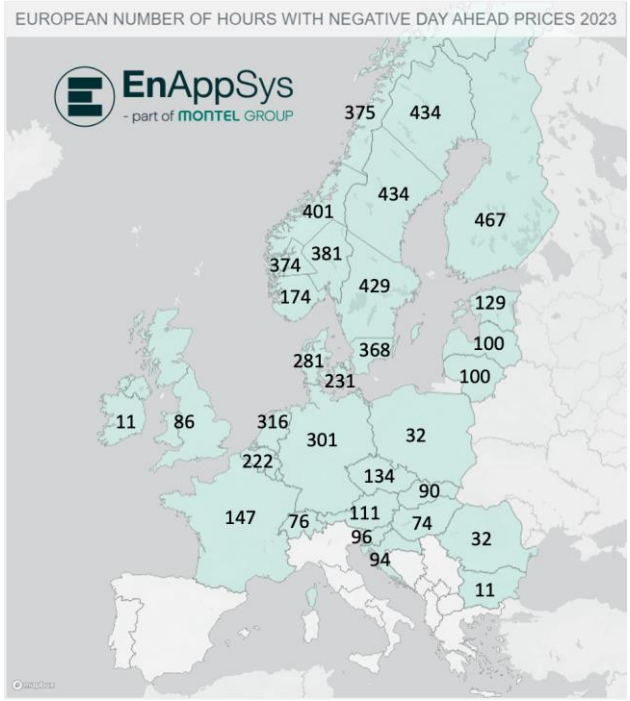
60% decrease in Alkaline electrolyser costs (2005-2020)
- From between USD 1 340/kW and USD 2 190/kW, to between USD 350/kW to USD 1 660/kW

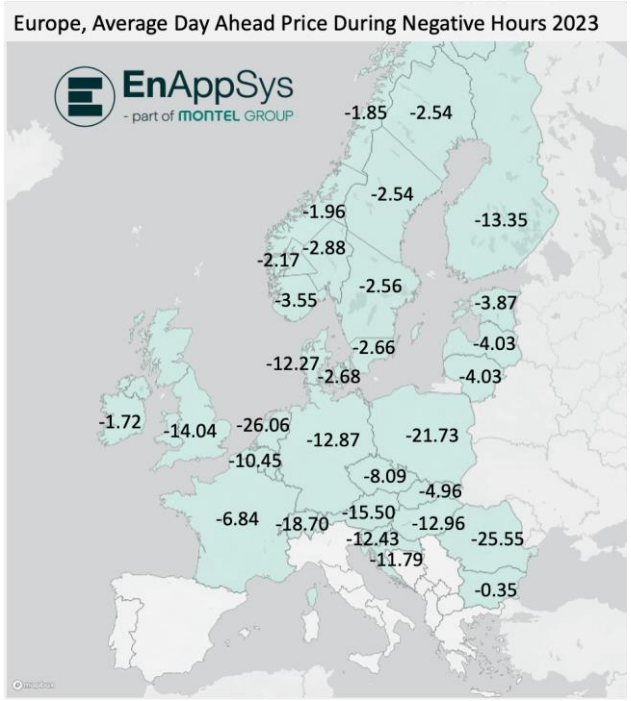
67% decrease in PEM electrolyser costs (2005-2020)
- From between USD 2 920/kW and USD 7 450/kW to between USD 400/kW to USD 2 940/kW
  - Manufactured at a smaller scale
    - Average size of projects 0.9 MW
  - More expensive bill of materials

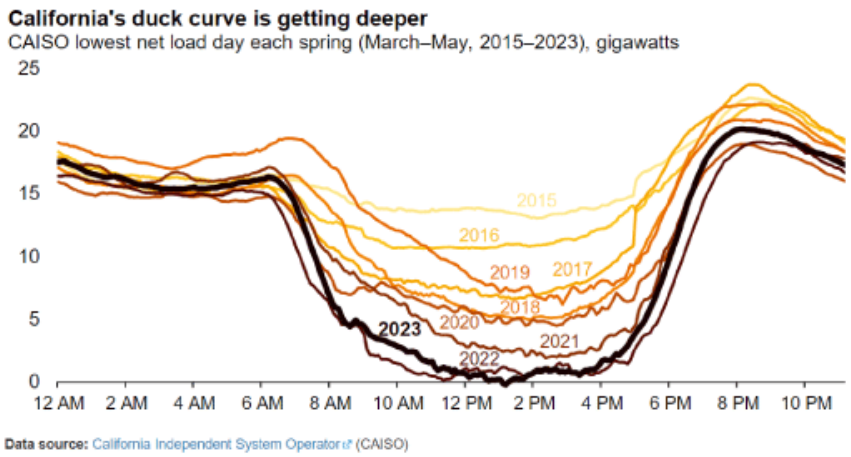
Alkaline Electricity Consumption 52 kWh/kg H_2
PEM Electricity Consumption 54 kWh/kg H_2

