

Energy Outlook in an uncertain worldwide situation

WORLD ENERGY MARKETS
OBSERVATORY 2024 | 26TH EDITION

Capgemini 

IN COLLABORATION WITH

 Hogan Lovells

vaasa 

 Enerdata



WEMO 2024 - 26TH EDITION

- Geopolitical situation
- Technologies progress
- We are not on the right trajectory to meet the Paris agreement's objectives. What should we do?
- Conclusions and recommendations



01

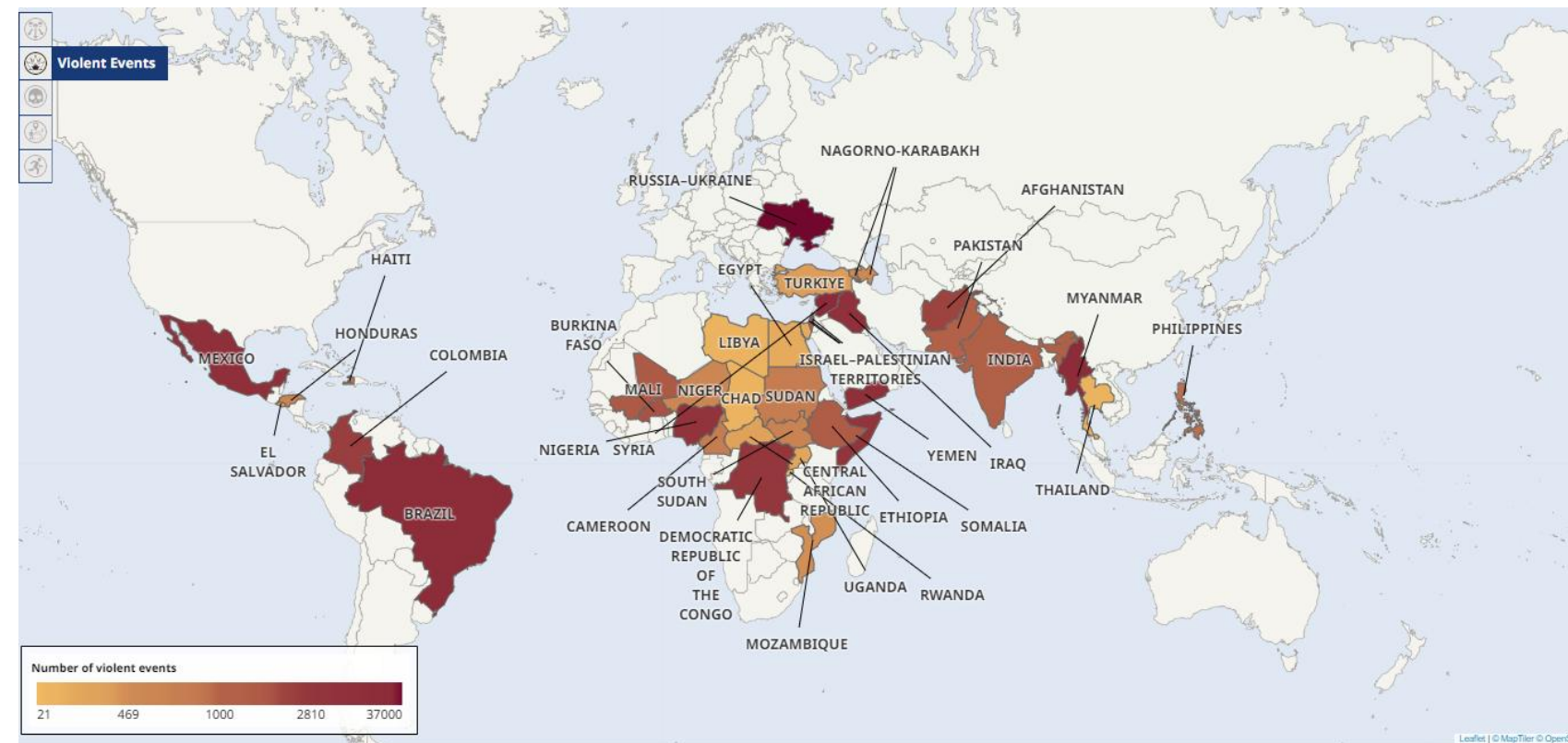
Geopolitical situation





MANY CONFLICTS ARE CLOSE TO KEY ENERGY SITES AND ROUTES

Increased threat of war has resulted in funding being directed to defense, with NATO members increasing spending from 1.4% to 2% of GDP over the past decade.



Source: International Institute for Strategic Studies (IISS) map of violent events
<https://www.iiss.org/publications/armed-conflict-survey/2023/iiss-conflict-trends-map/>

https://www.nato.int/cps/en/natohq/topics_49198.htm
<https://www.eia.gov/todayinenergy/detail.php?id=62263#:~:text=The%20amount%20of%20crude%20oil,chokepoints%20in%20the%20Middle%20East.>
<https://www.bbc.co.uk/news/world-asia-china-59900139>
<https://www.bbc.co.uk/news/world-africa-66776733>

Conflict Hotspot examples:

- In Ukraine and Russia there are now two nuclear power stations inside the conflict zone.
- 50% route length increase for Middle Eastern O&G shipments obliged to take the Cape of Good Hope route (instead of Suez canal) to avoid Houthi bombing
- High tensions between Egypt and Ethiopia over the filling of The Grand Ethiopian Dam across the Nile could lead to conflict.
- Major conflicts threats in Middle East (a big O&G producing region) and over Taiwan.



THE NEW US ENERGY POLICY WILL HAVE A GLOBAL IMPACT



Source: <https://dailyyonder.com/national-energy-emergency-what-trumps-energy-policy-means-for-rural-america/2025/01/23/>

President Trump exited the Paris Agreement
Complete change in the US Energy policy. It now :

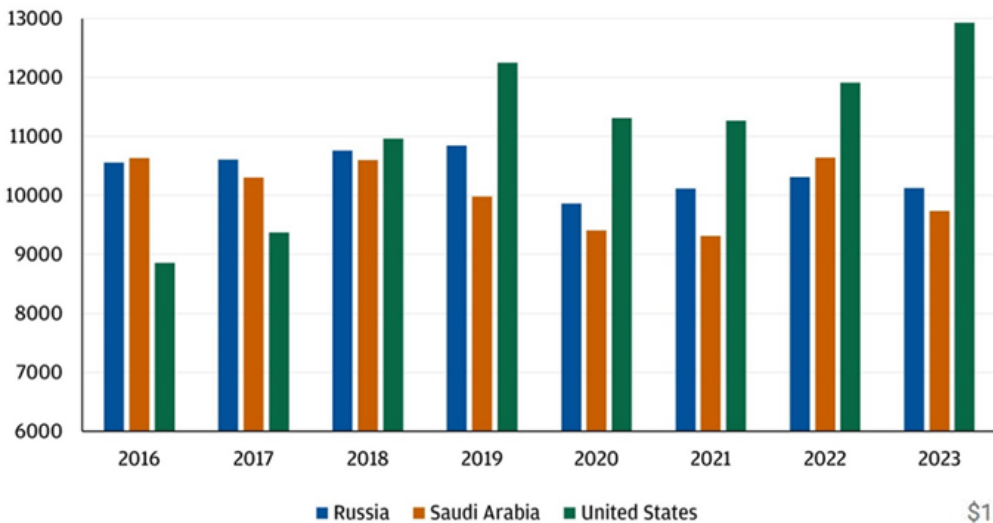
- Encourages O&G exploration and production.
- Will approve LNG export projects as expeditiously as possible
- Facilitate the construction of energy transportation including pipelines
- Aims at establishing the US as the leading producer and processor of critical minerals
- Terminates the Green New Deal (incl IRA) and stops the disbursement of funds for renewables, batteries, EV charging etc..
- Eliminate the EV mandate
- Temporary withdrawal of leasing for offshore wind
- The DOE head sees nuclear as part of the domestic energy strategy

DESPITE A TENSE GEOPOLITICAL SITUATION, OIL PRICES ARE STABLE



The United States produced more Crude in 2023 than any country, ever

Crude oil including lease condensate production (Mb/d)



Source: U.S. Energy Information Administration, International Energy Statistics. Data as of December 31, 2023.

Brent oil price yearly evolution



Oil prices ↑

- Tensions in the Middle East
- Houthis bombarding red sea
- OPEC production cuts

Oil prices ↓

- Record US oil production
- A sluggish global economy

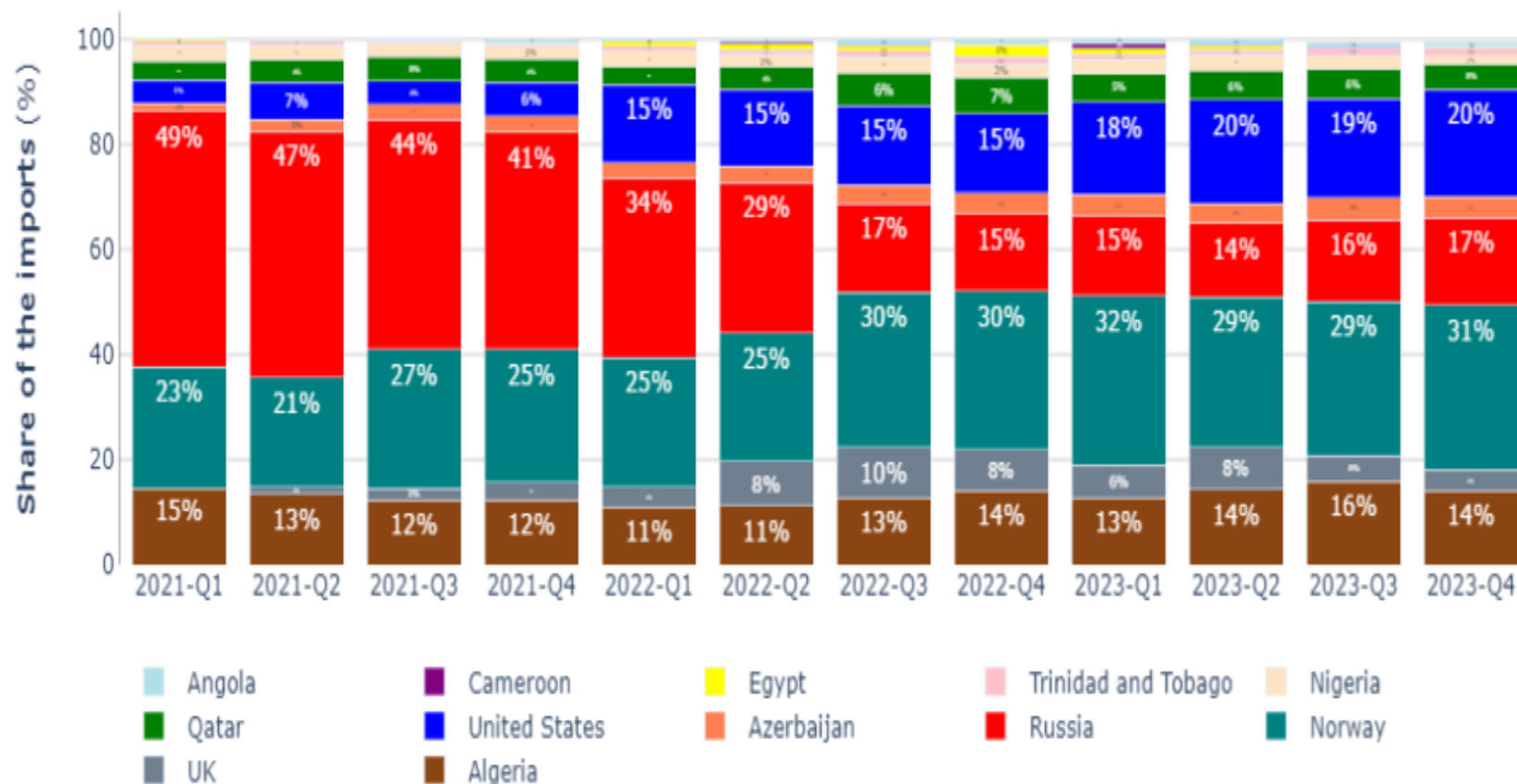
Since Oct. 2023, Brent oil level never surpassed \$95/bl.

WHERE ARE WE ON THE EU-RUSSIA EMBARGO?

RUSSIAN GAS EXPORTS IN EU



From 40% before the Russia-Ukraine war, to ~17% today.

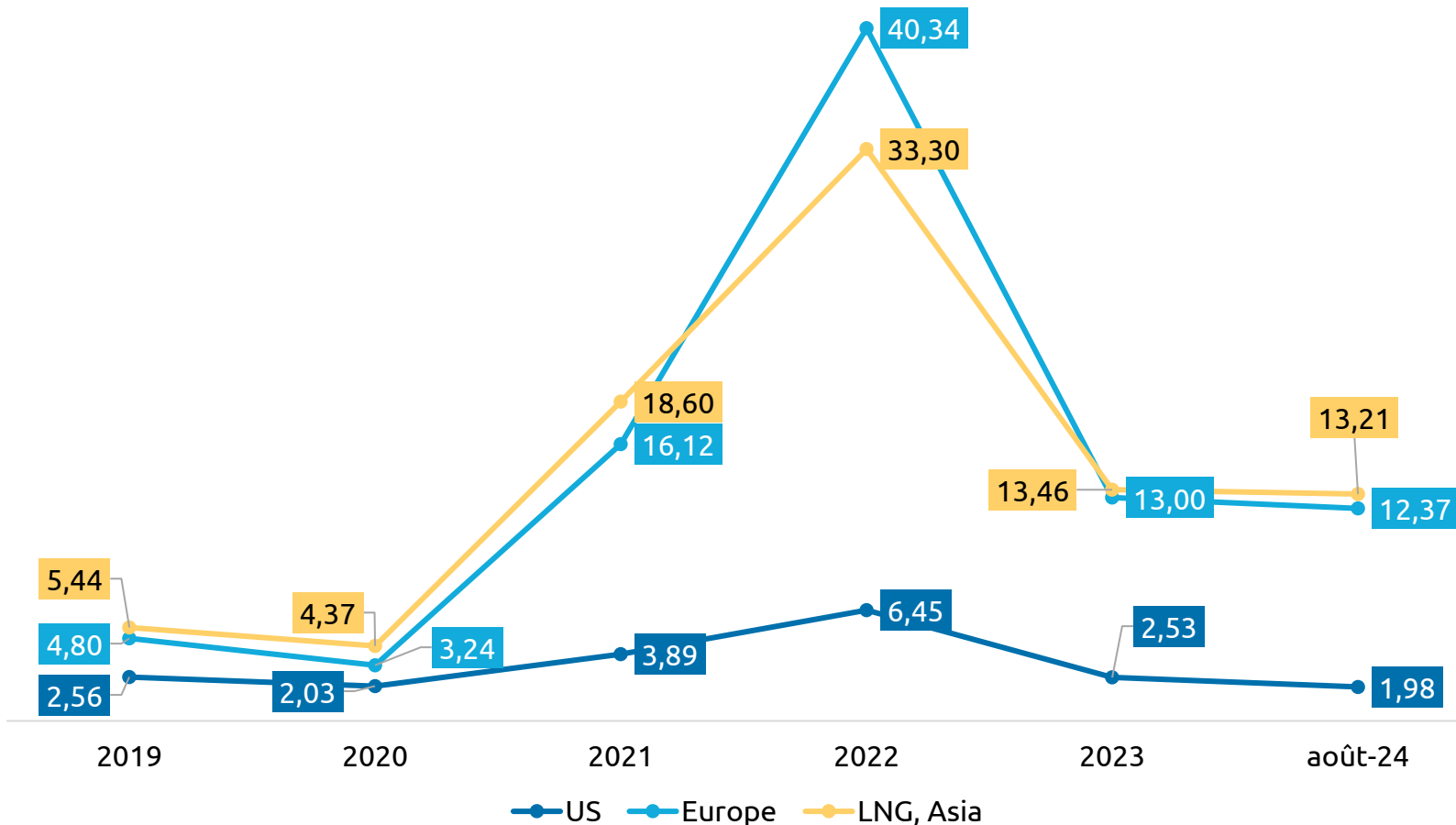


- A 19% increase of Russian gas (pipeline+LNG) imports, in Q4 2023, compared to the previous and 16% increase y-o-y
- Compared to 2021 Q4, total Russian gas exports were down by 64% (-22.5 bcm)
- Despite fluctuations, the importance of LNG in overall Russian exports to EU has increased (compared to the historic Russian gas export schemes)
- 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
- However, if there is peace between Ukraine and Russia, Russian gas will flow again through pipelines to Europe



AVERAGE NATURAL GAS SPOT PRICES HAVE FELL IN ALL GEOGRAPHIES IN 2023

Natural Gas Spot Prices, World | 2019-Aug 2024



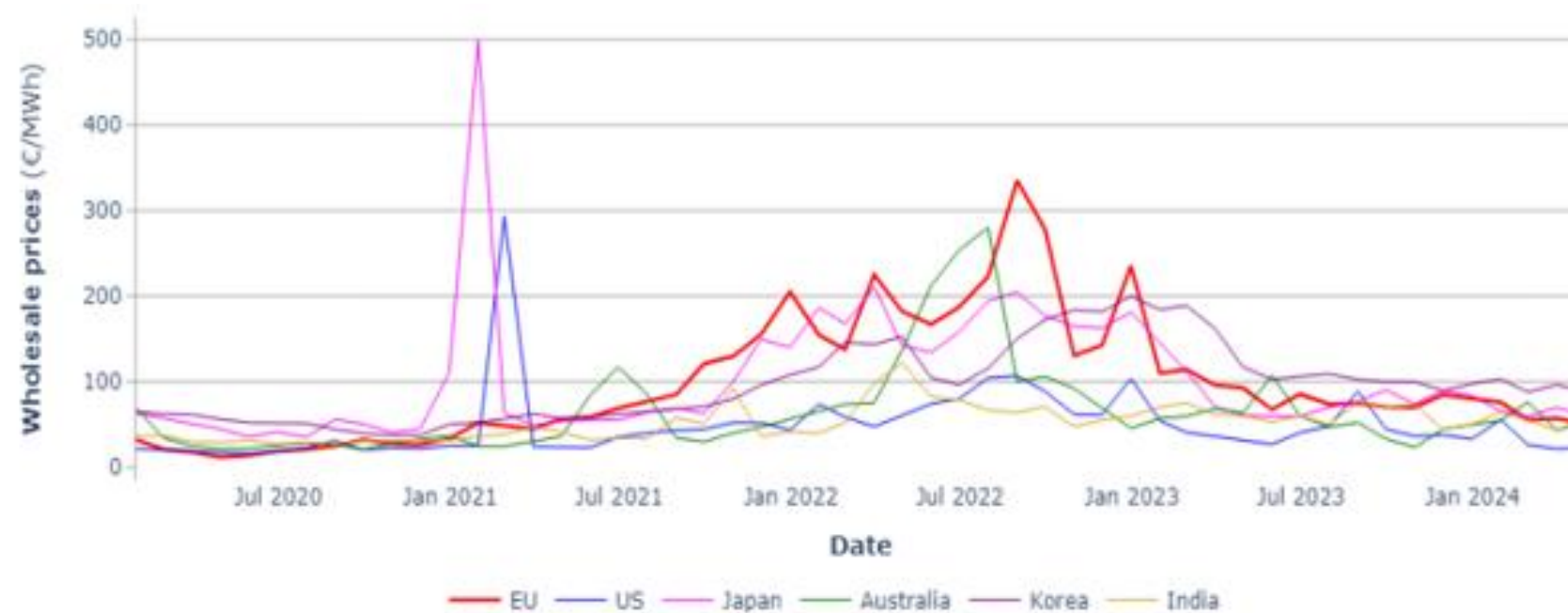
Source: World Bank, U.S. Energy Information Administration (EIA) and FRED Economic Data

- 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 US \$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 geopolitical tensions.
- Gas remained much cheaper in the US, giving a competitive advantage to energy intensive American companies.

ELECTRICITY SPOT PRICES ARE DECREASING



Electricity Spot Prices, World | 2020-2024



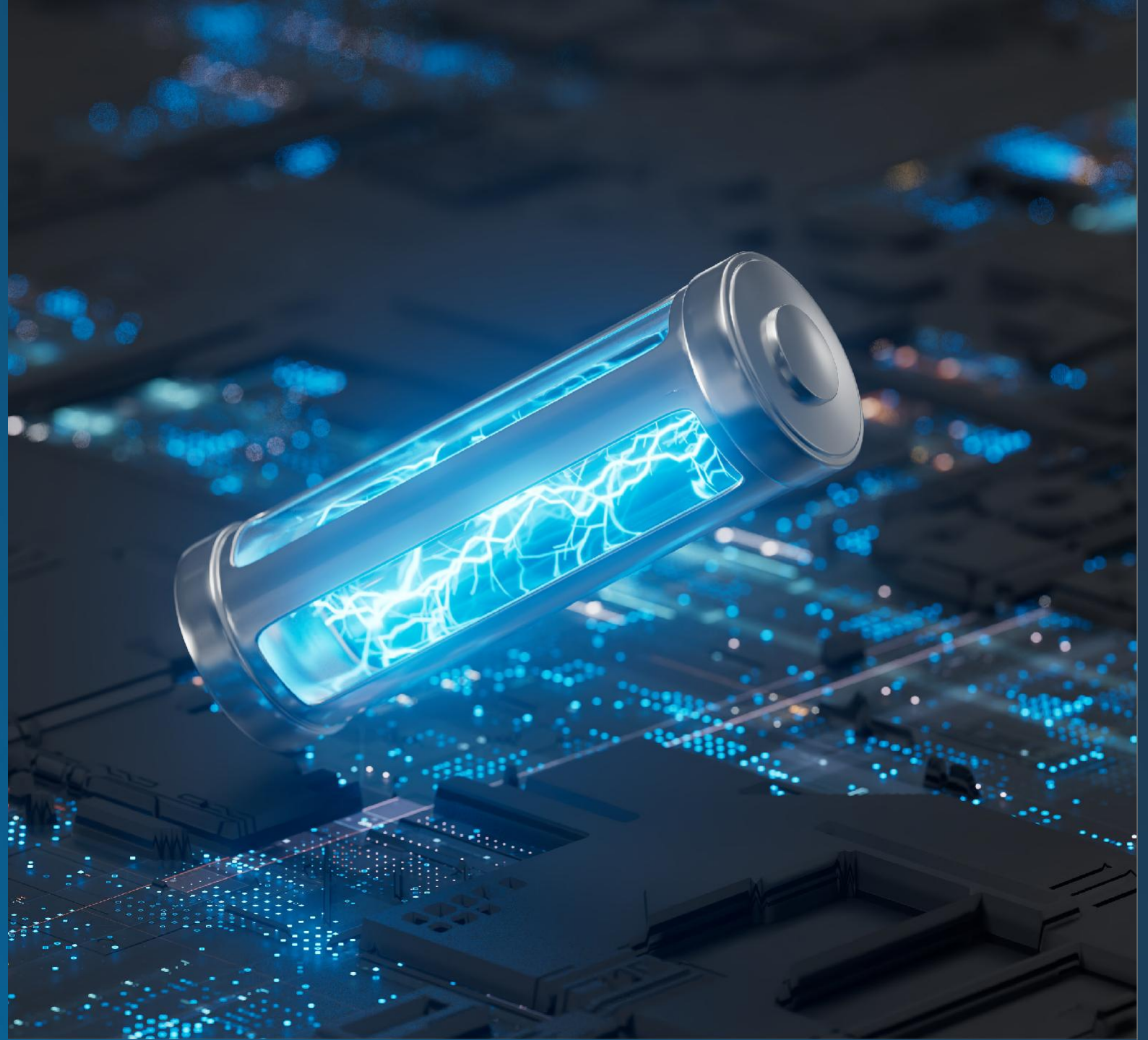
Source: European Commission

- France Nuclear fleet being back to production after the repairs on the stress corrosion defaults and
- New generation resources connected to the grid (renewables and Finnish Olkiluoto nuclear EPR),
- A sluggish consumption are driving down the prices, back to their pre-crisis levels.

US and Europe prices have a big discrepancy. Large energy consumption US companies are more competitive.

02

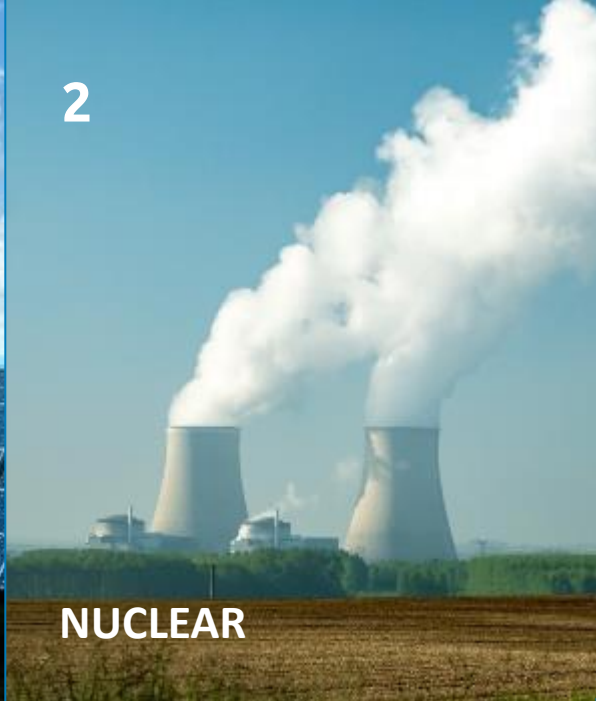
Technologies





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SOLAR AND WIND



2

NUCLEAR



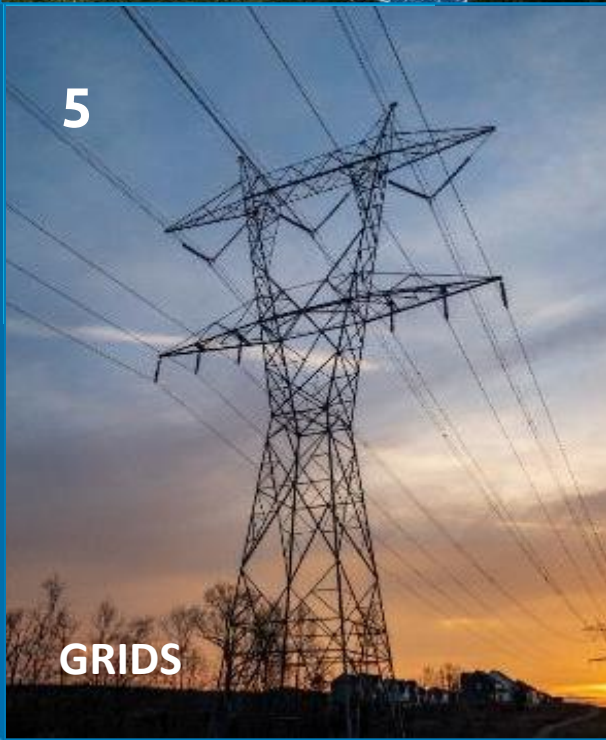
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STATIONARY BATTERIES



4

HYDROGEN



5

GRIDS



6

GEOTHERMAL



7

CCUS



8

BIO-ENERGY

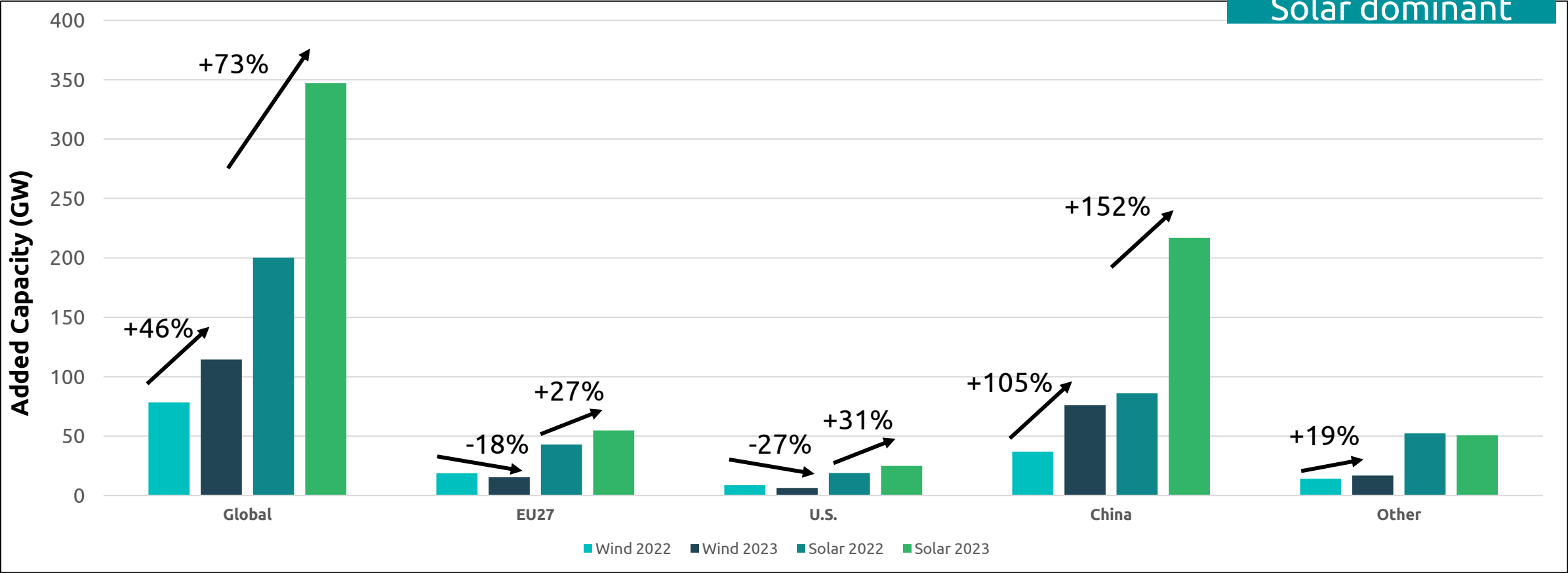


WIND AND SOLAR CAPACITY ADDED ACCELERATION, NOTABLY FOR SOLAR THANKS TO CHINA REPRESENTING MORE THAN HALF OF TOTAL NEW CAPACITIES