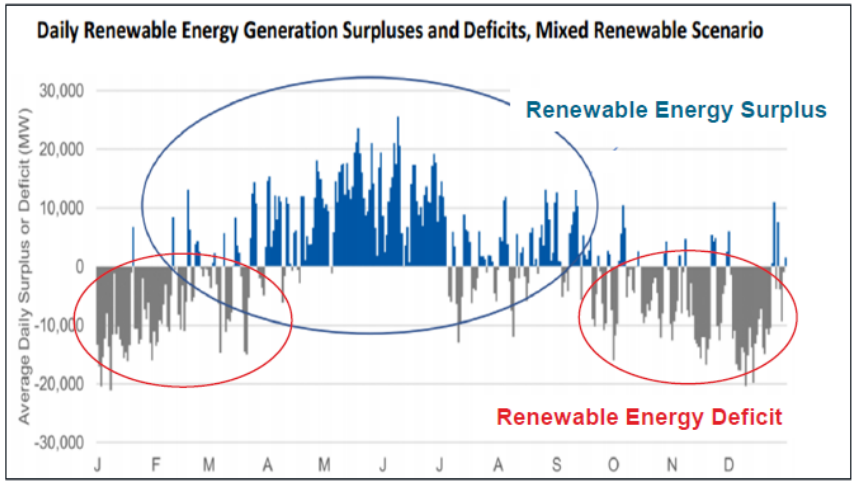
Technology: Intermittency of Renewable Energy

In 2023 many EU countries experienced many hours with negative prices in the day ahead market









Technology: Intermittency of Renewable Energy

Short Term Storage

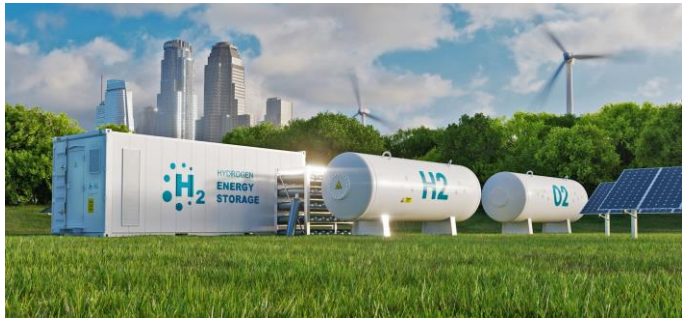
- BESS (utility scale and at homes)
- Electric Vehicles
- Demand response
- Virtual Power Plant