Global added wind and solar capacity in 2022 and 2023

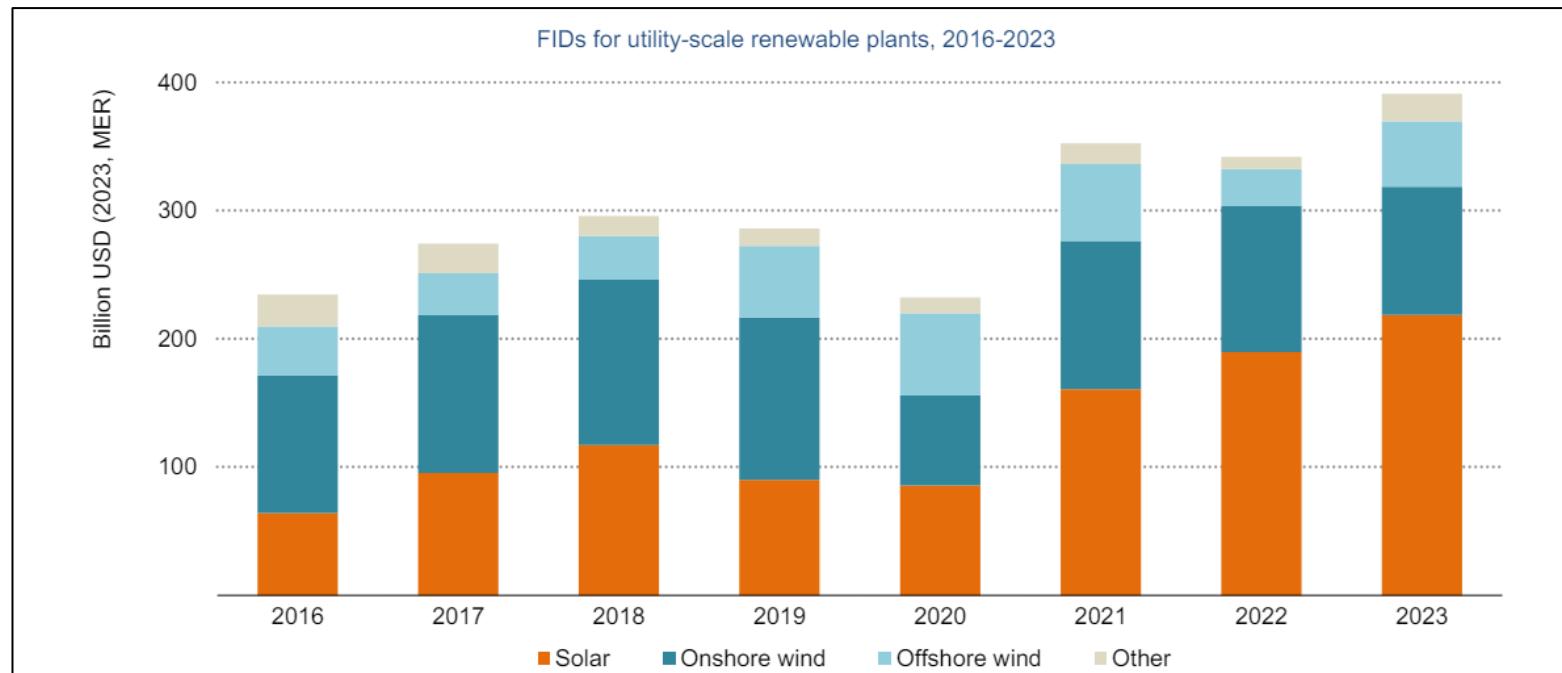
+460 GW in 2023
(+36% YoY)
+ 724 GW in 2024
(+57% YoY)
Solar dominant





2023: A RECORD YEAR FOR RENEWABLE INVESTMENT

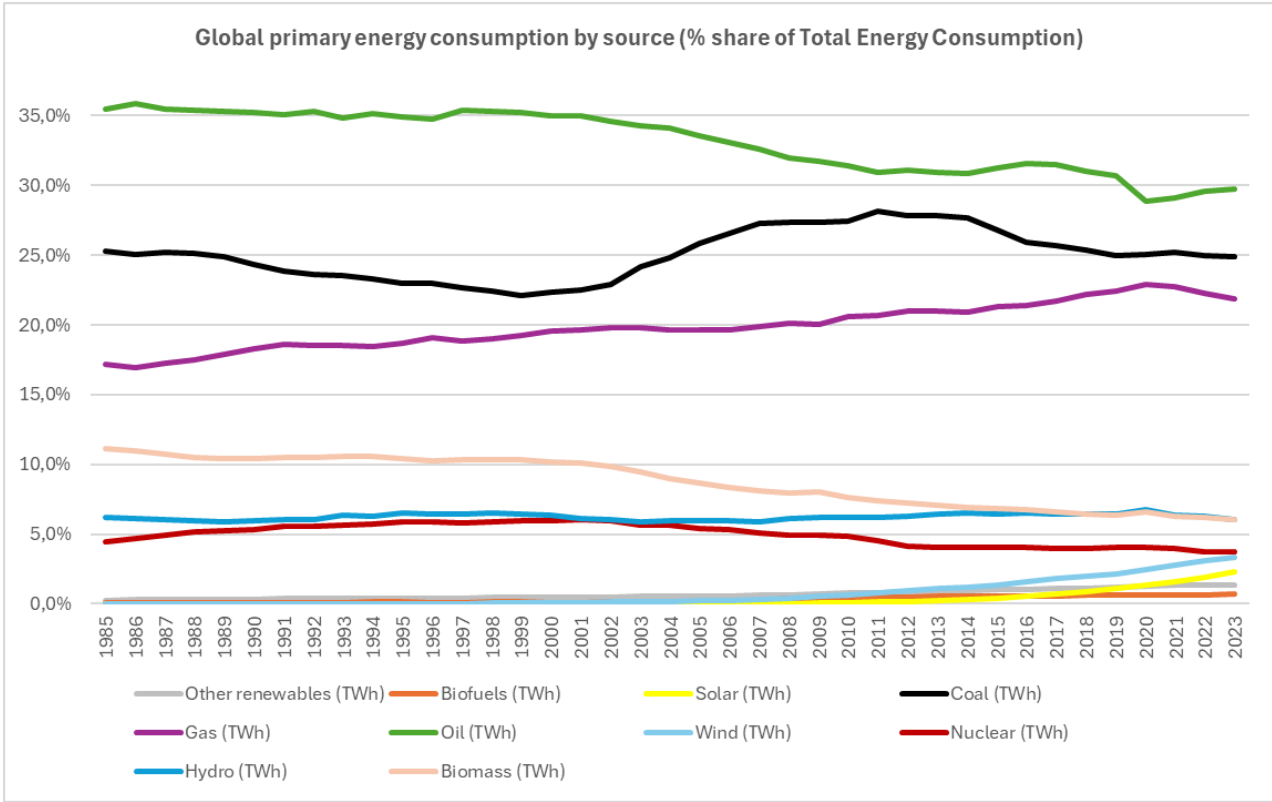
FIDs 2023



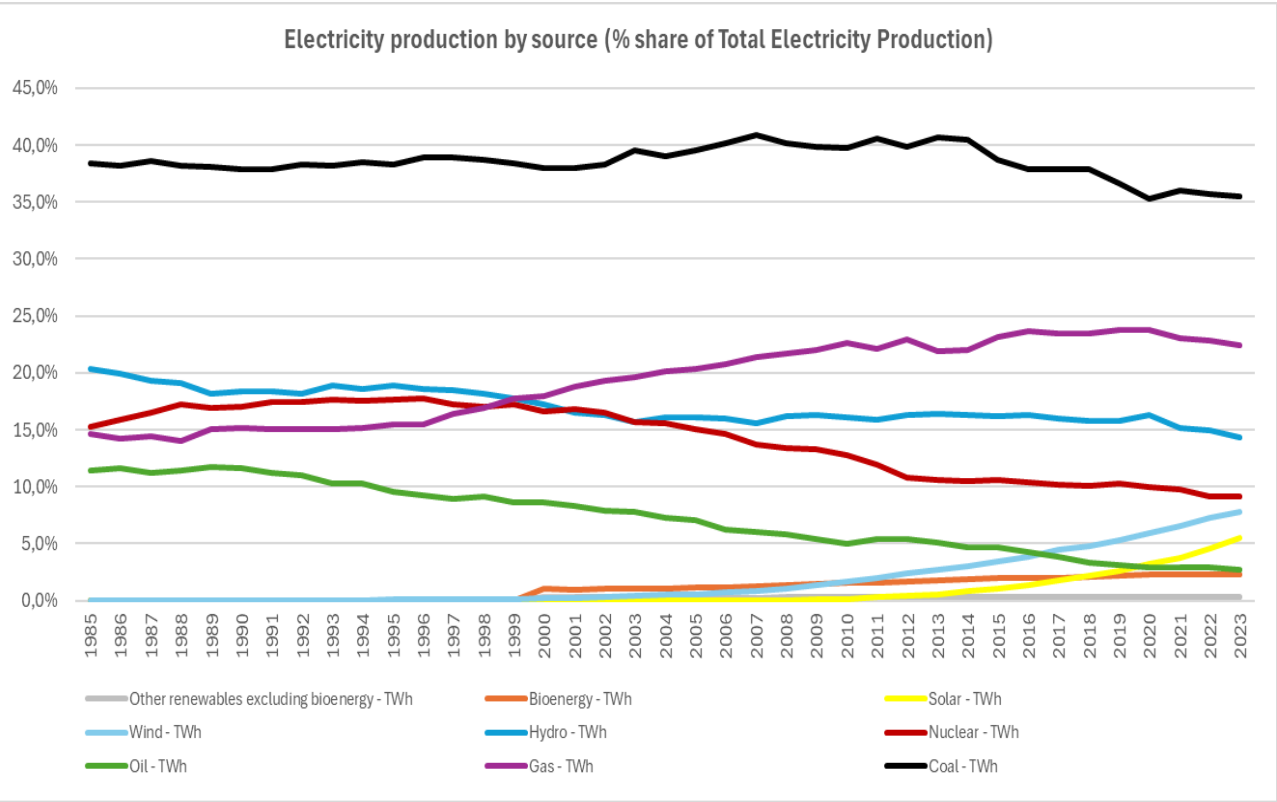
Notes: Excludes large hydropower. "Other" includes biomass, waste-to-energy, geothermal, small hydro and marine.
Source: IEA calculations based on Clean Energy Pipeline (2024)

- FIDs for utility-scale renewable projects increased by 15% year-on-year to almost USD 400 billion in 2023, an all-time high.
- FIDs for solar plants represented more than half of the total at USD 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.

FOSSIL FUELS GENERATION STILL MUCH HIGHER THAN RENEWABLES OR EVEN LOW CARBON GENERATION



Primary Energy consumption by source



Electricity generation by source

2023

Renewables: 30.2%

Nuclear: 9.1%

Fossil fuels: 60.7%

Sources: Our World in Data, Energy Institute - Statistical Review of World Energy (2024)

Sources: Our World in Data, EMBER (2024), Energy Institute - Statistical Review of World Energy (2024).
NB: Other Renewables includes Waste, Geothermal, Wave and Tidal



NUCLEAR RENAISSANCE

Existing reactors

2023

Safe operations

440 nuclear reactors (390 GW) have provided 9% of the world's electricity, 25% of the world's low-carbon electricity.

3rd generation reactors

6

64

In 2023, **6** reactors connected to the grid and 2 Japanese reactors restarted. 5 reactors stopped. **64** reactors under construction (mainly China and Asia)

SMR

2

in operations

4

in construction

80

SMR designs and concepts



- Improved security
- Less nuclear waste

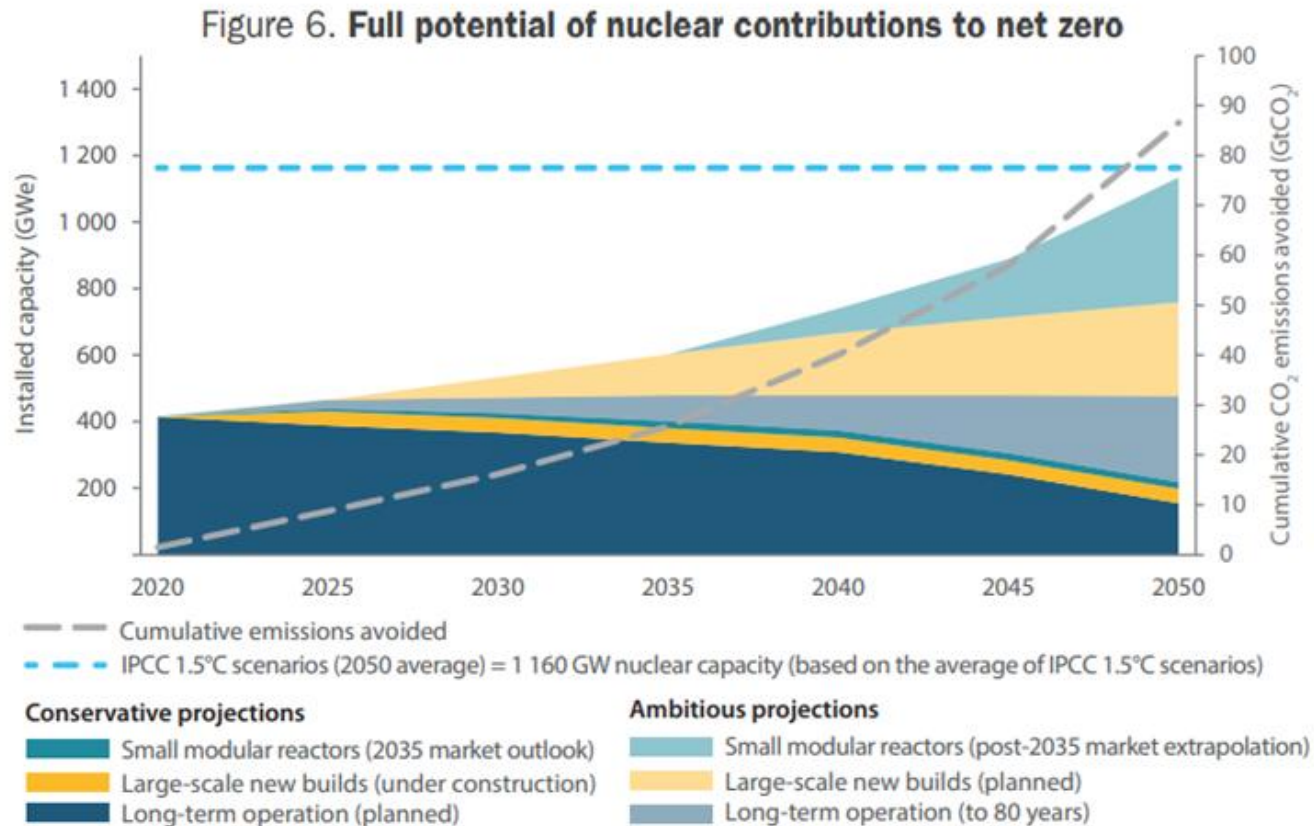


- Construction delays and cost increases
- Design to be simplified
- Financing is difficult in Western countries
- Emergence of many start-ups in the nuclear sector
- More manageable investment
- More advanced safety features
- Easier to connect to grids
- Costs per MWh could be higher than large reactors (e.g Nuscale)
- Series constructions are needed
- Nuclear authorities need to converge on safety requests



THERE IS A NUCLEAR REVIVAL BUT REACHING CLIMATE 1.5° OBJECTIVE IS VERY AMBITIOUS

How can nuclear contribute to net zero



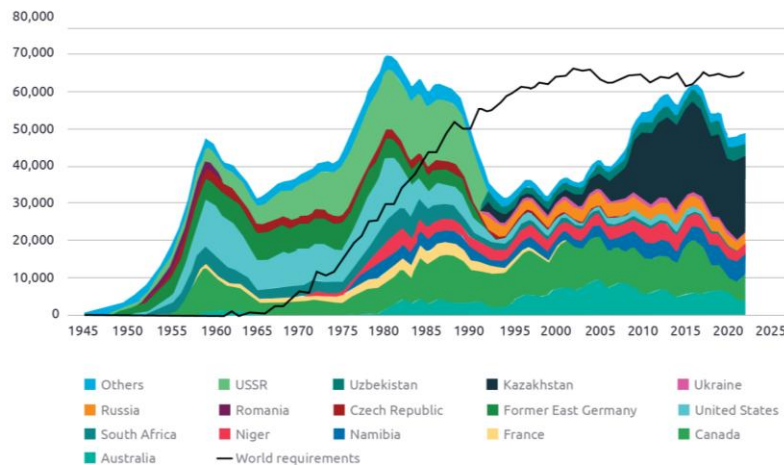
Source: NEA, 2022.

- The pathways for the 1.5°C require nuclear energy capacity to triple and to reach 1 160 gigawatts of electricity by 2050
- To meet this ambitious target a few things must happen:
 - lifetime extension (up to 80 years) of existing nuclear power plants,
 - large-scale plants new builds acceleration and financing
 - SMRs competitiveness improvement and deployment at scale
 - Reliable supply chain
 - Blue and white collars skills

WILL THE WORLD HAVE ENOUGH URANIUM?

Uranium prices have increased

World uranium production and reactor requirements, 1945-2022, tU



<https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production>

Uranium prices evolution the last 37 years



<https://www.marketwatch.com/story/this-perfect-storm-could-see-uranium-prices-bounce-back-to-the-years-highs-above-100-a-pound-4970fe1a>

Mitigation measures to meet the uranium demand growth

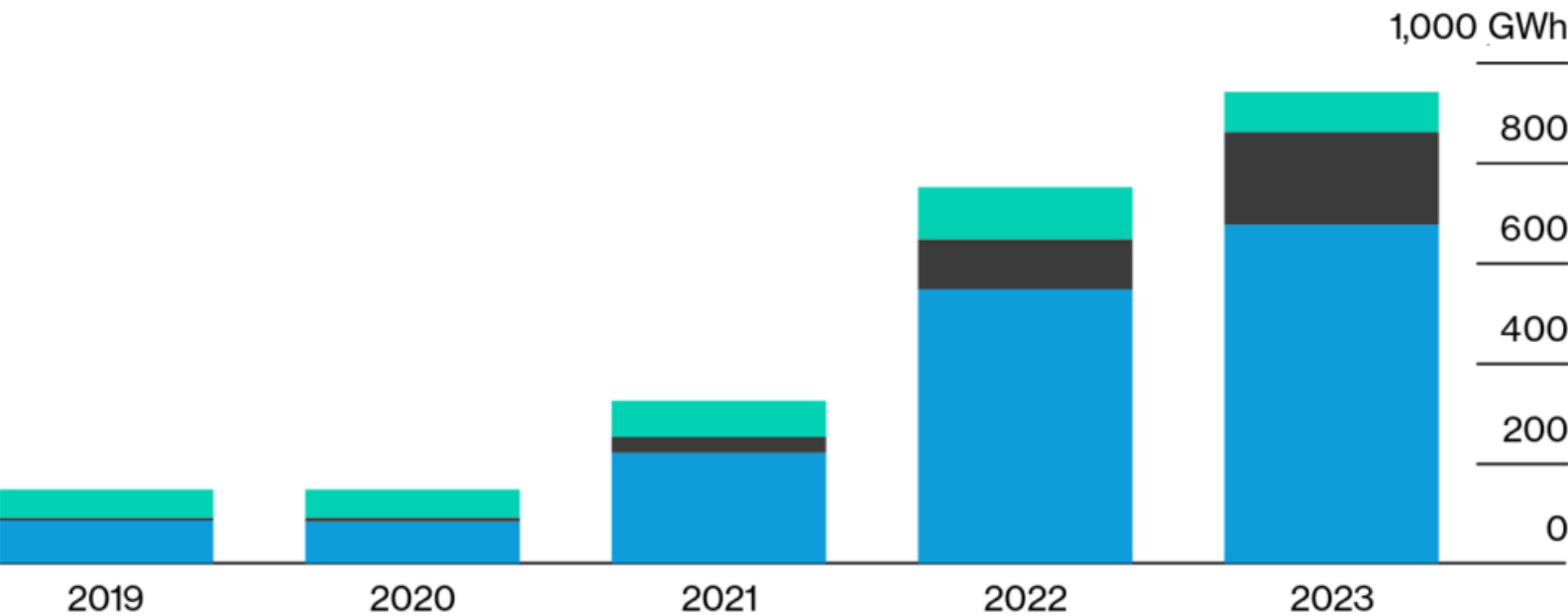
- Utilities have large strategic stocks
- AMR breeder to produce 200 X electricity with the same quantity of uranium
- China and India have projects using thorium instead of uranium
- Thorium is even more abundant than uranium
- Uranium cost is a small percentage of the total nuclear electricity cost
- **In the medium term the availability of uranium is not a concern**
- **In the short term, tensions could exist, linked to the time to open new mines.**

CHINA CONTINUES TO DOMINATE STATIONARY BATTERIES. FAR GREATER INVESTMENTS ARE NEEDED TO MEET THE NEEDS OF A RENEWABLES-BASED ENERGY SYSTEM

More Batteries For Stationary Applications

Annual lithium-ion battery output by segment in China

■ Electric vehicles ■ Stationary energy storage ■ Consumer electronics



Source: Ministry of Industry and Information Technology, China automobile battery innovation alliance, BloombergNEF

Note: Data reflects output from battery manufacturers and may differ from actual installations in a given year

BloombergNEF

<https://www.iea.org/energy-system/electricity/grid-scale-storage>
<https://www.pv-magazine.com/2024/04/26/iea-calls-for-sixfold-expansion-of-global-energy-storage-capacity/>
<https://www.pv-magazine.com/2024/08/15/energy-storage-installations-rise-61-this-year/>
<https://www.electrive.com/2024/09/19/italy-withdraws-funding-commitment-for-acc-cell-plant-in-termoli/>
<https://www.ft.com/content/b214a031-e975-4bb8-85b1-11a2252b71d7>



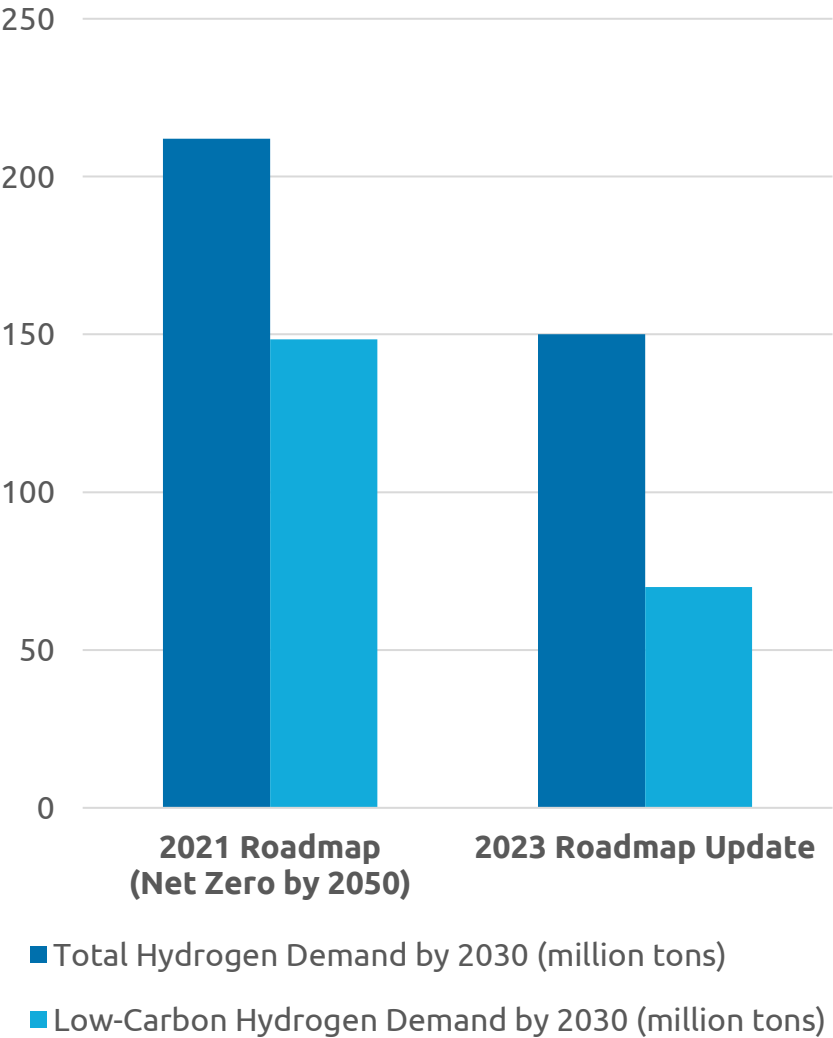
Total installed grid-scale battery storage capacity is growing but remains a fraction of that needed to support Renewables based energy systems.

China continues to dominate the market with other players struggling to meet the price and quality of Chinese production.

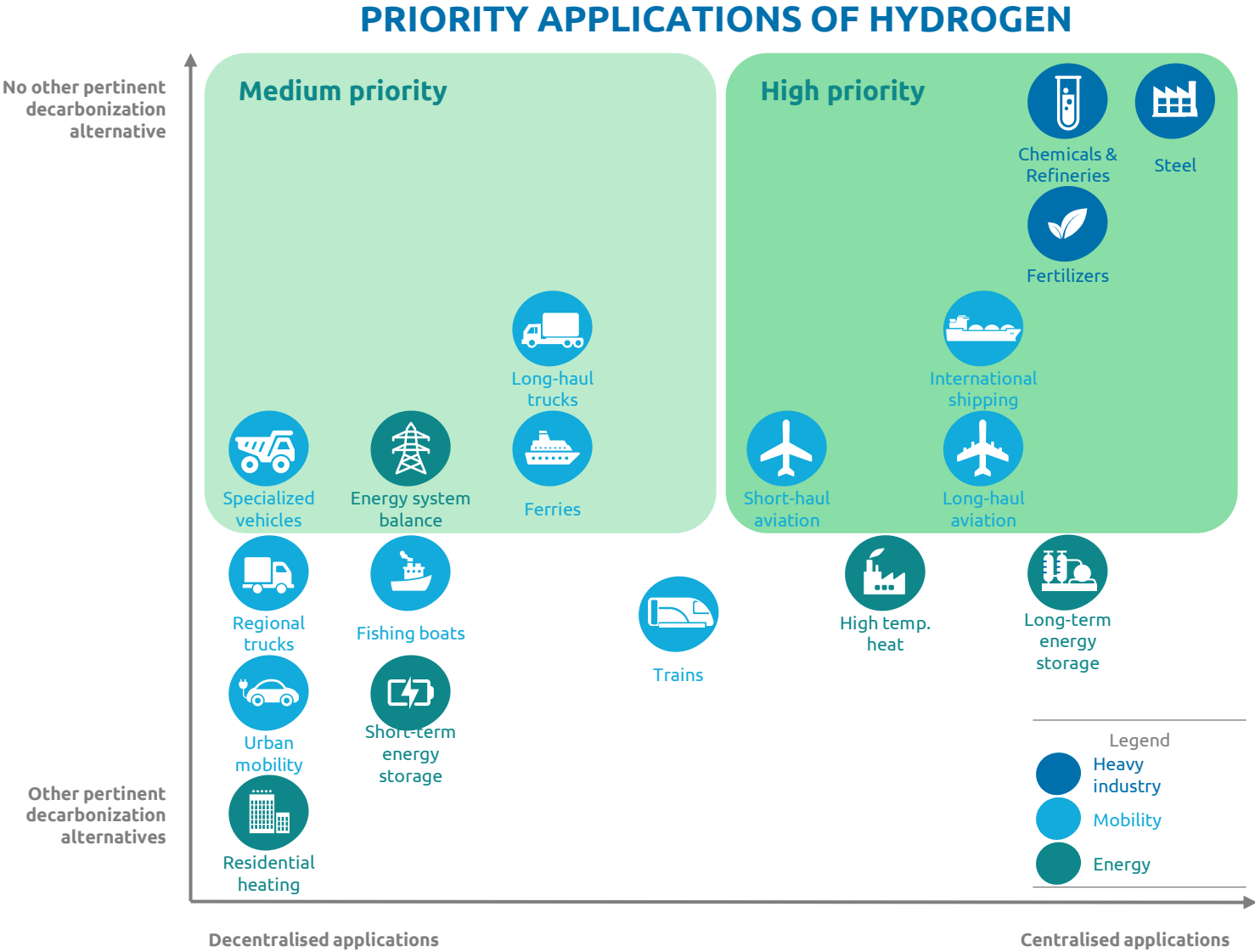
The business case for batteries remains fragile and highly dependent on local market regulations and conditions. There are good examples of profitable battery installations in Australia, Texas and California, but fewer elsewhere.

Battery technology LMFP battery seeks to improve LFP energy density and usable cycle performance by introducing manganese. Replacing liquid electrolyte with a solid electrolyte promised further increases in performance and reductions in cost.