Tailwinds →

- Dispatchable, instant output
- No emissions

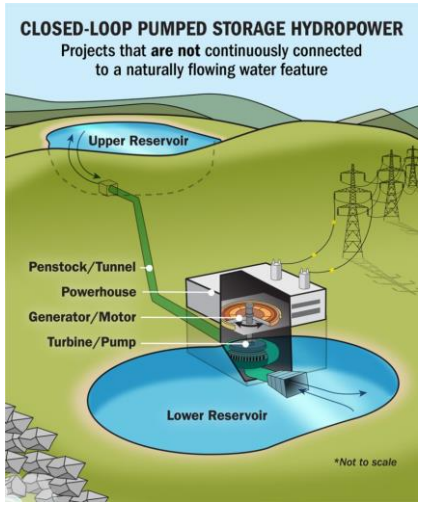
Headwinds ←

- Not continuous



Long Term Storage

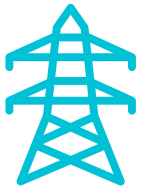
- Hydro pump storage
- H_2 + e-fuels



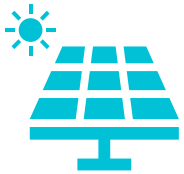
Energy Transition: Ongoing Risks

Supply chain disruptions and commodity prices

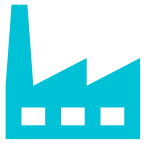
Regulatory and trade



Grid stability



Value deflation of solar panels



Stranded assets

Cyber attacks to infrastructures

Energy Transition: Emerging Risks

New technologies

CatNat model of new occupancies

More complex business models, derived from the physical restrictions of the grid

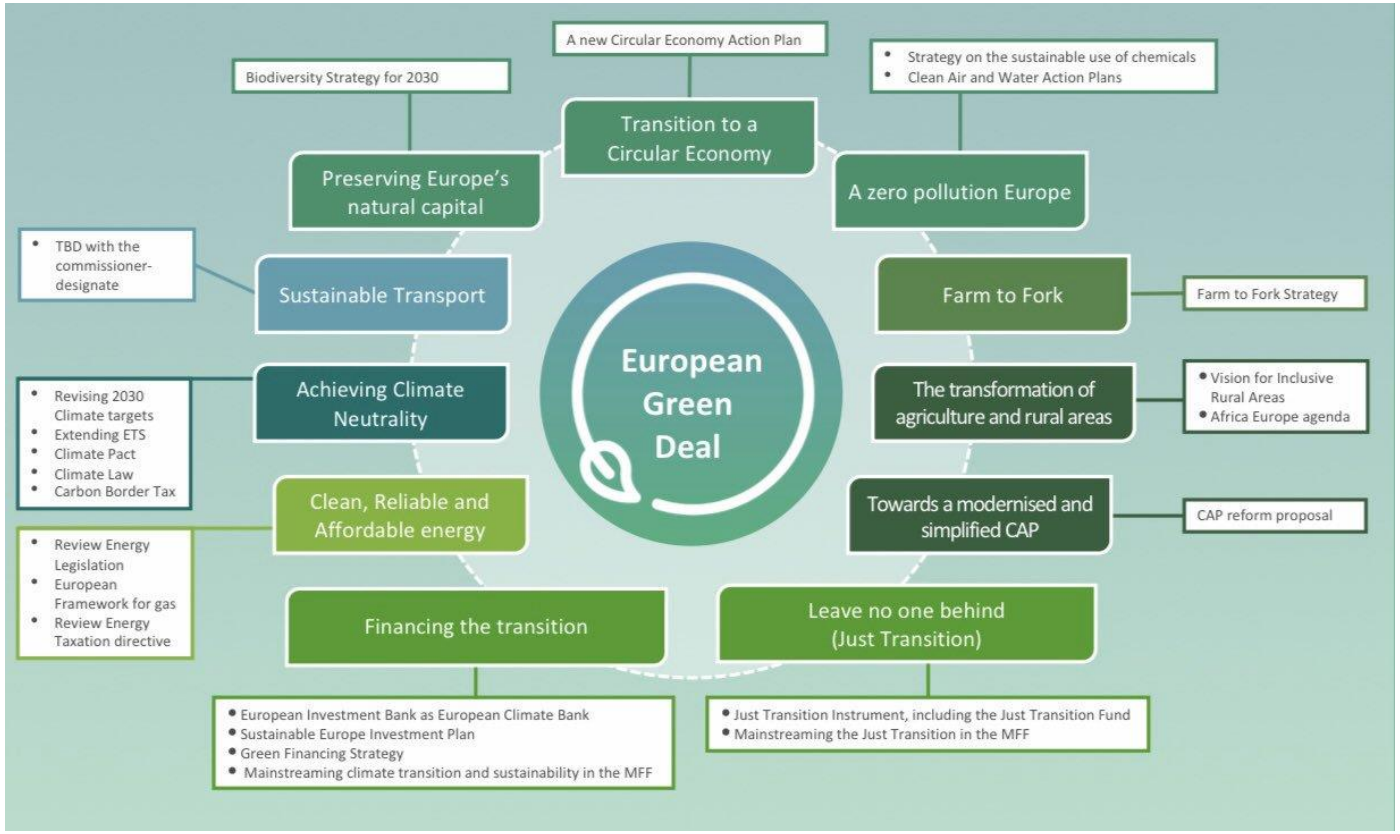
Technical expertise and capacity lagging demand