WHILE DEMAND FORECASTS DROPPED, LOW CARBON HYDROGEN SHOULD BE PRIORISED ON HARD TO ABATE SECTORS



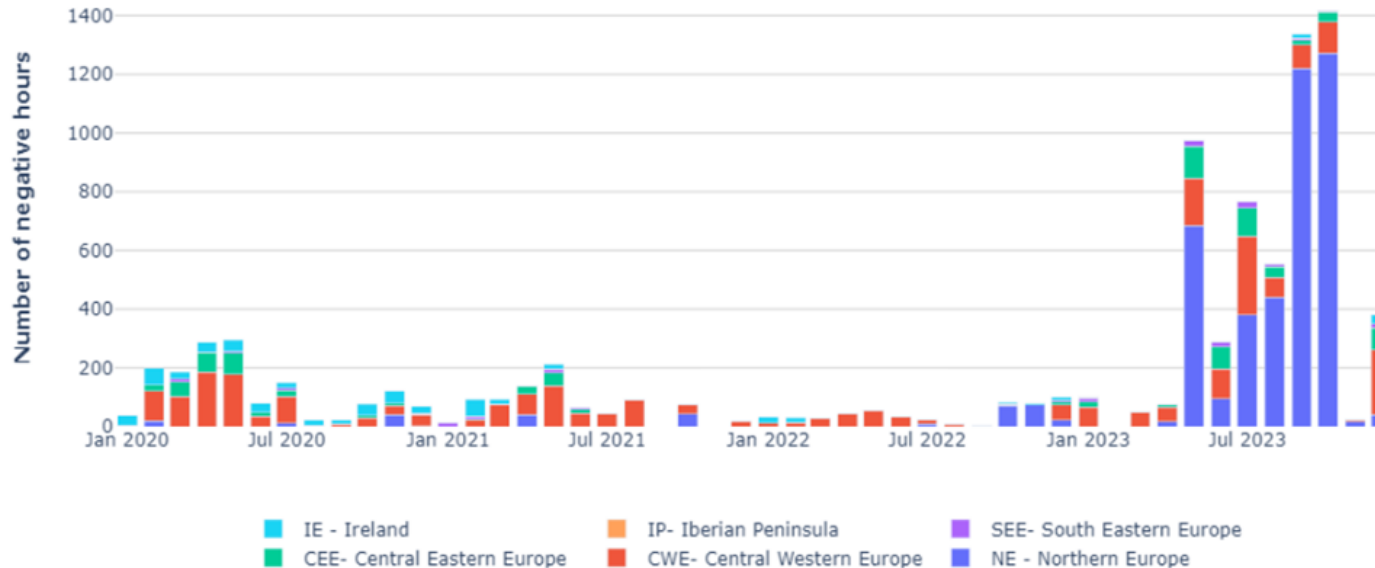
Source: IEA Hydrogen review 2021, and 2023
WEMO 2024



GRID STABILITY IS THREATENED BY INTERMITTENT RENEWABLES INCREASING SHARE IN THE ELECTRICITY MIX

In 2023, the number of negative hours reached a record of 6870 in European markets, compared to 569 in 2022

Number of negative hourly wholesale prices on trading platforms in Europe.



Source: ENTSO-E.

https://energy.ec.europa.eu/document/download/d48ec6b0-987f-4702-af0a-76bfb4fbce0c_en?filename=New%20Quarterly%20Report%20on%20European%20Electricity%20markets%20Q4%202023.pdf



Increasing share of intermittent renewables lead to:

- more frequent episodes of negative prices
- difficulties to insure grid balancing

Measures taken by grid operators:

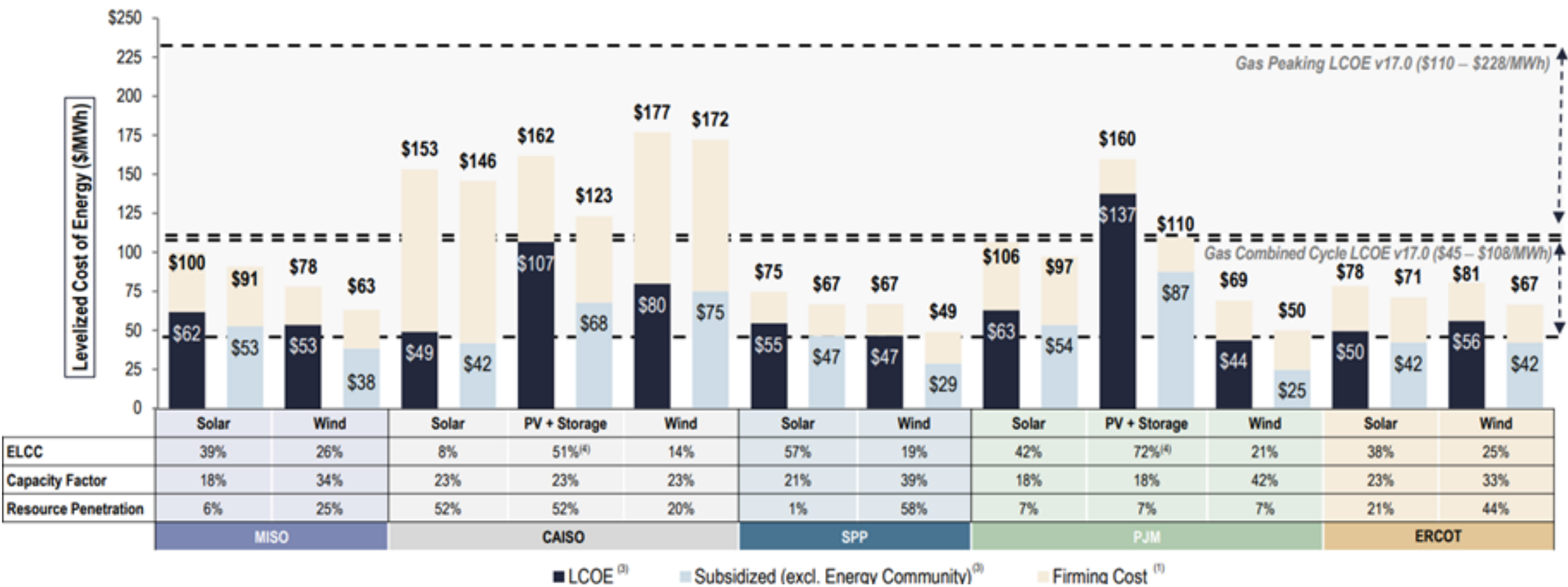
- ancillary services
- minimum requirements for system inertia
- obligation of associated battery storage to wind or solar farms
- in China restriction of new renewable projects
- renewable curtailment: Germany 8%, US around 5%, China between 5% and 8%

Curtailment has a negative impact on new renewables and nuclear projects profitability.

INTERMITTENT RENEWABLE REAL COSTS ARE INCREASING WITH THEIR PENETRATION RATE

Additional costs linked to grid balancing issues to be added to the LCOE, to make a fair comparison between intermittent renewable generation costs and dispatchable generation costs.

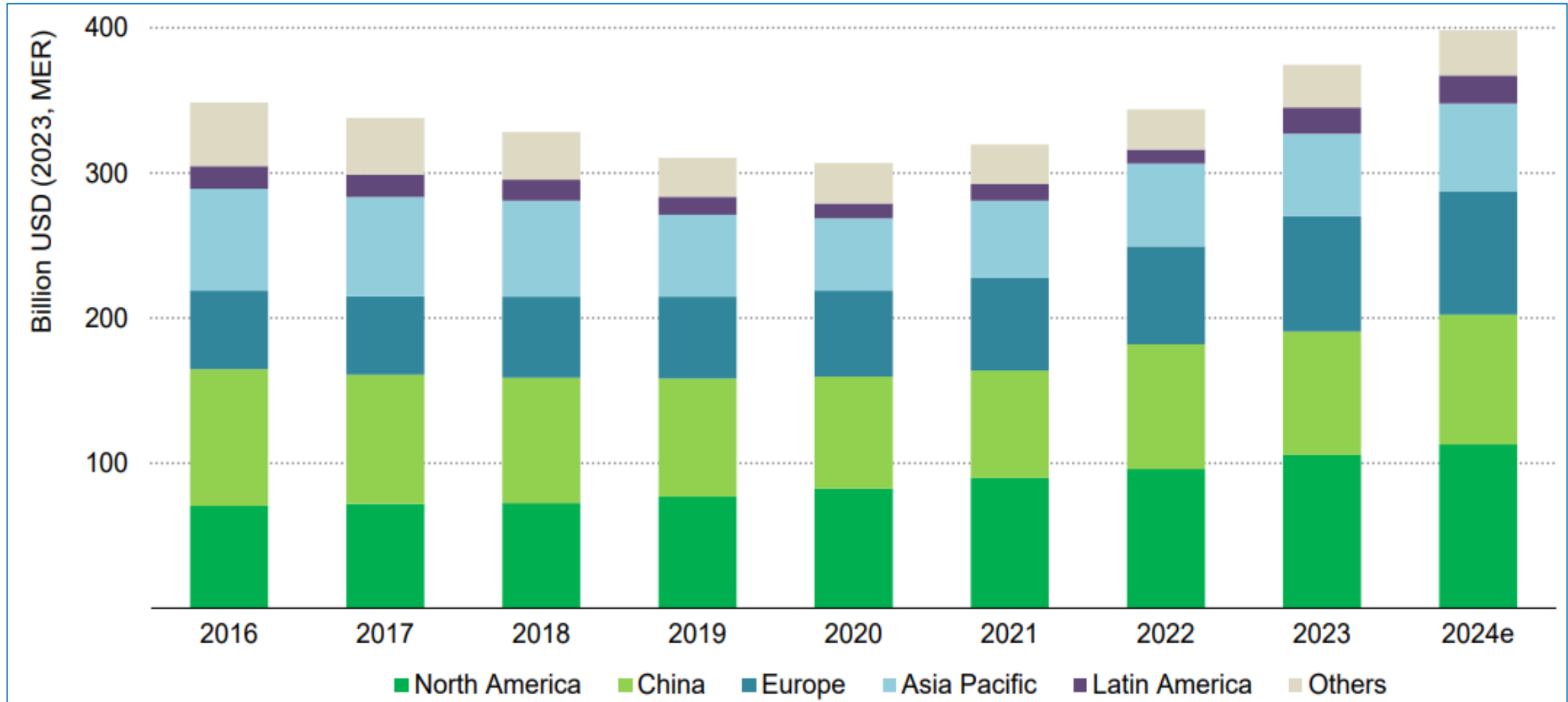
LCOE Including Levelized Firing Cost (\$/MWh)⁽³⁾



Source: <https://www.lazard.com/research-insights/levelized-cost-of-energyplus/>



INVESTMENT IN POWER GRID INFRASTRUCTURE IS PICKING-UP



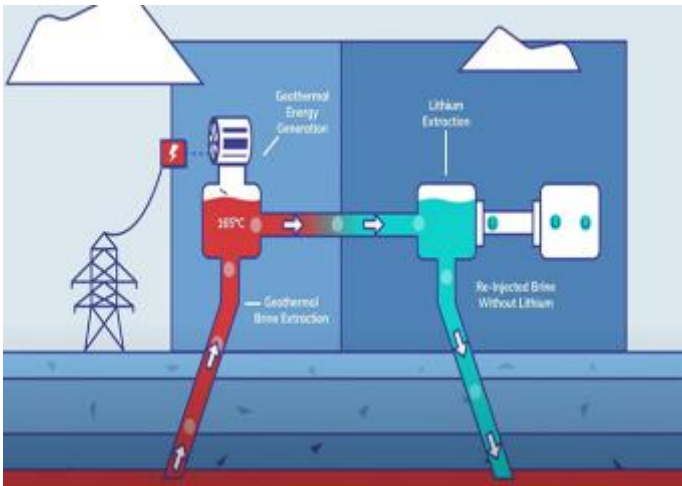
GEOHERMAL IS A SUSTAINABLE ENERGY RESOURCE

RESERVOIR TEMPERATURE	FLUID TYPE	APPLICATION	TECHNOLOGY
HIGH-T > 150°C	Water, vapour	Electricity generation Direct heat use	▪ Dry steam turbine ▪ Single/double/triple flash ❖ Heat exchanger
MEDIUM-T > 150°C	Water	Electricity generation Direct heat use	▪ Binary cycle ❖ Heat exchanger ❖ Geothermal heat pump
LOW-T > 150°C	Water	Direct heat user	❖ Heat exchanger ❖ Geothermal heat pump ❖ Direct heat use

Enhanced heat pump



Deep geothermal with Li extraction



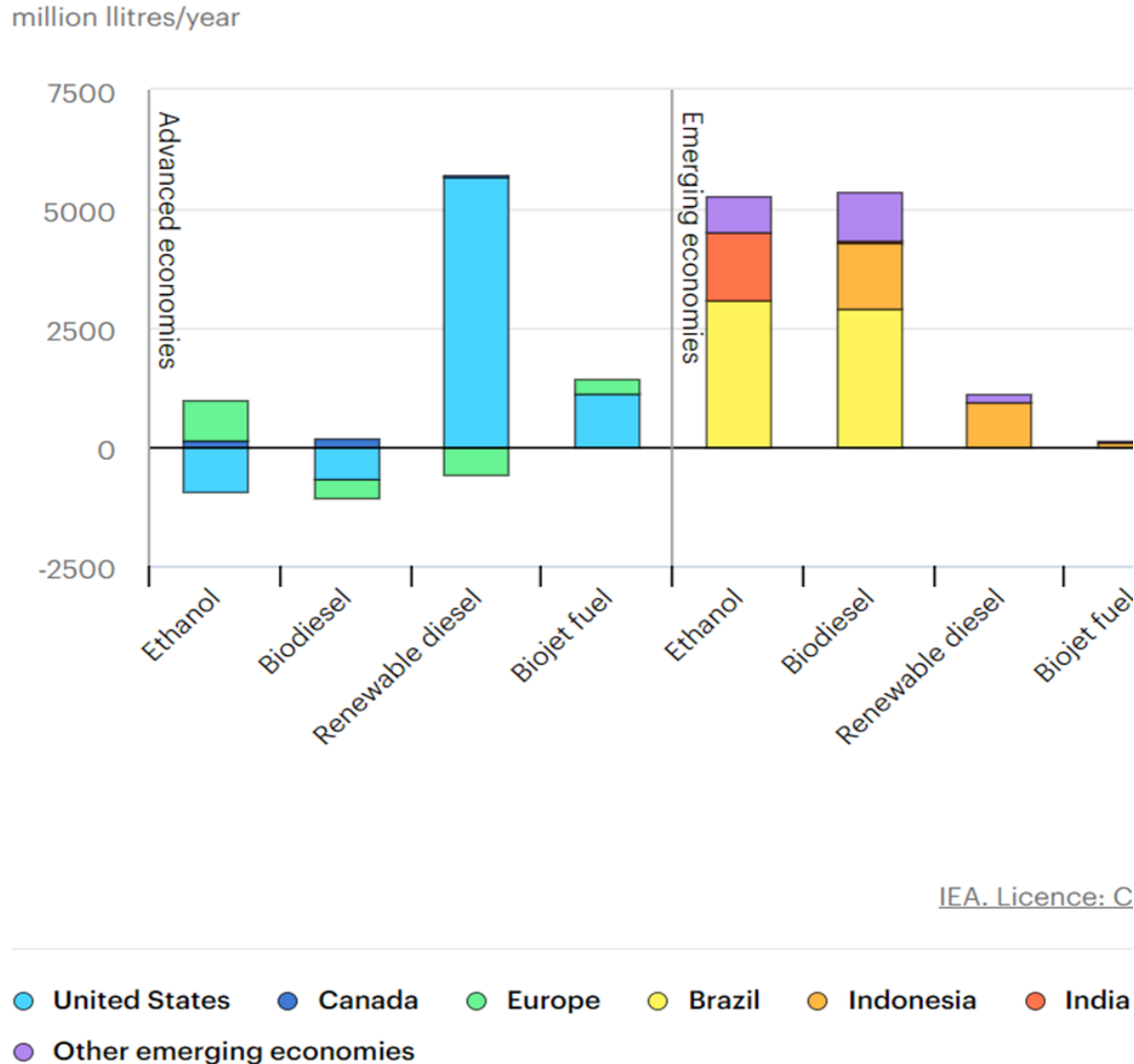
- Heating and cooling:
 - ✓ 50% of the global final energy consumption
 - ✓ 40% of global energy-related CO2 emission
- Heat generation : 75% of fossil fuel

Need for sustained heat generation sources

- LCOE comparable to solar and wind but high capital costs and complex operations
- Li extraction from geothermal brines in some cases
- In EU, geothermal
 - ✓ only around 0.1% of the electricity generation
 - ✓ 2% of heat consumption
- **Should be developed more**

MODERN BIOENERGY IS GLOBALLY THE LARGEST RENEWABLE ENERGY SOURCE

Biofuel demand growth 2022-2024 by fuel and region



- Modern bioenergy (excluding traditional uses) accounts for **55% of renewable energy and over 6% of global energy supply**
- It has increased on average by **3% per year** between 2010 and 2022
- To reach the climate objectives a **8% per year growth** is required between now and 2030
- However, growth must **exclude unstained biomass** production on cropland or forest land
- EU, US and India have adopted or extended policies supporting bioenergy

CCUS IS DEVELOPING. WE MUST GO FASTER.



CCS is developing

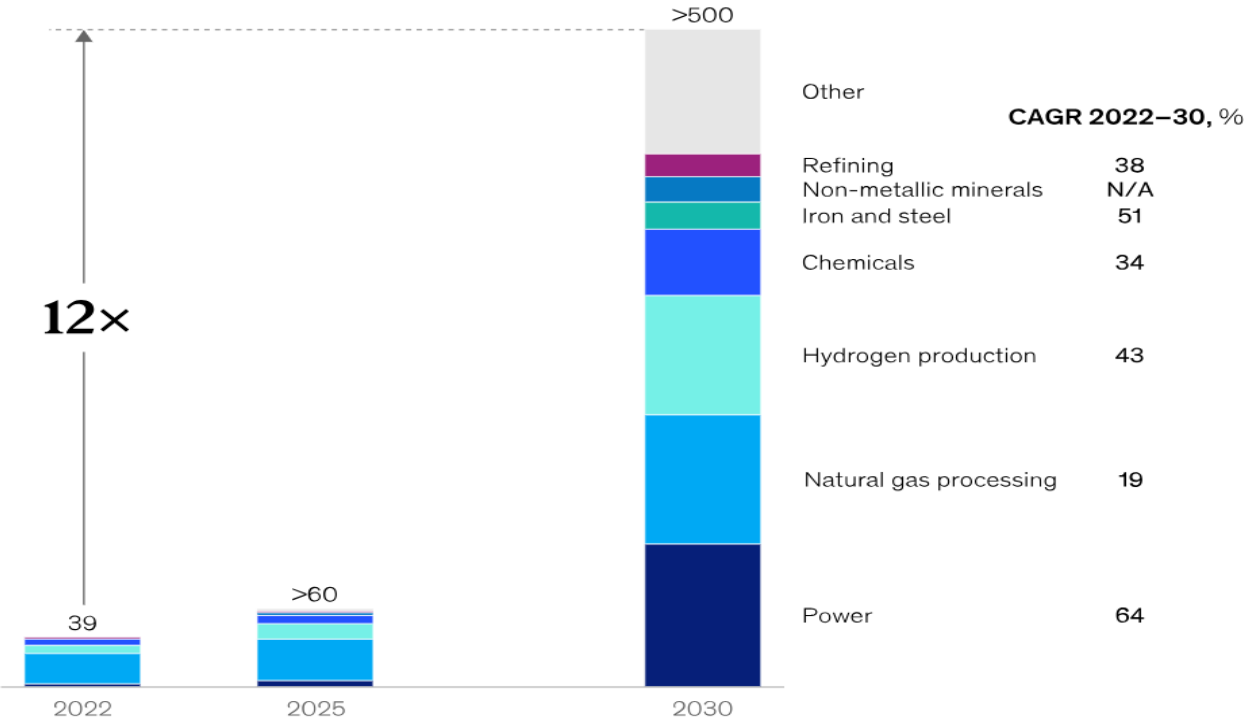
Main regions

Region	Operating	Projects	Capture t/y	% emissions
	15	121	22M	0.4%
	~50	~50	4M	0.0x%
			4M	Target 100Mt/y by 2030

But implementation is lagging...

- ✓ End-storage availability. Cross borders CO2 transport and storage rules to be adapted
- ✓ Large infrastructures to be built
- ✓ No bankable business models. Progress in UK (CfD) and US (tax credit)
- ✓ Carbon taxes and prices not high enough
- ✓ Not enough carbon markets in geographies

World projects to be completed



Source: McKinsey Energy Solutions: Global Energy Perspective 2023

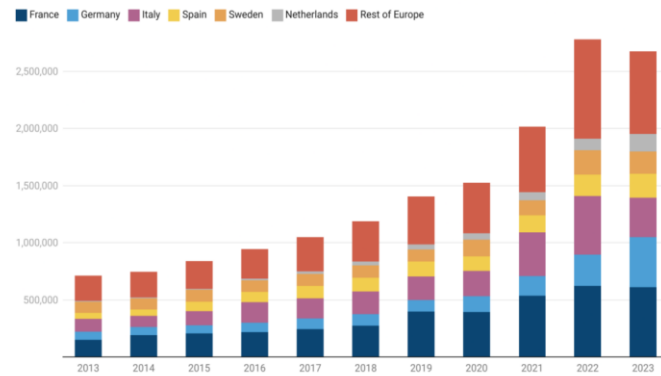
Japan and China are now building CCGT – CCS equipped.



DEMAND SIDE FLEXIBILITY IS ESSENTIAL TO ENABLING RENEWABLES

Deployment of flexibility enabling technologies has accelerated, but is not yet at levels required

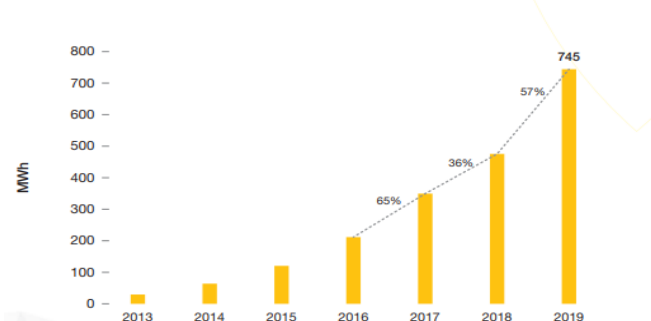
European heat pump sales fell around 5% from record high in 2022
Number of units sold per year, 2013-2023



Source: EHPA market statistics

- Heat pump adoption in Europe has accelerated over the past decade but has stalled in the past 2 years.

FIGURE 2.1 EUROPE RESIDENTIAL BESS ANNUAL MARKET 2013-2019

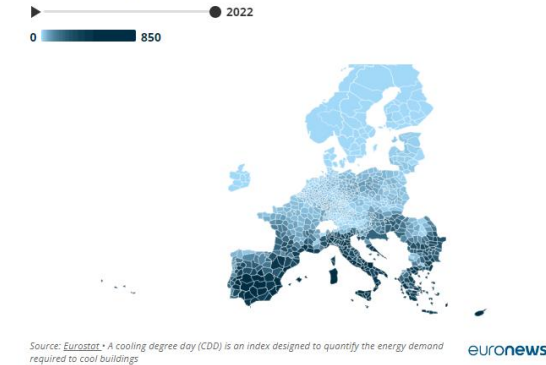


14 | SolarPower Europe / EUROPEAN MARKET OUTLOOK FOR RESIDENTIAL BATTERY STORAGE 2020-2024

- Domestic battery installations continue to accelerate but need a step change to provide enough storage to support increased renewables.

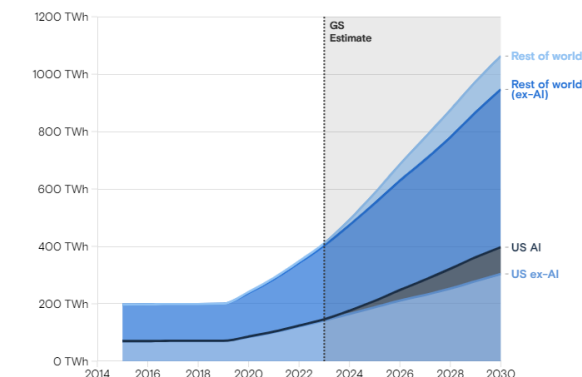
AC and Data Centers will have a key role to play

The need for cooling buildings in Europe has increased by a factor of 4 between 1979 and 2022



- Climate change is driving much higher peak temperatures and increasing demand for AC in both offices and homes – which could be an asset for balancing the grid

Data center power demand



Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Research

Goldman Sachs

- According to Goldman Sachs IT Energy use will increase from 1-2% of global energy today to 3-4% by 2030. The ability to shift compute timing can help to balance the grid.



THE CIRCULAR ECONOMY NEEDS ACCELERATION IN ENERGY, ALBEIT SOME GOOD EXAMPLES

Battery Passport

- EU Digital Product Passport (DPP)
- Provides a digital record of products throughout lifecycle.
- In **2026**, **batteries** will be the first product category to be **legally required to comply with DPP**

Material Re-use Obligations

- Europe will require new batteries to contain at least **6% recycled lithium** and nickel by **2031**
- the U.S. state of New Jersey made it **illegal** to discard **EV batteries in landfills**

Lithium Recycling

- 90% of Lithium available to recycling is recycled today – mainly laptop and phone batteries
- EVs are being design for recycling to minimize waste

PV Recycling

- International Energy Agency says **70%** of the photovoltaic sector's **silver needs** could be covered by recycling,
- The coverage rate being 20% for silicon and copper.

Windmil Recycling

- Recycling the carbon fibre contained in windmill blades and reusing it in other equipment.

Nuclear Life Extension

- If safety allows, extending nuclear plants lifetime to 80 years or beyond
- Most US plants have put in for regulatory approval for extension

7.2% of used materials are cycled back into the world's economy after use

If current trends were to continue, we would need three planets by 2050

03

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



CORRELATIONS BETWEEN GDP, ENERGY CONSUMPTION AND EMISSIONS (GLOBAL)



	2022	2023	2024 est.
GDP evolution	+3.5%	+3.2%	+3.2%
Primary Energy Consumption	+1.8%	+2.1%	+2.8%
CO2 emissions	+1.3%	+2.1%	+2.5%
Energy Intensity Improvement	+2.0%	+1.3%	+1%

Source: IMF,, Energy institutre,

ENERGY INTENSITY PROGRESS ARE SIGNIFICANT IN EUROPE, IMPROVING IN THE US, NOT SIGNIFICANT IN APAC AND OTHER GEOGRAPHIES

	2022	2023
World	+2.0%	+1.3%
Europe	+8.0%	+4.8%
North America	-0.3%	+4.0%
APAC	+1.5%	+0.0%

Source: IMF,, Energy institutre,

WEMO 2024



Energy Intensity = relationship between GDP and Primary Energy Use.

Europe meets the economy – energy intensity decoupling targets, thanks to:

- Obligations and actions leveraging technologies progress
- Costumers’ consciousness and participation
- Prices of energy

How developing countries can progress?