Excess demand outstripping material supply

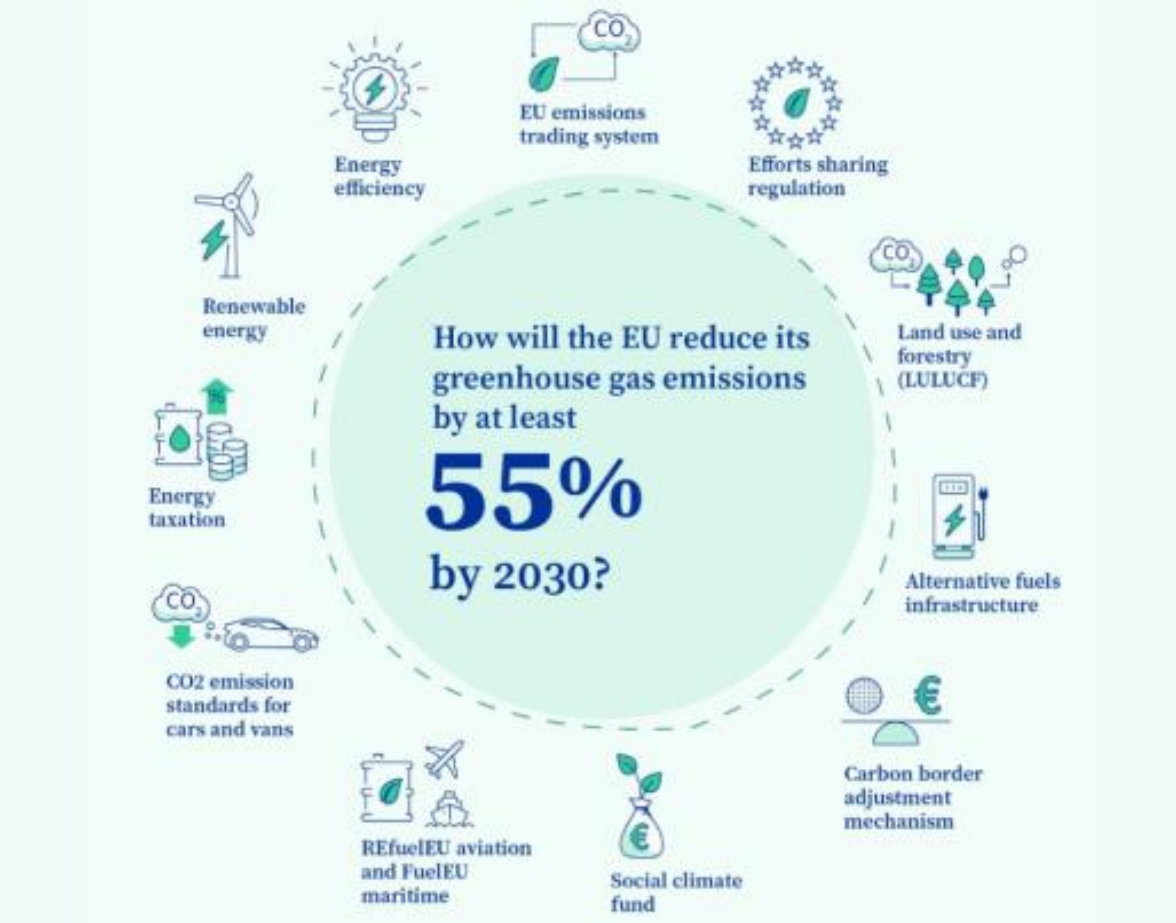
Government Support: Supranational Level

European Green Deal

- Approved in 2020
- Focusses on a wide range of themes; economy, agriculture, energy, buildings and industry
- Detailed strategies foe each sector covering biodiversity, circular economy, sustainable food, vehicle taxation and electric vehicles
- Aspirational plan that has it's roots in decarbonising some of the world's largest economies while maintaining a high standard of living for people
- Has an "effort sharing" mechanism in place; it establishes annual greenhouse gas targets for different member states with more developed nations having higher targets



European Union: Fit for 55 Package



- Proposed in 2021 by the European Commission, passed in 2023
- Part of the European Green Deal
- Target to reduce greenhouse gas emissions by 55% by 2030 (versus 1990)
- Sets new initiatives to ensure EU policies are in line with climate goals set by the Council and European Parliament:
  - Just and socially fair transition
  - Maintains and strengthens innovation and competitiveness of EU industry and create level playing field with third country economic operators
  - Lead the way in the global fight against climate change
- Encompasses a broad range of areas to meet goals

Government Support: National Level

Denmark

- Green fund to invest in clean technologies - $7.5bn
- Eligible projects: energy and supply, agriculture, buildings and infrastructure, materials and resources or transport and mobility

Poland

- Subsidy scheme to develop cogeneration from municipal biogas - $336m
- Grants or loans covering up to 100% of project costs

Switzerland

- Subsidy for large-scale solar PV - $628m
- Covers up to 60% of investment costs