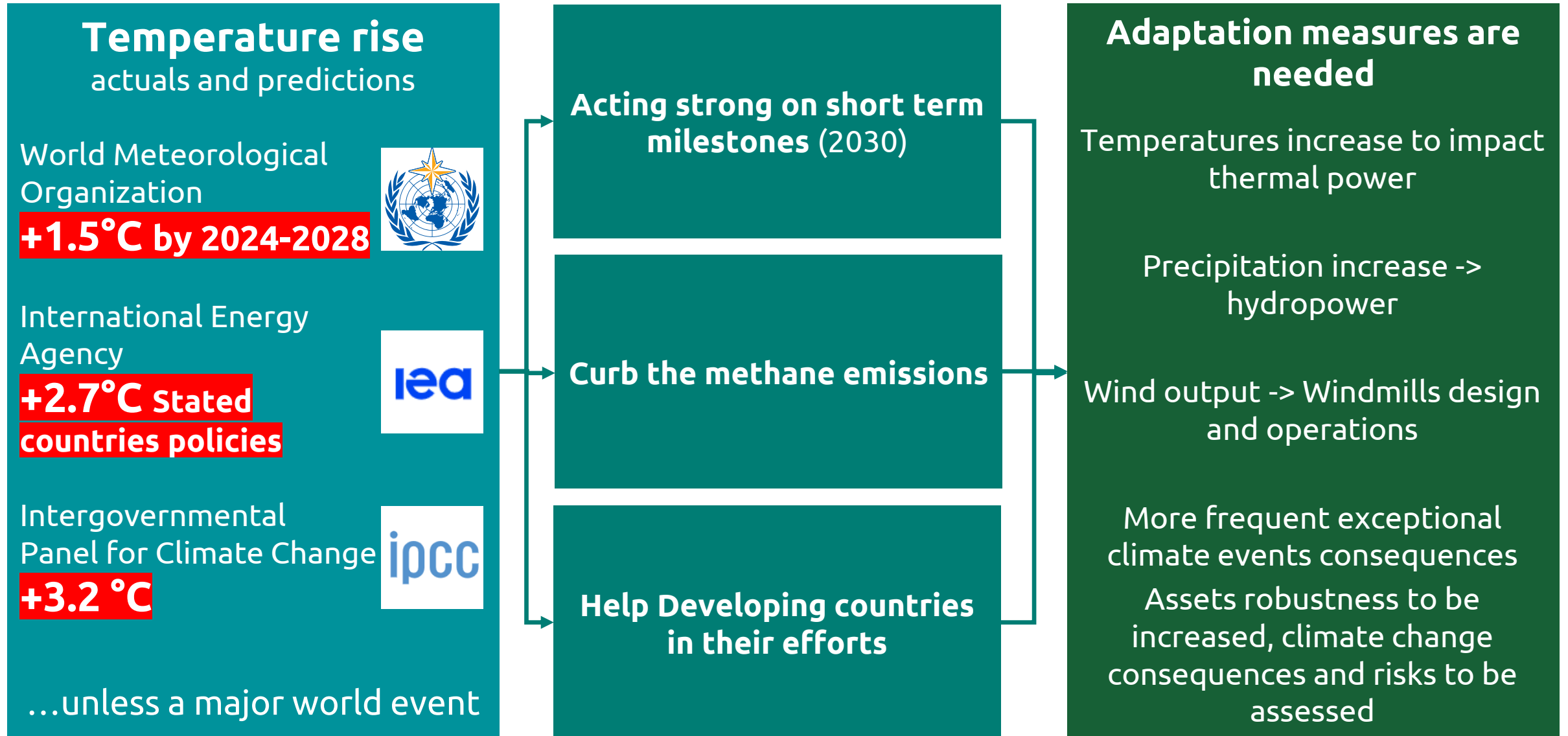
PATHWAY TO NET ZERO IS INSUFFICIENT ON ALMOST ALL DIMENSIONS

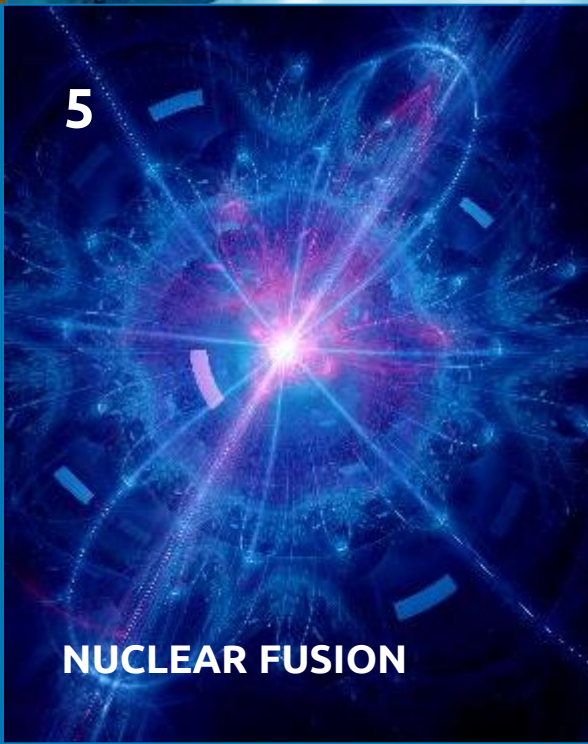
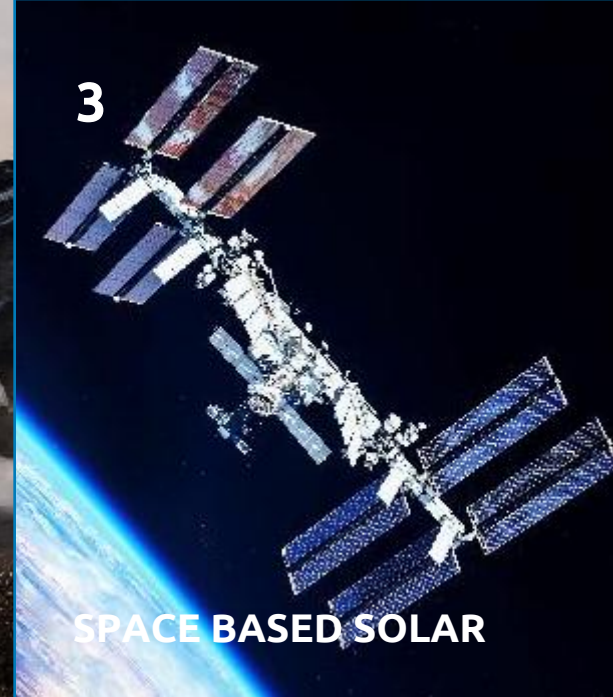


Deployment progress to be made by technology – main levers

Technologies	Today (Fleet/ Production) 2023 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 production 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	600 GWh stationary	6,000 GWh stationary 10,000 GWh pumped	
Electric transportation 	40 M (Fleet) 14 M (2023 sales +35% YoY)	360 M (Fleet)	2 180 M (Fleet)	
Heat pumps 	200 M units (fleet) + 18 M pa / +11% YoY (Growth)	450 M (Fleet)	800 M (Fleet)	
CCUS 	0,4 GT capture / y (production)	1.7 GT / y	3.3 GT / y	
Energy intensity progress 	1.3% / y (growth)	3.3% / y	2.8% / y	

WE ARE ON THE ROAD TO AT LEAST 2.7°C TEMPERATURE RISE BY 2100







BY 2040 DISRUPTIVE TECHNOLOGIES COULD BE DEPLOYED AT SCALE

Superconducting Wires



Superconducting wires when cooled at very low temperature (critical temperature) allow electricity transportation with no losses, **thus 7% gain in consumption.** In 1986, discovery of a superconducting material, at much higher critical temperature. Since then, many new high-temperature superconducting materials have been discovered. Presently superconducting wires need to be cooled at -200°C (liquid nitrogen temperature). However, for 15 years there is little scientific progress.

Are we witnessing a pause or a limitation by nature?

Space based solar power



Sunlight is **ten times** more intense at the top of the atmosphere than at the surface of the Earth. At a high orbit, **sunlight would be available on a continuous basis.**

This would lift fundamental limitations that solar panels have on Earth.

Many challenges remain:

- technical: how to get the space produced energy back on earth
- costs of launching solar panels into space



BY 2040 DISRUPTIVE TECHNOLOGIES COULD BE DEPLOYED AT SCALE

White Hydrogen



White hydrogen is found in the earth's subsurface.

White hydrogen deposits discovered on every continent, but scientists don't understand where to look for them.

The projected cost of white hydrogen (€0.5/kg to €1/kg), is competitive with grey hydrogen.

Helium is often a co-product which increases natural hydrogen deposits profitability.

Presently natural hydrogen extraction is not a reality, it could become one around 2030.

Advanced Modular Reactors



Generation IV International Forum selected 6 nuclear technologies to be developed with Small Modular concepts.

These technologies were born in the 80's in National Laboratories. Their designs include thermal and fast neutrons, closed and open fuel cycles.

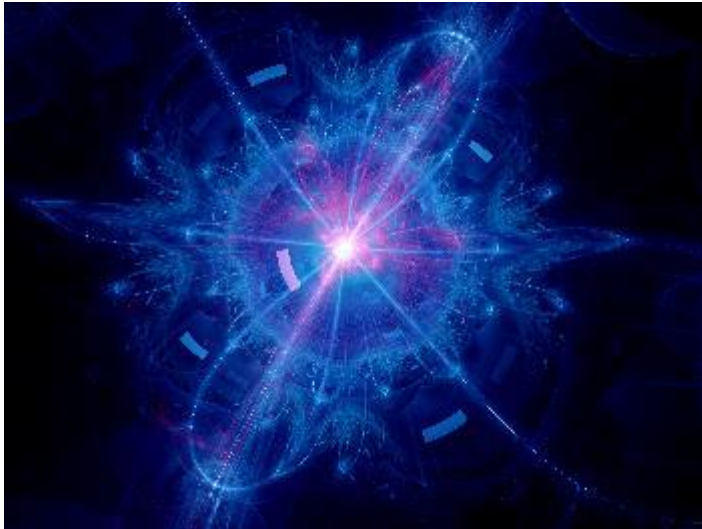
Many start-ups are involved bringing innovative ideas.

The first-Generation IV reactors deployed commercially by 2030-2040.

BY 2050 NUCLEAR FUSION REACTORS COULD BE INDUSTRIALLY DEPLOYED



Nuclear Fusion



Nuclear fusion is often considered as **the energy source of the future**.

2 plasma confinement: magnetic (tokamaks) and inertial (laser).

Most government-funded efforts on tokamaks, such as the international ITER project under construction. The huge project is undergoing a major setback: the start of deuterium-tritium first plasma is now planned for 2035, the start of operations at least for 2040!

After the **2022 breakthrough experiment** in the US: inertial confinement by **lasers** is viewed as more promising technology

Since 2022:

- many national programs have been launched.
- big increase in the number of private laser fusion companies.

Before commercial deployment can take pace there are big needs in Financial funding and technology developments

- ✓ on laser and photonics technology,
- ✓ deuterium-tritium targets manufacturing,
- ✓ large supply chain for lasers and photonics construction

AI NEEDS ENERGY AND ENERGY NEEDS AI. INVESTMENT IN AI REQUIRED TO REDUCE DATA CENTRE CONSUMPTION GROWTH.



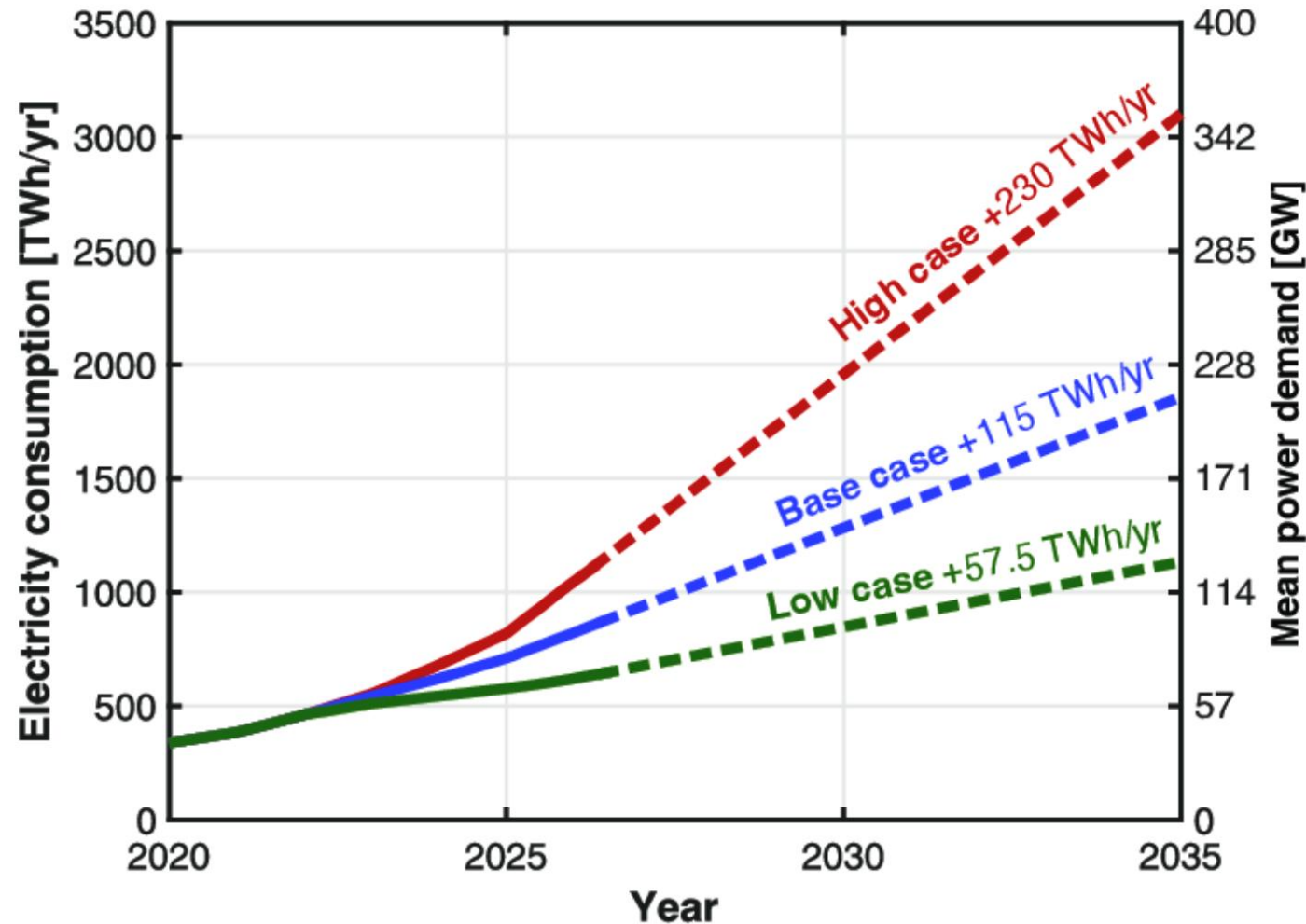
Data centers currently account for 2% of electricity consumption and it's expected to double in 4 years.

LLMs are a big energy user and need to be tailored to reduce consumption (e.g Deep Seek). Rapidly advancing hardware also has a big role in reducing demand.

Decentralization of compute power is poised reduce impact on the grid.

AI can have huge impact in reducing energy usage but needs more investment

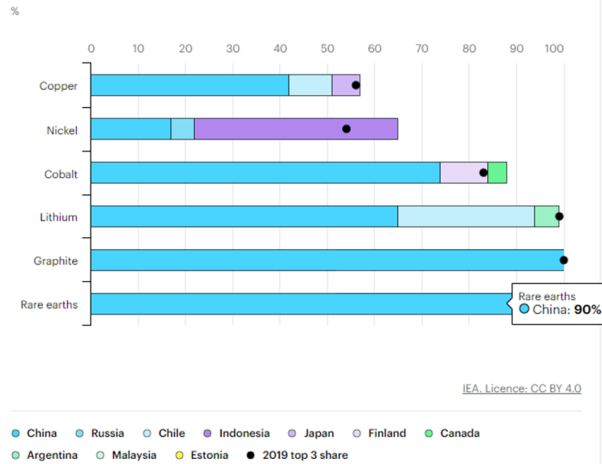
- Optimizing usage in data centers
- Optimizing waste heat
- Optimizing large loads on the grid, eg EVs



CHINA'S DOMINANCE IN LOW-CARBON TECHNOLOGY IS SO SIGNIFICANT THAT THE WORLD RELIES ON CHINA FOR THE ENERGY TRANSITION. GOOD OR BAD THING?

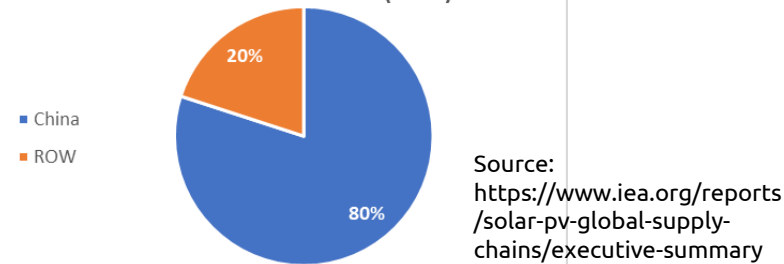


Rare earth and metals: Up to 90%



China vs Rest of the World (ROW)

Solar panels: 80%

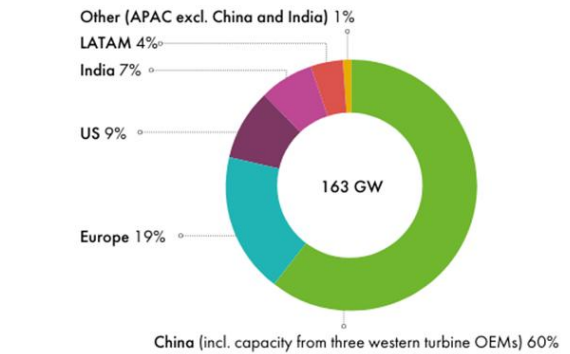


Region	Solar Panel Production Cost (USD/Watt)
China	0,15
USA	0,24
Europe	0,23

Source: <https://www.asiafinancial.com/china-solar-panel-costs-plunge-in-2023-60-cheaper-than-us>

Global wind turbine manufacturing capacity in 2023

Windmills: 60%



Note: Wind turbine manufacturing capacity refers to wind turbine nacelle assembly capability and doesn't represent actual nacelle production in 2023.

Source: GWEC Market Intelligence, February 2023

Global windturbines manufacturing capacity in 2023

Nuclear 3rd generation reactors

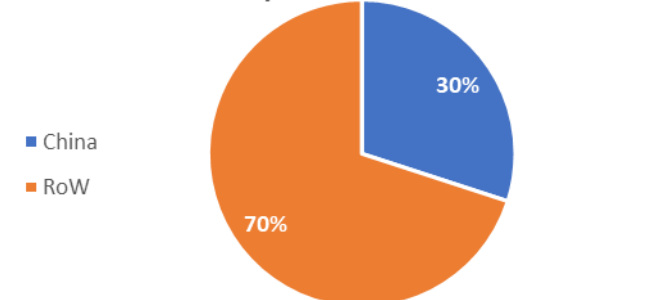
Country	Units	Status	Chinese tech?
China	2 (Taishan 1 and 2)	Operational	Yes
France	1 (Flamanville 3)	Under Construction	No
Finland	1 (Olkiluoto 3)	Operational	No
UK	1 (Sizewell C)	Planned	No
UK	1 (Hinkley Point C)	Under Construction	No

3rd generation technology (EPR, AP1000) came from France and US. Now China is building its 3rd generation reactor (Hualong).