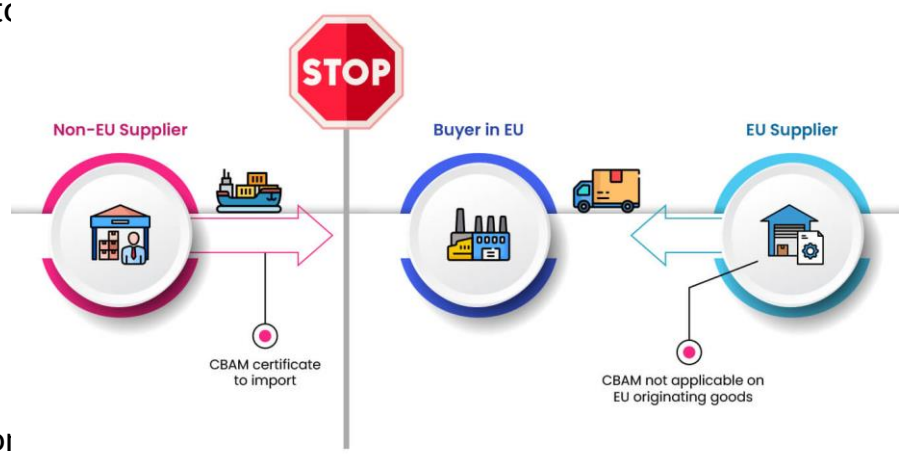
Netherlands

- Stimulation of sustainable energy production and climate transition (SDE++) provides subsidies for the use of techniques for the generation of renewable energy and the reduction of CO2
  - Submissions for subsidy closed in 2023
  - A budget of €8 billion was available for the SDE++
  - Subsidy awarded over a period of 12 or 15 years. The duration of the subsidy will depend on which technology you use

European Union Directives

Carbon Border Adjustment Mechanism (CBAM)

- From 1/1/21 building design regulations require both public and private new buildings to adhere to nearly net zero energy consumption
  - Deadlines in place for all buildings to reach energy class E and D by 2030 and 2033 respectively (retrofitting)
- In 2026 the EU Carbon Border Adjustment Mechanism (CBAM) will be implemented:
  - Aims to extend carbon pricing to products made in countries that do not have carbon pricing mechanisms
  - Initially applies to imported iron, steel, cement, fertiliser, aluminium and electricity generation
  - May cause an increase in the price of these imported goods



Buildings Efficiency

- From 1/1/21 building design regulations require both public and private new buildings to adhere to nearly net zero energy consumption
- Deadlines in place for all buildings to reach energy class E and D by 2030 and 2033 respectively (retrofitting)

UK: Energy Policy Post Election

FREETHS

Area	Conservative	Labour
Oil and gas	Windfall tax (35%) in place until 2029, promised new North Sea oil and gas licenses	Raise windfall tax (38%) & possibly extend to 2030, ban new licenses
Nuclear	24GW by 2050	No set target but supportive
Offshore wind	50GW by 2030	55GW by 2030
Floating offshore wind	5GW by 2030 (within the 50GW above)	5GW by 2030 (within the 55GW above)
Solar	70GW by 2035	50GW by 2030
Onshore wind	No set target	35GW by 2030
Green hydrogen	5GW by 2030 (part of overall 10GW 'low carbon' hydrogen target)	10GW by 2030

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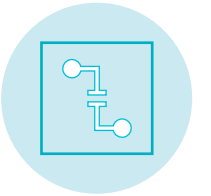
Conclusion

The **global economy** is actively **transitioning** towards **sustainable energy** sources to address **climate change** impacts.

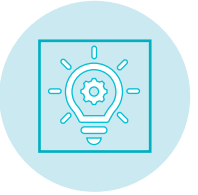
This shift involves moving **away** from **fossil fuel-based** energy sources **towards renewable** energy (RE).



The **energy transition** necessitates **changes** in **energy production**, **distribution**, and **consumption** methods.

The **investment required** to achieve the **goals** outlined in the **Paris Agreement** is **substantial** and demands significant **financial commitment**.

Successful **achievement** of energy **transition goals** relies on the **support** and **incentives** provided by **public policies**.



Research and development (R&D) initiatives have **improved the viability** of **certain technologies**, while others are still in need of further development.

The transition to carbon neutrality impacts all our clients.

Insurance is a crucial component of the value chain, supporting investment and mitigating risk.

We look forward to working with you to enable the energy mix of the future.