It currently has the second-largest nuclear fleet(after the U.S. and ahead of France) and is on track to become soon the largest.

Green hydrogen: 30%

Electrolysers. China vs ROW

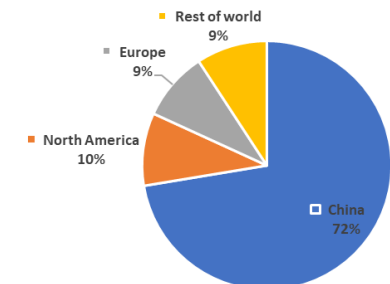


By the end of 2023, China's installed electrolyser capacity will reach 50% of worldwide capacity (1.2GW)

Gigafactories: 72%

Total	402
Under construction	238
Operational	164

World Gigafactories Sep 2023



Sources: https://source.benchmarkminerals.com/downloads/special-issues/1305958?mc_cid=b3fbca6cc2&mc_eid=fc872bf221

China's dominance makes technology cheaper in one hand and makes western countries dependant on the other hand

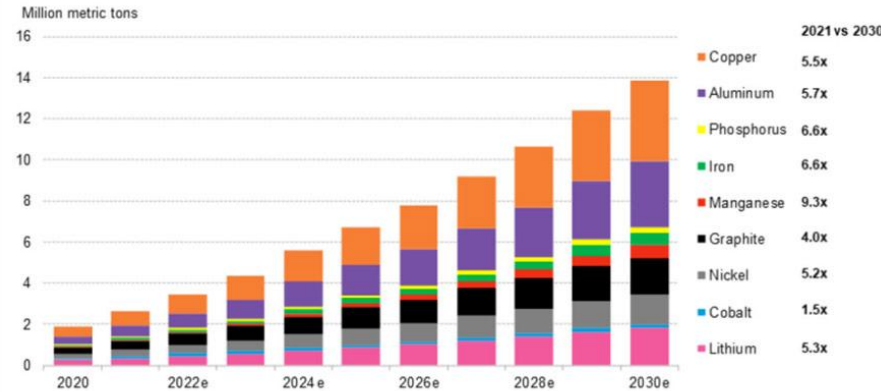


LI-ION BATTERIES ARE REQUESTING LARGE AMOUNT OF METALS

China has a dominant position in rare earth and rare metals supply

<https://aheadoftheherd.com/top-5-reasons-why-battery-metals-will-continue-to-boom/>

Figure 1: Metals demand from lithium-ion batteries



Source: BloombergNEF. Note: Metals demand occurs at mine mouth, one-year before battery demand. All metals expressed in metric tons of contained metal, except lithium, which is in lithium carbonate equivalent (LCE).

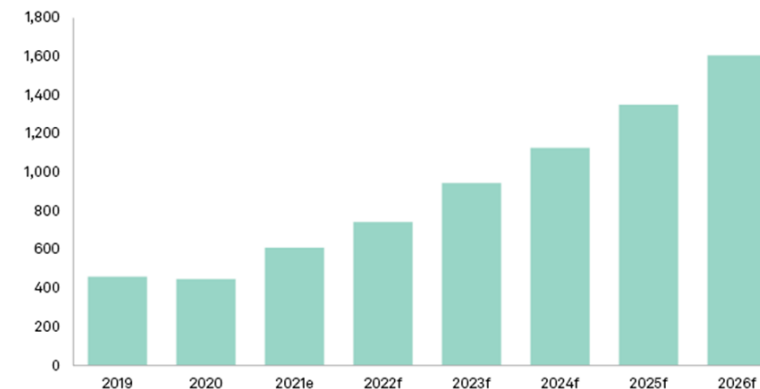
Metals and Lithium demand forecast

Lithium prices have fallen



<https://www.linkedin.com/pulse/decline-lithium-prices-due-slowng-electric-vehicle-demand-wang/>

<https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/iea-shrinks-lithium-demand-outlook-but-miners-will-still-struggle-to-keep-up-72734557>
Lithium raw material supply to more than double by 2026 (000 tonne LCE)

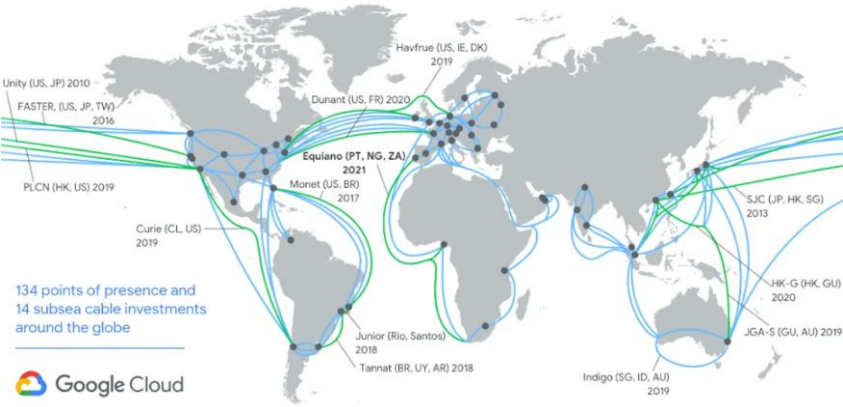


As of Oct. 24, 2022.
LCE = lithium carbonate equivalent; e = estimated; f = forecast.
Source: S&P Global Market Intelligence.
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- EV sales softening has triggered demand forecasts and prices decreases
- The new US administration wants to acquire foreign critical mineral resources (Ukraine, Greenland)
- Western C° are reacting to Chinese Lithium dominance
 - ✓ In Chili the government's plans a 70% lithium production increase by 2030.
 - ✓ French Eramet inaugurated a large Li plant in Argentina
 - ✓ New players are entering this market:
 - ❖ O&G Companies as Exxon-Mobil
 - ❖ Geothermal companies as Arverne Group

IN A CONNECTED WORLD, SANCTIONS ARE DIFFICULT TO ENFORCE

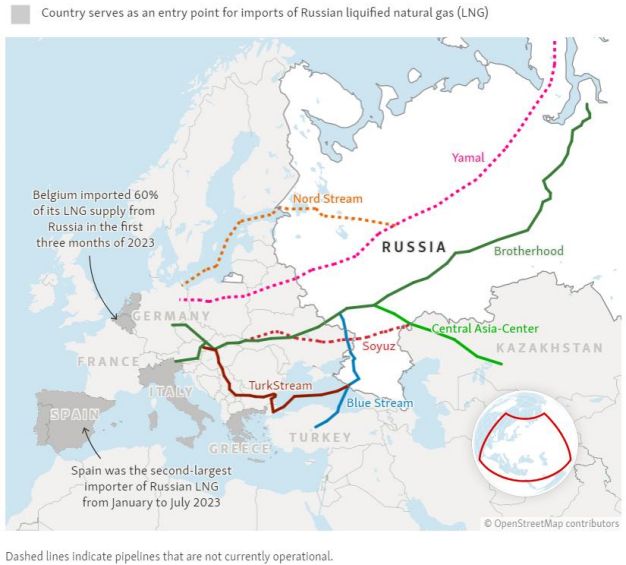
1.3 million kms of submarine cables
33 X the earth circumference



Global trade exchanges \$ 32 tn



Despite Ukraine invasion,
Russian gas transits through Ukraine



Indian solar panels (11% of US imports)
face scrutiny for possible links to China



- It is good that **sovereignty** is finally being considered in public policy.
- Let's not have illusions about the effectiveness of customs barriers and embargoes.
- Peaceful agreements** between countries are the best way of achieving the objectives of the energy transition, especially as pollution is global.
- However, the **present geopolitical tensions** should ease to make this possible.

04

Conclusions and recommendations





WEMO #26 KEY FINDINGS



Strong geopolitical tensions: increased defense budget endangering energy transition public spending.



Electricity and gas prices back to pre-crisis levels.



A record year for new renewable production : YoY new installed capacity increased by 57% with much more solar than wind.

A revival in nuclear plants projects



**Increased negative spot electricity prices frequency.
Increased grid balancing problems.**



Stationary batteries need a sound business model.

Hydrogen objectives are lagging, electrolysers encountering difficulties to load follow.



No progress on carbon markets coverage, ETS carbon price sharp decrease.



GHG emissions increased in 2024: **Not on track with Paris agreement objectives**, temperature projected increase : 2.5°C-3 °C by 2100 (instead of 1.5°C).

KEY RECOMMENDATIONS: NEW MARKET MECHANISMS



To replace present subsidies systems, adopt new market mechanisms allowing:

- Sound business development models for electricity storage systems (batteries, storable renewables)
- To maintain intermittent renewables profitability even at a lower level.
- To better finance new nuclear power which is low carbon & dispatchable
- To keep CCGT when needed for grid balancing
- A bankable business model for CCUS

Increase grid flexibility with increased storage, dispatch power and better use of data

Realistic hydrogen objectives and focus green hydrogen usages on hard to abate sectors

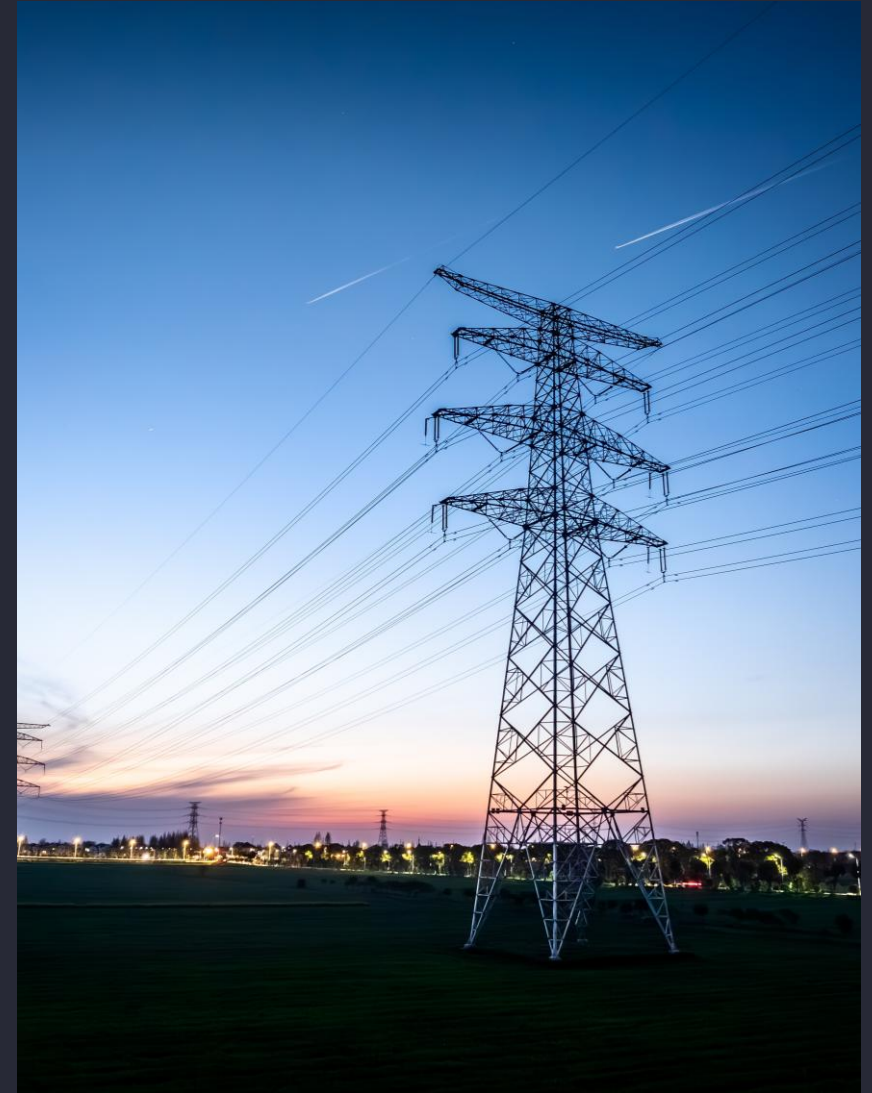




RECOMMENDATIONS: ACCELERATE ENERGY TRANSITION

We are not on the right net zero path. What to do?

- By 2030, deploy quicker existing technologies (Acceleration of wind, solar, heat and storage...), including AI, by:
 - ✓ More public and private funding
 - ✓ Appropriate and stable regulations & permitting
 - ✓ Consumer engagement and Demand Side Flexibility
 - ✓ Serious political commitments and policies
 - ✓ Preparing youngsters for future low carbon jobs
- Extending nuclear existing plants lifetime
- Stop methane emissions by 2030
- Final energy measurement, not primary energy
- While acknowledging the need to implement adaptation measures
- By 2040 deploy disruptive technologies prepared by appropriate R&D efforts



RECOMMENDATIONS: SOUND SOVEREIGNTY POLICIES



In 2023 and 24 China has increased its dominant position in the energy transition sector:

- In all clean technologies equipment
- In rare earth and rare metals needed for the energy transition

The new US administration energy policy

- A U-turn compared to previous administration.
- O&G (and probably nuclear) are encouraged.
- IRA repelled. Sustainable energies expansion is stopped. Tariffs imposed even towards friendly countries

Western countries are implementing sovereignty policies :

- Embargos and tariffs to prevent certain goods importation (Russian oil and coal, Chinese PV panels)
- Laws to encourage domestic production (NZIA)

However:

- We are in a global world and embargos are often circumvented
- Tariffs are increasing the costs for citizen and decreasing their willingness to accept energy transition.
- Peaceful agreements between countries would be the best way of achieving the energy transition goals
- **Is it possible?**





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Hogan Lovells has been established in Paris for over 30 years and now has over 180 lawyers, including 42 partners, working in all areas of business law. The law firm has also embarked on a strategy of specialisation by industrial sector, giving its lawyers in-depth knowledge of the sectors in which their clients operate.

Energy is a global strategic priority for Hogan Lovells. For this reason, the Paris office has strengthened its energy capabilities with the arrival in April 2024 of a new Energy Regulatory Law team to create the Energy Transition practice.

With leading experience in energy regulation, the team advises public and private companies operating in this sector, including integrated players in non-interconnected areas or in the regions, as well as the State and local authorities.

For more information about Hogan Lovells, the partners and their qualifications, see www.hoganlovells.com



vaasa ETT

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VaasaETT assists clients with market assessments and entry, Innovate retail development and M&A support, backed by a close eye on consumers, sustainability and profitable business models.

More information at: www.vaasaett.com



Enerdata

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Enerdata is an independent research company that specialises in the analysis and forecasting of energy and climate issues, at a variety of different geographic and business / sector levels. The company is headquartered in Grenoble, France, where it was founded in 1991, and has a subsidiary in Singapore.

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